Voula Mega

SUSTAINABLE DEVELOPMENT, ENERGY AND THE CITY

A CIVILISATION OF CONCEPTS AND ACTIONS

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A CIVILISATION OF VISIONS AND ACTIONS

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With gratitude
For all those who taught me
the greatness, integrity and beauty of our world

To all those who sow the seeds of civilisations and strive to extend the limits of the possible...

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ACRONYMS

ACRR: Association of Cities and Regions for Recycling
CEEC: Central and Eastern European Country
CEMR: Council of European Municipalities and Regions
CERES: Coalition of Environmentally Responsible Economies and Societies
CHP: Combined Heat and Power
COMEST: UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology
CSD: Commission on Sustainable Development
ECCP: European Climate Change Programme
ECMT: European Conference of Ministers of Transport
ECSC: European Coal and Steel Community
EEA: European Environment Agency
EEA / EFTA: European Economic Area / European Free Trade Association (Iceland, Liechtenstein, Norway, Switzerland)
EFDA: European Fusion Development Agreement
EFUS: European Forum for Urban Safety
EMAS: Eco-Management and Audit Scheme (The integration of energy efficiency in EMAS led to the E2MAS)
ESCT: European Sustainable Cities and Towns
EU: European Union
EU-15 European Union of 15 member States
EU-25 European Union of 25 member States (since 1.5.2004)
EURATOM: European Atomic Energy Community
EUREC: European Renewable Energy Centres
EWEA: European Wind Energy Association
FMCU-UTO: World Federation of United Cities
GDP: Gross Domestic Product
GEF: Global Environmental Facility
GHG: Greenhouse Gases (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O))
HIV/AIDS: Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
IAEA: International Atomic Energy Agency
ICLEI: International Council for Local Environmental Initiatives
IEA: International Energy Agency
IFHP: International Federation of Housing and Planning
IPCC: Intergovernmental Panel on Climate Change
ISOCARP: International Association for City and Regional Planners
ITER: International Thermonuclear Experimental Reactor

IPCC: Intergovernmental Panel on Climate Change
ISOCARP: International Association for City and Regional Planners
ITER: International Thermonuclear Experimental Reactor
JET: Joint European Torus
NGO: Non-Governmental Organisation
OECD: Organisation for Economic Co-operation and Development
OPEC: Organization of the Petroleum Exporting Countries (Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela)
RES: Renewable Energy Systems
RES-E: Electricity from Renewable Energy Sources
SME: Small and Medium-sized Enterprise
UNCED: UN Conference on Environment and Development (Rio de Janeiro, 1992)
UNDP: UN Development Programme
UNECE: UN Economic Commission for Europe
UNEP: UN Environmental Programme
UNESCO: UN Educational, Scientific and Cultural Organisation
UNFCCC: UN Framework Convention on Climate Change
UNPF: UN Population Fund
WBCSD: World Business Council for Sustainable Development
WHO: World Health Organisation
WMO: World Meteorological Organisation
WSSD: World Summit on Sustainable Development
WTO: World Trade Organisation

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PREFACE

By Professor Sir Peter Hall

It is a huge pleasure to be invited to contribute a preface to Voula Mega's remarkable new book. Many millions of words must have been written on the subject of sustainable development since its coinage in the historic Brundtland report of 1987, but very few of them address the theme of sustainable urban development so directly and so centrally as this work.

For the first time, the interested reader – whether beginning student or mature specialist – will find, within one set of covers, the essence of the challenge that faces urban professionals worldwide, and the essential knowledge needed to confront it.

Of particular merit is the fact that, drawing on her unusually wide experience in different professional agencies, Voula Mega has produced a book full of vital scientific and technical data, but has done so in a way that makes it immediately accessible to the non-scientist. But she goes with equal authority into the economic and social spheres, and then into specific physical planning actions with case studies taken from cities worldwide.

This book will instantly become a standard text – surely the standard text on the subject. But it deserves to be read by a much wider audience of concerned citizens in cities the world over. It is a brilliant achievement.

Professor Sir Peter Hall
Bartlett Professor of Planning
University College London

INTRODUCTION

SUSTAINABLE DEVELOPMENT, ENERGY AND THE CITY: THE ESSENCE OF A CIVILISATION

Since the beginnings of time, cities and energy are linked to the rise and fall of civilisations. Nurtured with Promethean visions, they always offered the foundations for new worlds and eras. At the dawn of the civilisation of sustainability, they are on the forefront of visions and actions. They have crucial links with the creation of a healthy environment, social cohesion and economic development, in harmonious co-evolution and through processes of democratic participation. Old models are being rejected and innovations open up the range of opportunities. Technological progress is essential, but institutional change and socio-economic innovation are equally crucial to meet the challenges of a prosperous, healthy and rewarding future.

The active participation of informed and aware citizens is a condition for advancing towards sustainable development. The main aim of this publication is to provide the unspecialized decision-makers and interested citizens, but also experts and leaders of the future, with significant information and insight in a nutshell about the civilisation of sustainability and the role of energy (flows, technologies and dynamics) and cities (spaces, economies, societies and cultures). Policy choices and investments of the next years will be most decisive. The cost of inaction, technological dependencies and unsustainable cultural patterns may be unbearable.

Defined as a call for inter- and intra-generation equity, an eternal spring with permanent efflorescence, or business's and communities' investment in the future, the concept of sustainable development evolved significantly from a strictly ecological concept into a journey towards an economically robust, socially equitable and environmentally sound future, promoted by active citizen participation. Sustainability largely extends traditional environmental policies. It widens the scope to cover socio-economic and cultural criteria and it demands new ethics, models and patterns. Dynamic integration and balance are key principles. Energy is crucially linked to all parts of the equation, while urban performances are critical for global progress.

Sustainability sheds light on the interrelated quantitative and qualitative aspects of development. Globalization projects communities and businesses onto the world; sustainability projects them onto the future. The road towards sustainable development could be construed as an Odyssey towards Ithaca. The ultimate goal is not only the destination but also the wisdom gained during the struggle against the Sirens of environmental deterioration and over-consumption.

The trajectory towards sustainable development asks for new policy approaches, including optimal portfolios of regulation and enforcement, economic instruments, voluntary measures, information and awareness raising. Diagnosis of the market and government failures, resulting in unsustainable patterns and hindering progress, should be followed by a prognosis of the adequate measures and their implementation. Alliances can bring together stockholders, stakeholders, shareholders and citizens and play a critical role in the implementation of sustainable policies.

Energy, the very fuel of all human activities, is synonymous to life and vitality. It is ubiquitous and concerns everybody, everywhere. It supports all socio-economic progress and has profound links with the environment. Its generation and use involve the irreversible use of precious natural endowments or the costly harnessing of inexhaustible renewable assets. Global warming, prominent issue in geopolitical strategic agendas, is mainly due to energy production and consumption. It is also the end result of decisions taken everyday in local environments.

Energy is a precondition and a catalyst of development. Two billion world citizens still have no access to modern electricity services. During the

20th century, the number of people on earth increased four-fold, while energy consumption was multiplied by sixteen. The degree of electrification has always served as an indicator of development. Fundamental unsustainable divides can be crystallized by the ratio of annual electricity consumption per capita in the least developed and developed world: 100 kWh versus 10,000 kWh.

In 2004, the first oil price crisis of the millennium is particularly worrying and can cast a shadow on the global economic landscape. Over a three year period, sustained high oil prices could reduce world economic growth by 1 percentage point.

The UN Conference on Environment and Development in Rio de Janeiro in 1992 was instrumental in mapping out opportunities for sustainable development. Ten years later, the Johannesburg World Summit on Sustainable Development highlighted the urgency for more sustainable urban patterns and for a substantial increase of the share of renewable energy in the total energy supply. Progress will largely depend on the rationalization of consumption patterns, particularly transport, often impinging on deeply held cultural values. Policies and actions, targeted at changing citizen behaviour, should also address the socio-economic and political context within which consumption decisions are shaped. Long-lived investments in energy and transport infrastructures, industry, and urban and regional planning, may lock individual and collective action into unsustainable patterns.

Eighty per cent of EU citizens live in cities, which consume seventy five per cent of final energy demand. "Habitat II", the last UN Summit of the 20th century, highlighted the opportunities and threats and the strengths and weaknesses of urban agglomerations in advancing towards sustainable development. Cities are complex and dynamic ecosystems that underpin socio-economic activity and cultural efflorescence. They mobilize large flows of people, raw materials, energy, products, waste and emissions, and have enormous ecological footprints.

Sustainability asks for urban metabolisms, which are the processes that lead from inputs of materials, energy and labour to flows of products and services, to become circular rather than linear and offer the optimal value with the least impact on the environment. Eco-efficiency, eco-design and eco-auditing are most important for businesses and local authorities

wishing to offer better, efficient, effective, citizen and environment friendly, products and services.

Environmental deterioration and social exclusion go hand in hand in many cities. Urban arteries often get blocked by traffic, pollution and waste. This may result in urban thrombosis and asphyxia. Sustainable regeneration and urban renaissance are major objectives for cities wishing to enhance their energy flows and quality of life. Cities are the only places where people and resources congregate at a point beyond which synergetic effects become more important than the simply additive ones. They also constitute laboratories of the future, places where most innovations are introduced and where cultural patterns are shaped. Last but not least, cities have always promoted open democracies. Citizen participation is the common denominator of all paradigm shifts introducing the civilization of sustainability.

The Johannesburg World Summit on Sustainable Development agreed on a comprehensive agenda to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound services and resources. Renewable energy flows are very large in comparison with commercial energy demand. Technologies to realise the potential of renewable energy flows exist to a large extent. Renewable technologies could be competitive with the conventional ones if the full costs and benefits of all energy options are taken into account. Government frameworks should help level the playing field and create a more favourable climate for the integration of renewable options in planning processes. The next decades will be critical, since more developed countries have to replace their ageing systems and developing countries get access to modern energy services.

Agenda 21, the Rio blueprint of action for the twenty first century, provided an international benchmark for urban performance. The preparation of local agendas for the twenty first century created a global momentum for the analysis and the enhancement of the urban environment. Energy is highlighted as an influential parameter for advancing towards the resourceful sustainable city. The Charter of European Sustainable Cities describes sustainability as a creative, balance-seeking process, extending into all areas of local decision-making. To succeed a sustainable city has to achieve a dynamic balance among economic, environmental and socio-cultural development goals, underpinned by an active citizen participation.

Knowledge embedded in products and services drives growth and employment and may be beneficial for the environment. Cities have to develop and adopt cleaner energy technologies and resource-saving innovations. They have to promote low-emission standards, to improve resource (and waste) management cycles and enhance the role of new and renewable energy technologies. Investments in research and technology have to be coupled with structural changes including restructure of public expenditure, fiscal incentives, guarantee schemes and public support for risk capital. Moreover, the knowledge-based eco-city not only requires advanced environmental technologies, but also education and change in behaviour and lifestyles. Technical and social innovation can reinforce each other and extend dramatically the limits of the possible.

At the beginning of the millennium, cities and the energy field are on the verge of dramatic changes. Urban and energy systems are capital intensive and have long lives. Immediate change is difficult and innovation is crucial for inefficient patterns to be transformed into more intelligent systems. Strongly entrenched ideas start to vacillate and new investments challenge the inertia of old infrastructures. New concepts, values and technological breakthroughs emerge, linked to policy and market initiatives, public expectations and scientific developments. A great proliferation of events and conferences, dissemination of the best practices and declarations of principles are characteristic of ground-breaking epochs.

In the European Union, energy and urban policy issues are at the crossroads of key economic, social and environmental policies, interests and concerns. Two of the three treaties establishing the European Communities (the European Coal and Steel Community and the European Atomic Energy Community) are about energy. The Strategy for Sustainable Development, launched in 2001, considers sustainable development to be a long term global objective grounded on common values and aspirations shared by the member States. The strategy completes and builds on the Lisbon strategy for the EU to become the most competitive and dynamic knowledge-based economy of the world, capable of sustainable economic growth with more and better jobs and greater social cohesion. Agriculture, fisheries, transport, energy and cohesion are instrumental EU policy areas.

The EU strategy asks for the integration of principles of sustainability in all policies and suggests an array of enriched and strengthened policy instruments, to engage decisively on the trajectory

towards sustainable development. The enlightening debate on urban sustainability promoted by the European Commission created new prospects for concerted action by European cities. The high dependence of the European Union on both fossil fuels and imported energy products is considered to be a prominent problem highlighting the urgency for EU research and policy agendas to promote the realisation of the enormous potential of renewable energy resources and invest in cleaner technologies. The Kyoto commitments are a powerful driving force. The entry into force of the protocol on 16 February 2005 is expected to inaugurate a new era of international cooperation for sustainable development.

This publication focuses on concepts and actions linked to cities and energy at the dawn of the civilisation of sustainability. It suggests that this civilisation cannot be the results of linear evolution and business as usual scenarios but of qualitative leaps and innovations. This often implies a radical shift to the creation of something new at the expense of something conventional.

Particular attention is being given to key European Union developments and innovations that can provide models and lessons for the world. This publication is based largely on research and studies managed by the author. It draws from articles published during the last ten years, after the author's experience with the related policies in the EU and the OECD. It embraces the broad horizon of issues and wishes to strike a balance among coverage and depth. It strongly advises to go further and deeper into each of the themes.

The first chapter examines the broad panorama of cities and the world demographic dynamics and focuses on European urban developments and the efforts of European cities to meet the challenges of sustainability. It highlights the importance of innovations and best practices for breaking new ground and the use of indicators as a yardstick of progress. The second chapter focuses on key elements of the urban environment and the principles and actions inaugurating new models and patterns. Eco-efficiency and improvement of the urban metabolism are crucial. Resource and waste management, energy and transport, quality of air, and contribution to climate change are of extreme importance to cities that become laboratories of ecological innovation and provide inspiring examples.

The third chapter offers an insight into energy production and consumption models. It examines cleaner energy options and technologies, and renewable energy sources. It presents the contribution of nuclear energy and the ethical questions linked to access and use of energy. The new member States of the European Union and the developing countries have to meet particular challenges. The fourth chapter addresses the issues of energy policy, security and markets, mainly in the EU. It concludes with the specific problems of renewable energies trying to penetrate the market and the actions devised to overcome obstacles. The fifth chapter sheds light on the potential of all energy options, from the traditional fuels to nuclear fusion and renewable energy sources, which can form part of a less unsustainable energy future.

The sixth and seventh chapters shed light on the socio-economic vitality and the cultural energy of cities. Issues of competitiveness and employment, equity and social justice, living conditions and public health touch the very heart of cities and impact their potential for sustainability. Heritage and culture define urban identity. Citizens project their hopes and desires into the urban reality and legend. Public spaces can promote collective life and local democracy and bring added value to places. The final chapter examines paths to brighter urban futures. From strategic planning and sustainable regeneration, to citizenship and institutional and civic alliances, the horizon of instruments and initiatives is rich and instructive.

The postface offers information about the EU research agenda on Sustainable Development and the main axes of the current Framework Programme on Research and Technological Development on global change and ecosystems, sustainable energy and transport systems. The European and international selected literature and websites, included at the end of the book, should respond in a more complete way to specific questions in relation to the issues. Last but not least, a set of sustainability indicators in the annex aims at inspiring cities in search of significant yardsticks of progress.

This publication is illustrated with some of the best practices and exemplary cases. They constitute a kaleidoscope of innovations at the forefront of urban and energy developments. One should be reminded that there are no "accreditation systems of best practices" at the European or international level and this overview should be seen under the prism of

relativity, intrinsically linked to the very notion of innovation, born to be surpassed.

The power of example may be decisive in navigating forward. The panorama of innovative urban sites and energy projects which breed noble emulation and continuous surpassing can inspire and encourage leaders, experts, and citizens. From urban paradigm shifts to nuclear fusion, innovations demonstrate that the most inexhaustible resources are not only renewable assets, but also knowledge and innovation.

Sustainability means, first and foremost, sustain ability to innovate and progress. The end of the petrol era will certainly come before the world runs out of oil. The end of divided and deteriorated cities will unquestionably come before they drown in their problems. Everything depends on human ingenuity to reinvent the world. This is the true and pure power, in every sense of the word.

Chapter 1

CITIES IN THE CIVILISATION OF SUSTAINABILITY

This chapter examines the broad panorama of cities and the world demographic dynamics and focuses on European urban developments and the efforts of European cities to meet the challenge of sustainability. It highlights the importance of innovations and best practices for the civilisation of sustainability and the use of indicators as a yardstick of progress.

1. WORLD CITIES AND DEMOGRAPHIC DYNAMICS

At the dawn of the third millennium (also called the "urban" millennium), humanity stands at a very important crossroads. For the first time in history, urban dwellers are about to outnumber the rural ones. The global urban population, estimated at three billion in 2003, is projected to exceed the 50% mark by 2007 and to reach five billion in 2030, the year in which more than three fifths of the world population are expected to live in urban areas. Almost all of this growth is expected to be absorbed by the urban areas of the less developed world. Beyond the simple demographic growth, urbanization is a prime cultural process and a key issue for sustainable development. Cities embody the values of the civilisations which created and transformed them (UN/HABITAT 2002, UN 2004a).

Everywhere in the world, cities are human nests, places of social interplay, confrontation and dialectics. They are theatres of civilization, schools of abilities and values, and temples of learning about life in society, citizen duties, and rights. They have been defined as places in which the human genius is expressed, a palette of possibilities, a melting pot of potential that has not yet been exploited. Alcaeus (7th century BC) suggested that "cities are not made from their roofs, stone walls, bridges and canals but from men able to grasp opportunities and make the most of them." According to Aristotle (4th century BC), the city is "built politics." Vitruvius (1st century BC) stated that "cities should be solid, beautiful and useful", built with order, eurhythmy, symmetry, propriety and economy.

Cities are both living organisms (ecopolises) and technical contrivances (technopolises). C. Levi-Strauss defined the city as nature and culture, individual and societal, a space of injected life and invested dreams. He called it the "human invention par excellence." L. Mumford spoke about the city as "the form and symbol of an integrated social relationship", and stated that "the test of a great city is the life it makes possible for its citizens." J. Jacobs defines cities as places that generate, in an ongoing way, their economic growth from their own resources and from the "disordered order" of human interactions. For L. Borges, "The city is also the other street, the one we never take, it is the secret centre of blocks, the ultimate courtyards, it is what façades conceal, it is my enemy if I have one, it is the person who doesn't like my verses, it is what is lost and what will be, it is the ulterior, the different, the lateral, the quarter that is not yours, neither unique, the one we ignore and we love." R. Sennet suggested that "a city is made out of difference, diversity and anonymity; it represents the possibility of meeting the unknown." Last but not least, according to P. Geddes "a city is a dramatic action."

Cities are hives of human activity, the only places where people concentrate at a point beyond which the dynamic synergetic effects become more important than the merely accumulative ones. C. Doxiadis characterized a typical small village as 250 red dots and one blue dot. The blue dot served as a metaphor for the one notably different person (e.g. a wise, a saint or a fool) distinctive from the population symbolised by the red dots. As the size of settlement increases to that of a small town, four or five blue dots appear floating around. In a still larger town, two blue dots may actually meet for the first time and, as the scale grows, blue dots

may come together, reinforce each other and impact on the surrounding red dots. A city is, therefore, a matter of critical mass, which, once reached, has a self-engendering and fulfilling capacity (Doxiadis 1974, 1975a, b).

It seems that cities display the resilient, self-organising, dynamic balance of living organisms. Their growth evolves along cyclic lines that constitute the phenomenon of "urban transitions. Urban transitions depend on the geographical position of cities, the architecture of the national territories and the pace of economic growth. Urbanization is the first stage of the cycle, characterized by fastest growth in the city centre. The second phase is sub-urbanization, with fastest growth at the suburban ring. Next is counter-urbanization, characterized by a population decline, mainly in the urban core and often even in the surrounding suburbs. This phase is also called "rurbanization", when rural regions benefit from the loss of the urban population. Last but not least, re-urbanization indicates that the core grows again faster than the suburbs. Most developed cities are at the third or the fourth stage of the cycle. Some of them have even initiated a new cycle with migration waves towards regenerated city centres.

The world has been steadily urbanizing for centuries. Industrialised regions were always more urbanized than the less developed ones and had already reached the "urban age", half a century ago. The gap in urbanization levels increased between 1950 and 1975 and has narrowed since 1975 and it is expected to narrow further by 2020. Urban dwellers represented 50% of the total population in OECD regions in 1950, 70% in 1975 and 77% in 1995. Waves of intense urbanization have followed periods of economic growth in Northern Europe and subsequently in the United States, Japan, Australia and New Zealand.

In less developed regions, the urban population shares of the total populations were less than 20% in 1950, 27% in 1975 and 35% in 1995. Towards the end of the year 1970, the share of the urban population in the total population growth in the less developed regions exceeded for the first time the one in the developed regions. Since then, most urban growth has taken place in developing countries, fuelled by both rural-urban migration and natural population increase. The reclassification of some settlements as cities contributed significantly in increasing the urban share in many countries. If China or other populous nations modified the

administrative boundaries of cities, estimates of the world urban population would change considerably (UN 2002a).

The annual rate of urbanization in the developed regions has almost remained unchanged from 1980 to date at about 0.3% per year. It is expected to remain relatively unchanged in the near future and to be at the same levels in 2020. The rate of urbanization in the developing regions was four times higher in 1980, when it started a downward trend expected to continue in the future. As a result, the world rate of urbanization was 1% during the decade 1990-2000 and it is expected to reach 0.8% in 2020.

The urban growth rate has been declining since the late eighties in both the developed and less developed regions. In spite of this decrease, the average absolute annual increment is steadily becoming larger. Paralleling the shift of the demographic centre of gravity towards the less developed regions, 90% of the global urban increment comes from the less developed regions. Their contribution is expected to reach 97% in 2020. Within the range of less developed regions, the least developed countries have both a lower rate of urbanization and a faster urban growth.

Europe's share in the world urban population is decreasing. In 1950, about two thirds of the urban population in the developed regions resided in Europe. Urban population growth rates reached their peaks during the period 1960-1965 and declined thereafter. Urbanization rates are higher in Northern and Western Europe. The growth rate of the rural population was already negative in Europe in 1950. The rural population in Europe is expected to be less than half the 1950 levels by the year 2020.

The process of economic development is closely linked to the phenomenon of demographic transitions. The causal mechanisms of a demographic transition include economic growth, education, health care, rural - urban shifts, family structures and employment patterns, especially linked to female labour, and public policies. Forms and speed of transitions vary greatly, but the general movement presents some broad characteristics.

Previous to the industrial revolution, all countries experienced high birth rates and high death rates resulting in slow or no population

growth. In the era of industrialization, and as many world countries reached a high level of economic development, death rates fell drastically, due to breakthroughs in science, better social conditions and improved health and hygienic care. At the same time birth rates remained high (and increased after the wars), resulting in a very rapid population increase.

Since the early 1970s, a second transition has taken place in OECD countries, resulting from declining birth rates. As birth rates fall, the population stabilizes at a new higher level. This transition is now also taking place in many developing countries, but stabilization in the population could take decades, since these countries have very young populations and large number of females in the birth giving ages. Recently, the second demographic transition has resulted in ageing population in many countries. Population levels have more or less stabilized and the number of the elderly increases continuously. In some European countries, and in particular in the former republics of the Soviet Union, population levels are actually decreasing.

In 1999, the total world population reached 6 billion. It was 1 billion in 1804, 2 billion in 1927, 3 billion in 1960, 4 billion in 1974 and 5 billion in 1987. The UN Population Prospects indicate that, presently, the population growth rates fall faster, fertility declines are broader and deeper and migration flows larger than at the beginning of the last decade of the century. Eighty per cent (4.7 billion) of the world population live in less developed regions and 20% in the developed countries, which comprised 32% of the world population in 1950. Asia alone accounts for 61%, Africa 13%, Europe 12%, Latin America and the Caribbean 9%, and North America 5%.

The current population growth rate of approximately 1.3% per year is the lowest one since the Second World War, significantly less that the peak growth rate of 2.04% in 1960-70, less than the 1.72% rate of the following two decades and less than 1.42% between 1990 and 1995. Average annual population increments exhibited a time lag of about two decades. In fact, 1990 marks a historic reversal: the absolute population increments reached their highest of 87 million persons added every year and have been decreasing since then (UN 2002a).

During the years 1995-2000, the world population grew by 78 million per year. The world population continues to grow by 76 million

inhabitants per year. In 2050, the world will count 2.5 billion additional inhabitants.

The world average figures conceal large differences across countries and regions. During the period 1950-1998, the population of the less developed regions increased by 168% (1.8% per year), while the population of the developed countries increased only by 45% (0.4% per year). During the last decade, only 6% of the global annual increment originated in the developed regions, while 94% originated in the less developed regions. It is important also to highlight the increasing demographic weight of the 48 least developed countries, which account for 17% of the total world population growth. They experience higher fertility, higher mortality and higher population growth, almost a full percentage point greater than that of the other countries.

Europe is the only world region with a growth rate less than one per cent during the last twenty years. Population growth is still positive (0.03%), but natural increase starts to be negative in countries like Germany and Italy. Seventy five per cent of the population growth in the European Union is due to net migration gains. Central and Eastern Europe experience population decrease, due to out-migration, sharp fertility declines and rising or stagnant mortality.

The global average fertility level stands at 2.7 births per woman, almost half of the fertility rate of 5 births per woman in 1950. Birth rates are now declining in all regions of the world. Africa has the highest fertility rate of 5.1 births per woman. In practically all OECD countries, fertility is currently significantly below 2.1 births per women, which is the fertility rate necessary for the replacement of generations. The United States and Mexico exhibit currently the highest population growth in the developed world (1.99% and 2% respectively). In Spain, Czech Republic, Italy, Greece, Germany, Portugal and Hungary, Austria, Japan and Switzerland the fertility is under 1.5 births per woman. In the Nordic countries, in particular Sweden and Norway, fertility substantially increased in the late 1980s and the early 1990s and approached or even surpassed the replacement level, before declining again.

Fertility rates in less developed regions have always been about double than in the developed regions. The African level is estimated to be almost twice as high as that of other less developed regions. In the early 1980s, all the developed regions, except Eastern Europe, presented below

replacement fertility levels ranging from 1.6 births per woman in Western Europe to 1.8-1.9 births per woman in North America and Australia, while fertility in Eastern Europe was at replacement level. In the early 1990s, fertility rates had increased in North America and fell sharply in Eastern and Southern Europe. Within the European Union, after years of steady decline, the total fertility indicator reached the bottom of 1.42 births per woman in 1995 and an upturn has been observed since then (UN 2002a).

Mortality is continuing to decline and, globally, life expectancy at birth increased by more than 6 years over the last twenty years. The estimated life expectancy at birth in the developed regions (74.2 years) is more than 12 years higher than in the less developed regions, which is, in turn, more than 12 years higher than the one in the least developed regions (49.7 years). OECD regions exhibit an average life expectancy of above 75 years. Japan has the highest life expectancy in the world (79.5 years), followed by Iceland and Canada. Among the world regions, North America (76.7 years) and Australia (72.9 years) exhibit the highest life expectancy rates. At the other end, Africa presents the lowest average life expectancy at birth (51.8 years) and the highest infant mortality. In Africa, 50% of all deaths occur below the age of 10, while in Europe and North America death occurring below the age of 10 is under 2 per cent.

In most world regions, there are gender differentials in life expectancy, favouring women, by four years on average. They tend to increase when overall mortality levels decrease and they score highest in Europe. Central and Eastern Europe were the only regions where life expectancy declined slightly over the last 20 years. This decrease is mainly the result of an increase in deaths from cardiovascular diseases.

At the global scale, the acquired immune deficiency syndrome (AIDS) epidemic has been the main demographic plague at the turn of the century. In many countries, it led to a dramatic drop in life expectancy. Over 22 million people have already lost their lives and more than 42 million are currently living with HIV/AIDS. The United Nations and the World Health Organization revealed that the impact of HIV/AIDS is particularly devastating in Sub-Saharan Africa. During the last decade additional deaths due to the epidemic represented 90% of all additional deaths due to AIDS in the developing world. In the 38 hardest-hit African countries, the average life expectancy at birth is currently almost 10 years less than it would have been in the absence of AIDS. In Botswana one

out of three adults is infected and life expectancy at birth is anticipated to fall from 61 years during the period 1990-1995 to 40 by 2005.

In 2003, three million people died of AIDS and an estimated five million were newly infected with HIV, half of them between ages 15 and 24. Yet only one person in five at high risk of infection has access to proven prevention actions. The HIV/AIDS epidemic has erased decades of progress in improving living conditions and advancing towards sustainability (UN 2004b). Studies by the UN Population Fund (UNPFA) suggest that if 15% of the population are infected with HIV, the GDP will decrease by 1% per year (UNFPA 2004).

The world geopolitical order has often resulted in significant population movements. Since the mid-1980s, international migration has rapidly gained importance and has been highlighted as a component of population change. The world stock of international migrants increased from 75 million in 1965 to 119 million in 1990 and attained 175 million in 2000, one out of every thirty five world citizens. International migration presents a greater importance for the developed world, where it amounted to 4.1% of the population, while only 1.6 per cent for the rest of the world. Europe and North America presented the highest numbers of international migration, while Japan and Korea have experienced low immigration. In Europe, the greatest flow during 1985-1990 was associated to the waning Cold War, and since 1990, the major source of migrants has been the former Yugoslavia.

The United Nations regularly present three variants of population projections based on past trends and possible future developments regarding fertility, mortality and migration. Medium variant represents the most likely to happen, while the high and low variants delimit the array of probable developments. According to the medium-fertility variant projection, the annual population growth rate will continue declining, from 1.33% in 1995-2000 to 0.34% in 2045-2050 (Figure 1). The absolute annual increment is expected to gradually decline to 64 million in 2015-2020 and then sharply to 30 million in 2045-2050. All variant projections yield similar results with respect to the distribution of the world population. The shares of the Asian and Latin American populations as a proportion of the world population are relatively stable at approximately 60% and 10% respectively, while one per cent decrease per decade of the share of European and North American populations is

expected to compensate for the increase of the African population (UN 2004a).

The population of the developed regions of the world is expected to reach a peak of 1.6 billion in 2020, after which the population is expected to decline. Around 2028, there will be as many people in the currently least developed countries as in the developed ones. Until the year 2020 the highest growth rates will continue to be in Sub-Saharan Africa, Middle East and North Africa. This pattern will, however, continue to differ from the pattern of absolute increase in population. The largest increments are expected in South Asia, East Asia and Sub-Saharan Africa.

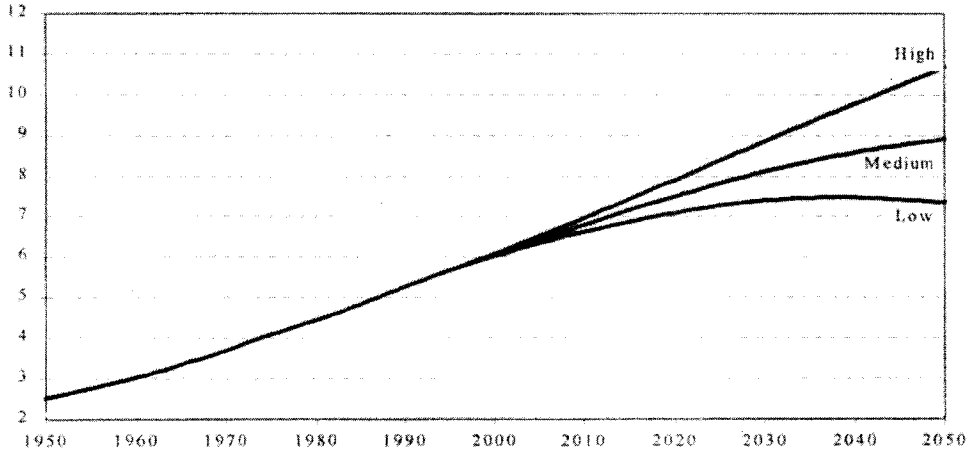

Figure 1. World population patterns and Outlook 2050. Source: UN

According to the World Bank, population momentum will be the most important contributor to population increase. Even if in many countries fertility rates have fallen below the replacement level, the population will continue to grow as large cohorts move through the reproductive ages, generating more births that are offset by death. Most OECD countries have population momentum between 1.0 and 1.6; however Japan, Finland and Germany seem to go towards population

decline. The main increase of the OECD population is expected to occur in the USA (Figure 2).

Population density in the developed countries lies below the median world population density and is now around 33 inhabitants per km^2. However, the average population density hides huge differences. The density patterns of Australia, followed by those of North America on one hand and the patterns of Japan and Korea on the other, occupy the two ends of the density spectrum. Europe occupies a broad central place, with Scandinavian density patterns overlapping with the ones of North American and the Dutch patterns ranging between those of Korea and Japan.

Population density is expected to remain relatively unchanged in the developed world, as the population stabilizes and national frontiers are well established. USA, Mexico, Australia and New Zealand will be the only regions to increase their population density. Europe has the densest network of cities in the world, with an average distance of 16 Km among urban areas, against 29 Km in Asia and 53 Km in North America.

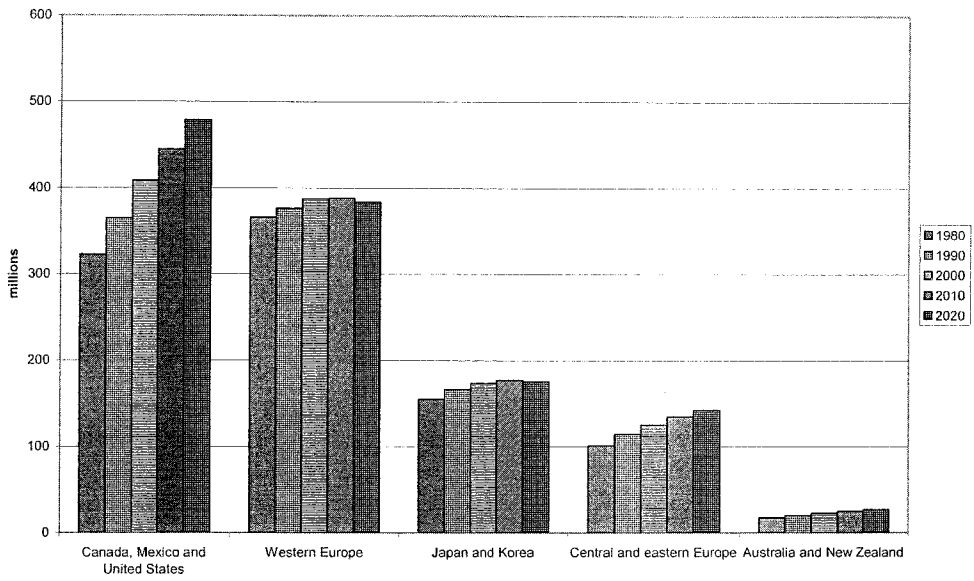

Figure 2. Estimated and projected population in OECD regions, 1980-2020. Source: UN

Age distribution highlights the rapid ageing of the world population. The ageing population gains ground because of a declining fertility rate and because of extending longevity. It is likely to continue growing in the next fifty years. The proportion of children under 15 years old is diminishing and the proportion of elderly aged 60 or over is increasing. The "older old" are becoming more numerous. Approximately one per cent of the world population is over 80 years old and in OECD countries, this percentage is as high as three per cent. The world median age increased from 23.5 years in 1950 to 26.1 years in 1998.

The industrialised world has been leading the process of population ageing since the beginning of the century. It is currently experiencing an unprecedented increase of the elderly people as a proportion of total population. The median age passed from 28.6 years in 1950 to 36.8 in 1998 and it is projected to exceed 40 by 2020. Most OECD countries will have more than 20% of their population over sixty by the year 2010. Over the next twenty five years around seventy million people will retire to be replaced by just five million new workers. This contrasts strongly with the past period where 45 million new pensioners were replaced in the workforce by 120 million "baby boomers" (Figure 3).

Europe is the world region experiencing the highest levels of ageing. Italy counts 60% more old persons than children. Greece, Japan, Spain and Germany have between 40% and 50% more older persons than children. According to the medium variant projections, this is expected to increase between 50% and 60% in 2020. The world age dependency (dependent population as proportion of working age population) is increasing and this has crucial implications with social security systems. The ratio retired/working population is expected to double in Europe by the middle of the century and reach 50 per cent.

Unbalanced age pyramids may have very important effects on the ability of societies to provide the labour force that is needed to produce the expected economic growth, enhance environmental quality and support sustainable development.

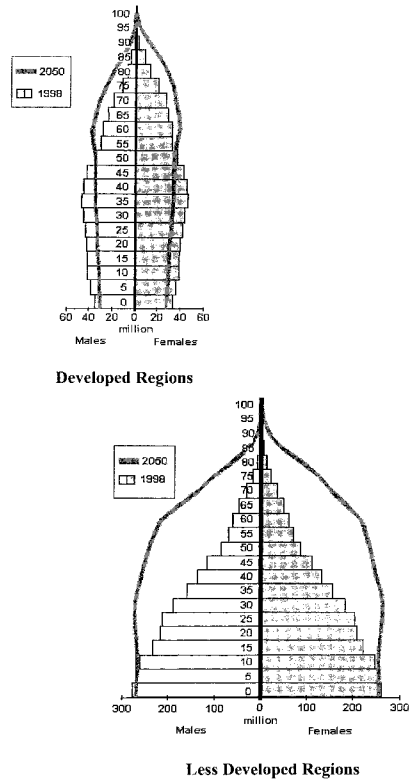

Figure 3. Age pyramids in the developed and developing world, 1950-2030. Source: UN

Since the waning years of the twentieth century, urban growth occurred almost exclusively in developing countries. This results in the urbanization of both poverty and environmental degradation to a greater extent than ever before. Most of the world's 2.8 billion people struggling to live with less than two dollars per day live in the cities of the developing world. Severe poverty, not just as lack of income but as a denial of opportunities, still affects one quarter of the world population. Poverty undermines progress in virtually every aspect of human behaviour. It may provide a breeding ground for discontent and anger and reduce the capacity for full enjoyment of benefits and opportunities. There is a growing consensus that eradication of poverty represents a major universal goal for the 21st century.

The UN Millennium Development Goals constitute a compact among nations to end human poverty. Human development is uneven and

it is one of the utmost importance to extend the wealth of possibilities to all world citizens. Ensuring environmental sustainability is one of the eight goals, together with universal primary education, gender equality and maternal health, fighting HIV/AIDS, malaria and other diseases, a global partnership for development and the eradication of extreme poverty and hunger.

Halving the proportion of people in extreme poverty by 2015 will require a dramatically accelerated pace of progress. The 2002 Monterrey consensus reminded the world that development is a mutual responsibility. It is the foundation of global stability. Globalisation should be fully inclusive and equitable (UN 2002b). The WTO Doha Development Agenda epitomises the integrated approach to globalisation in order to more effectively incorporate developing countries and sustainable development concerns in the international trading regime. According to the World Bank, concerted action is a sine qua non condition for the reduction of poverty (World Bank 2000). Cities have a key role to play since most of the world poor concentrate in giant developing metropolises.

The growth and multiplication of giant urban agglomerations, dominating the surrounding areas, marked the 20th century (Dogan et al 1988). They shelter an increasing proportion of the global urban population, even if more than half of the world's urban dwellers continue to live in small cities with less than 500,000 inhabitants. In 1950, there was only one urban agglomeration with more than ten million inhabitants in the world. There are now twenty four mega cities of that size. More than ten per cent of the world urban population is expected to live in mega-cities in 2020, almost all of which will be in developing countries (Figure 4).

Since 1970, Tokyo, with a population of thirty five million in 2003, is by far the most populous urban agglomeration of the world. It is projected that it will retain this position until 2015, when Bombay overtakes it in population. New York, which ranked first in 1950 and 1960, now occupies the third place, after Mexico City. It is closely followed by Seoul, Sao Paulo and Bombay (UN 2004a).

An increasing number of giant cities from the developing world, especially subject to demographic and social pressures, join every decade the list of the world largest agglomerations. The list of the fifteen largest

agglomerations includes six OECD cities (Tokyo, Mexico City, New York (Figure 5-7), Seoul, Los Angeles, and Osaka) and nine cities of the developing world. India is the only country with three urban agglomerations in this list (Bombay, Calcutta and Delhi). In contrast, European cities gradually disappear from the list of the most populated agglomerations. It is expected that, by 2020, nine out of ten mega-cities will be located in the less developed world and mainly in Asia.

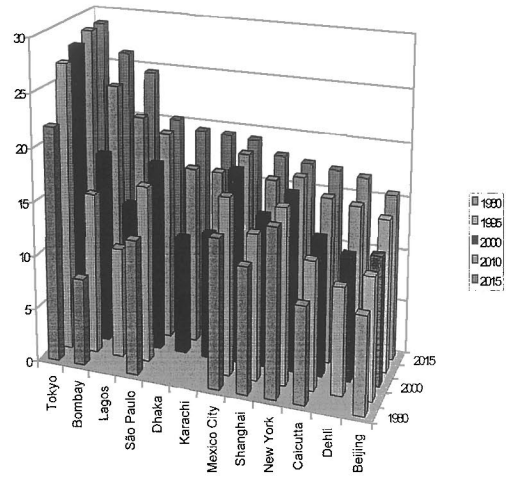

Figure 4. The world's largest urban agglomerations, 1998-2015. Source: UN

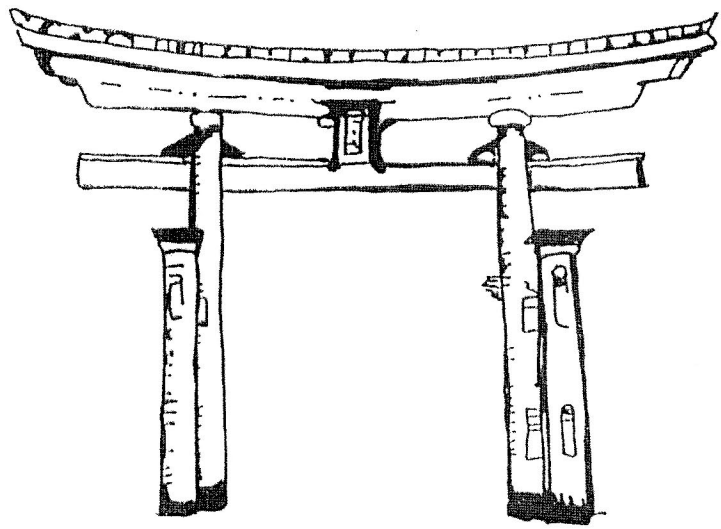

Figure 5. A symbol for Tokyo. Source: The author's exhibition of Artworks on Siren cities, European Parliament 2004

Figure 6. A Representation of Mexico City. Source: Idem

The expansion of some developing large cities has been explosive. Many mega-cities in the less developed regions exhibited a growth rate exceeding 4% per year in the period 1975-1995. Dhaka grew at a rate of 7.4%, Lagos at 5.7% and Karachi at 4.5%. If such a rate is sustained, the population of Dhaka would double in nine and a half years. In contrast, the mega-cities of the developed world experienced low annual growth rates during the same period, less than 1% for New York and Osaka and just over 1.5% for Los Angeles and Tokyo. Mexico City, together with the two Latin American mega-cities (Sao Paulo and Buenos Aires) and the two Chinese ones (Beijing and Shanghai) grew by less than 2% on average during the same period (UN 2002a). The giant cities phenomenon should not allow overshadowing the issue of smaller cities and towns, so important for social, economic and environmental development (UN 2001b).

Cities have always evolved as a result of their assets and the technology used to enhance them. The passage from the walled feudal city ("Arche-Città") to metropolises ("Cine-Città") and to metapolises ("Tele-Città") embodies the technological progress from agrarian to industrial and informational production. Energy developments are intrinsically linked with these transitions. L. Mumford classified the

evolution of technology into three phases: the eotechnical phase, marked by a shift in the energy source from man to animals and machines, the paleotechnical phase, based on coal and iron, and the neotechnical phase of the assembly line production. Twentieth century technologies primarily brought about a rationalization of the labour force. The oil and financial crises of the 1970s precipitated the pre-existing declining growth in traditional sectors in the late 1960s, and opened the way towards the reign of information technologies.

Figure 7. A Representation of New York. Source: Idem

The informational revolution gave rise to global, complex and interrelated developments. It impacted much on the time-space boundaries and the influence of cities. It gave a new significance to diptychs such as inside-outside, public-private, city-countryside or yesterday-tomorrow. Cities must harness the power of new technologies to explore their truly endless frontiers and optimize their concentration of knowledge and information. It is a holistic, multifaceted and synergistic process rather than a linear development.

The metropolises, "matrixes of civilization", are shaping the twenty first century. Metropolises are huge networks of infrastructures and social interactions and, at the same time, giant poles of global

networks. Their main concerns traditionally linked to infrastructures evolved towards the search of new models of metropolitan governance (Metropolis 1996, 1999). The problems of the metropolises were at the very heart of HABITAT II, considered as the summit of the megalopolises. Metropolises do not only dominate the world developments, but they also produce models and lifestyles, which are quickly disseminated to the rest of the planet. They not only impose themselves because of their sheer size, but also due to their powerful nature of interrelationships and interactions. The cumulative spiral leading to exclusion and environmental degradation is an obstacle to the development of metropolises.

Developing cities have inadequate infrastructures for water supply and sewage collection, disposal and treatment, and lack financial resources and governance structures that underpin development, democracy and political stability. In most mega-cities of the developing world, the supply of basic infrastructure falls far short of demand and health problems, mainly linked to water contamination, affect large parts of the burgeoning population. The willingness to pay for quality water is very high comparing to income and there is a clear potential to make progress with the proper institutional and financing mechanisms. For some European cities, health-related challenges can be encapsulated in the slogan "smoke-free cities" while many developing cities are still confronted with the challenge of securing the status of "malaria-free."

Demographic growth, social and economic development and environmental conditions are increasingly being seen as factors that are linked very closely together. The UN Conference on Environment and Development (UNCED, Rio de Janeiro, 1992) marked a breakthrough in the discussion of population and environment issues. Chapter 5 of Agenda 21, the key document from Rio to serve as a compass into the twenty first century, focuses on demographic dynamics and sustainability. The Population Summit (Cairo, 1994) and the Social Summit (Copenhagen, 1995) reflected the growing international awareness of the linkages and interrelation between urban growth, social and economic development, and the environmental and natural resources.

Population growth is exacerbating poverty and contributing along with unsustainable consumption patterns, to increased pressure on the global environment. Ten years after the Cairo Summit on Population and Development, where 179 countries adopted a landmark twenty years

Programme of Action, the UNFPA examined the progress made and the obstacles encountered at the halfway point in implementing the plan. A global survey indicated that developing countries have taken important steps to carry out the recommendations, but progress has been uneven. More than 350 million couples still lack access to a full range of family planning services and more than 500,000 women die every year from pregnancy-related complications. These deaths could be prevented by expanding access to attended delivery and emergency obstetric care. Almost all of the 151 developing countries surveyed have adopted laws or other measures to protect the rights of women and 131 have changed national policies, laws or institutions to recognize reproductive rights. Many countries have acted to integrate reproductive health services into primary health care, improve facilities and training, adopt national strategies on HIV/AIDS and address the reproductive health and rights of adolescents (UNFPA 2004).

HABITAT II, the last UN Summit of the twentieth century, preceded by the first World Assembly of Cities, offered governments and cities the opportunity to join visions and actions on all dimensions of urban sustainability (Figure 8). The HABITAT II Agenda focused on principles of equality, eradication of poverty, sustainable development, liveability and diversity, family, civic engagement and government responsibility, partnerships, solidarity and international co-operation and co-ordination. There were commitments to adequate shelter for all, sustainable human settlements, financing and progress evaluation. The Global Action Plan included provisions for adequate shelter for all, sustainable human settlements, capacity-building and institutional development, international co-operation, co-ordination, implementation and monitoring. Dissemination of the best practices and sustainability indicators were suggested as two important instruments for a qualitative leap forward (UN/HABITAT 1996; UN 1997). The World Summit on Sustainable Development (Johannesburg, 2002) provided a new impetus for a global deal to accelerate progress.

The preparation of Local Agendas 21 was the epitome of the concept "think globally, act locally." In reviewing ten years of Local Agendas 21, implemented by 6,400 local governments in one hundred and thirteen countries, at the Johannesburg summit, the Local Government Session provided the context for the launch of "Local Action 21." Following the Summit's theme of implementing the Agenda 21 agreements, Local Action 21 incites to move from Agenda to Action,

from plan to practice. In re-affirming the Rio principles, Local Action 21 becomes simultaneously a motto for accelerated implementation of sustainable development, a mandate given by the Summit to local authorities worldwide to engage in the implementation of local agendas and action plans and a movement of cities, towns and counties and their associations towards sustainability. The "Johannesburg call" issued by the South African Local Government Association, urged cities to be bold and unequivocal about changes and to develop very realistic and practical Action Plans.

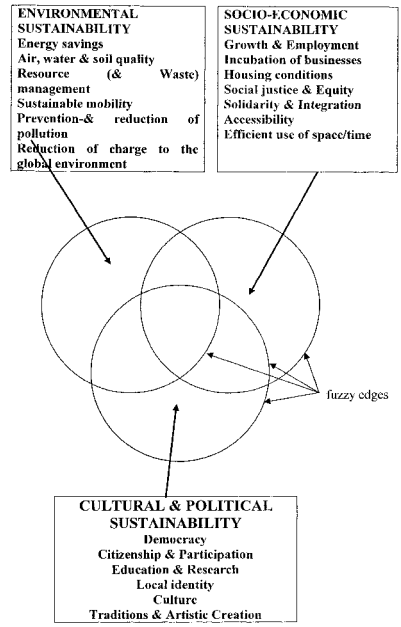

Figure 8. The Dimensions of Urban Sustainability

2. EUROPE, AN URBAN ARCHIPELAGO

Europe is first and foremost urban, an archipelago of three thousand five hundred agglomerations with more than ten thousand inhabitants, three hundred and sixty five agglomerations with one hundred thousand inhabitants and thirty two agglomerations with more than one million inhabitants. The constellation of European urban

systems appears more balanced in terms of demographic growth. The low rate of the population growth (less than 0.5% which is expected to reach zero levels about the year 2008) and the increase in the average age of the population are the main demographic trends in the European Union of the fifteen member States. However, the new member States have different urban patterns and new migration waves appear on the horizon. The contribution of international migration (0.3% of the total population) to population growth was 75% in 1995 (EC 1998a).

During the last decade, cities have emerged more strongly on the European scene, competed more among themselves but also demonstrated new models of collaboration. They establish brown, green and grey agendas to win the battle of sustainable development and to become more attractive to people and capital. Cities have become more ambivalent. There are cities that include but also exclude, that assemble but also divide, integrate but also disintegrate, enrich but also impoverish. The myriad of changes in their microcosm and macrocosm affect them in very different ways. Global economic forces and information superhighways create new conditions. The changes in family and social structures and the ageing of the population bring new problems and challenges (Rautsi 1993).

History played an important role in the development of European cities. Many of them have even mythological origins and are beacons of culture. Large cities no longer continue to grow. It seems that further growth would be synonymous to an unbearable burden of environmental problems and social shock waves. The key challenge is to increase economic competitiveness, but at the same time to reduce socio-political exclusion and environmental deterioration. Only London and probably Paris could claim the attribute "world city." Urban clusters, like the Randstadt, formed by Amsterdam, Rotterdam and The Hague in the Netherlands, develop in many European countries. Networking is a must for cities willing to build upon each other's experience. Last but not least, the united Europe is not a uniform Europe. The North-South and East-West divides are also sources of enriched dialectics. Europe has always prospered out of its magnificent diversity (Hall 1995, 2000).

Europe is the continent of small and medium-sized cities. "Small large" cities having an intermediate position in the urban system may play a capital role for the dynamism of the urban network. Medium-sized cities are usually on a more human scale and they offer a better physical

and social environment than large cities. Their advantages make them attractive for many productive investments, now that more powerful cities have environmental and social problems and capital and information can fly around the world in nanoseconds. Medium-sized cities are often more open to the countryside and may act as a filter between larger cities and regions. Medium-sized cities on the periphery of metropolitan areas face special opportunities and threats. Their geographic position gives them advantages of access and networking, but disadvantages in developing their autonomous identity and their complementary functions (EFILWC 1997d, Bellet et al 1998).

During the past decade, urban affairs have been high in the political agenda of the European Union. The Green Paper on the Urban Environment and the Reports on the Sustainable City recognized the role of cities as fulcrums of economic activity, innovation and culture (EC 1990, 1994a, 1996). The EU Communication "Towards an Urban Agenda in the European Union" issued in 1997, expressed the intention to make EU policies more urban-sensitive and to improve integration at urban level. The Framework for Action for Sustainable Urban Development in the European Union insisted upon better co-coordinated and targeted EU action for urban areas (EC 1997b, 1998a).

The European Initiative "URBAN", launched in 1994, marked the turn of the century. During the years 1994-99, the initiative Urban I financed projects in a total of one hundred and eighteen urban areas hosting 3.2 million people throughout Europe. The Initiative targeted neighbourhoods in extreme deprivation and addressed problems of isolation, poverty and social exclusion through interventions that improve physical surroundings and social conditions. Approximately ninety per cent of the programmes were located in cities with a population of more than one hundred thousand inhabitants (EC 2003a).

The continuing programme Urban II (2000-06) aims at promoting the design and implementation of innovative models of development for the economic and social regeneration of distressed urban areas. Urban II projects propose innovative development models in order to improve living conditions, create jobs, integrate the less favoured into the education and training systems, develop environmentally friendly public transport systems, create effective energy management systems and make greater use of renewable energy and enhance the potential of new technologies. A specific programme, the "European Network for

Exchange of Experience" (URBACT), favours exchange of good practices across Europe.

In January 2004, the European Commission adopted a Communication "Towards a Thematic Strategy on the Urban Environment", as one of the seven thematic strategies set out in the Sixth Environmental Action Programme of the European Community (EC 2001a). The Communication proposes that the objective of the Thematic Strategy, to be issued in 2005, should be to improve the environmental performance and quality of urban areas and to secure a healthy living environment for Europe's urban citizens, after a widespread consultation with stakeholders (EC 2004a).

The Communication starts with the premise that the knowledge and techniques needed to bring about significant improvements in environmental performance in urban areas are already known. While there are some gaps in knowledge, the focus should be on achieving clear changes in urban areas rather than calling for further consideration of the issues. It is recognised that towns and cities themselves are best placed to develop the actions to meet their challenges and proposed that the role of the EU should be to establish a supportive and motivating framework. The four priority themes, selected in co-operation with stakeholders, include urban environmental management, urban transport, sustainable construction and urban design.

European cities are networks of networks and at the same time they are the poles of global networks. Society is based on networks and local actors constitute the diversified poles of the global networks. Technology, information, and markets are global, but people are local. Information technology provides the infrastructure for the integration of the global system. The space of global flows is in interaction with the space of local places and cities gain an increasingly dual global-local function. Competition is geographically uneven and new technologies have the power to shrink distance and to extend geographical distribution (Sassen 1991). Social movements are a source of social change, critical factors in collective consumption and in building up awareness and consciousness.

Ancestral links between cities and their countryside gave rise to regional cities and urban regions, which prolong the complexity of agglomerations. The Dutch urban heart of Randstadt offers a prime

example of a preserved space in the middle of the urban conglomeration. Rural sustainability and urban sustainability are the two faces of the same coin, both critical for the achievement of sustainable development. In many cases the cities have undertaken environmental protection actions and improved their internal sustainability performance at the expense of deterioration in their region or in more distant places. Coastal and mountain areas face particular problems and spatial alliances have to be created to overcome divergences between physical and institutional boundaries.

Less polluted rural areas often have to respond to demands for short-term economic growth and, when sparsely populated, lack social capital and interactions enhanced by proximity. Rural amenities may include exceptional natural and artificial ecosystems, landscapes and recreational areas, historic and monumental sites and unique social and cultural activities and traditions. Pressures arise from economic activities, especially tourism, or mismanagement of resources, like intensive water extraction. An optimal balance has to be stricken between conservation and the development of amenities, so that the total capital is not depleted. Inter-communal and regional co-operation is essential, in order to identify priorities and compose policy portfolios.

3. THE CHALLENGE OF URBAN SUSTAINABILITY

Sustainable development has been one of the most emblematic and numinous terms of the turn of the century (UNESCO 2004). Europe is the continent where the concept of sustainable development has found the most fertile ground for visions and actions. It has been defined as a process and not as an end-point, as a journey rather than a destination; it may be construed rather as a struggle between the Scylla of social exclusion and the Charybdis of over-consumption. Sustainability is not about embalming cities or sustaining them as they are now. It is about making them more balanced and equitable and better equipped to meet the challenges in the global scene of the future. Sustainable development advocates for a dynamic balance between quality and quantity of development and asks for optimal integration of socio-economic and environmental concerns (EC 1996, 1997a, 1999a; EFILWC 1997a-g; Hall et al. 2000; MOPTMA 1995; OECD 1994, 1996, 2001a, b; WHO-OECD 1996).

The journey to sustainability demands multiple efforts against the depletion of the capital stock, composed out of human and social, natural and environmental resource capital and man-made capital. The human capital includes personal skills, ethical values and lifestyles, while social capital comprises cultural patterns and institutions. Natural capital is described as the physical endowments, assets typically transacted in markets, while the environmental resource capital includes the life support systems, offering their services for free. Progress can be estimated through the evaluation of the increase or decrease of the aggregate capital stock.

Policy challenges stemming from the interfaces between sustainability and globalization include the enhancement of the opportunities from probable parallel globalization of environmental quality and the optimization of consumption models. A key question concerns the extent to which different components of wealth can be substituted for each other. Strong sustainability implies that substitution of social and environmental capital is impossible and loss is irreversible. A minimum of environmental, social and economic capital form a triple bottom line. For weak sustainability the matter is not whether a particular natural resource will be available infinitely, but whether human ingenuity can preserve and increase the global capital (OECD 2001a).

Strong sustainability is the signal of Agenda 21 and this requires the most active involvement of governments, local authorities and citizens. The chapter 28 of Agenda 21 specifically addresses local government action. The Local Agenda 21 process includes the management and improvement of the environmental performance and the integration of sustainable development aims into all policies and activities. It is a major commitment for any local authority, which ultimately has the responsibility to act not only on behalf of its present but also its future citizens. Institutional fragmentation is sometimes a barrier to holistic approaches. Local governments have to commit to local environment and economy, equity and social development. They should become more open, flexible, proactive and responsive (CEMR 1996).

On the road from Rio (1992) to Istanbul and HABITAT II (1996), the first conference on European Sustainable Cities and Towns (Aalborg, May 1994) marked a paramount step in the move towards urban sustainability. The main objective was the discussion and issue of

the "Charter of European Cities and Towns: Towards Sustainability", signed by eighty municipal and two hundred individual signatories at the end of the conference and starting point for the European Campaign of Sustainable Cities and Towns. This campaign constitutes the most massive movement of cities in Europe and is an important pillar in the pantheon of world networks and movements (ICLEI 1995). The second conference on European Sustainable Cities and Towns (Lisbon 1996) urged cities to move from charter to action (ICLEI 1997), while the third conference on European Sustainable Cities and Towns (Hanover 2000) included the Mayors convention declaring local sustainability as their highest political priority (ICLEI 2001).

The Charter of European Cities and Towns Towards Sustainability, seen as the European version of Local Agenda 21 (CEMR 1996), states that cities and towns should base living standards on the carrying capacity of nature and progress towards social justice, prosperous economies and environmental improvements. The Charter recognizes that natural capital has become a limiting factor for economic development in cities, and urban economies should give priority to investments in conserving the remaining capital and encouraging its growth by reducing the levels of current exploitation, relieving pressure on natural capital stocks and increasing end-efficiency. Social equity is considered to be a precondition to the achievement of sustainability, as the inequitable distribution of wealth both causes unsustainable behaviour and makes it harder to change. The Charter advocates for the development of urban sustainability indicators as yardsticks of progress.

Sustainability is described as a creative, local, balance-seeking process extending into all areas of decision-making. The Charter embraces an ecosystem approach to urban management and declares the responsibility of European cities and towns for many of the environmental problems facing mankind. Patterns of division of labour and land use, transport, industry, consumption, leisure, and, hence, values and lifestyles are responsible for the reduction of sustainability. Sustainable development cannot be achieved without local communities, governments and citizens rising to meet the major challenge of sustainability. Each city has to find its own individual path towards sustainability. Integrating the principles of the Charter in their policies reinforces their strength and forms a common basis for progress.

City and town signatories of the Charter recognize that they cannot export problems into the broader environment or the future and seek equitable regional interdependencies. Priority is also given to ecologically sound means of transport and the decrease of enforced mobility. Emphasis is placed on the stabilization and reduction of greenhouse gases, the enhancement of biodiversity and the preservation of the ecosystems. The local authority signatories of the Charter committed to develop Local Agenda 21 plans in partnership with their citizens and asked for sufficient powers and solid finances to carry out projects heralding sustainability (ESCTC 1994).

The European campaign of sustainable cities and towns is built around a partnership of important networks/associations of local authorities. They include the Association of Cities and Regions for Recycling (ACRR), Climate Alliance, Council of European Municipalities & Regions (CEMR), Energy-Cités, Eurocities, International Council for Local Environmental Initiatives (ICLEI), Medcités, Union of the Baltic Cities (UBC), World Health Organisation-Healthy Cities Project (WHO), and World Federation of United Cities (FMCU-UTO).

The Sustainable City Award created by the European campaign of sustainable cities and towns aims at recompensing best practice and promoting emulation. Ferrara, Heidelberg and Oslo have been the 2003 award winners. The campaign recognized their active, progressive and ongoing commitment to the sustainable development process. It highlights that the three cities demonstrated outstanding work and excellence in the overall accomplishment towards urban sustainability. They have implemented all key dimensions of sustainable development, the social, economic and environmental and their approaches have been innovative, creative and pro-active, reaching out to their citizens and their stakeholders. Sustainability has become embedded in the institutional culture and practices, established through a regular, effective and meaningful dialogue with their citizens.

The Charter of European Cities and Towns Towards Sustainability has completed ten years of visions and efforts, which was celebrated with the "Aalborg + 10" Conference. This fourth conference of European Sustainable Cities and Towns climaxed on 11 June 2004 when representatives of one hundred and ten local governments signed the Aalborg Commitments, devised to assist cities and towns in achieving

sustainability. The ten Aalborg Commitments must be viewed as a tool to help local governments set clear qualitative and quantitative targets for practical work to implement the urban sustainability principles of the Aalborg Charter. One week earlier, at the International Conference for Renewable Energies in Bonn, three thousand participants stressed the importance to work within a global policy network and implement the commitments of Johannesburg on renewable energies.

Sustainability may symbolise a continuous efflorescence and invention of new opportunities, a permanent aspire for a better world. Pure evolutionary change and merely adaptive responses are not sufficient for progressing towards sustainable pathways. Sustainability asks for innovations to maximise and optimise investments in capital, labour, skills and chance (Figure 9).

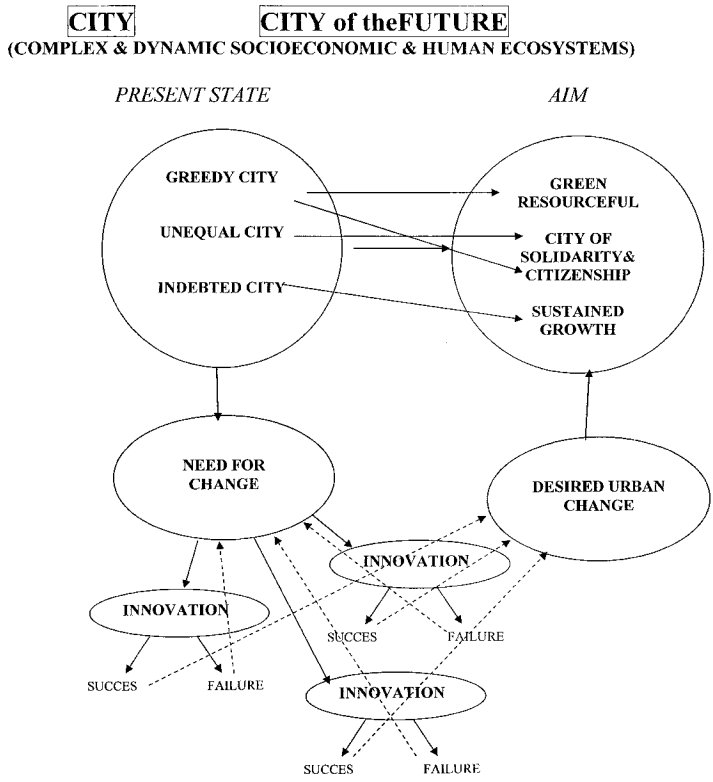

Figure 9. The progress towards the sustainable city

Institutional innovation is essential for creating the conditions for change. The Brundtland Report had already noted in 1987 that the challenges presented by population growth, economic development and the need to transform agricultural, energy and industrial systems were highly integrated and interdependent. However, the institutions responsible for managing these issues tend to be independent, fragmented and working to relatively narrow mandates with closed decision-making processes.

4. INNOVATION, SINE QUA NON CONDITION FOR SUSTAINABILITY

Business as usual scenarios are totally insufficient for progress towards sustainability. This is particularly crucial when the failure of past policies, or their inadequacies with respect to the social or environmental aspects of growth, become evident. Many old beliefs and patterns have to be destroyed for new ways of thinking and acting to be born. There is an urgent need for innovations and paradigm shifts. Old assumptions have to be discarded and new alliances have to be forged.

Innovation is "creative destruction", the key to progress (Schumpeter 1976, OECD 1996). Innovative projects are witnesses to the strategic visions that cities try to develop, in order to meet increasing social, economic and environmental challenges. Success is never a certainty, but inaction is surely a prelude to failure. It is essential to analyze the spark of each innovation, which, together with the other elements of fire, brings the desired significant change (EFILWC 1997g).

Innovative doctrine exploits radically new paths and destroys old patterns. Old principles, ideas and practices die, while a new order is born. The cutting edge is where innovation lies, but it is rather a process than an event. Innovation theory starts by distinguishing innovation from invention, at the one end, and transformation, at the other. Innovation involves a dramatic and thorough change that opens up the range of opportunities and an organizational restructuring that allows the new product, concept or idea to bring about the desired transformation.

Some axioms are very significant on the role of innovation and change in an organization's tasks and incentives. The more complex and

diverse an organization, the greater the number of innovations that will be conceived and proposed, but the fewer the number of innovations that will be adopted. Any innovation creates the conditions for its own demise. The more established an organization, the more difficult it is to change. Discipline, hierarchy and conformity are the enemies of change and resistance increases when innovations touch the core interests or boundaries of institutions. The most challenging, but potentially most effective, innovation is often to halt an established practice (MIT 1997).

Forceful ideas can ignite fires. One should distinguish innovation from pure evolutionary change and adaptive responses to new technologies, within the established rules and procedures. Innovation comprises a managerial and institutional response to the opportunities offered by invention, research and new technology. Its main sources are necessity and choice. Innovations originate from scarcity, pure accident, defence, crisis, creative conflict and strategy. Complex problems that inhibit innovation often create a sharper need for it. Innovation may also be the result of a struggle for survival. Crises force people to take a hard look at reality and generate a plethora of new ideas. After all, necessity is the mother of invention.

Innovation and sustainability share a desire for immortality, a pursuit of perfection. With advancing globalization, shifts in the economy may prove swift and lethal for institutions, which do not innovate. Sustainability demands optimisation of environments, spaces and times, opportunities and skills. Cities, as very complex systems, are by definition organizations where many new ideas, concepts and products are created, but where difficulties of implementation also abound. All approaches require vision and tactics, design of tools and methods, organization and communication. They need co-operation and concerted action. In terms of capacity to change the face of civilization, the will and effort of people uniting to enhance their opportunities have always far outweighed any technical invention.

Cities are untapped reservoirs of ideas, enthusiasm, commitment and labour. They are places where creativity concentrates and cross-fertilizes. Urban innovations towards the sustainable city (Figure 10) require human ingenuity, which imbues all visions and actions with an extraordinary poignancy. An innovative city is one that can compose a better future out of its people's creativity. This presupposes recognition of the creativity of every individual actor. From a new idea to its grafting

into a mainstream policy, the birth, growth and death of an innovation depend on a city's creative assets and their mobilization towards solving urban problems and not only adapting to change, but creating the desired transformation. Innovation requires commitment and enthusiasm from the actor that conceives it, confidence that the innovation represents a plausible option and willingness to accept responsibility. It also needs intelligent, efficient and effective coalitions. Responsibility has to be shared among all actors. Nurturing creativity can be contagious; it can create a climate for mobilizing more creative potential (Laundry et al 1995).

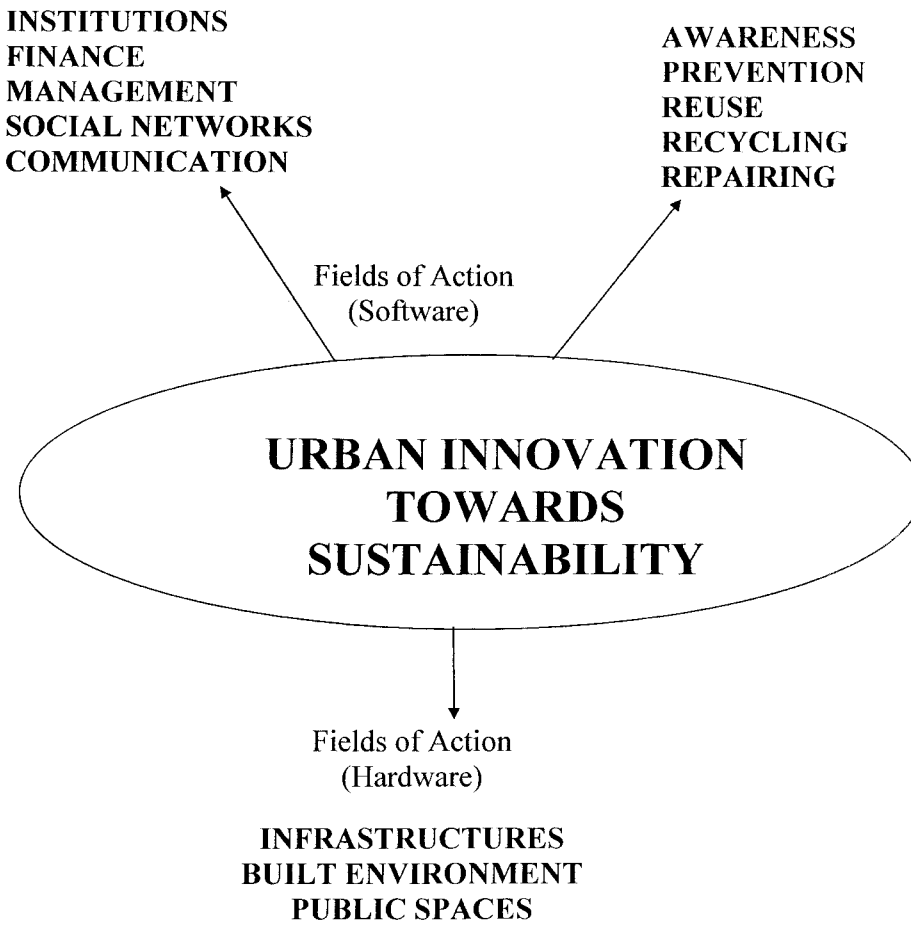

Figure 10. Innovations for urban sustainability

P. Hall suggests that "innovative cities at their zenith (Athens, Florence, London, Weimar, Berlin) were cities in transition, out of the known, into new and still unknown modes of organisation" (ACDHRD 1995). A city supporting and fulfilling innovations might not be the most efficient in the short term, but innovations are not necessarily expensive. Many innovations are linked to a small initial capital and produce considerable innovation. Sometimes, the purposeful and knowledgeable use of capital is impossible unless small sums have first been spent on a variety of small-scale new departures. The success of each small experiment is an expression of the creativity that fertilized each small sum and of the mechanisms that allowed it to happen (Jacobs 1969).

Efficient but non-creative use of capital or technology in cities can lead to the systematic imitation of innovations that are produced elsewhere, a chronic import of creative solutions. Trial is limited in the search for the optimal and most efficient conditions for transplanting innovations. No rapid mobilization of creativity and innovation can take place if there is not a permanent environment for the peaceful incubation of genuinely new ideas and unproven goods and services. Education and research may help enormously in this long-term effort with many cultural dimensions and added value.

The continuous assessment of innovations has to consider and compare the situations with and without an innovative project. Evaluation involves forecasting and comparison and has to weigh innovative options. In the simplest form, one has to consider the costs of stimulating, generating, designing and implementing an innovation and compare them with the achieved benefits. The financial balance sheets are an important starting point. Costs and benefits are represented in straightforward financial terms: the capital and operating costs, and the money earned in return, suitably discounted. Very often, there are unintended hidden costs and returns not included in conventional financial appraisals.

However, a project aiming at sustainability is not always designed to produce a financial return. In the era of sustainability what matters is the overall benefit, with its environmental, economic and social dimensions. The passage to a sustainability balance sheet is much more difficult. External or social costs may not enter into the financial profit-and-loss calculus of the decision-makers. One has to take into account all the dimensions of urban sustainability and estimate the contribution of an

innovative project in reinvigorating the hardware, software and heartware of a city (Figure 11).

The criteria to estimate the overall generative potential of innovative projects may be separated into end-point and process criteria. The first set of criteria includes financial (the strict financial return to social investment and also the level of social capital required when affordability matters), environmental (the contribution to environmental sustainability), social (the contribution to social sustainability) and economic (the contribution to sustained economic growth) factors. Process criteria evaluate whether the path followed in reaching the above goals is conducive to sustainability. Capacity building and institutional development are deemed essential, together with the transferability of projects and their contribution to an innovative milieu (EFILWC 1997e).

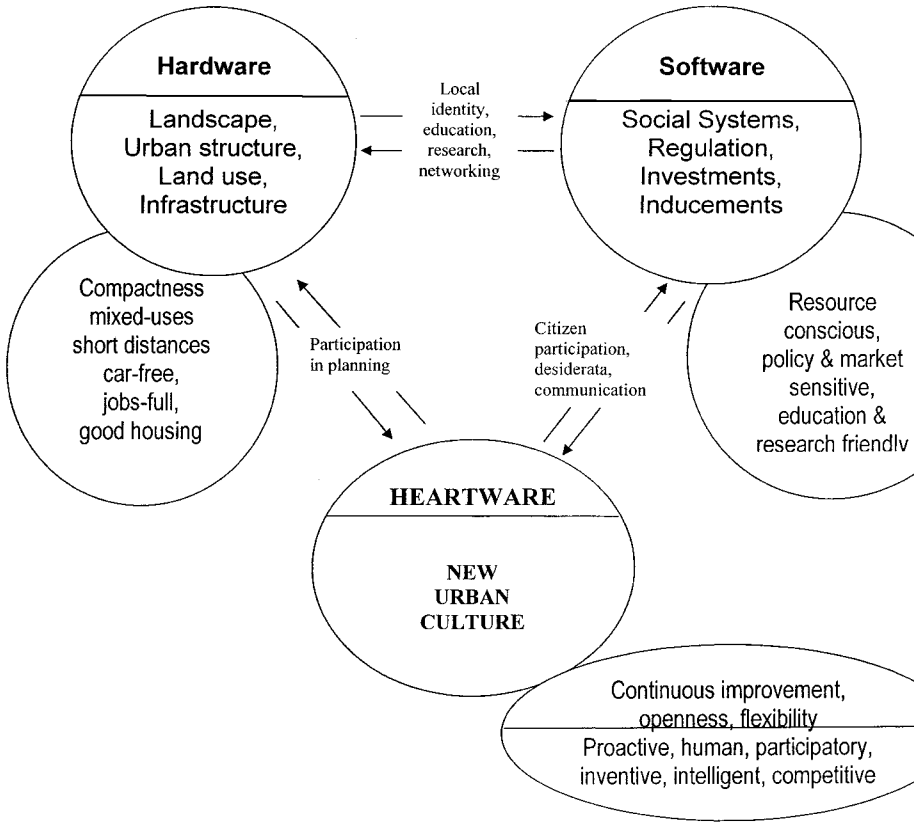

Figure 11. Engaging the urban hardware, software and heartware

The assessment framework can be further detailed by analyzing contributions to environmental, social and economic sustainability. The benchmark to estimate contribution to sustainability is essential and is probably best defined locally. According to which criteria a cost or benefit is judged to be considered low, high or medium, is very important and impacts the precision of the classification. Weighted summation is the decisive step since it determines the overall rating of a project. It can be compared to aggregating a unique sustainability indicator after having established thematic ones. Weighting the same criteria differently provides different results and highlights the subjectivity and relativity of the process. Effects could be mitigated if assumptions are made explicit.

Governments at all levels become more enablers rather than providers, but equally, initiators of innovations. By studying problems and policy options, they can provide the means for an innovation and can inspire innovations elsewhere. The social partners can co-initiate innovations, making them grow, finance unprecedented activities, stimulate other actors, create the social climate for acceptance. They all share the responsibility of making a society proactive.

Innovation can come from any individual or collective actor, but usually needs many more actors to ensure its success. Much depends on the maturity and the cohesion of the community, the quality and commitment of human resources and the political will. Governments should give special opportunities to the concepts and ideas proposed by those usually without a voice. Empowering them ultimately empowers everyone.

Coalitions that place people at the centre of a genuine, far-reaching development strategy seem to have an unparalleled potential. Charismatic leaders, scientists or simply local citizens/workers are all potential bearers, initiators, generators or adapters of innovations. A common problem or a common perspective often ferments the common ground for the coalition. Anticipation of problems might be decisive. Alliances based on agreement, mediation, political manoeuvring and negotiation can best direct the wave of the future. Mediation at an early stage can be critical in certain cultural settings as a face saving measure. Making compromises and reaching an agreement at an early stage is much preferred to tiresome, time-consuming, costly and hostility-engendering processes of conflict and arbitration (MIT 1997).

The very notion of an innovation is very relative and ephemeral and it is difficult to make a unanimously accepted taxonomy of innovations (Figure 12). Strong alliances are needed for key actors to create the space and the conditions for the innovations. The architecture of coalitions is very diverse and challenges general rules. Sharing costs and benefits being the essence of any participatory action, the multiplier dimensions in matters of innovation are impressive. Accountability, transparency and communication are decisive for the social acceptability of innovations. The involvement of the business sector, social partners and citizens makes possible projects at an otherwise prohibitive cost (Jacobs 1969).

Paradigm shifts of the future	Nuclear fusion			Virtual tourism
Technology clusters	Process Automation			
Paradigm shifts	Bio-energy Solar power Wind energy	Fuel cells Hydrogen	Decentralised generation	Socially acceptable nuclear waste management
Innovation	Improved nuclear safety Hybrid systems	Electric car Solar cells Wind turbines Green television	Combined Heat and Power	Risk Governance Codes of conduct and reporting
Incremental improvement	Increased eco-efficiency	Better heating / cooling systems	Car sharing Car pooling	Eco-stations Eco-compasses
	Process Innovation	**Product / service Innovation**	**Innovation in Producer / Consumer relationship**	**Social and institutional innovation**

Figure 12. Tentative taxonomy of innovations for sustainability

Innovations are powerful processes that can be both superb and dangerous. Radical innovations are rare and may change the status quo and the flow of power. They might create serious disruptions, lead to points of no return and affect the socio-cultural equilibrium of a city. A

strategy of moderation may be needed to prevent tensions between the imperatives for change and the need for security. Citizen participation can act as a cultural net and business participation as a financial one. Openness, awareness, civic engagement, efficient management and a balance of interests should assure homeostasis, change within stability.

5. SUSTAINABILITY INDICATORS-REVELATORS FOR CITIES

Sustainability appraisals, reporting and indicators may serve as compasses in the journey of urban sustainability. Sustainability indicators are tools for evaluating progress towards sustainable development. If sustainability is a coherent policy goal, it should be possible to measure whether we are moving towards it. The question of the measures is critical, since, as A. Einstein formulated it, "not everything that can be counted counts and not everything that counts can be counted." Indicators may provide a yardstick and can be instrumental for policy making (prospective) and for assessing policy implementation (retrospective indictors).

The World Bank defines indicators as performance measures that aggregate information into a usable form, highlighting, however, the unresolved issues of fluctuation, inter-temporal variations and uncertainty. In order to be successful, indicators should be meaningful, clear, scientifically sound, verifiable and accepted. Descriptive indicators, illustrating the status of the urban environment and based on real, concrete physical measures, are easier to establish and interpret by judging them against specified benchmarks and thresholds. Performance indicators, based on policy principles and goals, have to be integrated in an urban policy framework, including a diagnosis of the current situation, identification of the factors that should change and directions for change and, if possible, ultimate targets to be attained.

The significance of indicators extends beyond what is directly obtained from observations. Sustainability indicators cannot include solely environmental indicators, as environmental performance is not the only factor in achieving sustainability. The "pressure-state-response" model is a widely accepted framework for the construction of sustainability performance indicators. The model links the causes of

environmental changes (pressure) to their effects (state) and finally to the projects, actions and policies (response) designed and implemented.

Sustainability indicators have received much attention in recent years, but their real use in measuring sustainability performance is at an initial stage. They have often been linked to the question of greening the national accounts systems, aggregating and comparing data in monetary forms. Genuine saving indicators attempt to broaden the usual measure of saving (equal to the difference between income and expenses) to account for the cost of environmental depletion and degradation and investment in human capital (OECD 2000a).

Urban thematic indicators should reveal in what fields a city is doing better than in others and according to its specific goals. Aggregate indexes, like the genuine savings indicator, may inform if a city becomes more or less sustainable. The passage from thematic indicators to an index of sustainability policy performance for cities is a complex task, since indicators have to be weighted by contribution to sustainability levels and all the previous levels of aggregation have to be taken into account. A special effort must be made to avoid multiple counting of individual sustainability pressures, which are taken into account in the composition of the thematic indicators. Last but not least, one has to highlight that no indicator can inform if a city integrates socio-economic and environmental objectives in its overall development strategy (OECD 1996).

Indicators should contribute to making the city more visible and transparent, aid in comparison, evaluation and prediction, help construct and harmonize data banks, provide decision-making with relevant information, stimulate communication and promote citizen empowerment and participation. They should embrace all sectors and neighbourhoods contributing to the co-evolutionary process of sustainable development. As with all innovations, the development of indicators is strengthened by the existence of a permanent innovative milieu. Seattle, Washington, in the USA, is often quoted as a classic example of a dynamic city, and as a breeding ground of successful businesses such as Boeing and Microsoft, with a coherent set of indicators. Last but not least, indicators should reinforce communication processes and promote common understanding at the local, regional, national and global level.

Targets for thematic indicators may be defined at the city level, according to the priorities of each city, with probable reference to global protocols and standards. The performance of a city at a national or supranational level should therefore be judged according to both its local objectives, its national objectives and the international commitments.

The UN Commission on Sustainable Development proposed in 1996 a working set of indicators, organised in the "driving force-state-response" framework (UN 1996). It includes indicators for promoting sustainable human settlement development. They comprise three driving force indicators (rate of growth of urban population, per capita consumption of fossil fuel by motor vehicle transport, human and economic loss due to natural disasters), state indicators (percent of population in urban settlements, area and population of urban formal and informal settlements, floor area per person and house price to income ratio), and one response indicator (infrastructure expenditure per capita).

International comparative analyses should always be regarded with a sound dose of scepticism, since they are limited by national differences in definitions and data collection and estimation methods. Comparisons are meaningful when they refer to truly comparative, in size and function, units. Systematic territorial indicators are necessary complements to national indicators serving for international comparisons. Moreover, by reporting regularly and systematically on territorial progress towards international targets and commitments, attention is focused on the task ahead and national decision-makers become more accountable at the local and international level.

European efforts for creating a common set of urban indicators have multiplied over the last years. The EU sustainability monitoring initiative "Towards a local sustainability profile - EU common indicators" launched in 2000 has been developed as a bottom-up approach in close collaboration with local authorities. Communities participate on a voluntary basis. The set includes five core indicators on citizen satisfaction with the local community, contribution to global warming, mobility patterns, green spaces and local services and air quality. Five additional indicators have been suggested. They focus on the children's commuting patterns, local management, noise pollution, sustainable land use and sustainable products, including eco-labelled, organic and fair trade products (EC 2000h). Energy consumption and

efficiency indicators are key yardsticks for measuring the progress of cities towards sustainable development (IEA 1997).

The Urban Audit, launched by the European Commission in 1997, can also be seen as an important exercise to develop indicators. Its purpose is to enable an assessment of the state of EU cities and to provide access to comparative information from other EU cities. Fifty-eight cities were invited by the European Commission to participate in the Urban Audit during the pilot phase. The indicators cover five fields, including socio-economic aspects, participation in civic life, education and training, environment and culture and leisure. A comparison of the indicator scores allows cities to judge their progress and to identify particular problems. The Urban Audit pilot phase developed and tested a methodology for collecting data to inform the indicators. All available information sources at national, regional, and local levels have been investigated and where appropriate used, taking into account the variety of data definitions used in different contexts. The indicator scores have been calculated at the city level and, for twenty seven of the fifty eight cities, at the wider territory or conurbation level.

Local Agenda 21 or the Charter of European Cities and Towns may serve as valuable policy frameworks for the development of performance indicators. An indicator can be a priori assigned for each policy theme (EFILWC 1998a). The differences in nature and scale of the policy themes and the diversity of territories dictate the variety of the indicators to be developed. The composed indicators should assert whether a city follows the adopted directions for sustainability. Frameworks and sets of indicators underline the importance of focusing on the policy issue and the objectives than the indicator itself. The annex includes a recommended set of significant indicators based on the European Charter of Sustainable Cities and Towns.

Chapter 2

THE RESOURCEFUL CITY AND THE ENERGY CRITERION

This chapter focuses on key elements of the urban environment and principles and actions inaugurating new models and patterns. The world momentum of local agendas 21, charters and declarations brought to the forefront eco-principles and eco-actions for the improvement of the urban metabolism. Resource and waste management, transport of citizens and goods, quality of air and global warming are of extreme importance to cities that become laboratories of ecological innovation and provide inspiring examples. Energy is the common denominator of most actions.

1. THE ECOLOGICAL CITY

Cities are open, complex and dynamic human ecosystems, which require a remarkable array of material and labour inputs and produce an equally remarkable array of outputs and outcomes. They have most complex metabolisms and mobilise tremendous flows of people, resources, energy, products, waste and emissions. The sustainability journey demands from cities the improvement of their performance and, especially in developed countries, the disassociation of the economic activity from resource use and pollutant release. The design of urban policies should be preceded by material and energy flow analyses and followed by continuous impact monitoring.

Cities are the main contributors to and victims of planetary and local environmental problems. At each stage of urbanisation, environmental conditions in cities were improved dramatically. The supply of clean water, the removal of waste and the rise of standards of comfort and cleanliness needed radical innovations, which have long become common practice. Cities confront now a range of problems, like urban sprawl, high car dependency, the loss of green spaces, the development of brownfields, growth of distressed urban areas, and lack of dynamism in city centres that are not addressed by conventional policies. The result is the accumulation of problems and the search of new strategies reinforcing the capacity of cities to offer the quality of life expected by their citizens.

A sustainable city respects the geophysical and cultural local limits, mobilises invisible economic and social structures and seeks synergy and symbiosis with the bioregion. Sustainability demands moves towards life-cycle approaches and strategic long-term efforts to tackle the underlying causes of environmental damage. Urban environmental planning for sustainability requires a comprehensive interdisciplinary assessment of urban assets, a natural resource information system and an identification and analysis of the policy distortions and bottlenecks. All approaches to the environment, as one of the three pillars of sustainability, have to be adapted in the urban context. Prevention should be considered an investment and not expenditure.

The precautionary principle is subject to much debate and sometimes contradictory views. In the USA, the approach is more focused on significative risks and regulation is based on scientific evaluation. An EC Communication issued in 2000 suggests a structured decision-making process to ensure the correct balance between the freedom of individual organisations and the need to protect the environment and public health. The approach aims at building a common basis for assessing, managing and communicating risks that science is not yet able to determine with sufficient certainty. The acceptable level of risk is an eminent political responsibility. Respecting the principle should lead to transparent, coherent, proportionate and non-discriminatory actions and at the same time avoid unwarranted recourse to the principle as a disguised form of protectionism.

Environmental deterioration is due to the incapacity of public policy and the market to properly manage environmental resources. The passage from the "Command and Control" regulatory approaches to the polluter pays, complemented by the user pays principle has been a significant step in Europe. The absence of markets for air or water is linked to the absence of property fees for these goods. The lack of a price of access is at the origin of their unlimited use. Economic instruments act like substitutes of markets that are costly and difficult to organise. The advantage of economic instruments is that they can be applied using the fiscal infrastructure of a city. Their success depends on the meta-policy and the institutional context.

Economic instruments impact on the energy and innovation which markets can unleash and may induce polluters to choose the most efficient and effective pattern of abatement in response to the price signal they receive. They promise reduced bureaucracy, incentives to improve over time, better environmental performance and generation of funds to finance sustainability policy measures. Subsidy reform, especially for energy, can have significant economic and environmental benefits. The use of charges and taxes has to reflect scarcity value as a powerful tool for sending signals to producers and consumers. Taxation is, however, always unpopular and revenue-neutral tax reform including tax shifts (e.g. from labour towards natural capital) constitutes a key way to ease green taxes.

Other economic instruments include the assignment of property rights, liability systems and performance bonds, pending satisfactory environment performance, and transferable development rights, when the landowners in sending areas are given development units, to be exercised exclusively in the receiving zone. All economic instruments should be integral parts of efficient, effective and equitable policy portfolios. Information and awareness are organic part of these portfolios. The UNECE convention on Access to Information, Public Participation in Decision making and access to justice in environmental matters (Aarhus 1998) has marked an important step forward.

Industrialised cities and regions consume too many valuable resources and produce too much waste and emissions. They have enormous ecological footprints, estimated after the evaluation and aggregation of the biophysical capacity of land needed to produce the necessary resources and to absorb the territorial waste. The ecological

debt of the industrialised countries gets accumulated. Over the thirty last years, the global ecological footprint increased by 70% (while the population increased by 65%).

In 1961, the global community needed half of the biological capacity of Earth. Forty years later, humanity needs 1.2 planets to survive! The average surface needed by world citizen today amounts to 20.2 hectares. It ranges from 0.3 hectares in Afghanistan to 9.5 hectare in the USA (wwf 2004).

London's ecological footprint is estimated to occupy an area one hundred and twenty five times greater than administrative London, even if assessment is limited to the consumption of food and forest products and the capacity to generate emissions of carbon dioxide. Its life has to be supported by an area equivalent to 94% of Britain's productive land area. The ecological footprint of the Netherlands is evaluated to equal 14-15 times its national territory (Girardet 1992).

Some years ago, the European Environment Agency had estimated that a European city of one million inhabitants consumes every day, on average, 11,500 tonnes of fossil fuels, 320,000 tonnes of water and 2,000 tonnes of food (EEA 1995a). Stabilising consumption is a major issue today and an important objective, close to the heart of the Charter of European Sustainable Cities and Towns, which recognises that decreasing consumption levels may be an over-ambitious aim impossible to achieve.

Consuming better goods instead of more goods could be a devise for sustainable consumption. Improved technology and increased efficiency have contributed to lowering the levels of pollution, but increased consumer demand has often more than offset these benefits. The citizens of the industrialised countries represent 20% of the world population but consume 80% of resources and contribute to an ecological footprint six times heavier than the developing world citizens. If the latter were to increase their consumption by 50%, the former would have to decrease its consumption by 15%, which would imply a drastic change of habits in the industrialised countries.

Agenda 21 identified unsustainable patterns of production and consumption, particularly in industrialised countries, as a major cause of environmental deterioration. The Johannesburg Plan set out a range of

actions that countries should take to influence consumption patterns. Policies to influence production patterns, like cleaner production and eco-efficiency, are in general, better developed and understood than demand-side policies, where progress depends on all consumers and citizens.

Actions to influence conception patterns include regulation, economic instruments, social instruments and other government and NGO actions. Regulation measures range from the insulation of new buildings to the mandatory installation of water-saving systems. Economic instruments try to ensure that the price of household energy, road fuels, water and waste, fully reflects the associated environmental and social externalities. They range from differential taxes to encourage the use of environment friendly fuels to taxes on municipal water supplies and eco-taxes for waste. Social instruments comprise a series of means to raise consumers' awareness about the adoption of more sustainable lifestyles. They range from cartoons, comic strips and Internet services to junior eco-clubs, touring exhibitions and eco-labelling, like the flower, white swans or blue angels.

The flower is the symbol of the European Eco-label, part of a broader strategy aimed at promoting sustainable consumption and production. It is a voluntary scheme designed to encourage businesses to market products and services that are more environment and consumer friendly. A flower offers a sign which is easy to identify for public and private purchasers. It has the ambition to serve as a guide to greener products and services and can be found throughout the European Union and the countries of the European Economic Area / European Free Trade Association (Iceland, Liechtenstein, and Norway).

Green public and private procurement is of key importance for creating new market niches and improving production and consumption patterns. The European LEAP project brings together eleven local authorities to prepare and test a strategy on joint procurement of green products. The EcoProcura conferences, held every two years, bring together purchasers, suppliers, decision-makers and regulators to share the latest developments in the field of eco-procurement. The Dutch 3P (people, planet, profit) approach is exemplary (EC 2004e).

Environmental and consumer organisations are often the source of innovative action to improve consumption patterns. The Global Action Plan (GAP) is based on the principle that individual action can make a

difference and that people should be provided proper support structures. It addresses especially those who are willing to do something about the environment, but are not quite sure about what to do. GAP collaborates with households and communities on action concerning natural resource use, water quality, CO_2 emissions and waste production and disposal. Teams of four to five households meet regularly for six to eight months on a specific theme: household energy use, household waste management, water consumption, transport and shopping. The participation of children is highly welcome. Action already taken is being evaluated and next steps are being determined. Results in the UK, where the Plan is supported by companies such as British Gas and Groundwork Trusts, highlight an annual reduction of waste by 35%, CO_2 emissions by 9%, petrol consumption by 10% and water use by 13% (EFILWC 1996a).

Many European cities are in search of ecological models. The medium-sized cities of the metropolitan district of the central UK experienced both the decline of their textile and engineering base, and industrial air and water pollution and traffic exhaust emissions. Kirklees was the first local authority in the UK to produce a "State of the Environment report". The local commitment to environmental matters led to a happy partnership with the Friends of the Earth looking for a pilot authority to take on board their environmental Charter for Local Government. The "Friends of the Earth Charter for Local Government" set out key recommendations for action. They include provisions on making environmental requirements part of purchasing and procurement policy, encouraging and enabling public participation, implementing environmental criteria in grant-aid conditions and contract and tender specifications and greening land use and development plans.

Since the 1970s and especially after the Rio Summit, cities are striving to gain environmental credentials and urban ecology offers them new visions. Awareness of environmental quality is increasingly regarded as a new civic value and more and more cities strive to adopt proactive policies leading to the conception of new systems of production and consumption. New environment friendly lifestyles cannot be imposed from governments. They are developed through innovative partnerships rooted in the local culture. "Green City" does not simply mean green spaces, grass roofs, timber frame constructions, improved energy systems and water cycles. A cultural reform is needed to give meaning to all technical achievements. A wide urban consensus is a necessary precondition.

From Lahti, Finland, to Lavrion, Greece, European cities were among the first to adopt local plans 21, many of them providing international models of excellence. All Swedish local authorities had adopted local agendas and plans 21 by the targeted deadline in Rio (1996). The plans include comprehensive actions on resource and waste management, transport, consumption patterns and environmental education. They are essential for cities trying to create an eco-culture and conceive, introduce and manage new systems of supply and demand, founded on active citizen participation. Stockholm (Figure 13) developed a comprehensive eco-cycle balancing strategy, in which waste from some activities become precious input to other productive activities. A new culture of co-operation has been introduced among the energy organisations, the water company and the waste management agency (Beatley 2000).

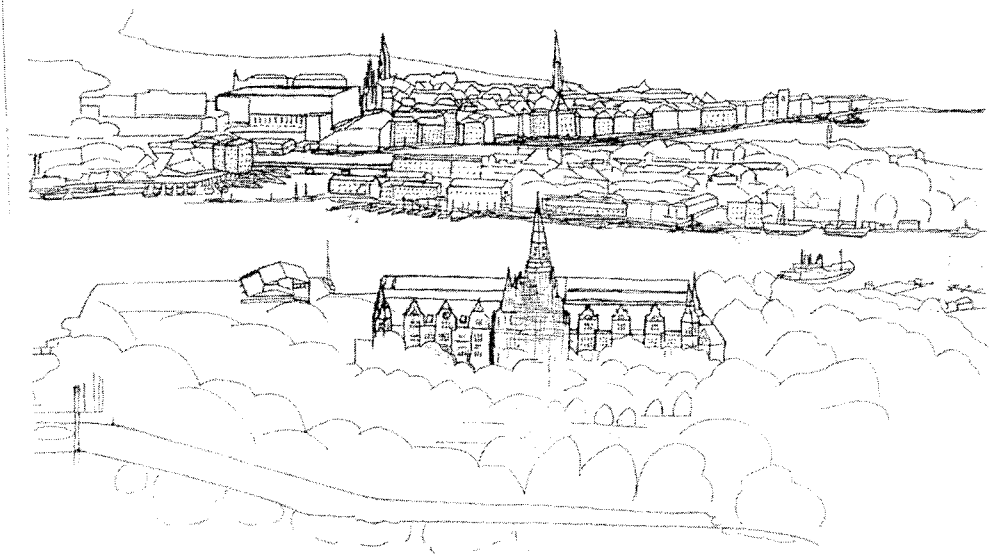

Figure 13. A Representation of Stockholm. Source: The author's exhibition of Artworks on Siren cities, European Parliament 2004

Environmental charters have been prepared by many European cities in the 1990s. In France, environmental charters constitute contracts between the State and each city. The Charter of Mulhouse is a clear example of the strong will to improve the environment and public health. In Italy, the University of Naples prepared a Charter for the sustainable development of Naples and through a large consultation process with citizens associations. The Local Environmental Charter has been shaped through well attended seminars which challenged ecological urban practices in Naples and examined new opportunities stemming from sustainable development (Gillo et al. 1997).

Integrating ecological concern in all urban policies has been a key condition for the concept of the "Ecological city" in the framework of the eponymous OECD project (OECD 1996). The process could be described as an essential bridge between the macro-level concept of sustainable development and the micro-level of everyday local performance. In The Netherlands, the vision for the city of the future is centered on the interrelated concepts of the liveable city, the well-ordered city, the affordable city and the sustainable city.

The Tokyo government promotes the creation of an eco-society in order to advance towards a clean, sound and citizen-friendly metropolis. The action plan includes comprehensive actions on resource management, water recycling, energy, transportation demand management and promotion of environmental education and awareness (UN/Tokyo Metropolitan Government 1998).

In Germany, environmental awareness has often been linked to socio-economic change, first and foremost in the cities which have been the scene of socio-political transformation. With the reunification, the ecological restructuring concept came into prominence. It advocates a new sustainable symbiosis between economy and ecology in the urban landscape and places the emphasis on environmental preventive policies to tackle the anthropological origins of problems. A European model project linking ecological urban restructuring with Local Agenda 21 was implemented in Leipzig (Hahn 1997). The concept has many points in common with the research programme on "Man and the Biosphere" of UNESCO, the first international organisation to use the term "sustainable city" (UNESCO 1988).

Urban ecology has been an important element for the "renaissance" of Berlin, after the fall of the wall during a night of celebration on 9 November 1989. Some projects from the years of euphoria that followed reunification provide convincing examples. In Kreuzberg, the renovation of Block 103 highlighted links between social well being and environmental upgrading. Former squatters of the block have been given the opportunity to own the space they occupied, if successfully trained in converting the houses into environment-friendly and resource-saving buildings. Another complex, Block 6, has been the field of innovation for alternative water systems. The project provided tenants with the possibility to monitor their hydraulic resources and take good care of their rain and grey waters. The process emphasised communication and learning and resulted in fifty per cent savings on water. Eco-stations have been created in many neighbourhoods to promote awareness raising, training and counselling.

Many cities become ecological laboratories and experiment with new concepts, products and processes. Schwabach, a small self-sufficient German city, offers an example for the elaboration of an urban ecology planning strategy. The city has been selected by the Federal Ministry because of its unified, dynamic local government and its ecological achievements to date, especially in waste management. The driving principle is that nothing is impossible and everybody has to participate. The pilot study aimed at introducing ecological concepts and actions to a normal city, under ordinary conditions. They have been translated into a concrete 1993-2003 Model Urban Development Strategy, leading to Schwabach Ecological City (Schmidt-Eichstaedt 1993).

Tourists constitute a special population target for sustainability. Many hotel chains worldwide associate residents in the prevention of water consumption. Special ecological and waste programmes in Mediterranean tourist destinations try to promote sustainability concepts and actions. In the over constructed tourist destination of Marbella, ecological actions comprise reforestation, the paint your tree campaign, and even a programme for the environmental awareness of dogs.

Ecological innovations and best practices come not only from the environment conscious cities but also stem from crises. In Huelva, one of the most polluted Spanish cities, an area of 400 hectares previously used as a deposit site for industrial waste, has been thoroughly rehabilitated.

Community protests and the subsequent social dialogue in search of viable alternatives have been decisive to the success of the project.

In old industrial cities, many environmental problems are linked to the decline of industrial industries. In cities of the former East Germany, like Dessau, ecology was an organic part of the radical upheaval during the 1990s. Eighty-four per cent of the city was destroyed during the Second World War and reconstruction often made things even worse. The collapsed old industry had to innovate in order to survive and develop. A new land-use plan is favouring mixed uses and promoting civic participation. But in 2004, unemployment in former East Germany is still ten points higher than in West Germany (18.5% versus 8.3%) and this has serious consequences for the advance of ecological projects.

The energy balance of cities depends on the urban and energy policy and planning, the urban infrastructures, transport patterns and citizen lifestyles. City structures and policies can contribute immensely towards minimising the material and energy intensity of goods and services, reducing toxic dispersion, enhancing material reuse and maximising the use of renewable resources. Sustainable urban policies should be carried out with respect to the carrying capacity and the equilibrium of the urban and sub-urban ecosystems and with regard to the availability and the distribution of resources. Energy flow analyses and impact monitoring are crucial.

Sustainable development asks for circular rather than linear urban metabolisms and improved energy stocks and flows throughout cities. More efficient and environment-friendly energy systems, gradually integrating new and renewable energy forms, become features of the European urban landscapes. Cities try to improve technologies and demand patterns, optimise production and distribution networks, including decentralised combined heat and power systems, and enhance synergies of excellence. Renewable energy forms become increasingly attractive. The EU-supported SIREN project tries to address barriers to the integration of renewable energy systems at the municipal level and raise awareness of the socio-economic benefits among stakeholders.

Leicester, the first city to be awarded the status of "Environment City" in the UK, offers a plethora of ideas. The city has been assisted by the Business Sector Network to bring together ideas from the city's commercial sector and provide assistance to businesses, and Environ, a

non-profit-making company, helping local organisations with environmental audits and advice. The energy efficiency centre promotes action for improving the efficiency standards for buildings and schools, introduces an energy education package for teachers and invites students to contribute to the energy monitoring of their schools. The energy efficiency bus, equipped with solar panels and connected to the Internet, visits schools and enterprises to promote consciousness about renewable energy. Energy passes to optimise the energy conditions of houses is a common measure in the German Länder (Energie-Cités 2001).

In Germany, Freiburg is a pioneer city in the use of renewable energies and bio-climatic architecture, enhancing physical and climatic factors for optimal design and planning. The political and public support created favourable conditions for the city to be the centre of two national and international renewable energy research Institutes, the Oko-Institute and the Fraunhofer Institute. Developments, such as the Heliotrope constructed in 1985, exhibit the advantages of optimised passive solar compact buildings. The tariff structure of the Freiburg utilities offers more favourable rates for photovoltaic energy users. The virtuous circle of technical demonstration, awareness raising and participation is established, thanks to the commitment of the city and its citizens.

The Kronsberg development in Hanover uses some of the latest energy technologies, while the city of Malmo invests in energy innovation. Barcelona confers a prime example in promoting energy efficiency in buildings. The Municipal Action Plan included the replacement of incandescent lighting by low-energy lighting, improvement of air-conditioning devices, installation of solar heat collectors in educational buildings, office premises and sport complexes and of photovoltaic panels in university and office buildings. A range of improvements was introduced to save energy in municipal buildings. These activities have brought savings of 1,700,000 kWh per year, translating into 243,500 € per year.

Renewable energy options become increasingly popular among cities and citizens. Barcelona has given an exemplary boost to the promotion of thermal solar energy. The BARNAMIL project, conceived by the Barcelona City Council has involved many local organisations and groups, together with the local energy agency BARNAGEL and the Catalan business association APERCA. The adoption of the Thermal Solar Municipal Ordinance, which encourages the installation of solar

heat collectors in buildings, marked an important step forward. The ordinance defined the rules and conditions for the installation of solar collectors in all new and renovated public and private buildings.
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The city of Mataro, North of Barcelona, took advantage of the construction of a new library to experiment with photovoltaics and to create a prototype building to demonstrate that the use of solar energy is not only feasible but also profitable. A computerised monitoring system enables the photovoltaic installation to operate at 62% efficiency. The project has been well received by citizens and the city promotes it, through the dissemination of leaflets and brochures explaining the advantages of solar energy (Energie-Cités 2001).

Symbolic events hold much potential for introducing innovations and influencing everyday decisions. The 2004 edition of "Green Week", celebrated by some one hundred and sixty cities and towns in the 25 EU countries in June 2004, under the banner of "Urban Green Days" offered a greenhouse of ideas and actions. The event focused on four essential themes: green travel, green homes, green neighbourhoods and green reporting. Participating cities often went beyond the state of the art.

Modena presented the co-action of two companies introducing a free bus service for the commuting of their staff, which constitutes a novel car-pooling experience. In Orléans, a 300m^2 replica house demonstrated the impact of lifestyle choices. The living room focused on energy consumption, the kitchen on fair trade, labelling and recycling, the bathroom on the water cycle and cleaning chemical products and the office on the use of paper and electronic appliances. At the level of the neighbourhood, London's Lewisham Borough opened a new park on previously industrial wasteland named Ferranti park after the designer of the world's first large-scale power scale in 1890, built in the area. On green reporting, London used the Urban Green Days to launch a new website www.london-green-map.org, mapping community-based environmental events across the city.

2. ECOEFFICIENCY, ECODESIGN, ECOAUDITING

Improving eco-efficiency (economic and ecological) is a promising path for visionary and committed cities, governments, industry and citizens willing to advance towards sustainable development. The

Business Council for Sustainable Development (later WBCSD) adopted eco-efficiency as a business concept in 1992, in its report to the Rio Summit. Eco-efficiency demands more and better with less impact on the environment. It is achieved by the delivery of competitively priced goods and services that satisfy quality of life, while progressively reducing resource intensity and ecological impact throughout the life cycle. Energy intensity, material minimisation, service intensity of goods, minimisation of the toxic dispersion, enhancement of the life cycle and maximisation of the use of renewable resources are key criteria for eco-efficiency (Fussler 1996; WBCSD 1997).

Traditionally, the noblest aim for businesses and cities was to provide good products and services and meet the needs of citizens with worthy returns to shareholders and satisfying working and living environments. With advancing globalisation, growing importance of corporate governance, emergence of ethical consumers and rising of green and pressure groups, industry has to satisfy an increasing number of stakeholders, including all those potentially impacted by products and services. Legislation and enforcement are quoted as powerful drivers of corporate environmental performance, together with business values, corporate image and reputation, agreements between government, trade associations, cost of waste disposal, customer and citizen participation (WBCSD 1999).

Studies have revealed important improvements in eco-efficiency over the last years. However, the increasing demand for resources outweighs the eco-efficiency gains. Improving eco-efficiency throughout the economy demands actions such as the adoption of eco-efficiency input and output indicators at national level and the promotion of eco-efficiency economy-wide. Strategies for social innovation include efforts for sounder household and mobility consumption patterns, eco-education, information and communication. Adoption of best practices can improve environmental performance and increase benefits or reduce costs.

Sustainable eco-consumption is the main driving force for eco-developments. Eco-innovation can be supported by various instruments. New types of voluntary agreements and approaches, such as extended producer responsibility, disclosure requirements and environmental management systems, encourage changes in resource inputs and the complete remodelling of products and processes. Eco-design, design for the environment and the economy, takes into account environmental

considerations into product and process engineering and marketing procedures. Eco-companies and enlightened businesses aim at reducing the impact of processes and products throughout their life cycles.

It is estimated that 80% of all product-related environmental impacts are determined during the product design phase. An EU framework directive on eco-design requirements for energy-using products, issued in 2003, promotes the integration of environmental considerations as early as possible into the product development process. The directive is a fine demonstration of the integration of life-cycle thinking in European decision-making. The reduction of the energy consumption of products benefits the economy, the environment and the society. A number of studies have demonstrated that regulation is a motor for eco-design.

Values relating to fair trade gain ground. Green, ethical and vigilant consumers call for cities and companies to design and prove their contribution to sustainable development. Citizen associations and the media tend to create a climate of trust, surrounding sustainable cities and businesses. Companies and municipalities without a declared commitment to sustainable development may face consumer boycotts, attacks on fixed assets, failure to attract good stakeholders, residents and employees, expenses to remedy past mistakes, restrictions on operations and obstacles in raising finance and insurance. Pro-action is a must, since damaged reputation, impaired licenses, disillusioned shareholders and disappointed citizens may impose a disproportionate a-posteriori cost. The ERICA sea accident in 1999 and the way that TotalFinaElf tried to restore trust provide a prime example.

A growing number of cities and companies are preparing for zero emissions. Pioneer businesses adopted the concept of sustainable development as a central corporate value and try to integrate socio-environmental objectives in the overall business principles. Business groups encourage their member companies to align corporate and societal values and simultaneously consider both shareholder and societal added value. Declarations and codes of ethics introduced a new era of corporate social responsibility. At the international inter-governmental forefront, Agenda 21, seen as the highest value reference for sustainable development, included guidelines for local authorities and businesses (Mega 2000a).

Like urban declarations, corporate codes of conduct gain momentum. Their effectiveness is however hard to evaluate. Assessment and public reporting is a necessary complementary component of the whole process. The voluntary non-binding nature of most codes is often related to the absence of any form of independent auditing, even if codes spell out the necessity for monitoring, assessment and reporting. Businesses adopt a broad range of approaches, from non-reporting to social reporting (SustainAbility/UNEP 1998, 1999). The EU Strategy on Sustainable Development invited all publicly-quoted companies with at least five hundred staff to publish a triple bottom-line report and present their performance against economic, social and economic criteria.

The principles suggested by CERES, a leading US coalition of environmental investor and advocacy groups, seem to be the highest watermark in terms of commitment to monitoring and publicly reporting on progress. Endorsers commit to annually complete a report, to assess opportunities and weaknesses. Such reports help stakeholders and investors to get more fully involved in the process of corporate goal setting and evaluate adherence to the principles. The global reporting initiative, launched in 1997, proposed a harmonized public disclosure to deliver a steady flow of consistent, comparable and verifiable information (CERES 1998a, b, 2002).

Local clusters of excellence are essential in promoting shared responsibility and new approaches. They often forge strong links between research and production. In Ireland, the Clean Technology Centre, established in 1991 as a partnership venture among the Cork Regional Technical College and ten leading companies in the chemical and pharmaceutical industry, is regarded as a pole of eco-innovation in one of the most contentious environmental management areas. Environmental pressures impacting on industry include licensing, regulations and voluntary initiatives. The Clean Technology Centre aims at promoting waste minimization techniques, clean technologies and cleaner production. The project bridges the concern for the environment and the need to produce well-equipped graduates for industry. Industry improved access to information and skills and the community established confidence in environmental management in the region.

Eco-auditing constitutes a valuable instrument on the road towards sustainability. Eco-auditing schemes have first been adopted by private sector organizations as management tools in order to assess,

report on and improve environmental performance. Their backbone is a systematic environmental monitoring considering all aspects of an organization's activities and services, products and processes. Environmental auditing in the public sector and especially among local authorities is a rapidly expanding instrument for challenging urban performances. The field is still in a state of flux and it is difficult to provide a well-defined paradigm out of hybrid methodologies. A good example is provided by the EU Eco-Management and Audit Scheme (EMAS).

The EMAS aims at recognizing and rewarding organizations that go beyond minimum legal compliance and continuously improve their performance. It is an instrument available to companies since 1995. Originally restricted to industrial sectors, it has been open to all economic sectors since 2001. Participation is voluntary and open to all public and private organizations operating in the EU and the EEA. To receive EMAS registration and signal it to the outside world with an attractive logo, an organization must conduct a thorough environmental review and consequently establish an effective environmental management system, with requirements equivalent to international standards ISO 14001. The organisation has to carry out an environmental audit, assess the system in place and provide a statement of its environmental performance. All above four stages have to be approved by an accredited EMAS verifier. External, independent third party verification plays a key role for the credibility, reliability and transparency of the scheme. Integration of energy efficiency in EMAS led to the E2MAS scheme.

Transparency, credibility, accountability are the three key components of auditing schemes. Cities and enterprises often adopt parallel paths when conducting their environmental auditing. It is essential to have the rigour associated with financial auditing in the process. Diagnosis should be followed by prognosis of trends and adequate design of policies. The environmental balance sheet of Sundsvall, in Sweden, including the accounts of stocks and flows of environmental resources, can provide a model. In the periphery of Barcelona, Igualada undertakes the auditing of all urban activities, while in the UK, the richness of the components of environmental auditing in Kirklees offers a horizon of lessons. From the internal auditing of the municipality to the external auditing of the community, urban eco-auditing practices can inspire many cities (EFILWC 1995a).

3. ENERGY AND THE BUILT ENVIRONMENT

Environmental concerns are increasingly embraced by the EU citizens. They are often linked to damage caused by energy supply systems, e.g. oil slicks, nuclear accidents and methane leaks, but also to the inherent inefficiencies of the combustion systems. Climate change, a long-term battle for the world community is inextricably related to energy. The European Union has 5% of the world population but produces 14% of the global emissions. Improving energy efficiency across sectors and throughout activities is a key factor for meeting the challenges towards sustainable energy.

The Action Plan to improve energy efficiency in the European Community estimates a potential for energy efficiency improvement of more than 18% of present energy consumption. It is equivalent to over 160 Mtoe or 1,900 TWh, and it is not yet realized partly due to impediments which prevent the adequate diffusion of energy-efficient technologies and the resourceful use of energy. The Action Plan includes policies and instruments for overcoming obstacles and enhancing opportunities (EC 2000d).

Buildings account for 45% of total energy consumption in the EU, mainly for heating, lighting, appliances and equipment. Increasing living space per capita and higher levels of comfort and equipment for homes and offices lead to rising energy consumption. The impact of energy use in buildings is pervasive, since it is estimated that Europeans spend 90% of their time indoors. Studies demonstrate that there is a large potential for cost-effective energy savings in this field, probably larger than in any other sector. Buildings in Europe have lifetimes of between fifty and one hundred years or more. Given the low turnover of buildings, the largest potential for improving energy performance, in the short-term, is in the existing building stock.

New ethics are increasingly reflected in new building regulations. An EU Directive, issued in 2002, on the energy performance of buildings, suggested a common framework of harmonized measures for the development of integrated energy performance standards, to be applied to new and existing buildings when renovated. Energy performance

standards should lead to certification schemes for buildings, which would be presented to the public. Especially for public buildings, standards would recommend the optimal climatic conditions for energy efficiency. Last but not least, the directive highlights the importance of the inspection of boilers and other heating and cooling systems for energy efficiency. A total energy saving of 22% could be achieved by 2010 with these measures.

The proposed common approach to energy performance standards covers efficiency aspects ranging from clean and efficient energy generation to insulation and installed equipment. An integrated method addressing all energy aspects would facilitate the most effective and efficient combination of measures. To some extent, this method has already been applied in Finland, Germany, Ireland, the Netherlands and the United Kingdom. Expanding this approach for the EU would not only increase energy savings, but also provide a basis for designers and builders to be able to recognize and utilize high standards across different member States.

The certification schemes founded on the above methodology would be applied to buildings and dwellings when they are built, sold or rented. They should not be over five years old, and should include guidance on how to increase energy efficiency. The specific inclusion with the rental of buildings could counteract any negative aspects of the different interests of the building owner and tenant. As owners are not responsible for the energy bills, they are often less motivated to improve the energy efficiency of the buildings and are unlikely to invest in energy saving features such as insulation. However, if tenants are authorized and exhorted to view the energy efficiency standards when choosing a property to rent, there are incentives for owners to invest in improvements.

Certification schemes are currently mandatory in new buildings in Denmark, Germany and the United Kingdom. Some member States operate a voluntary certification scheme for existing buildings, which is mandatory only in Denmark. Estimations in Denmark that included the certification of 160,000 houses over three and a half years achieved energy savings of 125 million €. This is extremely encouraging for the promotion of energy efficiency in buildings, particularly when compared with the cost of 25 million € for certification for the same period. Overall,

this practice produced a return of over thirteen per cent on investments, demonstrating the scheme's cost-effectiveness.

Finally, the EU framework highlights the importance of the inspection and assessment of heating and cooling systems. The examination and subsequent maintenance of such systems is now acknowledged as a key method for upholding energy efficiency. The frequency of inspections should correspond to the range of the particular installation. For example, with the range of 10 kW and 100 kW that is shown by boilers in small residences to those in blocks of flats or offices, these installations should be examined at least every four years. However, a frequency of inspection of up to two years is necessary for boilers that have an output higher than 100 kW. In the situation where the boiler is over fifteen years old, it is recommended that the whole heating system should be inspected in order to determine which measures are most appropriate to improve its energy performance. Within the European Union, the inspection of boilers is already mandatory in some member States, with the remainder following voluntary and information programmes.

Public buildings and privately owned buildings that are used by the public can act as pioneers and serve as models for intelligent resource-saving buildings. The display of energy performance certificates and recommended optimal climatic conditions, e.g. the most favourable indoor temperatures, in all buildings frequented by the public can promote awareness. Symbols are important, such as the buildings hosting the Danish and Dutch ministries of Environment.

4. THE BATTLE OF CLIMATE CHANGE

Climate change is a multi-faceted phenomenon and the most prominent issue of sustainable development agendas. Its primary indicator is air surface temperature. Average global annual air temperatures have risen by 0.6°C since the late 1800s, and the Intergovernmental Panel on Climate Change (IPCC), created in 1988 by two United Nations organisations (WMO and UNEP), foresees a considerable increase of 1.4 to 5.8 degrees Celsius by 2100. Sea level rise is also most often associated with climate change and if present trends continue, projections suggest an increase of 9 to 88 cm by 2100, a rapid

and profound change. Temperature change may also cause extreme weather events, such as storms, floods, hurricanes, heat waves and droughts. Evidence of climate change is growing, both on land and in the oceans, with receding glaciers and disturbed marine species (IPCC 2001).

Scientific evidence highlights that emissions of greenhouse gases (GHG), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the three main fluorinated gases, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6), are causing a rise in air temperatures. The Greenhouse Effect is a natural phenomenon, without which the earth would have temperatures around 33°C lower. However, the unnatural rise in greenhouse gases, which have increased seven fold during the twentieth century, has led to what is known as the Enhanced Greenhouse Effect, causing global warming. The origins of climate change are very diverse, stemming from a multitude of natural and human activities. Energy production and consumption have an enormous contribution. Power supply is the single most important contributor to GHG emissions. Deforestation contributes to releasing CO_2 and conversely geological sequestration helps to diminish CO_2 into the atmosphere (IPCC 1996).

Climate politics is high on the global agenda, attracting significant attention from scientists, policy makers and citizens, but still clouded by uncertainty on the impacts, costs and benefits of action. It is a planetary challenge with important intra- and inter-generation equity dimensions, since action is needed now to alter long-term trends affecting future generations and to prevent change, which is not expected to be uniform across the globe. Countries that have caused the bulk of emissions (USA, China and the EU are causing 21%, 15% and 14% respectively) are not those most likely to suffer its worst impact. The most severe harmful impacts are expected to occur in the developing world, further aggravating poverty and socio-economic disparities. Low land populations, such as those in Bangladesh, seem particularly vulnerable, due to flooding. Industrialised countries have a responsibility for leadership in addressing emissions. A global participation, with common but differentiated responsibilities, is required for a lasting solution (OECD 2003).

The key starting point for action against global climate change is the United Nations Framework Convention on Climate Change (UNFCCC), issued during the 1992 Rio conference. The Framework

Convention on Climate Change, ratified now by one hundred and eighty nine nations legally bound by it, recognized the challenges posed by climate change, and set an ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. According to the convention, industrialised countries should aim to reduce their GHG emissions, report on relevant policies and present emission projections. The Conference of Parties to the Climate Convention would meet periodically to review commitments and bring possible amendments to the Convention.

At the Third Conference of the signatories in Kyoto in 1997, the Kyoto Protocol to the UNFCCC, marked an important milestone. It constituted a major pact among industrialised countries, committing them to clear emission reduction and unambiguous targets for GHG emissions. The protocol introduced three new flexible instruments, including emission trading, joint implementation and the clean development mechanism. At the forefront of international efforts, the European Union committed itself to reducing its greenhouse gas emissions to 8% below 1990 levels by 2008-2012.

The United States withdrew from the Kyoto Protocol in 2001. All EU member States ratified the Kyoto Protocol in 2002. Russia joined on 18 November 2004. Russia's support brought the number of countries and CO_2 emissions they account for over the limit to make the protocol legally binding. This fact marked the start of the ninety day count down to the entry into force of the protocol on 16 February 2005 adopted by 141 countries. The Kyoto Protocol is considered to be the first step in a long struggle to tame global climate with concerted efforts by all nations. There is however increasing evidence that climate change cannot be prevented and adaptation measures are also crucial (OECD 1999a, 2000c).

Global change and energy are among of the cornerstones of the EU Strategy on Sustainable Development. Long-term visions, systematic research and comprehensive policies are vital for moving effectively towards low emission pathways. Emission patterns are influenced by long-lived investments in energy supply, transport infrastructure, housing and industrial installations, which impact consumption patterns at a long time horizon. Instant change is impossible and the need for technological, socio-economic and institutional innovation is sharper (EC 2001b).

Global warming is partially the end product of millions of individual decisions made by the world's residents within their immediate environments. The contribution of each city to global warming depends on its environmental and economic performance, social well-being and awareness about its impact on the global environment. A network of global-minded cities, the Alliance of European Cities for the Climate, brings together hundreds of communities in Germany and the rest of Europe, all of them dedicated in achieving 50% reduction in CO_2 emissions by 2010 as compared to 1987.

Carbon dioxide, the dominant greenhouse gas accounting for 78% of emissions, is primarily generated by the energy system, responsible for 95% of the total CO_2 emissions. As the efficiency of the combustion process is low, there are many carbon dioxide emissions in comparison to the actual value of energy created. There is a huge potential for research and technological innovation to dramatically reduce carbon dioxide emissions by improving efficiency or by switching to fuels with low or zero carbon content.

Methane, the second most important greenhouse gas, accounting for around 9% in GHGs, is a powerful gas; each tonne of methane is equivalent, in global warming terms, to twenty one tonnes of CO_2, over a time span of one hundred years. The contribution of the energy system to total methane emissions fell from 23% in 1990 to 20%. The main sources of energy-related methane are coal mining and the production and transmission of natural gas. Natural gas is typically composed of between 85% and 95% methane, and, when natural gas is released during the extraction of coal and oil, a significant amount of CH_4 emissions are also generated. Nitrous oxide is a very powerful GHG, with each tonne equivalent to three hundred and ten tonnes of CO_2, over a time span of one hundred years. The main sources of N_2O are industrial processes, agriculture and fuel combustion. The contribution of the energy system is about 16% (EEA 2002).

From 1990 to 2001, the European Union marked an overall 2.3% reduction in GHG emissions. CO_2 emissions had increased by 1.6% above 1990 levels, while CH_4 and N_2O had decreased by 21% and 16% respectively. In 2002, emissions were 2.9% below 1990 levels. Achieving the target on a linear path, emissions should have fallen by 4.8%. This means that the EU has only made the third of the way towards meeting

the Kyoto objectives. More worrying are the trends in Ireland, Portugal which exceeded their target paths by 20% (EEA 2003).

Progress resulted from an amalgamation of developments in most sectors (energy supply, industry, agriculture, waste management), some of which cannot be repeated, such as the introduction of technical measures to decrease nitrous oxide emissions in plants in France and the UK. In the UK, the achieved reduction of 14% in GHG emissions is primarily due to the shift from the use of coal to the use of natural gas in power generation. Trends in emission reductions could change very swiftly, as in the UK, where due to a slight increase in coal use in 2000, carbon dioxide emissions for this year have marked an increase of 2% above their 1999 levels (EEA 2003).

The transport sector represents the main obstacle to progress. Emissions originated from transport increased by 21% during the period 1990-2001. Increased transport demand has largely outstripped gains from technological improvement and fuel efficiency. The automobile industry, under its voluntary agreement with the European Commission, has multiplied its efforts to reduce CO_2 emissions from passenger cars. Even if a reduction in emissions from new cars was achieved, all three manufacturing associations (Europe, Japan and Korea) must intensify their efforts in order to meet their longer term objectives.

Based on scientific evidence, the EU has reached political consensus that + 2 °C above pre-industrial levels is the maximum safe level taking into account the pre-cautionary principle. The latest projections highlight that the European Union will be unable to meet the Kyoto objectives in the absence of intense efforts and stringent measures (Figure 14). All new member States, except Slovenia, are on track to meet their reduction targets, mainly because of the economic transition and the consequent restructuring or closure of heavily polluting industries. Projections for the EU-25 expect emissions to be only 3.8%below 1990 levels by 2010.

The European Climate Change Programme (ECCP) set up by the European Commission in 2000, aims at identifying the most environmentally beneficial and cost-effective additional measures as a means of enabling the EU to meet its target, complementing the efforts of member States. In 2003, the second ECCP progress report provided an overview of the results including the status of implementation of the

range of measures and suggests further actions in the most promising directions. The policies and measures included in the ECCP report have a total emission reduction potential of 578 - 696 million tonnes of CO_2 equivalent emissions. This meant, for the EU of the fifteen member States, a capacity for emission reduction twice as required (336), confirming the EU ability to meet its target if the appropriate measures are put in place (EC 2003c).

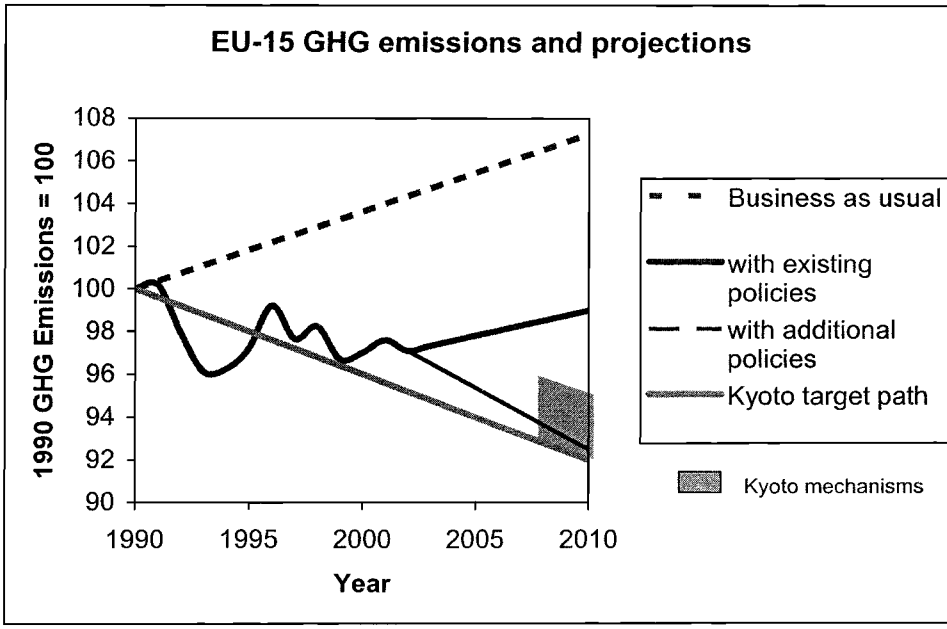

Figure 14. EU-15 Greenhouse emissions and projections 1990-2010. Source: EC 2004

The cost-effectiveness of policies to fulfill the Kyoto commitments is an important element of the EU strategy. Cost estimates of the different combinations of emission abatement measures exhibit considerable variation between studies. The most cost-effective methods are expected to achieve a cost of between 0-50 € per tonne CO_2 equivalent reduction, including savings that offset the cost of the measure (e.g. avoided fuel costs). Cost-effective measures may be straightforward, such as reducing the leakage of natural gas from pipelines, which is economically attractive as it decreases fuel losses while dropping emissions.

Emission trading is a flexible mechanism, which is increasingly attractive for EU member States wishing to reach their targets at significantly lower costs (EC 2001e). The EU framework for emission trading confers more flexibility and cost-efficiency than direct regulation and may offer higher degree of effectiveness regarding the fulfillment of the commitments than other economic instruments, such as taxation or voluntary agreements. Model simulations developed in various EU research projects demonstrate that EU-wide emission trading would reduce the cost of meeting the EU Kyoto objectives by 25% or more. In July 2004, the European Commission has accepted the first eight national allocation plans, which define the number of CO_2 emission allowances that member States intend to allocate to energy-intensive industrial plants so that they can participate in emissions trading from January 2005. The scheme is expected to cover some 12,000 industrial and energy production plants across the EU.

5. URBAN SOIL, WATER AND AIR

Land is the essential ingredient in any urban growth. Urbanisation increases the demand for land and the pressure on wild land. Forests are being changed to agricultural land or urban areas. Urbanisation is likely to lead to a doubling in size of built-up areas in most developing countries over the next fifteen to twenty years. Coastal cities and zones, which attract a high percentage of the world population are under increased stress. The retreat of the shoreline affects many coastal regions. Biological diversity is ever more threatened. Devising efficient, effective and equitable land development policies, incorporating environmental imperatives, is a major challenge facing decision-makers and planners.

The latest report on environmental signals issued by the European Environment Agency highlights that the area of built-up land in Europe is growing much faster than the population and that social pressures are driving a trend towards more and smaller households, which use resources less efficiently than large ones. Urban sprawl may have disastrous effects on the environment. Agricultural land is been abandoned or intensely exploited while new forms of rural development may bring additional pressures on the environment (EEA 2004).

In the European Union, concerns about the degradation of soil led the European Commission to take the initiative of a strategy to protect soils as one of seven thematic strategies foreseen under the Sixth Environment Action Programme (EC 2001a). Soil is a vital and largely non-renewable resource. Soil erosion, the decline in soil quality and the sealing of soil are major and often irreparable problems across the EU. They have crucial urban dimensions.

Fresh water is a vital and scarce natural resource. In Europe, many cities experience water shortages or are supplied with ground water, the quality of which is seriously threatened. Maintenance of distribution networks remains a major concern. Leakage and risk detection are increasingly parts of integrated management and early warning systems. Renovation of networks and surveillance systems in order to limit leakage, which often reaches 30%, is under way or planned in many cities. In Tokyo, the set up of a system for identifying leaks has reduced losses to nine per cent.

At the global scene, more than half of the world population has no access to safe drinking water. Water is a potential source of conflict, but it can also be an effective means for dialogue to built trust and co-operation among countries. Good water governance is essential to prevent a global water crisis. Water management strategies have to halt the unsustainable exploitation of water resources and promote both equitable access and adequate supplies. The International Year of Freshwater 2003 shed ample light to the sustainable use of global hydrological resources and the ethical and socio-economic principles to guide water management and development practices. The Water Campaign, launched by the International Council of Local Environmental Initiatives (ICLEI) in June 2000, aims at building a worldwide movement of local governments committed to achieving tangible improvements in the sustainable use of fresh water resources by protecting and enhancing local watersheds, reducing water pollution, and improving the availability and efficiency of water services.

Water management reflects economic, social, environmental and cultural values. Sound water management requires the consideration of the entire water cycle, including its natural phase (rain, water tables, rivers) and the phase linked to human activity (from collecting water to purification of polluted water), and sheds light on the importance of innovation, policy integration strategies and monitoring. Water

observatories allow the meeting of quantitative and qualitative demands for drinking water, the evaluation of risks related to water pollutants and flooding and the elaboration of a meaningful water management policy. A strong institutional framework, incremental rates systems that penalise the largest customers, improved information and awareness and active participation of stakeholders are key elements of efficient and effective policy portfolios.

The EU Initiative "Water for Life" launched at the Johannesburg Summit as a comprehensive partnership designed to help countries achieve water and sanitation targets, progressed with the conclusion of specific agreements between Africa, Eastern Europe, the Caucasus and Central Asia. It constitutes a multi-stakeholder process involving greatly the partner regions, the business world and the civil society. The Third World Water Forum (Kyoto, March 2003) offered a unique platform for exchanging ideas and experiences, and discussing the global water crisis. The European Commission confirmed its commitment to cutting by half the number of people living without drinking water and basic sanitation. During a special Europe Day in Kyoto, delegates had the opportunity to learn about progress in implementing the Water Initiative and problems experienced in partner regions (Africa, Newly Independent States and Mediterranean).

Air pollution critically affects human health and may also damage ecosystems, buildings and monuments. It results from the combination of gases that are emitted into the air. The most significant of these include sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), suspended particles, and certain metals. The primary source of air pollution is the combustion of fossil fuel in energy generation, industrial processes and transport (EEA 1997). During the last ten years there has been significant success in reducing certain pollutants through source control and abatement strategies and fiscal measures. Lead concentrations dropped sharply. However, guideline thresholds issued by the WHO for sulphur dioxide, carbon monoxide, nitrogen oxides and particular matter are still exceeded in a great number of European cities.

Reports from the European Environmental Agency highlight that as many as sixty thousand deaths per year in large European cities are caused by long-term exposure to air pollution. Children are increasingly exposed to environmental risks than adults. One child in seven is affected

by asthma. Air pollution indices developed for forty five European cities, with a total population of eighty million, highlight that 35% of the inhabitants are exposed to concentration levels that exceed the short-term air quality guidelines for SO_2 and/or winter smog conditions. Even higher percentages of citizens are exposed to ozone-related summer smog conditions, due primarily to NO_x concentrations. Studies indicate that life expectancy in polluted urban areas in Poland and the Czech Republic is significantly below average for these countries as a whole. Apart from local air pollution, the combustion of fossil fuels causes important problems on a regional scale, notably acid rain (EEA 1995a, 1997, 1998, 1999, 2002).

In European cities, the dominant sources of atmospheric pollution are shifting from the combustion of high sulphur fuels linked to energy and industrial processes to the combustion of gaseous fuels for motorised traffic. Nitrogen oxides, particularly nitrogen dioxide, are known to cause specific damage to lung tissues and to contribute to acidification, eutrophication and photochemical smog. The great majority of NO_x emissions (98%) are produced by energy production and consumption. Over the period 1990 to 1998, total NO_x emissions fell by 20%; the same decrease was achieved in energy-related NO_x emissions.

Sulphur dioxide emissions contribute to acidification and the production of fine particular matter, which can have major health effects. The great majority of SO_2 emissions (94% in 1998) come from the energy system. Fossil fuels contain varying levels of sulphur. The utmost source of EU SO_2 emissions is electricity production by conventional power stations. Due to technological progress in electricity generation, strict SO_2 emission abatement measures, changes in the sulphur content of fuels and the introduction of differential tax levels, EU emissions have substantially decreased. Over the period from 1990 to 1998, total SO_2 emissions decreased by 52%. The same drop was registered for energy-related SO_2 (EC 1999c).

The energy sector is responsible for three extremely important air pollutants, particularly with regard to human health: arsenic, cadmium and nickel. Within the EU, the greatest source of arsenic (87%) and nickel (59%) is stationary combustion, including public power generation, co-generation and district heating, domestic burning of solid fuels, and industrial combustion. Heavy metals occur naturally in fossil fuels, in particular solid fuels and oil. These fuels burn with a high ash

residue (hence their high production of suspended particulates), onto which the heavy metal compounds attach themselves in the flue gas. The level of heavy metal emissions is also greatly affected by the actual combustion process itself, including the conditions, temperatures and secondary emission abatement systems.

There is a large array of factors that impact air pollution. They include the type and the location of the pollution source, the type and concentration of emissions, the time of year (warmer temperatures increase chemical reaction rates), and the geomorphology of the region, since valleys tend to trap air pollution. Similarly, the extent to which air pollution affects human health also depends on numerous parameters, the most significant of these being the level and length of time of exposure, individual susceptibility and age.

For several years high ozone concentrations have been reported in the air in Europe between May and August. In the higher layers of the atmosphere (stratosphere), ozone shields the planet from damaging UV radiation; in the lower atmosphere it is an aggressive gas, which alters cellular function particularly in the ocular and pulmonary mucous membranes. Epidemiological studies have shown that peaks in ozone concentration cause irritation of the eyes and of the respiratory tracts, coughs, headaches and disturbances in respiratory function particularly in children and asthmatics. Since 1994, an EU Directive on air pollution aims at informing and alerting the population when the permissible thresholds of air pollution are exceeded. Tropospheric ozone develops from compounds such as nitrogen oxides (NO_x) and organic volatile compounds in the presence of solar rays. These component parts are emitted into the atmosphere through human activities, mainly transport, and from natural sources.

Air pollution is rarely caused by a single pollutant and the effects of exposure to a cocktail of pollutants can either be multiple, or amplified if different pollutants cause similar impacts. The heavy metals produced during energy generation by fossil fuels can cause various cancers, digestive and nervous problems. Similarly, particulates can be carcinogenic, but they also cause cardiac problems, respiratory diseases, and increase the risk of infant mortality. Since these pollutants often occur together as the particulates are a vector for heavy metal compounds, they may intensify mutually carcinogenic properties and cause a range of serious health problems (EC 1999c).

6. SUSTAINABLE WASTE MANAGEMENT

Sound waste management is inextricably linked to sound resource management. Any paradigm shift concerning waste starts by its consideration as a precious resource. But if the rest of resources should not be depleted, waste should not be generated. Integrated product policies shed light on the life-cycle of products from the extraction of natural resources, through their design, manufacture, assembly, marketing, distribution, sale and use to their eventual disposal as waste. Eco-efficiency and eco-labelling are crucial for the prevention of waste generation. Packaging waste has to be given particular attention.

Reconsideration of the urban metabolism insists on waste prevention, action before the waste is generated, even if investments still concentrate on the recycling end. However, municipal waste still increases in line with GDP. The costs for disposing of urban waste are very high and reach 30% of the total environmental expenditure. Zero waste seems a utopian slogan. However, throughout Europe, many cities abandon conventional waste disposal policies and adopt innovative waste management.

Regulation obliging waste generators to separate all waste at source has been the common element of many waste management programmes. Source separation is conducted in co-operation with the treatment facilities. It is normally preceded by introduction of technology or practices to prevent and reduce waste. Household waste is in general collected at three levels: residue, organic and bulky waste. Glass and paper waste are usually collected in neighbourhood containers. Enterprises sort waste into many more different fractions. Hazardous waste is usually subject to more research and treatment.

The Danish waste management system can provide insight into comprehensive waste management. Thirty years ago the main question was to optimise infrastructure and logistics. Municipalities came voluntarily together to form inter-communal partnerships and optimise the size of waste processing facilities. In the mid-1980s, municipalities obtained the authority to regulate all waste generated by the local residential, commercial, construction and industrial sectors. Throughout

the 1980s, a national law obliged waste generators to pay a tax for the disposal of waste for landfilling and incineration. The Copenhagen City Council adopted a comprehensive urban waste regulatory system in 1991. In 2001, the objectives of the waste regulatory system were for 58% of the urban solid waste to be recycled, 24% to be incinerated and 18% to be landfilled.

From the recycling of hi-tech electronic material to the composting of organic waste, European experiences are multiple and diverse. In Bolzano, a project to verify and compare measurement methods of urban waste is aiming to support for change in financing from tax to tariff for waste produced. The Clean City Awards Scheme, set up by the Corporation of London was designed to develop a partnership with businesses to achieve a clean environment through sound waste management.

A project set up by the Municipality of Oeiras, in the metropolitan area of Lisbon, for the backyard composting of organic waste led to the dramatic reduction of the volume of waste the municipal services collect, transport, treat and dispose of. The project had a great impact in increasing public awareness of urban environmental problems and offered inhabitants the possibility to produce a high quality fertiliser for their gardens. In Rimini, a medium-sized city with a double population during the summer months, the municipality decided to unify waste management, summer-intense activity with garden maintenance, conducted especially during the winter months. The public company created for this two-season activity promoted diversified collections, mainly for paper derived from domestic use and organic waste collection from hotels. The first collection was based on the stimulation of public participation through the exchange of used paper for a plant. The collected paper was transported and recycled in a paper-mill near the city, which was entrusted to a centre for the rehabilitation of drug addicts.

In Parma, the public company for waste collection has always been active in organising diversified collections, mainly paper and glass in the 1970s, aluminium cans and batteries in the 1980s. Creative advertising has been used to create awareness and encourage civic participation. "We will build a kindergarten with the profits received from the sale of used paper" was the major slogan of a paper recycling campaign. In the 1990s, its project "Friendly Plastic" aimed at transforming plastic waste into building material. A company for the

recycling of heterogeneous plastics was founded and produced recycled plastic, but the new material was not easily accepted by the market and its competitive forces (EFILWC 1993).

New urban neighbourhoods offer ample opportunities for innovative resource and waste management. According to Aristotle "habits are being formed the first day." The Understenshöjden ecological village in Stockholm is a good example of improving urban metabolism with ecological self-building and user participation in the design. In Kronsberg, a new quarter of seventy hectares, built in Hanover for the EXPO 2000 and hosting seven thousand residents by the end of 2001, the Waste Management Concept initiated preventative waste management planning instead of conventional waste disposal.

The design and construction of the Kronsberg district incorporated all currently available know-how on ecological aspects of construction. This extended from energy-saving construction methods for all buildings to rainwater management and ecological management of excavated soil to the exemplary waste concept. The model includes the building waste concept, the commercial and domestic waste idea and communication. Within the construction waste concept, the city of Hanover reached a contractual agreement with developers to use exclusively environmentally compatible and healthy building materials. Construction waste was reduced by 80% through sorting and recycling measures. Waste at Kronsberg could be reduced by 30% to 154 Kg per resident and year, compared to the Hanover average of 219 Kg per person and year.

To promote communication, the City of Hanover and the institutions concerned by the creation of Kronsberg, created KUKA, Kronsberg's Environmental Liaison Agency. KUKA played an important role in advising and training local residents on waste sorting (glass, waste paper, organic waste, packaging and the rest) and disposal at nearby collection points. Special attention was given to the awareness raising of immigrants and children. One of the most interesting concepts was the low-waste breakfasts. The project won the Barcelona Royal innovation award, a bi-annual award that recompensed in 2002 best practices in waste management.

7. MOBILITY AND ACCESSIBILITY

Environmental problems in urban areas do not arise mainly as a result of production. They essentially result from consumption and, in particular, from traffic. Traffic infrastructure covers 10% to 15% of the urban space in the EU and is source of many concerns. The road network should facilitate traffic flows and not dominate the body of the city. The vehicle stock grew by 50% in the period between 1980 and 1995 (while vehicle occupancy rates declined) and kilometres travelled by 65% (compared to a population growth of 13% and a growth of GDP of 44%). Inland transport costs, in terms of accidents and environmental impact, may represent 5% of GDP. In urban areas, the high cost of congestion could further increase this figure. In cities like Athens more than 80% of air pollution is attributable to traffic.

Transport is the fastest growing source of greenhouse gas emissions. At the global level, road transport has become the largest single most intractable anthropogenic source of CO_2 emissions. It seems that current policies cannot prevent problems from getting worse and that a drastic overall reduction in travel is necessary. Addressing greenhouse gas emissions from transport requires a fundamentally novel approach with the public engaged in policy development and debate. Technological, social and political innovation should be promoted, together with demand-side management and governance. The EU White Paper on Transport insists that pricing infrastructure should reflect real transport costs. The ECMT work on the socio-environmental externalities of transport proposed a common basis for the costs and the mix of policy instruments (EC 2001f).

Mobility has long been regarded as a cardinal urban value. The private car is a supreme symbol of freedom for urban dwellers. Mobility patterns depend on both the supply of transport infrastructure and the increasingly complex and unsystematic mobility demand. Demand is impacted by the largely unconstrained location decisions of firms, developers and households. Sub-urbanisation has always been inextricably linked to transport infrastructure. Many metropolitan areas suffer from a vicious circle of road construction and further sub-urbanisation. Commuting times show an extraordinary stability through

time, in all territorial systems, and expert suggest that there is an anthropologic constant in the form of a fixed time budget (EC 1992).

Economic growth has been a major factor for increased car ownership and transport waves. After the "Celtic tiger" phenomenon in Ireland, during the 1990s, Dublin experiences unprecedented rise in private car ownership and use, approaching the European average of one car per two citizens. The level of demand for transport increased at almost double the rate originally predicted by the Dublin Transportation Office in 1994. In 1998, the tonnage of freight going through Dublin port was almost double than what was predicted for 2001, passenger numbers in Dublin airport reached those predicted for 2001 and travel by private car rose by 38% more than the one forecast for 2001. The city was facing gridlocks particularly during peak hours. To respond to this a number of new measures were introduced. These included expanded bus lanes into the city centre, a new tram system which began in 2004 and the construction of a Dublin port tunnel to keep all the heavy goods freight traffic out of the city centre. However, traffic congestion remains one of the major headaches for the city.

Sustainable mobility is about minimizing the negative effect of transport on the environment. All European sustainable transport approaches aim at achieving a significant switch from the use of private cars to public transport, cycling and walking in cities and their commuter belts. Complementary policies are also put forward, such as increasing benefit-in-kind taxation to make company cars less attractive, imposing tax on free off-street parking spaces and considering road pricing.

The experience of Oslo and London with urban tolls offers many lessons. The limitation of cars entering the twenty two Km^2 central area of the British capital by tolls has been introduced in February 2003. The congestion charging scheme represented an investment of one hundred million £ in electronic equipment. The number of cars entering the City centre has been reduced by seventy thousand. The annual revenues are estimated 20% higher than the annual cost of the system (80M£). Complementary measures to provide for citizens who chose to leave their private cars included reinforcement of the bus fleet and improvement of the frequency, with waiting time in stations reduced by 35%.

The doctrine of "mobility at any price" has no meaning in the era of sustainability. Redirecting the focus onto accessibility seems a

plausible alternative. The distinction between access and mobility is not a trivial one (ALFOZ 1995). Unlike sheer mobility, access means not only getting people where they need to go, but also getting to them what they need, and new information technologies may play a major role in that process. The role of cities in assembling as opposed to dividing may be reinforced by the removal of architectonic barriers, in particular those relics of heavy transport infrastructure that blight so many European cities. Elimination of these barriers and designation of the recovered space for public use represents an action that is both exemplary and transferable. Integral urban accessibility programmes developed in the Spanish cities of El Ferrol and Salamanca took away the obstacles that hinder mobility and facilitated access to central poles, public transport, pedestrian crossings, etc. Accessibility is linked to proximity, however, physical proximity does not necessarily eradicate social distance (EFILWC 1993).

The human leg is the only truly sustainable transport means. A pedestrian-friendly city is more human. Copenhagen has been a pioneer city in recognising the social value of pedestrian streets. When the central street Strøget, became pedestrian in 1962, as one of the very early such systems in Europe there was a heated discussion. Detractors of the project suggested that the scheme was contrary to Nordic mentality and culture, but success came almost right away. The creation of pedestrian precincts continued in coordination with the downtown parking policy and the elimination of 2% to 3% of the parking spaces per year. The public transport system was improved and the bicycle network enlarged. More and more space has been taken away from traffic and given to citizens, who started leaving behind anonymous peripheries and coming back to the city centre. Stroget hosts now civic architecture, sculptures, fountains, concerts and many visual delights.

Civilised pedestrian streets expand throughout Europe. Vienna's pedestrian center is one of the most interesting in Europe. Oulu, in Finland, is extending its pedestrian zone, which is proving to be very successful, despite temperatures that can reach as low as -30°C. The Italian cities have been pioneers in closing the historic centres to private cars and introducing park and ride systems. Rome (Figure 15), Milan, Florence, Bologna, Bolzano experimented with various scales of car restrictions. Venice remains always the archetype of a car-free city par excellence, but it is Zurich and Basle that register the higher public

transport use, around five hundred in terms of trips per inhabitant per public transport means per year.

Perugia, one of the first Italian streets to restrict the use of private cars in the historic centre, created not just a passage to link the pedestrian area to the parking spaces, but a gallery of urban archaeology. In Evora, one of the World Heritage cities, the municipality prepared a plan to deal with the excess traffic in the historic centre, surrounded by an ancient wall, the chaotic parking situation, and the quality of life of citizens and tourists. The project includes the creation of large car parks outside the city walls, a high-quality public transport system, with mini- and microbuses adapted to the narrow medieval streets, park-and-ride and the creation of agreeable pedestrian streets and cycle tracks (EFILWC 1993).

Figure 15. Rome, Historic centre. Source: The author's exhibition of Artworks on Siren cities, European Parliament 2004

In Orvieto, the alternative mobility system has been created out of the need to improve urban quality life threatened from tourist pressure. Tourist buses were driving in the historic town on top of the hill causing much damage to the fragile rocky morphology. The city revitalised the

old funicular railway and asked all visitors to leave their cars in large car parking spaces at the foot of the Orvieto hills. The funicular railway is taking all passengers to the top of the hill, where they can use the network of minibuses take them around the city. A single authority for public transport and private car parking could internalise more equitably the environmental costs of private motoring and improve public transport.

The role of the street is exalted in the European Urban Charter issued by the Council of Europe in 1992 (CoE 1992). The "Code of the street: streets for all" introduced in 2004 in Belgium, asks for more attention to be paid to the rights of the pedestrians, cyclists, children, the elderly and the handicapped. The code requires drivers to respect one meter minimum distance from pedestrians when the latter are allowed to cross streets. It also reinforces repression measures. The concept of crossing curbs is being introduced to promote safe crossing and incite drivers to reduce speed.

Bicycles are the only other sustainable transport means, second to walking. Is it a paradox that both walking and cycling have been developed in northern, rather than in southern cities where climate allows more outdoor activities? Nurture seems stronger than nature. Denmark has already a bicycle network of more than 10.000 Km long. Amsterdam and Copenhagen are the capitals with the most elaborate bicycle network, complementing the road and canal routes. Both cities developed successful public "City Bikes" programmes. Amsterdam also has the higher rate of stolen bicycles, one stolen bicycle per inhabitant per year!

Thanks to the development of policies and infrastructure to promote cycling, the bike has become a useful means of transport in many European cities. In Münster and Erlangen, 35% of all transport needs are satisfied by bicycle. Cities like Basle can be crossed and enjoyed by bicycle. The "Velo-city" conferences promote new alliances between the bicycle and the city. The cities of Zurich and La Rochelle lend bicycles free of charge to residents and visitors. In Leipzig, local authorities encourage the 500,000 inhabitants to use their bicycles to connect to the public transport network, to which they are offered access for free if they parked their bicycle in a bicycle park next to a network. This "Bike and Ride" system is enhancing the 200 Km bicycle network, which offers the basis for 13% of all urban trips.

The irresistible rise of the private car has not yet been tamed. Motorised traffic is considered to be the single most destructive enemy of European cities. The study undertaken by the European Commission on "A Car-Free City" suggested redesigning cities in pedestrian terms. A city without cars could be composed of autonomous units, fully accessible on foot from one end to the other, separated by green spaces and united by high-speed public transport. The car-free city seems to be not only ecologically effective, but appears to be even economically efficient. It is estimated that it can be two to five times less costly, depending on urban population density (EC 1992; EFILWC 1995c).

Most cities try to quell the surging number of cars and encourage people to relinquish their private vehicles. Bologna was the first city to organise in 1985 a referendum on the restriction of the private car in its city-centre. Amsterdam, which had also gone through a recent referendum on the restriction of the private car, in early 1990s, organised in 1994 the conference "Car-Free Cities?" The question mark is significant, as it expresses reactions and inhibitions. On that occasion, cities committed to promoting policies discouraging the use of private cars launched the Car-Free Cities Club. The passage from car-occupied spaces into noble citizen-occupied spaces represents a major challenge for European cities (Municipality of Amsterdam 1994; Car-free Cities Club 1994).

Safe, clean, reliable, fast, frequent, noiseless, flexible, easily accessible, well-designed, environment friendly and economically viable public transport is a precondition for combating dependence from private cars. Even if Europe seems far away from places like Tokyo, where only one per cent of commuters use their private car, there are many innovations in upgrading public transport. Zurich is one of the few cities that developed a coherent solution to a problem of traffic build-up at intersections. Preserving and upgrading the tram system and rearranging the bus lines were the key elements of the improvement of the public network. The particularity of the system is its ability to deal with each public transport vehicle individually, allowing it to cross intersections without stopping.

Innovative practices in the limelight expand and transform urban landscapes. In Germany, the concept of short distances gains ground. Heidelberg, Freiburg and Basle have been pioneers in introducing low-noise vehicles in noise protection districts and eco-tickets for public

transport. Tramways are returning in European cities. Nantes, Grenoble and Strasbourg introduced from 1985 onwards, three technological generations of tramway. In Valencia, the new tramway is advertised as a tramway named desire. The tram, abolished in 1960 in Athens, returned back in August 2004. Equipped with the latest technology, it offers the city the possibility of a valuable alternative mobility and the capacity to transport eighty thousand passengers per day.

Innovative combinations among tram and train/metro systems are not new in cities. In Brussels, the network links the efficiencies of metro, pre-metro and tramway systems. Saarbrücken's new tram-train system shares existing tracks with the national railway, making infrastructures more efficient. National-municipal co-operation is reflected on the co-operation between the four municipalities of the Helsinki metropolitan region and the railways. Inter-region rail traffic is increasing and rail functions, in some parts, as a metro.

The socio-cultural aspects of the transport systems deserve much attention. Major stations of the new metropolitan system in Athens host archaeological galleries which exhibit also the findings during the excavations for the creation of the underground. In Budapest, the administration of the metro, around a hundred years old, is still seen as embodying arbitrary features of the old regime. A young cineaste has devoted a film to the metro controllers. The film was recompensed by the administration which was criticised.

Perugia carried out innovative experiments for reorganising the bus network, especially for peripheral zones and better adapting supply to the changing demand patterns. The telebus service, introduced in 1985, runs along a principal route, and can serve additional secondary routes only by request. This is enabled by a magnetic card distributed to the user and a communication centre. The system has proved very efficient and it is particularly useful for areas with sparse settlement and for access to transport for people with reduced mobility.

Electric, bio-buses and hybrid cars develop and intelligent transport management systems permeate many transport policies. Car-pooling and car-sharing schemes expand with mixed results. Green lanes exclusively reserved to public transport are now a common feature in cities. Smart transport passes, often linking transport to other public services, and eco-tickets are also in continuous progress. In Toulouse, the

municipality, the semi-public enterprise for public transport and the company which has created a smart-pass, worked together for the readjustment of the transport services to public needs.

The creation of pedestrian paths and careful articulation of transport means offer new possibilities for partnerships. The AUTOPLUS system in La Rochelle created new synergies between bus companies, taxis, boats and hotels. The pilot park-and-ride project "De Slinge" in Rotterdam offers an interesting example of multiple benefits. The car park had become an arena for vandalism. No enterprise was attracted to undertake its rehabilitation and its management, nor did the municipality have the means. An autonomous structure was created with the help of European funds, and not only renewed the car-park but it installed there a workshop for bicycle repair, some small shops and containers for waste recycling. Twenty-one new jobs have been created.

Bangkok, one of the world's most asphyxiated cities by private cars, has also marked important steps over the last ten years. The creation of the Mass Rapid Transit Authority in 1992 led to the construction of a long discussed elevated light train in the city centre and linked to the underground to serve peripheral areas. The aerial train Bangkok Mass Transit System, inaugurated in 1999, added an important dimension to the common transport landscape of the Thai capital. Each train has a capacity of one thousand passengers and stands as the equivalent of eight hundred cars. Quick, secure, environment and citizen-friendly, the skytrain has been easily adopted by inhabitants and tourists. During its first four years, it provided a service to more than 320 million passengers. Each working day, it transports more than 330,000 passengers. The observed punctuality is 99.94 per cent and the recorded clients' satisfaction is 82%. The 2003 annual security inspection, done in collaboration with American maintenance teams, gave satisfactory results. Multiple social and cultural activities are being organised on the skytrain to promote its use as an integrated public service.

Freight transport accounts for about 10-12% of vehicle traffic in cities. It is essential for the economic functioning of cities and has significant effects on congestion and the environment. Construction works and retail are responsible for much of the goods traffic. Commercial vehicles vary largely from dirty, noisy and intrusive trucks to smart electric cars. Many cities impose vehicle size or weight restrictions, or limit access in certain areas. A balance has to be struck

between access requirements, essential to a city's vitality and transport and environmental objectives. Policy responses include the German model, based on private transport companies coming together to serve and the Dutch model based on licences provided by authorities to transport companies.

OECD-ECMT studies highlight the importance of integrated transport and land-use policies for improving mobility patterns. Reconciling and mixing land uses is often necessary, but rarely a sufficient condition for reducing traffic flows. Density may be inversely related to travel demand and energy consumption. The strength of the land use/transport inter-relationship depends on assumptions about mobility and cultural behaviour. High mobility leads to travel patterns that may not be very sensitive to land use patterns. Optimal transport/land use interventions depend highly on the context. The search of efficiency, accessibility and choice has to take into account many parameters, such as the size and structure of the city, the location of other activities, the distribution of the employment, public transport alternatives and the parking policy (OECD-ECMT 1994).

Optimal policy portfolios include the promotion of lower-consumption vehicles and new propulsion technologies, demand-management schemes, such as parking controls and access restrictions, information and communication, fair and efficient pricing regimes and land-use and planning. Noteworthy European initiatives include ELTIS (European Local Transport Information Service), jointly funded by the EC and the International Union of Public Transport, the citizens' network benchmarking initiative and the European platform on mobility management. The European CIVITAS initiative, launched in 2000, aims at introducing a radical strategy for Clean Urban Transport. The participating EU cities deploy exemplary efforts in developing attractive alternatives to the use of private cars.

The European JUPITER initiative and other targeted transport projects try to demonstrate innovative urban transport measures to improve the environment. The JUPITER II project achieved reduction in energy consumption of 20% and emissions of harmful air pollutants of between 16% and 25%. The strategic assessment of the project highlights that modal split has significantly improved in most cities, with a 12% increase in public transport. A more extensive implementation could double this figure. A substantial reduction of 4% in CO_2 emissions and

20% in particulate emissions was recorded and demonstrated the potential of innovative energy and environmental technologies.

Biogas fuels give new opportunities to cities which strive to lower vehicle emission and dependence on petroleum. Stockholm developed, in collaboration with other European cities, the project ZEUS (zero and low emission vehicles in urban society). One of the ZEUS sub-projects is the introduction of vehicles fuelled by biogas, originating from recycled liquid organic waste. A pilot station for biogas production has been constructed and hybrid vehicles functioning with petrol and/or biogas were gradually introduced. A fleet of two hundred vehicles, lorries and private cars, has been the result of the co-operation among the municipal enterprise for waste water management, fuel companies and city infrastructure services. A biogas-fuelled lorry ensures the transport of biogas to the filling station (EC 2000g).

Symbols are powerful. From the 16th to 22nd September 2004, European citizens had again the opportunity to enjoy a full week of events dedicated to sustainable mobility. A wide range of initiatives tackling different aspects of urban mobility were carried out by local authorities on each day of the week and in partnership with local organisations and associations, NGOs and businesses. The Car Free Day on Wednesday, 22 September 2004 was the highlight of the week, with the challenge of organising "In town without my car" on a working day!

The European Mobility Week represented a platform for local authorities as well as organisations and associations from all over Europe to promote their existing policies, initiatives and best practices on sustainable urban mobility, launch new policies and initiatives and raise citizens' awareness on the damages that current urban mobility trends generate on the environment and the quality of life. Safe streets for children was the central focus of the European Mobility Week 2004. Many events highlighted the importance of the safest possible mobility patterns for children.

Chapter 3

ENERGY PATTERNS, MODELS AND ETHICS

This chapter offers an insight into energy production and consumption patterns. It examines cleaner energy options and technologies and focuses on renewable energy sources. It also presents the contribution of nuclear energy and the ethical questions linked to access and use of energy. The new member States of the European Union and the developing countries have to meet particular challenges on energy. Development being a mutual responsibility, the chapter concludes with energy partnerships with the developed countries.

1. ENERGY PRODUCTION AND CONSUMPTION PATTERNS

Energy has deep and broad relationships with each of the three pillars of sustainable development and a significant role to play in the journey towards an environmentally sound, socially integrated and economically flourishing future, promoted by active citizen participation. In order to offer citizens the conditions for fulfilling life, cities have to provide secure, sustainable, competitive and affordable energy. States and cities are interdependent as regards action against climate change and the

security of energy supply. Technology and innovation towards efficient energy systems, gradually integrating new and renewable energy sources, are fundamental (EC 2002b).

The term energy sources covers all fuels, flowing water, sunlight, and winds, from which and with the aid of appropriate conversion devices useful energy is being produced. The primary energy sources of the European Union include indigenous sources and imported products that are necessary to satisfy the gross inland consumption, defined as the overall demand. Indigenous energy resources in the European Union, including fossil fuels, uranium and renewable energy sources, satisfy currently half of the total demand. The rate at which resources will be depleted depends on the extent of reserves, technological progress, national policies, the competitiveness of the energy products in international markets and changes in citizen behaviour and consumption patterns (EC 2000a).

Fossil fuels still form the backbone of the world energy primary sources (Figure 16). Although deposits of fossil fuels continue to be discovered and mining methods improve, the reserves of these fuels remaining in the earth are finite. A global crunch is less feared today than two decades ago. Experts and politicians suggest that, as the stone age did not end because the world ran out of stone, the end of the fossil fuels age will not come with the depletion of the deposits, but with man's ability to grasp new opportunities (The Economist 2001).

Eighty per cent of the fossil fuel reserves of the EU are solid fuels, including coal, lignite, peat and oil shale. Together with steel, coal was regarded as a cornerstone of European economies in the early 1950s. The primary objective of the European Coal and Steel Community (ECSC) Treaty, signed in Paris in 1951, was to establish a common market in coal and steel and to contribute to economic growth and employment generation in the Member States. Demand soon outstripped supply and the High Authority of the ECSC encouraged greater production through the opening of new mines and the conclusion of long-term supply contracts.

Coal mining, a labour-intensive industry, contributed considerably to the full employment economy of coal regions after the Second World War. However, since the 1960s, the sector has gone into rapid decline due to international competition and the advent of other

cleaner fuels to produce electricity and heat, mainly gas. In 2000, the European Union produced 1.2 Mtoe of peat a year, 50 Mtoe of lignite and 60 Mtoe of coal, around 5% of world production. Lignite and peat are profitable businesses, but, due to geological and labour conditions, the average cost of producing coal is three to four times the international market price. Since 1990, imports, mainly from the United States, Australia, South Africa and Columbia, have exceeded the indigenous production.

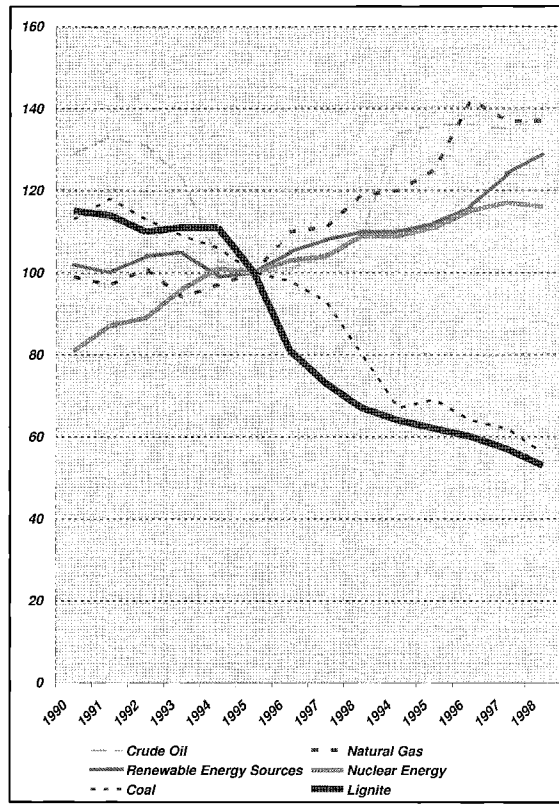

Figure 16. Composition of the primary Energy mix in EU-15. Source: EC 2001

Some of the EU member States (Portugal, Belgium and France in 2005) decided to cease all production. Others (Germany and Spain) opted for restructuring the industry and the United Kingdom decided to make production competitive with that of imported coal. Coal mining became the epicentre of political turmoil in some countries, in particular Germany. The coal compromise, concluded in 1997 between the German

Federal Government, the Länder and the private sector, provided for a considerable reduction in State aid, production and employment.

Solid fuels are the only fossil fuels that the European Union is rich in and the only ones whose reserves increased (more than doubled) after the 2004 enlargement, but the coal-related industry faces difficult and challenging decisions. Maintaining access to certain reserves and assuring minimal capacity of production in realistic economic conditions is deemed to be a judicious solution. This would guarantee the maintenance of the equipment and the continuity of operation, while at the same time allowing European technology to keep its leading position in clean coal production.

Oil, used in transport and for electricity and heating, has the lion's share in the primary energy mix consumed in the European Union (41%). In 1995, imports were around 2.8 times greater than EU production and by 1998, they were three times greater. Oil reserves are very unevenly distributed around the globe and the European Union produces scarcely 4.4% of the world output. Resources are mainly located in the North Sea and belong primarily to the United Kingdom. The cost of extracting one barrel of oil in Europe is around four to six times more expensive than in the Middle East.

Natural gas, discovered at the beginning of the 1950s and once considered as a second-rate by-product of the exploitation of oil, has become a polyvalent source of energy. Cleaner and easy to use, with its own distribution network, it gained ground in all sectors, including power generation (24% of the gas consumed, including combined heat and power), production of heat or, more recently, transport. 26% of the industrial needs are currently satisfied by natural gas, while the residential sector consumes 30% of the produced natural gas. Consumption rose by 60% during the last decade. The European Union produces 12% of the world output. Most of these reserves are located in the Netherlands (56%) and the United Kingdom (24%). In 1995, net imports of gas were around 65% of EU production and had already reached 72% in 1998. Dependence on imports increased more rapidly that for any other fuel.

The use of solid fossil fuels, oil, and, to a lesser extent, natural gas has important environmental implications. During the combustion phase, in addition to energy production, a high number of by-products are

also generated, including carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4) and other hydrocarbons, nitrous oxide (N_2O) and various nitrogen oxides (NO_x), particulate matter and certain metals and radionuclides. The carbon content varies between the types of fossil fuels and coal emits around 1.7 and 1.25 times as much carbon per unit of energy as natural gas and oil respectively.

The extraction, processing and distribution of fossil fuels impacts the environment. During the extraction phase, methane and carbon dioxide may be released, for example when natural gas, which is typically 85% to 95% methane, is flared from oil wells producing CO_2. Oil and natural gas usually occur together in deposits and oil drillers may burn off the gas or release it straight into the atmosphere, especially if the oil well is far from any gas pipelines. However, since the demand and subsequent price of natural gas have risen, this fuel is increasingly being captured for use.

Natural gas may also be released during the extraction and processing of coal. As the coal is being extracted, miners inadvertently break open gas pockets in the coal and coal-bearing rock, releasing large quantities of methane into the atmosphere. The quality of coal and the method of extraction affect the level of methane emissions. Poor quality coals, such as lignite, tend to have a lower content of methane than higher quality coals, such as bituminous and anthracite. Surface mining releases around 10% of the methane per unit emitted by deep mining, since coal buried under high pressure in the earth can retain more methane. Finally, the release of methane, and to a lesser extent CO_2 and hydrocarbons, may occur accidentally due to leakages from natural gas pipelines during distribution.

Energy transportation flows are linked to the geographical distribution of the energy resources on the planet (Figure 17). The safe transport of precious energy resources is of utmost importance for public health and the environment. The fortuitous release of all fuels during transportation is extremely hazardous and strict measures must be taken for their prevention. Oil spills are particularly dangerous. Accidents occurring to oil tankers, which may release devastating hydrocarbons into the oceans, are disastrous and should absolutely be prevented.

The European Union possesses hardly 2% of the global known natural uranium reserves, but production is expected to shut down in

France and Portugal. Resource depletion, relatively lower prices in international markets and concerns regarding nuclear power generation are the main reasons for the closure of the uranium mines (EC 2000a).

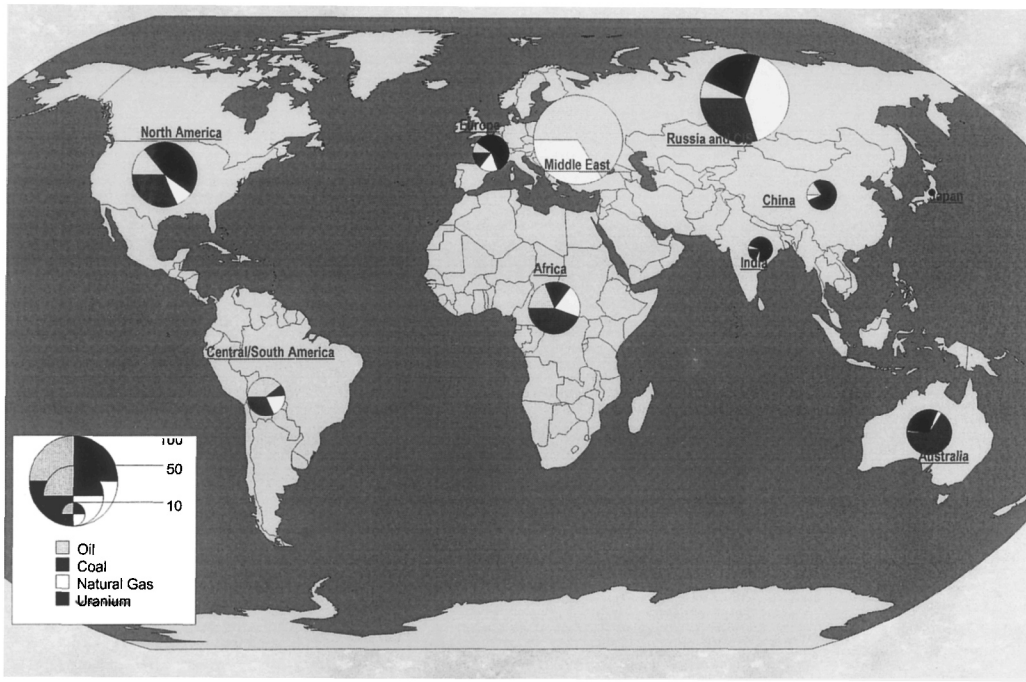

Figure 17. Energy reserves in World regions. Source: EC 2001

Fissionable nuclear fuels are remarkable sources of energy. The energy released from the fission of one atom of uranium, is, for example, several million times greater than that produced by the combustion of one molecule of gasoline. The fission process utilises only a small part of nuclear fuel. Once separated from their waste, amounting to around 4%, recovered uranium and plutonium can both be used again to generate more electricity. Material obtained from the decommissioning of nuclear weapons can also be recycled as nuclear fuel. In the longer run, thorium could be used as fuel for nuclear fission reactors.

Renewable sources of energy (RES), including hydropower, solar, wind, biomass and biofuels, geothermal and tidal energy, are fundamental vectors towards a sustainable energy future. They account for almost 6% of the EU energy supply. Countries that use renewable

energy to a significant extent include Portugal (15.7%), Finland (21.8%), Austria (23.3%) and Sweden (28.5%).

In 2000, renewable sources contributed 14.1% of electricity generation in the EU. Hydropower accounted for 87% of the total electricity produced from renewable energy sources. Biomass remained the second most important contributor to electricity from renewables and is particularly significant in Finland, where it accounts for 10.7 per cent of electricity generation. The contribution of wind power is increasing but remains at only 0.5 per cent of total electricity generated across the EU.

The promotion of renewable sources of energy is a high priority in the European Union. The long-term socio-economic and environmental advantages are incontestable. Renewable energy sources are unevenly distributed throughout the EU member States, but they are indigenous and contribute to the security of energy supply. Their progressive integration into the evolving energy systems is expected to create new market and business opportunities, especially for SMEs, while endowing remote and island communities with assets and benefits (EC 1997c).

Primary energy sources are finally transformed into electricity, heat and motion. In 2000, electricity in the EU was generated (Figure 18) from nuclear (35%), solid fossil fuels (27%), oil (8%), natural gas (16%), and hydro and other renewables (14%). The largest contribution came from thermal power stations, which accounted for 51% of the total in 1998. Electricity generated from thermal power stations increased by 11%, between 1990 and 1998, while electricity from nuclear power stations rose by 19%, although it remained constant from 1996 to 1998. The amount of hydro-power increased by 18% over this period and electricity produced by other renewable energy sources has shown the most rapid growth, increasing by 144% between 1990 and 1998 (EC 2000a).

In the European Union, electricity consumption increased by an average of 2% per annum during the last ten years,in line with the GDP, while total energy consumption which increased at an average annual rate of 1.1%. Demand for electricity is expected to continue to track GDP growth closely until 2020. More than 300 GWe of capacity have to be installed over the next twenty years to replace old power stations and meet increasing demand. This holds a great potential for alternatives in line with sustainability.

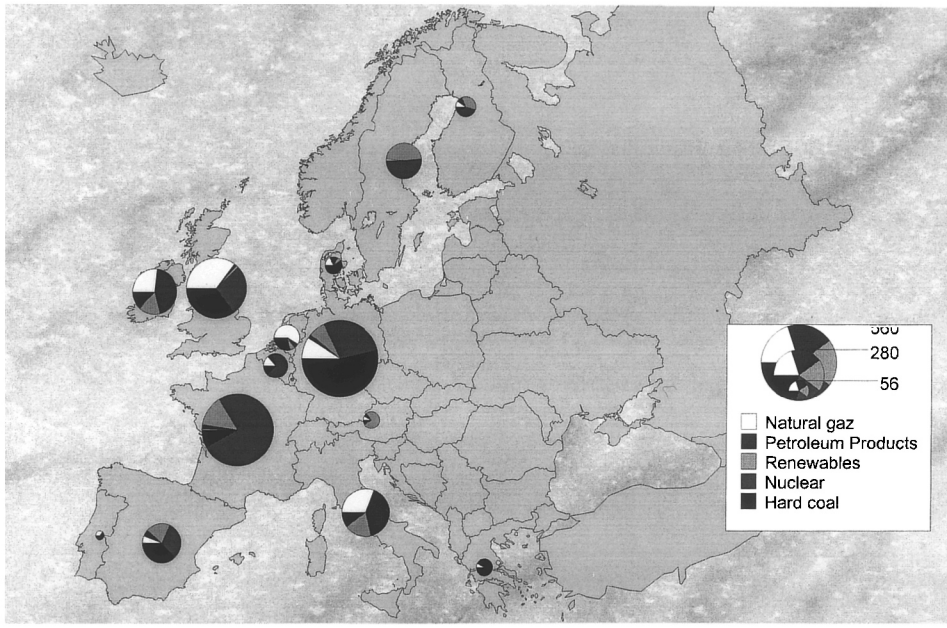

Figure 18. Electricity production by energy source in the EU-15 member States. Source: EC 2001

According to the laws of thermodynamics, during the process of conventional thermal electricity production, involving the combustion of fossil fuels, waste or biomass, up to 70% of energy input may be lost as heat. Between 1990 and 1998, the average efficiency of thermal power stations increased from 38.7 per cent to 45.5 per cent. This improvement resulted from fuel switching from coal to gas, often accompanied by the introduction of combined cycle gas turbine systems. Technological improvements have allowed the efficiency of combined cycle gas turbines to reach almost the theoretical limits of the process. Over the same period, nuclear power stations increased their average efficiency from 34.1 per cent to 35 per cent.

Apart from generation of electricity, there are also net electricity imports in the EU, but they represent less than 0.7 per cent of the total generation (13.1 TWh versus 2,472 TWh in 1998). Electricity exchanges among EU member States are much greater. France is the largest exporter and Italy is the largest importer.

The reliability of the electricity systems is fundamental for energy security. The effective management of electric transmission and distribution networks has to decrease the risk of electricity supply disruptions. Blackouts can paralyse economies and societies and seriously affect the knowledge-based society.

Electricity production is predominantly centralised. National policies have favoured the construction of large power plants and huge transmission grids to serve distant consumers. A significant evolution could be the partial transition to smaller decentralised power plants and networks nearer to the end-users. Local generation of electricity based on small, modular energy supply or conversion units, can reduce risk, capital expenditure and transmission losses and result in substantial environmental benefits. Current passive grids are expected to develop into active grids with numerous producers and consumers, electricity storage systems, power switches, supported by information and communication technologies. The prospects for the creation of an e-electricity market are numerous.

In industrialised countries, efficient micro-power is expected to gradually develop alongside the grids as a supplement to centralised power supply. Micro-power may become vital in developing countries, where the grid cannot reach much of the remote population and its extension is very costly (Dunn 2000).

Heating and, increasingly, cooling of buildings, account for about one third of total energy consumption. Consumption patterns range from office and household heating and cooling, including hot water, to steam production for industrial uses. Unlike electricity, heat production is predominantly decentralised, whether it takes the form of individual heating systems and/or of dedicated heat stations with their associated networks.

One century after Thomas Edison's first heat and power plant, the potential of co-generation for the improvement of energy efficiency in the process of electricity generation is being rediscovered. Combined heat and power (CHP) enhances waste energy from electricity production, while it helps to avoid the environmental impacts from additional heat generation. The overall system can reach very high efficiencies due to the inherent characteristics of the process. To fully enhance benefits, a sufficient heat load must be connected to the system. The produced heat can be used locally for district heating and industrial processes.

Combined heat and electricity generation led to 35% energy savings in Denmark. However, in recent years, CHP has faced difficulties due to low electricity prices and current high gas prices, in the case of gas fired plants. Some member States have support systems in the form of buying obligations, tax reductions or guaranteed prices for co-generation. CHP and decentralised district heating are not a novelty for European cities. Saarbrücken installed its first district heating system in 1964. It now uses co-generation plants for almost all its electricity production. CHP systems accounted for 11% of electricity generation in the EU in 1998, but they represent more than 50% in Denmark and the Netherlands (EEA 2001b, OECD 2001b).

Sixteen per cent of the overall energy consumption in the EU is being covered by coal, 41% by oil, 22% by gas, 15% by nuclear and 6% by renewable energy sources. Gross inland consumption in the EU increased by 1% per year over the last decade. Final energy consumption, the energy actually spent by consumers, is lower and the difference is mainly accounted for by losses in conversion and distribution. The ratio gross inland to final energy consumption remained relatively stable (65.% - 66.2%) and final energy consumption increased by 1.1%. While industrial energy consumption is being stabilised, mainly as a result of the transition to a digital, knowledge-based and service-oriented economy, there was increased demand for transport and electricity and heat from households and the tertiary sector.

Energy consumption patterns in the EU countries present key differences but also many common points. Everywhere, overall energy consumption growth is generally disassociating from increase of GDP, much more than the use of other goods and the production of waste. Oil and oil products are the main source of energy in all EU countries except Sweden and France (nuclear energy) and the Netherlands (gas). Gas is the

second most commonly used fuel, although it represents a small percentage of the total energy mix in Sweden, Greece and Portugal. Renewables are the second largest source of energy in Finland, Portugal and Austria and the third largest in Sweden. Great differences among member States seem to occur not only in the composition of the energy mix, but also in the per capita consumption of energy. Luxembourg presents the highest level of consumption, followed by Finland, Belgium and Sweden (EC 2001c).

Among the different sources, natural gas has shown the most constant trend of robust increase since 1990. Natural gas exhibited the strongest growth in demand among all fuels, even in the Netherlands where the market for gas was thought to be oversupplied. The highest annual growth, over 8%, was in Denmark, Austria, Ireland and the UK. Solid fuel utilisation showed a consistent trend of decrease, most significantly in France, Germany and the UK, which accounted for 71.3 per cent of European solid fuel consumption in 1990 (Figure 19).

Energy intensity, defined as the total (gross inland) energy consumption per unit of GDP, fell by an average 0.9% per year at the turn of the century, but is still increasing in Belgium, Finland, Greece, Italy, Portugal and Spain. The energy consumption per capita reveals links between growth of energy demand and maturity of the economy. Since 1990, the majority of member States experienced an annual growth rate in energy consumption between 1 and 2.2%. However, Portugal, Ireland, Spain, Denmark and Greece all exhibited an annual growth of over 2.2%. These countries, particularly Ireland, also had the highest rate of GDP increase. However, energy consumption per capita in Portugal, Spain, Ireland and Greece is still below the EU average. On the other hand, countries such as France and Germany continue to have a higher per capita rate of energy consumption, even though their national rate of growth in energy demand is much slower. Energy consumption actually decreased in Germany by 4%, during the 1990s, due to the restructuring of the former East German economy.

The level of energy consumption in Europe is not only related to economic conditions, but is also linked to climatic and cultural features, population density and the structure of human settlements. Northern countries with colder climates and low population density, such as Sweden and Finland, present high levels of energy consumption. Countries with a warmer climate are installing a growing number of

cooling systems and the seasonal distribution of energy consumption is changing. The severity of winters is also reflected on energy consumption peaks.

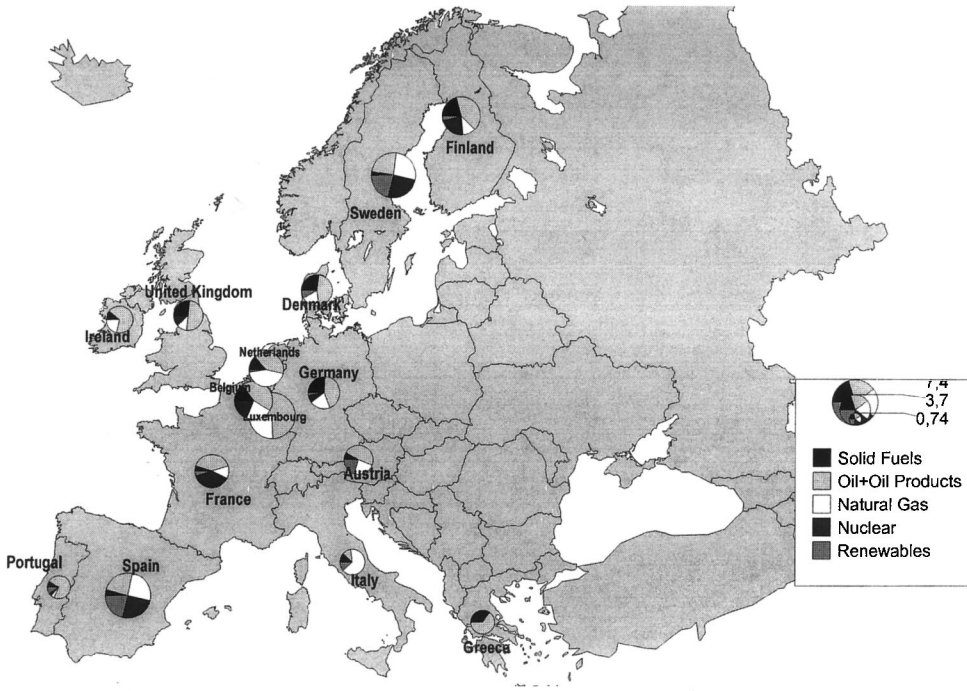

Figure 19. The composition of energy consumption per capita in EU-15 member States. Source: EC-Eurostat 2001

Industry accounted for 28% of total energy consumption in 1998 (31% in 1990). Investment in technology and innovation has enabled European industry to become more eco-efficient and advance towards the stabilization of energy consumption. All energy intensive industrial sectors demonstrated significant reductions in energy consumption during

the last years. Consumption in the iron and steel sector, (representing 20% of total industrial consumption in 1998) fell by 5%, in the chemicals sector (15% of industrial consumption) by 20% and the glass, pottery and building materials sector by 12%. Environmental regulation and enforcement have been key driving forces. Conscious efforts have been made to reduce dependence on oil, now representing only 16% of total industrial energy consumption, invest in combined heat and power and diversify into natural gas and electricity (EC 2001g).

The energy consumption by the residential/tertiary sector grew at a moderate rate between 1990 and 1998, as improvements in energy efficiency were partly offset by a systematic rise in levels of material comfort and increase in the number of (smaller) households. The result has been higher per capita consumption, with energy used for space heating falling slightly and electricity rising by 31%. Overall, the energy consumption in households increased by 9.6% between 1990 and 1998.

The residential / tertiary sector remains the largest energy consumer (Figure 20). Excluding personal transport, oil and gas supply 63% of household needs. The residential sector is the largest single consumer of natural gas (one third of total gas consumption, supplying 40% of household demand) and accounts for approximately 18% of total oil use (25% of the demand).

Energy consumption in the transport sector, depending almost entirely upon oil (98% of transport consumption, representing 67% of final oil demand) has increased steeply. The transport sector accounted for 32% of total consumption in 1998 and it is the fastest growing energy consumer in the European Union. This is mainly due to the continuing growth of the road transport, passenger and freight, which consumed 82% of the total energy for transport in 1998. Air transport is also increasing dramatically (40% rise over the period 1990 to 1998), due to the rising of leisure trips. The shares of rail and inland waterways transport are declining and modal split shifts towards less unsustainable means, mainly road transport. Current price structures continue to favour private over public transport.

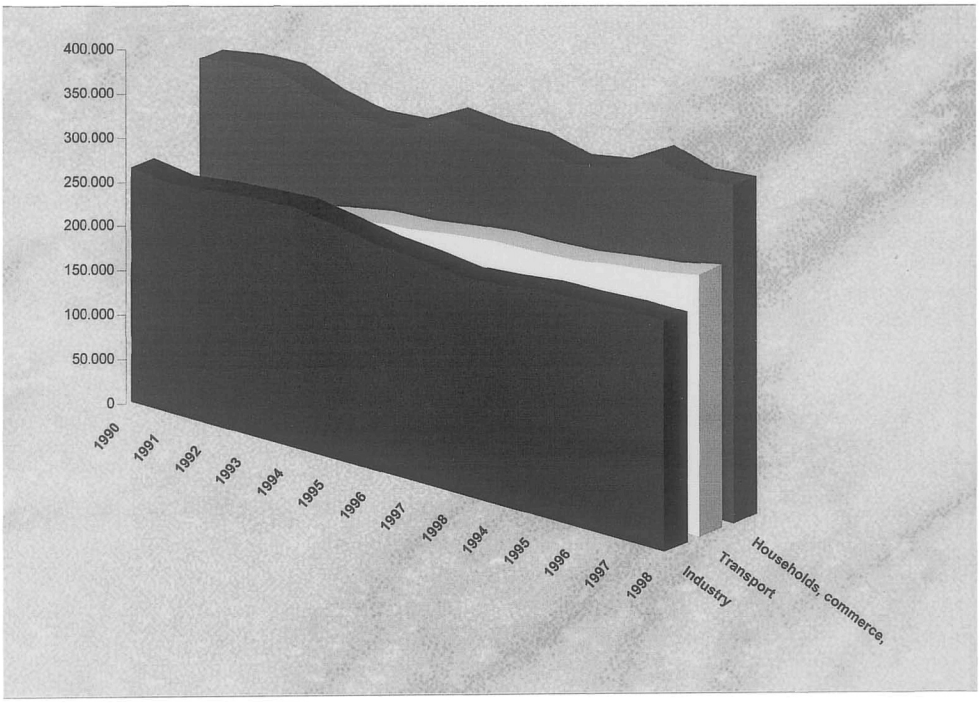

Figure 20. Final Energy Consumption, by sector in EU-15. Source: EU-Eurostat 2001
Units: Thousand tonnes of oil equivalent (ktoe)

2. CLEANER ENERGIES AND TECHNOLOGIES

Producing smarter and consuming less and better are the main paths towards sustainable development. Technology is a major dynamic in all equations evolving around these directions. Within the energy sector, technology can be a decisive component of four key approaches. First, it can contribute to the reduction of the level of use of energy services, such as heating, lighting and mobility. Second, technology is critical in reducing the amount of energy required to generate a unit of energy services by increasing the efficiencies of both energy supply and energy end-use systems. The choice of fuel used for energy production is a third area where technology can play a key role. Last but not least, technology can enable the decrease in pollutant emissions through their removal from combustion gases (EC 2002b).

Enhancing the potential of cleaner technologies is essential for cities. The traditional means of electricity generation already benefit from technological advances that allow them to increase efficiency and production capacity while reducing polluting emissions. This has been made possible by general progress in technologies, with multidisciplinary research, for example on combustion and new materials, and the synergies developed with other fields. Thus, a combined gas/steam cycle turbine has now achieved an efficiency of over 55%. Efficiencies of 60% to 65% are expected in the medium-term. Solid fuel power stations are currently capable of efficiencies of about 45%. Efficiencies of 50% to 55% are expected in the medium-term. Co-generation leading to improved efficiency and trigeneration, combined heat and power with additional production of cooling, promises further improvements.

Technological improvements led to the current trend for the substitution of high carbon fossil fuels, such as coal, by low carbon fossil fuels, mainly natural gas, in energy generation. This is the first step to be followed by the progressive transition to cleaner renewable energy systems. Research on advanced materials for the production and storage of energy can also have a decisive contribution. Emerging technologies, such as nanotechnologies, particularly nanotubes, have an enormous potential in the energy sector. New intelligent materials, incorporating multi-functionality, intelligence and autonomy, are expected to further improve the efficiency of energy production.

Continuous technological development is necessary for thermonuclear fusion and the widespread adoption of new and renewable sources of energy, such as fuel cells, photovoltaics, large-scale wind farms and biofuels. Once the technological barriers have been overcome, their uptake will be determined by their cost in relation to conventional fuels, which have an economical advantage due to their longstanding use and lack of internalisation of environmental costs.

The importance of EU regulations on pollution abatement for the development and widespread application of new technologies can be clearly illustrated by the Large Combustion Plant Directive. This EU Directive, adopted in 1988, includes emission limits for post 1987 plants with a thermal input of 50 MW or more, and national total emissions from pre-1987 plants. Sulphur dioxide was one of the pollutants targeted and the directive is considered to be a main factor for the increased use of

technologies that led to the drastic reduction of SO_2 emissions. The Integrated Pollution Prevention and Control Directive has been another important step in encouraging the advancement of new technologies in the energy sector, as it requires power plants to utilise the Best Available Technologies in their pollution abatement strategies.

CO_2 sequestration technologies for post-combustion capture and storage in oil and gas depleted fields and aquifers could result in important reductions in emissions. The underground storage capacity for CO_2 in the EU is sufficient to store the CO_2 emissions resulting from the total EU electricity production for seven hundred years. Available separation processes are best suited to large emitters, such as power stations, oil refineries and chemical industries. For power stations, the cost of capture and storage is about fifty US$ per tonne of CO_2 avoided. Emerging technologies try to reduce this cost and the oxy-fuel combustion offers new opportunities. This process generates a flue gas consisting largely of CO_2 and water, from which CO_2 can be easily separated.

The Saline Aquifer CO_2 storage project, supported by the European Commission, offers a prime example of the first industrial scale endeavour in this field. Since 1996, one million tonnes of CO_2 have been stored at the Sleipner Field in the North Sea. CO_2 is injected into a thick saltwater-bearing sandstone formation, one Km below the sea bottom. The project is the result of a broad collaboration among industrial partners, national authorities and research institutes. It uses the latest techniques in seismic surveying and aims at developing a sound scientific methodology for the assessment, planning and monitoring of underground CO_2 storage. The possibilities are endless.

3. RENEWABLE SOURCES OF ENERGY

Renewable energy sources have an undeniable appeal both for the environment and for the security of the energy supply. Although the share of renewable energy in total consumption in the EU is still only 6%, the promising pace of development and the move from the periphery of the energy sector to becoming part of the mainstream debate are decisive for the future. The European Union has set the target of doubling the share of renewables in global energy consumption 6% to 12% in 2010. A particularly considerable effort will have to be made in the electricity

sector to achieve the objective for electricity generated from renewable sources in 2010, twice as much as in 1997, and 22.1 per cent of the total (EC 1997c).

This aim is a most challenging one, since hydroelectricity, accounting for one-third of renewable energy sources at present, has few possibilities of expansion and only for small-scale hydropower (smaller than 10 MW). Large hydropower projects are meeting with strong resistance from landscape and ecosystem-sensitive communities. The other forms of renewable sources (biomass, wind energy, solar radiation, geothermic) will have to provide almost all the targeted growth, by achieving a four fold, rather than a two fold, increase of their proportionate shares. In some countries, like the UK and Ireland, the increase has to be ten-fold.

The first windmill capable of producing electricity was built in 1890 and the resulting energy was stored in batteries. Almost one century later, wind energy has emerged as a major renewable source. In Denmark, the large Tjaereborg wind turbine, created with the help of the European Commission, constitutes a fully-fledged local electric power station, generating 3,500 MWh per year. Over the last twenty years, wind energy marked impressive leaps. The technology related to grid-connected wind turbines is becoming mature. Wind energy is now advantageous in some privileged places and expected to be competitive with conventional fuels at a wider scale within the time horizon of 2005 to 2010 (EWEA 2001).

The EU now possesses more than 13 GW installed capacity, over two thirds of the present global wind-generated power capacity. 80% of the European capacity is installed in Germany, Denmark and Spain. The top markets in the world are headed by Germany, USA, Spain and Denmark, followed by India, the Netherlands, the UK, Italy, China and Greece. 90% of the manufacturers of wind energy systems are based in the European Union, where the sector created over thirty thousand jobs over the last ten years. The first five world suppliers are Europeans and three of them are Danish. Wind provides enough electricity to supply 15% of Denmark's needs.

Wind energy technologies develop very rapidly. The average weight of wind turbines has halved in five years, the annual energy output per turbine has increased four-fold, and costs have decreased by a factor

of ten in ten years. The average wind turbine size installed in 2001 was over 900 kW, compared to 440 kW five years ago. Several companies are now developing wind turbines of 3 MW and above. The cost for wind power to generate electricity continues to drop steadily. As markets develop, fair access to the European grids is vital for wind generators. Research and development have to address issues related to the intermittent character of the wind energy, storage and backing up of the produced energy and the integration of highly fluctuating energy into the grid.

Clean and environment-friendly solar energy can be harnessed by using photovoltaic cells (PV), which directly generate electricity and solar thermal collectors, which convert sunlight into heat. Photovoltaics, made of silicon, a most common element of earth's crust and the basis of the global electronics industry, can convert radiation directly to electricity, through the intrinsic photo-effect, realized in layers of semiconductors. The silicon solar cell, announced in 1952, is a reliable source for power generation in space where the sunlight presents an inexhaustible source of energy. Solar panels can power houses, streetlights, traffic lights, parking meters, billboards and advertising panels. Portable solar equipment can fuel laptops and recharge mobile phones. Since 1997, worldwide production of photovoltaic modules increased at an average of 30% per year. The EU and Japan have been pioneers in connecting photovoltaic systems to national grids. Thin film cells appear advantageous compared to thick crystalline cells. Japan doubled its capacity and now manufactures close to half of the world PV systems (EPIA 2001).

Solar thermal technologies can transform direct radiation into heat and has a broad range of applications, in buildings and plants. Solar collectors concentrate the sunlight received after reflection onto parabolic troughs, parabolic dishes and heliostats. Heat and/or electricity are then produced directly by heat exchanger or by chemical reaction. Standard modules for electricity generation are now available in the capacity range 10-50 MWe, while future systems could be of 200 MWe. In the longer term, systems in the range 200-1000 MWe could produce electricity at a cost below 0.04 €/kWh.

Solar energy has the highest theoretical potential, but the required investment cost is still too high compared to conventional energy production. Presently, Europe generates one quarter of the world solar

energy. Technology and design are improving constantly. Continuous research has to address problems related to efficiency, the intermittent character of the solar energy and storage-related issues.

Bio-energy sources of supply, including residential organic, agricultural and forest residues, have the advantage of being versatile and generate electricity, heat, and/or transport fuel. In addition, the use of biomass as a fuel source could reduce the problem of domestic waste management and disposal, and transform a liability into an asset. At the world level, biomass is the fourth largest energy source, able to deliver a variety of energy products and services, including heat, electricity, gas through gasification and digestion of wastes and liquid fuels through fermentation and through synthesis after gasification. However, most of the biomass resource is non-commercial and only about 14% of it is used today in modern processes, to produce electricity, steam and biofuels. In the EU, Austria, Finland and Sweden are currently the leaders in biomass utilization (EC 2000g).

The share of biofuels in the energy mix of the European Union is still small, amounting to 0.15 per cent of the total consumption of mineral oils as fuel in 1998. The principal obstacle to their use is the price differential with fossil fuels ranging from 1.5 to 4 for products without tax. Biofuels can be primarily divided into biodiesels (70% to 80% extracted from organic oils and sunflower) and alcohols extracted from beetroot, wheat, etc. Numerous production options are available. Preference is being given to high-yield crops with low intermediate input and no effect on biodiversity. Biodiesel could be used without any major technical problems to replace normal diesel. Alcohols can be mixed with conventional petrol up to a level of around 15% without any technical modifications required for the vehicle fleet (IEA 2004b).

Biogas sources include recovered gases from sewage, landfill sites and agricultural waste. Since these gases are primarily made up of methane, the use of biogas actually reduces the emission of this greenhouse gas. The environmental impact of biomass energy is dependent on the primary source. For example, the utilization of waste will be more beneficial than the use of wood. Although the use of wood or crops is still CO_2 neutral, as is the other types of biofuels, the implications on land and fertilization necessary for their continuous supply may reduce their environmental benefits in comparison to other renewable energies.

Photovoltaics represent the only renewable technology which could, potentially, cover the total energy demand, provided that this technology could be made cost-effective. The long term potential of supply of biomass, wind, geothermal energy and solar thermal energy is estimated to be 20%, 15%, 15% and 10% of the current EU energy supply respectively. A key issue is the adaptation of future RES-based energy supply, which will be predominantly produced in the form of electricity to the energy demand. It is also worth highlighting that among RES technologies only biomass produces solid or liquid fuels which could be used as, or transformed into, fuels for heating in buildings and industry and transport. High priority in the medium and long term should therefore be given to the transformation of biomass into fuels for road transport.

Within the framework of the white paper on renewable energies, the European Commission proposed to increase the supply of energy with the addition of over 1,000 MW from photovoltaics, 10,000 MW from large wind farms, and 10,000 MWth from biomass installations. Geothermal energy and heat pumps are likely to provide a less significant contribution within this time period, with hydropower increasing slightly but maintaining its position as a major renewable energy source. The total estimated investment costs for the promotion of the three main renewables targeted is 18 billion € and is expected to result in substantial avoided fuel costs and environmental benefits (EC 1997c).

In addition to the above increase in biomass, wind and PV, the white paper highlights a number of priorities aimed at reducing the obstacles to the widespread use of renewable energy systems (RES). A key priority is fair access for renewables to the electricity market. Various promotion schemes are been investigated, many of which have been proposed or introduced by the member States. Under the common rules for the internal market in electricity, member States can require electricity from renewable sources to be given preference. It is vital that such preference schemes for renewable energy sources of electricity are harmonised throughout the EU so that they do not cause any trade distortions.

According to an EU Directive on the promotion of electricity from renewable energy sources (RES-E), issued in 2001, EU member States should establish individual targets for future consumption of

electricity from renewable energy sources. The European Commission would monitor the compliance to these national targets with relation to the overall EU aims, the specific objective for consumption of RES-E and the EU commitments for climate change. The directive promotes priority access for RES-E, correct certification and improvement of the procedures applicable to electricity from renewables.

RES and decentralised generation have the potential to become a cornerstone of a future, more sustainable European energy supply. Apart from the obvious contribution to clean and diversified energy supply, local generation reduces energy transmission losses, helps to avoid congestion in the existing distribution grids and enables the use of by-product heat, thus improving overall system efficiencies. Power quality and reliability can also be enhanced.

4. NUCLEAR FISSION AND FUSION

Nuclear power, produced by the fission of nuclei of uranium, covers more than one third of the needs for electricity in the EU. It accounts for 80% of the electricity produced in France, 60% in Belgium, 50% in Sweden, and around 30% in Germany, Spain, Finland and the United Kingdom. For the last forty five years, nuclear energy contributed to the diversification and security of supply in Europe. However, due to public perception of risks linked to nuclear accidents, proliferation and the management of radioactive waste, prospects for new nuclear installations are limited.

The development of nuclear energy progressed under the Euratom Treaty, signed in 1957, the 1968 Treaty of Non-Proliferation, which entered into force in 1970, and the rules established in the framework of the International Atomic Energy Agency (IAEA). The Euratom Treaty aimed at enabling the European Union to develop its know-how and obtain the means of exploiting nuclear energy for civilian purposes. Regardless of their resources in uranium, all member States, which were able to, embarked on major civil nuclear programmes. Nuclear fission now offers a mature and reliable technology. The lifetime of nuclear reactors is extending beyond the initial expectations and up to sixty years, primarily due to better knowledge of the performance of materials and plants. Nuclear fission is competitive compared to other

fuels, especially natural gas, and does not generate greenhouse gas emissions.

Health, safety and radiation protection standards, established at EU level, are enshrined in the legislation of each member State. The same norms govern the use of radioactive materials in medicine, research and industry. Euratom safeguards award the Community undeniable credibility in terms of non-proliferation of nuclear materials. The Euratom Supply Agency's target of diversifying supply also means that the EU does not excessively depend on a single geographic region for its uranium requirements.

Nuclear fission has the advantage of not producing greenhouse emissions. However, the waste produced during the mining, milling and enhancement of uranium and in the process of nuclear electricity generation includes high-level radioactive waste. High-level waste constitutes only a small percentage of the total nuclear waste but represents a larger potential threat to the environment than waste from other uses of radiation, such as in medicine, agriculture and industry.

High-level waste is produced from spent fuel and also the spent fuel that is reprocessed. It is highly radioactive, remains hazardous for over ten thousand years, and also emits heat. The potency of this class of nuclear waste is demonstrated by the fact that it represents almost 99% of the radioactivity of all nuclear waste, even though its volume only accounts for 1%. Low-level waste is created in all nuclear activities, and is low in radioactivity and "short-lived" i.e. has little remaining radiation after several decades. Medium-level waste is also "short-lived" but consists of a higher level of radioactivity.

In the summer of 2004, the European Union had one hundred fifty four nuclear power plants, eleven of which are in the new member States. The nuclear plants have capacities of around 1 GW. In general, plants produce about 100 m^3 of "short-lived" operational waste annually, although recent plants may be able to reduce this to up to 50 m^3. These reactors annually discharge spent nuclear fuel that totals twenty to thirty tonnes of heavy metal (uranium and plutonium) subject to the enrichment of the fuel used. The eventual decommissioning of an average nuclear power plant would produce approximately 10,000 m^3 of radioactive waste, which would have a lifetime of decades.

If inadequately managed, nuclear waste could be a potential risk for future generations. In most countries in the world this issue focuses on long-life highly radioactive waste, which may remain hazardous for tens of thousand of years. At present, the nuclear power industry safely contains all fuel waste near reactor sites in dedicated storage facilities. With the continuing nuclear supply, waste is accumulating and a more permanent solution has to be adopted. Definitive disposal is feasible and construction and operating techniques are mature enough to be applied. Research and development on disposal in deep geological formations is progressing and underground laboratories are attracting much attention. By partitioning (chemical separation) and transmutation (radionuclide conversion), it might be possible to reduce the long-lived component of the radioactive waste, and facilitate management. Technological achievements have to be accompanied by social mechanisms addressing perceptions of risks and safety by the public (EC 2000e, 2001h).

While scientists generally agree that geological isolation is the best way to dispose of high-level and long-life nuclear waste, progress in implementing these methods is slow. The storage of nuclear waste within the EU is currently being made by surface, shallow and deep geological disposal. High-level nuclear waste is usually stored in central storage facilities, and its disposal delayed for a minimum of fifty years up to over a century, or until deep facilities for its removal become available. Finland, France, Spain, Sweden and the UK operate surface and shallow disposal facilities for low-level radioactive waste and waste containing only a small amount of long-lived radionuclides. A deep disposal facility in a former salt mine is operational in Germany for low-level waste (EC 1999d).

EU member States are currently involved in preparatory studies for the disposal of their stored high-level waste, for example, by operating underground research laboratories. Technological progress has to address uncertainties in scientific results and advice, which may fuel societal preoccupations. A better understanding of the origins and nature of these concerns is essential in order to address them effectively. New social mechanisms and processes have to reinforce trust and confidence in decision-making (EC 1999d).

Concerning nuclear proliferation, it is debatable if the use of commercial nuclear energy increases risks for making nuclear weapons. Continuous developments can shorten the time necessary to acquire

fissile materials but enhances also international safeguards and political alliances. These are essential to prevent the tensions that encourage proliferation.

Nuclear accidents have heavily stained the public image of nuclear fission. The Three Mile Island accident in Pennsylvania, USA, in 1979, gave rise to the Swedish referendum on nuclear energy. The Chernobyl accident (26 April 1986), undeniably the most serious accident in the history of atomic energy, had a great impact. The Italian referendum took place only few months later. The growing importance of ecological parties and citizen and pressure groups onto the political stage led five out of the eight member States with nuclear power in EU-15 to adopt or announce a moratorium. France, the United Kingdom and Finland have not yet taken a decision to stop nuclear energy, but except Finland, there are no new reactors likely to be built within the next few years. Italy renounced nuclear energy following the 1987 referendum, and Germany announced in 2001 the intention to shut down its remaining reactors. At world level, six new reactors were installed in 2000, three in India, one in Brazil and the last two in Pakistan and the Czech Republic, while new developments are expected in Japan and Korea.

An acceptable, consensual and safe solution to the management of nuclear waste is a critical factor for nuclear energy, together with the economic viability of the new generation of power stations and the prevention of nuclear proliferation. Policies against global warming may favour nuclear energy, which can prevent 312 Mt of emissions of CO_2 per year in the European Union (7% of all the emitted greenhouse gases), almost equivalent to the CO_2 emissions produced by some 75 million cars. The Swedish Government's decision to shut down one reactor in the nuclear facility of Barsebäck in 1999, after 23 years of operation, created a production shortfall of 4 billion kWh per year, which has to be made up by electricity imports from coal-fired Danish and German power stations. This leads to an indirect increase in CO_2 emissions of around 4 Mt per year, i.e. about 8% of total emissions in Sweden.

The societal attitudes concerning nuclear energy are difficult to evaluate. An important number of citizens seem by principle against nuclear energy. The risk of nuclear accidents and the question of radioactive waste pose the major problems that crystallise fears and determine prospects. Increasing concern about climate change has the potential to change perceptions, especially if improved nuclear safety and

a lasting solution for nuclear waste management are achieved (EC 1998b).

A chain of rational and emotional elements governs public concerns regarding nuclear energy. A series of opinion poll surveys undertaken near French nuclear sites (Saint-Alban, Civaux, Gravelines, Tricastin, Chooz, Dampierre, Belleville and Bugey), between 1996 and 2000, offer some interesting signals. A large and continuously increasing percentage of respondents (39% in 1996 and 66% in 2000) think that the presence of a nuclear site may have an uncontrollable impact on human health. It is interesting to note that the last statement was emphasized by health professionals. Fears are shared not only by the protesters against nuclear energy, but are also embraced by some of those who favour nuclear production of electricity, in so far as less risky options are not available.

Emotional fears are major causes of the rejection of nuclear energy by the public. The sector has been stained by the original dual purposes, civilian and military. Terrifying apocalyptic images, multiplied by the media, had a great societal impact. The accumulation of health scandals, such as the genetically modified food and bovine spongiform encephalopathy, which question the credibility and responsibility of supervising authorities, has resulted in public distrust. Many citizens feel that those entrusted with the task of representing the public interest do not really know what the long-term effects are.

Surveys reveal the public perception that nuclear authorities are not fully transparent when insisting on the security of nuclear sites, as if zero risk were possible. Sixty five to seventy seven per cent of individuals living near nuclear sites think that nuclear authorities usually adopt a defensive position. Scientific uncertainty and the precautionary principle are often quoted to point out not evaluated and probably not assessable risks, which generate fears. It is noteworthy that ecological associations and the media benefit from even less credibility than public institutions. No organization seems absolutely trustworthy and nearby health professionals are the only ones who enjoy strong credibility, precisely because they do not serve the interests of an institution.

The challenges for risk governance are important. Opening of the sites and access to the public may have an important symbolic influence in rationalising positions. Nuclear authorities could also provide the

elements of a consensual elementary culture on health effects, by vulgarizing and disseminating scientific information. The training of respected health professionals near the sites and communication and awareness raising campaigns involving all actors (media, local representatives in the parliament, schools) are key actions for changing perceptions on nuclear sites.

The near zero contribution of nuclear energy to greenhouse gas emissions may play an important role in future decisions. A series of interviews undertaken in Sweden by Demoskop, on behalf of Swedenergy in December 2000, highlight that 83% of the Swedes consider very/fairly important to take into consideration its zero contribution to global warming when deciding about the future of nuclear power. It is worth mentioning that, among the resolutions passed by the Swedish Parliament regarding environmental objectives, stabilization of greenhouse gases was deemed by the interviewees more important than nuclear phase-out and protection of unspoiled rivers. Finnish surveys highlight, however, that appealing to the Kyoto commitments as an argument favouring nuclear power does not win support among Finns. Rather it increases uncertainty (Demoskop 2000, FEIF 1999).

The decision about developing nuclear energy in Sweden, thirty years ago, is not regretted. Seventy six per cent of respondents stated that the decision to start using nuclear power in Sweden was good/rather good. Twenty one per cent of them are more critical and state that it was not a very good decision or that it was not a good decision at all. A majority (53%) of the respondents appears in favour of a continued use of present power plants as long as they comply with the security requirements. Those who want to continue using nuclear power amount to 24%, and those who suggest to phase-out nuclear activities to 21%. However, only 7% of citizens suggest that the use of nuclear power should be increased and, if necessary, new plants should be built, once the present ones have completed their lifetime. Concerning the use of dismounted nuclear weapons as fuel for nuclear stations, 35% of respondents continue to consider that it would be a good idea. Eleven per cent think that it is not very good idea and 24% think it is not good at all.

Controlled thermonuclear fusion is considered as a new long-term option that could provide a substantial contribution to the energy needs of the society, in particular base-load electricity, in the second half of the century. Nuclear fusion is the most widespread and immense

source of energy in the universe. It is produced in the core of the sun and the stars. Under the effect of gravitation and high temperatures, the nuclei of hydrogen merge to form heavier helium atoms, releasing enormous quantities of energy (EFDA 2001).

Reproducing this prodigious energy mechanism on earth has represented a vision, which became reality after four decades of concerted efforts. Today, fusion continues to be the subject of intense research and is expected to produce safer and cleaner energy. Within the framework of Euratom, the integration of all EU nuclear fusion activities into a single European fusion programme conferred European research a position of excellence.

Research focuses on achieving controlled fusion of deuterium and tritium, the heavier and less common hydrogen isotopes, which yields helium, a noble non-radioactive gas, and neutrons. Deuterium is a non-radioactive element that can be extracted from seawater, and tritium, easily produced from lithium, abundant on earth's crust, is a relatively short-lived radioactive. The potential of fusion power for base-load electricity production is very substantial since the primary fuels are virtually inexhaustible and non-radioactive, and the amount needed in a fusion power station is very small. 100 kg of deuterium and 3-4 tonnes of lithium fuel could supply a 1 GW power station compared to 100 tonnes of enriched uranium or about 2.5 Mt of coal.

Fusion processes are very complex. In order that light elements fuse, the atomic nuclei have to be given sufficient kinetic energy to overcome mutual electrostatic repulsion. This energy is achieved by heating the fuel to very high temperatures, over one hundred million degrees. The method of magnetic confinement helps to maintain the plasma in a doughnut shaped device (the most advanced and tested development line is called Tokamak) and not in contact with the walls of the reaction container, which could cause a cooling down effect.

Over decades of research, scientists and engineers worked together for the construction of a fusion furnace and the achievement of extremely high temperatures. The principle of fusion energy generation has been demonstrated by the Joint European Torus (JET) facility in Culham, in the UK. In 1991 and for the first time, JET produced substantial fusion power (1.7 MW for a short time) as an experimental process, marking a European milestone. Successful experiments led to

fusion power production in the ten-megawatt range for some seconds (maximum 16 MW), in 1997. This already gave back a fusion power output corresponding to a large part of the power required to heat the plasma to fusion temperatures. Moving towards achieving fusion power in the hundred megawatt ranges and net power production (i.e. power production much greater than the one needed for the process) requires a larger, more powerful facility than the JET.

The scientific community working on nuclear fusion is carefully studying the lessons emerging from public resistance to nuclear fission. Fusion does not involve any radioactive substance other than tritium, produced and burnt inside the reactor. The presence of only a few grammes of fuel in the plasma is considered to be a fundamental safety feature of a fusion power station, since it allows the process to stop very quickly. Moreover, the smallest leakage of air into the combustion chamber terminates the process immediately.

Public interest and involvement in fusion seem to increase dramatically with the perspective of locating a major fusion research facility nearby. A study conducted in 1997 in Porto Torres, considered by the Italian government as a possible site for the international venture ITER(International Thermonuclear Experimental Reactor), revealed a strong interest and, ultimately, an almost unanimously positive attitude of citizens towards hosting ITER (which, in Latin, means the way) in their community. The early involvement of the interested public in the licensing process is considered to be a prerequisite for success. EU-supported research intends to identify possible safety and environmental issues which could be of concern for the interested public.

5. ENERGY ETHICS: FOR A SCIENCE WITH CONSCIENCE

Ethics in energy lie at the origin of the profound and persistent differences and inequalities that exist among individuals, nations, generations and energy options. Ethical issues arise with the freedom of choice, when faced with alternative courses of action. They are intrinsically linked to the right to energy for all and the options offered to citizens. The universal right to energy demands increasing efforts for ensuring access to energy for all. The provision of energy services should

not compromise the environment and the rights of others. Each energy option has incontrovertible weaknesses and strengths and presents simultaneously irreducible advantages and disadvantages. Any decision is based on choices, which are implicitly or explicitly made following a hierarchy of values, attributing that more or less weight to the features of the various energy options.

The key reference on Ethics in the European Union is the Charter of Fundamental Rights, adopted in 2000 and including provisions on dignity, freedoms, equality, solidarity, citizens' rights and justice. It is integral part of the Constitutional Treaty solemnly signed by the twenty five Heads of State and Government of the European Union in Rome on 29 October 2004. Policy decisions grounded in strong ethical considerations have to assess criteria and alternative courses of action.

Energy-related government choices are conditioned by previous decisions with long-term effects, high-scale invested capital and long-lived infrastructures. Citizen choices are constrained by the options offered to them in precise places and contexts. The overarching concept of sustainable development shed light on the obligation to preserve the global capital and on ethics as regards future generations. Sustainability ethics ask for energy strategies to facilitate the transition to sustainable energy supply, through energy savings and the enhancement of renewable resources. Research and technology are essential for minimizing the negative environmental consequences of energy production and consumption.

UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) has already undertaken a state-of-the-art on the major ethical issues linked to access to and use of energy resources, including fossil fuels, nuclear energy and renewable energy sources. Studies and debates placed emphasis on the importance of research in this field with the multi-fold objective to increase efficiency, effectiveness and equity and reduce the inherent risks. They also highlighted that the ethics of energy can only be comprehended in the context of a better understanding of how energy is woven into the social and economic fabric (UNESCO 2001).

Many ethical questions are related to the radical character and speed of technological change. Harnessing the potential of new technologies is essential to assess advances in science and analyze

potential risks to society. The deployment of technologies for increased environmental health and safety, the fostering of local capacity to monitor developments and voluntary energy/environmental audits and agreements have important ethical dimensions. Reversibility is often highlighted as a main issue. It seems essential that choices in the field of energy make the distinction between the reversible or irreversible consequences they might have in the short, medium and long term. Specific energy issues, such as the retrievability of nuclear waste, have important transgenerational ethical implications. The precautionary principle asks also for the prevention of unexpected and unintended consequences that introduce new uncertainties and may have irreparable effects. The search of an optimal and consensual solution to the management of nuclear waste, taking into account potential long-term risks and the issue of definitive waste disposal versus retrievability allowing future generations to take their own decisions is subject to many debates.

Public perception of the energy options in the European Union has been approached through opinion polls included in diverse Eurobarometer surveys, based on a questionnaire completed by 16,000 respondents, forming a representative sample of the EU population. The three main criteria for choosing energy options include lowest risk of pollution for the future, highest price stability and greatest reliability in terms of supplies. According to these criteria, most EU surveys of the last decade suggest that Europeans most favour renewable energy sources and natural gas. Nuclear energy comes in general at an intermediate position, while solid fuels and oil come last.

The last energy poll, conducted in spring 2002, provided thought-provoking answers. Citizens of the EU appeared to have a rather vague, in general, idea of the overall structure of energy consumption and underestimate in particular the amount of energy used for transport. Nearly nine out of ten respondents consider global warming and climate change to be serious problems requiring immediate action. About two thirds of respondents (61%) consider it important to know how much electricity they consume at home and 68% of those questioned feel they know roughly how much electricity was used in their homes during the last year. Seventy five per cent of respondents are of the opinion that fossil fuels contribute significantly to climate change. However, almost half of respondents (47%) consider that nuclear energy contributes significantly to climate change (27% being of the opposite opinion). Nearly three-quarters of those questioned (74%) consider transport to be

largely responsible for climate change. Europeans would most of all like to have information on concrete issues such as energy savings and alternative forms of energy (EC 2003b).

The most sought after pieces of information are those of a practical nature: how to save energy at home (53%), followed by the more complex issue of how to use new energy sources at home (42%). Next, in descending order, come the alternatives to using petrol or diesel (39%), safety of nuclear power stations (36%), advances in the field of new forms of energy (27%), EU activities in energy-related research and development (23%) and, lastly, how to save energy at work (13%). In the European Union as a whole, 85% of those questioned admit not being aware of EU energy-related research and development activities. The only areas about which they claim to know something (or, more likely, in which they are interested) are renewable energy sources (9%) and cleaner means of transport (7%). The main sources of information on energy issues and related technologies are television (80%), newspapers (47%) and radio (27%). The Internet was cited by only 10% of the respondents.

The dependence of European Union on energy imports is perceived as being a real problem, to which Europeans wish to see responses founded on sound research into new energy sources and of energy-saving policies. Protection of the environment and keeping prices low for consumers appear as the top priorities for EU citizens. Renewable sources of energy are perceived by a majority of the respondents as being the least expensive, the best for the environment, and to a lesser extent, the most efficient. The analysis of the European public's attitudes to producing energy from nuclear fusion clearly reveals that the issue is still difficult for the public to grasp. However, a very large majority, 59% as opposed to 6%, believe that much more research is needed to confirm its potential.

Safety issues are of great concern to Europeans, especially in relation to nuclear power stations, followed by food safety, safety at work and the safety of industrial sites. According to the usual paradox, the public is demanding more public policy action on nuclear power which, so far, has cost fewest lives and material damage generally while calling for little action to deal with road accidents which cause more harm. As far as energy-related research is concerned, EU citizens expect to see significant consequences for environmental protection and ask for more

action with regard to renewable energy sources and cleaner means of transport.

A crucial question in public surveys concerns the energy options and citizen preferences for the future. The most frequently quoted criterion was protection of the environment and public health (72%), followed by low prices for consumers (62%), and uninterrupted energy supplies (30%). There is a public enthusiasm about renewable energy sources, considered to be the most advantageous and environment friendly and, to a lesser extent, the most efficient source in fifty years time. The level of education tends to favour support for renewable energy sources and nuclear fusion. Last but not least, a very large majority of the respondents seem conscious that, in twenty years time, EU energy needs will be satisfied by a mix of different energy sources (81%) rather than by one single energy source (5%).

With regard to energy-related research, Europeans would support more EU-assisted research on renewable energy sources (69%) and on cleaner means of transport (51%), followed by nuclear fusion (21%), and conventional energy sources lagging far behind. New energy sources and clean means of transport are chosen most often in Sweden, the Netherlands and Denmark, but there is a very broad consensus on them throughout Europe. The main reason for continuing nuclear research is increased power station safety (48%), followed by improved waste disposal (43%).

A majority of EU citizens consider that it is industry which could have the greatest impact on energy savings. EU citizens also want to see stricter regulations and measures by industry. As regards energy savings, citizens give preference to measures which do not impose obligations on individuals, although a quarter of the respondents would accept stricter regulations for cars or the insulation of buildings. Out of eight actions they could do to save energy, respondents have done an average of two. The average is markedly higher in Northern Europe. Actions to save energy vary from country to country and according to social or cultural background. Only a minority of Europeans say that they do nothing to save energy. About two-thirds of Europeans say they would like to do more in future, again focusing more on domestic uses than on transport. The survey thus reveals, or confirms, the emergence of a market for green energy products amongst consumers, especially in Northern Europe, as just over a third of those interviewed would agree to pay more for

renewable energy. The same proportion of respondents says they pay attention, when buying new equipment or appliances, to the amount of energy they require (EC 2003b).

Public perception of nuclear waste in the European Union has been approached through dedicated opinion polls included in diverse Eurobarometer surveys. The last specific survey on radioactive waste, carried out in August 2001, highlighted that EU citizens were rather poorly informed about radioactive waste. Forty eight per cent of Belgians consider themselves not very well informed on the issue, compared to just 12% of Swedes. Across the EU, 32% of Europeans trust independent scientists and 31% have faith in NGOs - but they simply do not believe neither EU bodies, nor the nuclear industry. EU bodies appeared as the fourth trusted source of information concerning the management of radioactive waste in EU countries other than that of the respondents.

The management of nuclear waste appears to be a crucial issue for Europeans, since eight out of ten declare that they are very interested in this subject in their country and seven out of ten in other EU countries. Interest increases with the level of education and transcends socio-demographic classes. The concern is high, since three quarters of Europeans stated being worried about the management of radioactive waste, both in their country and in other countries.

Sound information is essential in order to have a dispassionate debate on nuclear waste management. Six out of ten respondents abstained from answering the question about the quantity of produced nuclear waste and only 7% provided the correct answer, i.e. that it consists of less than 1litre/inhab/year. Eight out of ten Europeans believed that all radioactive waste is very dangerous. Even though a twenty-five year moratorium was imposed on this practice at the end of the London Convention in 1983, 26.4% of Europeans declared that radioactive waste is dumped into the sea. Seventeen per cent of European citizens declared that they do not know, 45% responded however correctly, that radioactive waste is stored temporarily pending a decision on disposal.

In the previous survey of 1998, 75% of respondents thought each country should keep its nuclear waste to itself, whereas now only 63% think so. Concomitantly, the share favouring waste treatment at the European level has risen from 12% to 18%. Just under half those

interviewed (as against three-quarters in 1998) think that there is no safe way to manage high-level waste. And they are equally divided about the most serious risks of living near a waste disposal site, giving equal ratings for those due to immediate threats such as leaks and those affecting health and the environment in the longer term. And the very large majority - over 90% - want the present generation to take responsibility now for the produced waste - and not leave it to future generations to manage.

Three quarters of respondents declared that the fact that no country has yet decided how to dispose of highly radioactive waste demonstrates that there are outstanding safety questions and this has a negative impact on the image of nuclear energy. Over half of the Europeans believed, however, that this delay illustrates how cautious public authorities are. They trusted them to weigh all the risks before taking any decision. Most Europeans would prefer that each country producing radioactive waste build its own underground deposit sites. Citizens from Denmark and the Netherlands, and also the Eastern Germany are in favour of pooling resources. Before building a deposit site, Europeans ask for public authorities to keep citizens informed, undertake environmental impact assessments, consult medical experts and people living near the site and get advice from independent scientists and environmental associations.

Concerning the minimum distance from a radioactive waste site, only 9% of the respondents declared being satisfied with a minimum distance of 500 km (18% in Finland) but 42.7% would consider at least 1,000 km. However, the second average percentage (15.3% of the Europeans) opted for no minimum distance. The location of sites is deemed to have an impact on local land economy. Seven out of ten Europeans were afraid that the construction of an underground site for radioactive waste may lead to a drop in land and property prices. This concern decreased with the level of education and degree of urbanization.

There is an overwhelming apprehension about the transport of waste to a deposit site, should this be built nearby, and 90% of Europeans declared that they would be very/fairly worried. 93% and 90% of Europeans confirm that they would be very/fairly concerned about the harmful impact on their health and on the local environment caused by the potential building of an underground site near their homes. Only the Swedes display a less acute level of concern, more than twenty and

fifteen points respectively below the average. Nine out of ten Europeans stated that they would be very/fairly worried about the long-term safety implications of the deposit sites.

A most noteworthy result from the survey highlights the support shown by citizens for the involvement of the European Union in establishing the rules for the processing and safety of radioactive waste. 68% of them (87% in Italy) declared that they would be reassured if the EU regulated the issue. Supporters of the EU involvement belong mainly to young, well-educated and high-income social groups. Last but not least, in the view of a majority of Europeans (54%, but 71% of the Danes), it is the present generation that should be responsible for finding a solution to the problem of radioactive waste. A third of them deemed however that this responsibility should be shared between present and future generations.

Governance has to address issues related to public resistance to certain energy options, which can raise difficult ethical considerations. Trust implications may result in certain technologies being rejected or inadequately developed. Increasing knowledge and public understanding of the social costs and benefits of alternative technologies involve agreeing on approaches for opportunity and risk management. Carefully targeted research in areas that offer concrete prospects for achieving a turn-around in public opinion may be most beneficial. The broader involvement of society in setting research and policy agendas can contribute to developing technologies that respond to the needs, values and preferences of society. Restoring trust and respect is essential if policies are to be implemented effectively. Credibility is a key to acceptability.

Following the Chernobyl disaster, the European Commission initiated a major research programme, named ETHOS, for the analysis of the consequences of the accident, in co-operation with the ministries for Chernobyl in Belarus, Russia and Ukraine. The improvement of the living conditions in the contaminated settlements was one of the key objectives of the project. Main impediments for sustainable improvements included the local dependency culture and the highly centralized planning of remedial actions. A decentralized approach was developed and tested, with the active involvement of local communities. The integration of social and psychological factors in the planning and implementing of countermeasures has proved to be decisive. The project

demonstrated tangible improvements in socio-economic conditions and contributed to the development of a coherent approach to effective contingency planning.

Risk governance, involving participation in assessing and managing hazardous activities, is receiving renewed attention. TRUSTNET, an EC-supported initiative, aimed at analyzing the factors which influence the credibility, effectiveness and legitimacy of the scientific and regulatory framework and developing more coherent, comprehensive and equitable approaches to risk management (EC 2000e). Through a broad range of case studies on environmental, energy and industrial sensitive issues, and brainstorming seminars, it offered insight into the social management of risk. TRUSTNET advocated for the "mutual trust" approach, versus the "top-down and bottom-up" paradigms. Public dialogue on nuclear waste or ageing oil platforms and support structures in the shelf seas can be decisive. Chronic safety problems, including tanker catastrophes and oil slicks, have not only to be addressed effectively, but also to increase the feeling of security and promote citizenship.

A TRUSTNET case-study focused on the involvement of stakeholders in Bavaria. The State Parliament asked the Finance ministry to organize a "Round Table" with stakeholders, representing all those potentially affected by the related decisions, in order to examine the energy options of the future and draft guidelines for coping with market liberalization, the phasing-out of nuclear energy, decided by the Federal Government, and global climate change objectives. The Round Table brought together thirty three representatives from government, parliament, industry, energy producers and suppliers, consumers, environmentalists, trade unions, churches, etc. for one year. Consensus has been achieved on three main fronts: promoting the move towards a sustainable energy path, supporting Germany's ambitious climate protection policy and increasing energy efficiency. The future of nuclear energy has provided the dividing line. Thirteen of the stakeholders were in favour of the extension of nuclear energy (especially in order to meet the climate-related objectives), while six suggested that abandoning nuclear energy is irreversible. A compromise was achieved in the form of leaving open the use of nuclear energy until 2010.

6. CHALLENGES FOR NEW AND CANDIDATE EU MEMBER STATES

The year 2004 is a year of historical importance for the European Union, since it marks the re-union between Eastern and Western Europe. After the signing of the Accession Treaty in Athens in spring 2003, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia joined the European Union on 1 May 2004. With twenty five member States and 455 million citizens, the European Union is starting to assume a new continental and international responsibility. The term "candidate countries" covers now Romania and Bulgaria, expected to join the EU in 2007, and Turkey (and most recently Croatia).

The green light for the enlargement was given by the 1993 Copenhagen Council, which had confirmed that membership was open to the Central and Eastern European Countries (CEECs) that wished to join the European Union. Accession would take place as soon as applicants are able to assume the obligation of membership by satisfying the economic and political conditions required. The conditions set out for accession, known as the Copenhagen Criteria, included the obligation of candidate countries to accept, and fully implement, the "acquis communautaire" the collective of all the principles, laws and practices within the Union, the most notable of which include the content, principles, and political objectives of the EU founding treaties. The 1994 Essen Council devised a strategy to assist the associated CEECs in their preparation for accession. Ten years later, enlargement brought definitively the post-war division of Europe to an irreversible end and inaugurated a period of peace, prosperity and well being.

The new member States face different difficulties in implementing the environmental acquis regarding the energy sector, since they vary from highly industrialised to low environmental impact economies. However, there are common aspects of the energy sector, such as increasing the efficiency of energy consumption, which concern all accession countries. A widely held concern is that the accelerated economic growth that the new member States are expected to experience will lead to greater energy consumption (Figure 21), exacerbating

pollution emissions. Private car use is especially projected to rise dramatically and the repercussions on the environment may be critical.

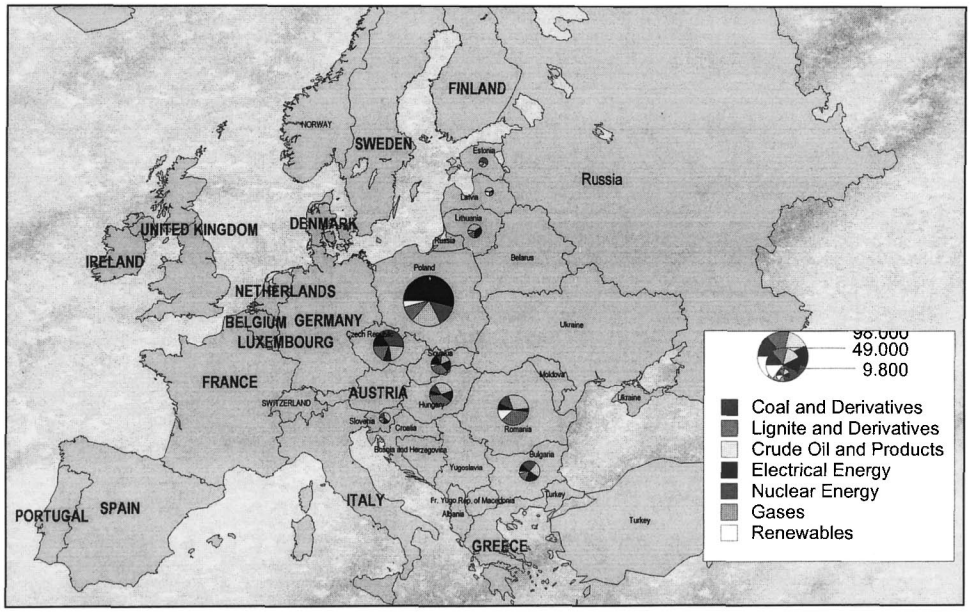

Figure 21. Gross Inland Consumption by energy source in new member and candidate EU States. Source: EC 2001 *Units : Thousand tonnes of oil equivalent (ktoe)*

In terms of the challenges faced in their compliance with climate change commitments, the Kyoto reduction target for the ten new member States is 70 Mt CO_2 equivalents in total. In the period of 1990 to 2000 these countries experienced a downward trend in carbon dioxide emissions and a reduction in solid fossil fuel use, mainly due to industrial collapse and restructuring. Furthermore, carbon dioxide emissions are projected to be 7.5% lower than 1990 levels by 2010, even though energy demand is expected to increase. Total emissions of the six main greenhouse gases are projected to decrease by 11% for this period. This perspective in emission reductions incorporates current EU trends in improved energy efficiency and the greater use of natural gas and

renewable energies instead of fossil fuels. It should be remembered, however, that the adoption of these strategies in the new member States faces similar obstacles as experienced in the former member States, such as technical barriers and high initial investment costs.

The maintenance of a high level of nuclear safety is another major challenge for new member States and candidate countries that have nuclear power facilities. All CEECs, apart from Estonia, Latvia and Poland, have a park of vintage nuclear reactors and facilities. The European Community has been providing support to the CEECs to help them to improve nuclear safety, within the framework of the PHARE programme, since the beginning of the 1990s.

As from 2001, EU support to nuclear safety projects was administered through a horizontal programme and each beneficiary was entrusted to engage in its implementation through dedicated national programmes. Assistance concentrated on enhancing the capacities of nuclear regulatory authorities and technical safety organisations and enabling them to exercise their precautionary and licensing functions. Regulatory assistance, reactor safety, emergency preparedness in case of a nuclear accident, radioactive waste management and radiation protection constitute major areas of support.

Nuclear safety requirements are not specified in the "acquis communitaire" which chiefly covers radioactive protection, as nuclear safety is the responsibility of the individual member States. The EC strategy for support to nuclear safety reflects a general approach to increase awareness and accountability and complement the efforts of the beneficiary countries with financial assistance.

Support was also made available to safety-enhancing projects for certain reactor types and for ensuring a high level of operational safety throughout the remaining operational lifetime of certain reactors, subject of early closure commitments. The decommissioning of nuclear power plants requires a high level of financial resources, including provisions for the management of the related nuclear waste. In some cases it will not be necessary for the nuclear power stations to be decommissioned and instead they may require improvements and upgrading, in order to safely complete their life cycle.

7. CHALLENGES FOR DEVELOPING COUNTRIES

Two billion people in the developing world are still without access to modern energy services, considered to be a sine qua non condition for well being and quality of life. Significant penetration of cleaner energies in developing countries would need access to the best available technology, capital for the necessary investments and an adequate institutional and financial framework. Technology transfer requires effective co-operation between governments, industry and financial institutions.

The picture of the developing world is very complex and diverse in terms of energy resources and use. There are importing, producers-exporting and transit countries. Abundance of energy resources does not mean eradication of poverty. The example of some OPEC countries (Venezuela, Algeria, Nigeria), which built their entire economy on oil exportation is significant. International co-operation is essential in order to secure smooth exchanges, access to effective services and transfer of state-of-the-art technology. The most conspicuous area of international co-operation in energy investments has been the oil and gas exploitation and trade. Emerging lessons could benefit sectors most critical for sustainable development, notably renewables. Long-term joint ventures to develop concession areas for wind energy and biomass could prosper within a similar framework, adjusted for the social and commercial realities of these energy sources.

World primary energy consumption increased by an average of 1.4% a year during the last ten years. This average figure hides large variations among the world regions. Whereas energy consumption in the OECD area grew by 1.5% and in Central and Eastern Europe decreased by 2% per year, massive increases in demand were exhibited annually in the Middle East (4.8%), Asia (4.5%) and in Latin America (3.6%). The weight of Asia has rapidly grown. Its share of global energy consumption increased from 15.8% in 1980 to 24.5% in 1997. Furthermore, total world energy consumption is projected to increase significantly, due to sustained population and economic growth in developing countries.

The structure of energy supply in the developing world as a whole presents some particular features. There is relatively more use of coal and renewables, particularly due to the primitive use of biomass, and

relatively less consumption of oil, gas and nuclear energy. Non-commercial energy, mainly including firewood, charcoal, crop residues and animal waste, accounts for approximately 10% of global primary energy use, but reaches 30% in developing countries. Its use, based on obsolete technologies, is highly unsustainable.

Regional differences are important. Coal is by far the most prominent source in Asia accounting for 40% of total energy supply, 77% of its power generation. Latin America relies on oil for almost half its energy supply, three-quarters of its power generation. Traditional biomass represents 70% of final energy consumption in sub-Saharan Africa. The limited recourse to nuclear energy is concentrated in Asia (China, India, South Korea and Taiwan) and South Africa.

Population increase, industrial growth, urbanisation and the substitution of non-commercial energy by commercial products and services are key drivers for voracious energy demand in developing countries. In addition, in regions where wood and charcoal are still the main sources of energy, deforestation and erosion problems become dramatic. Since 1990, annual growth in final energy consumption in Asia, the Middle East and Latin America reached 7.6%, 6.7% and 5.1% respectively.

Escalating energy demand in emerging dynamic economies, particularly in Asia, causes great environmental concern. These regions are driving oil consumption and their overall share of global oil consumption growing rapidly. The dependence of developing countries on imported oil has already had clear financial implications and there is a close causal link between oil price rises since the 1970s and third world debt. The relative importance of oil in the energy mix of developing countries is expected to increase, notably in Asia. The share of gas is forecast to increase in all regions, particularly Asia and Latin America. The developing Asian region, currently a net exporter, is likely to become a net importer by 2020. Coal consumption in developing countries is forecast to grow by almost 3% per year until 2020. The consumption of solid fuel in Asia raised its proportion of world solid fuel use from 32.7% in 1990 to 41.3% in 1997.

With regard to global energy and environmental politics, China concentrates essential opportunities and threats. China's rapid growth has sparked a surging demand for energy. It is now the second largest energy

consumer and third largest producer in the world. The most striking feature of China's energy sector is its extreme dependence on coal, currently providing about 76% of energy demand. Coal-fired power plants are cheaper and quicker to build. In the absence of drastic measures and the adoption of cleaner technologies, China may become the largest emitter of global greenhouse gases within the next decades, overtaking the USA.

Nuclear power is expected to more than double its capacity in developing countries between 2000 and 2020. With few exceptions these plants will be built in China, South Korea, India and Taiwan, where the share of nuclear in electricity generation is planned to increase. For the developing world as a whole, the share of nuclear energy in electricity generation is expected to remain around 4%. Low prices on coal and gas and increasing cost associated with establishing safe operations may cause difficulties to demonstrate short-term economic feasibility necessary to ensure financing. Future use of biomass is difficult to predict, although it can be expected that with economic and social development, consumption of traditional biomass will decrease. With population growth, wood-fuel is becoming a scarce and unsustainable resource in many areas, contributing in many cases to deforestation. Fuel-switching represents an opportunity for cleaner energy options and international co-operation should help to grasp it (IEA 2001c).

Emerging economies hold ample opportunities for energy efficiency improvements in every single sector, as they present rapidly increasing rates of energy consumption at very low levels of efficiency. The 1996 China five-year plan assigned a high priority to energy efficiency, calling for improved management, institutions and energy-saving networks, as well as the adoption of necessary regulations and practices. The choice of technology for power generation in developing countries is of paramount importance for successful action to curb CO_2 emissions (IEA 1999b).

The EU, the world's largest donor of development aid and biggest trading partner has a critical role to play, particularly in creating strategic partnerships for the transfer of cleaner technologies. Advanced energy technology dissemination actions, carried out in developing countries, could boost the development of energy services based on renewable sources. The penetration of renewable technologies in the developing world can yield multiple benefits for the environment,

security of energy supply and the global economy. Decentralised generation presents a special opportunity and the command and control power grids, which presently leave a large share of the population outside, could gradually be completed with more decentralised and efficient, cleaner and service-oriented systems.

Collaborative projects, known as "Implementing Agreements", offer the legal mechanisms and the management structures for the development of new energy systems, as well as for the deployment of clean technologies in the market place. Activities under the current forty active "Implementing Agreements" cover work on virtually all clean energy fields. Examples include the Bioenergy Agreement and the Solar PACES Agreement. "Implementing Agreements" play an important role in producing and disseminating scientific and technological information. IEA "Coal Research" offers information on clean coal technology and IEA "GREENTIE" distributes information on almost 8,000 energy technology suppliers whose products help to reduce greenhouse gas emissions.

Labelling and standardisation programmes are increasingly subjects of international co-operation, especially for designing tests, co-ordinating implementation and monitoring and harmonising methods and procedures. International co-operation may also facilitate policy reform and effectively address tax exemptions to energy and raw material production and use. Special tax regimes not only deprive governments of revenues, but also, more importantly, lead to large price differentials, lower efficiency and higher costs of achieving the global emission targets agreed with the Kyoto Protocol. Examining the prevalence and magnitude of various support programmes to primary energy sources and establishing joint schemes to respond effectively to the Kyoto challenges are key fields of international co-operation (IEA 2000d).

Developing meaningful EU approaches to international co-operation can be an important vehicle for effective collaboration with other OECD countries, as well as a bridge with less developed regions that are increasingly major energy consumers and contributors to global emissions. Public private co-operation in large developing countries offers many opportunities, especially for countries such as India, China and Brazil, where already joint research programmes oblige both sides to co-venture for the development of applications and devices. EU and national funds could be channelled into supporting selected energy sector

research, pilot and demonstration projects of pre-commercial technologies, in areas presenting a convincing ongoing potential for implementation. European Union investments in such projects would confer a degree of confidence in private sector technology agents who might otherwise be reluctant to expose their competitive technical edge.

"Energy for Poverty eradication and Sustainable Development" is one of the more than 200 partnerships launched by the Johannesburg WSSD. Among the Summit's main targets, the New Partnership for Africa's Development (NEPAD) has to ensure energy access for at least 35% of Africans in the next 20 years. The "Energy for Africa" conference (Nairobi 2003) helped identify priority areas for EU development co-operation, including household energy, biomass, rural electrification and capacity building.

With the entry into force of the Kyoto protocol, on 16 February 2005, the clean development mechanism gets a major boost. The mechanism encourages investments in developing countries which promote sustainable development while limiting the emissions. On 11 January 2005, UNFCCC registered the first small scale CDM project, the Rio Blanco Hydroelectric Project in Honduras. The project produces power in a run-off-river hydroelectric plant and it sells it to the national electricity utility.

Chapter 4

ENERGY POLICY, SECURITY AND THE MARKET

This chapter addresses the issues of energy policy, security and markets, mainly in the EU. Public policy has to ensure that energy systems are economically robust, socially beneficial and environmentally sound. Renewable energy sources could be competitive with the conventional ones if the full costs and benefits of all energy options are taken into account. Government frameworks are important in order to level the playing ground and create a more favourable climate for the integration of renewable options.

1. ENERGY POLICY AND SECURITY IN THE EU

Cities and governments have to ensure secure, competitive and environment-friendly energy supply and must respond to any contingency, e.g. disruption of electricity or oil supply, quickly and effectively. Public policy has to maximize and optimize the possibilities of the energy systems. Authoritative public bodies must foresee and integrate the complexities of the evolving energy systems, establish targets, evaluate progress and redirect policies to meet the three fold aim of security of supply, competitiveness and sustainability. The search of a sustainable energy policy aims at achieving a meaningful balance

between security of energy supply, competitive energy products and services and environmental protection (IEA 2000c).

As the individual States, the EU as a whole has to achieve progress towards sustainable energy, security of supply and competitive and affordable products and services. The internal energy market holds new challenges, since the member States are interdependent as regards action against climate change, imported energy supply and gradual completion of the internal market.

Promoting competitive energy and creating new business opportunities in the related industries and services constitute prime EU policy objectives. Government involvement in energy was traditionally seen as a national security issue. Over the past years, virtually all EU member States have introduced competition in the electricity and gas sectors. Market options get multiplied and rising competition may unlock new opportunities. Electricity markets are gradually converging towards a common approach, allowing consumers to use the electricity supplier of their choice.

The European Union is the largest energy importer in the world. Fifty per cent of consumed energy in the EU has now to be imported. Almost all member States rely on energy imports to satisfy their gross inland demand. The energy balances of EU member States reveal enormous deficits (Figure 22). In 2000, only the UK, and to a lesser extent Denmark, demonstrated net energy exports rather than imports. Demand increasingly outstrips indigenous production and external dependence for energy is rising.

In the 1990s, energy self-sufficiency declined slowly but regularly. Energy dependence can have serious consequences, such as supply uncertainty, higher energy prices and exposure to political instability of exporting world regions. The structural weakness of the European Union to balance its energy system can be witnessed in all sectors of the economy. Transport and the residential sector largely depend on oil and gas and are at the mercy of unpredictable movements in international markets.

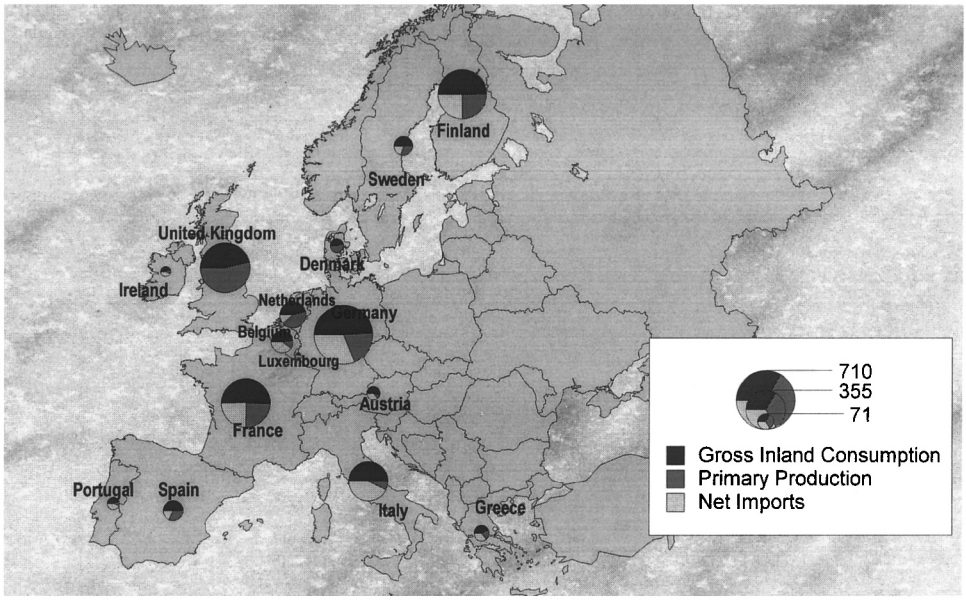

Figure 22. Energy balances of the EU-15 member States, 2000. Source: EC
Units: Tonnes of Oil Equivalent

Geopolitics, international trade, the liberalisation of the markets, environmental concerns and concerted actions against climate change impact on the energy policy options exercised by the European Union. Last, but not least, scientific and technological progress may open new pathways, extend the endless frontiers of knowledge and influence policy developments.

The EC Green Paper on a European strategy for the security of energy supply has generated a vigorous debate in search of meaningful policy measures. Industrial production patterns have largely been adapted to environmental requirements. They are more concentrated in space and

more easily to target and change. The transport and construction industries still have to apply an active energy savings policy and diversification in favour of non-polluting energy systems. The Green Paper advocates for a real change in consumer behaviour. Taxation measures can steer demand towards energy options that are more respectful of the environment and generate revenues to be invested in environmental protection.

The Green Paper concludes that, unless energy consumption rates show a downward trend, the energy dependence of the EU will reach more and more worrying levels. Indigenous fossil fuel stocks are bound to decrease. After the last enlargement of the EU and including Norway in the equation, the European Union's energy dependence is expected to rise by 20 percentage points from current levels to reach some 70 per cent in 2020-2030 (EC 2000a).

No single energy option has the capacity to fulfill all energy needs in the immediate and near future. Diversification is necessary and has to be reflected in the political decisions and in the research priorities. Science has an essential role to play in improving energy efficiency and in exploring and capitalizing on the potential of all energy options including nuclear fission and fusion. Intensive research, development, demonstration and innovation programmes hold much potential towards a more sustainable energy future (EC 2000a).

Governments have to ensure that energy systems are economically robust, socially beneficial and environmentally sound. Traditionally, public policy for energy includes regulation, state aids and support to fundamental research and technological development, together with the promotion of portfolios of integrated measures, including economic instruments and horizontal actions for education and awareness raising. An informed citizenry has long been regarded as the cornerstone of a democratic society and education, training and communication constitute undeniable public policy ingredients.

In most EU member States, there is an increasing dissemination of economic instruments. However, direct regulations still play a fundamental role in energy policies. The privatization of energy has often prompted reforms of regulatory and institutional structures. Framework conditions aim at reducing policy and market distortions and increasing the efficiency of resource allocation, for example by providing better

information on the real costs of products and services and market access to competing energy options.

Many governments are taking initiatives to shift citizen behaviour towards energy options that are more environment-friendly and use taxes to influence consumption. Eco-labelling and certification, green purchasing and assignment of property rights may create new markets and sound employment. Eco-labelling schemes inform consumers on the environmental characteristics of products and processes and green government procurement can uphold sustainability priorities. Awareness campaigns can overcome information deficiencies and increase consumer knowledge of the ecological impacts of their behaviour and the potential benefits of alternative energy consumption patterns.

Energy policy instruments are complementary and can be enriched with strategic partnerships with businesses, trade unions and civil society, including consumer and environmental organizations. Liability systems and performance bonds pending on environmental performance may create a thrust towards sustainability excellence. Encouraging public reporting by enterprises on environmental performance can accelerate progress. Voluntary approaches confer both industry and governments a positive image and spur the active participation of the local society.

The ongoing liberalization of the energy sector can have positive effects on the environment through improved efficiency of existing plants and faster penetration of cleaner technologies. However, lower prices achieved by increased competition may lead to rising consumption of electricity, with negative effects on the environment through higher emissions of greenhouse gases, sulphur dioxide and nitrogen oxide. Comparative assessment of country experience curves can help decision-makers to design reforms that maximize the gain in economic efficiency while optimizing consumer satisfaction and reducing the potential of damaging effects on the environment. Last but not least, governments have to support innovation and change within stability in order to engage decisively into more sustainable pathways.

Energy has been one of the most heavily subsidized sectors in industrialized countries. Subsidies for the entire sector have traditionally included support towards coal, nuclear and oil and they usually served purposes of social and national development. OECD data on coal

subsidies demonstrated that, although direct producer subsidies have dropped significantly, they still stood in 1997 at almost 8 billion US$. Most often, subsidies to coal neither secured employment, nor reached the intended recipients. They postponed structural adjustments and contributed to higher emissions of greenhouse gases, by stimulating the continued use of coal-fired power generation at the expense of alternative, less carbon-emitting forms of energy production, such as gas turbines or renewable energies.

Subsidies encouraging inefficient use of energy constitute a significant drain on public funds, have negative effects on the environment and may discourage technological innovation. Their elimination can promote greater transparency and accountability and lead to accelerated technological progress and a more entrepreneurial approach to energy exploration, production, conversion, distribution and supply. Their removal could however cause employment problems and mitigation measures to help structural adjustments in regions in crisis should be considered (De Moor et al 1997).

If the removal of subsidies to polluting energy sources is a central element of many subsidy reforms, support for renewable energy technologies to take off and expand is seen favourably in most EU countries. Investing in renewable energies has a high and often prohibitive cost for economic agents and citizens. The EU guidelines on state aid for environmental protection explicitly foresee that member States may grant operating aid to new plants producing renewable energy. It is also suggested that the amount of the state aid reflects the lower external costs, i.e. the damage to public health and the environment.

A subsidy reform portfolio could include the shift of support from polluting fuels to sustainable energy sources and consider mitigating and accompanying measures. Subsidy reform schemes, including support for renewable energy forms, may bring significant economic and environmental benefits. It can level the playing ground among energy products and services, create fairer conditions for competitiveness and allow consumers to make more objective and pertinent choices. The overall result depends on the institutional context and governance.

Eco-taxes can impinge upon lifestyles and may induce citizens to choose the most efficient and effective energy options in response to the

price signal they provide. Prices impact remarkably on the vitality and ingenuity which markets can unleash. Energy taxes present generally lower cost of compliance than legislation, reduced bureaucracy, incentives to improve over time, better environmental performance and generation of funds to finance public policies. Eco-taxes can improve the reward structure throughout the economy and lead to the mutual reinforcement of environmental and fiscal policies.

The use of charges and taxes has to reflect scarcity value as a powerful tool for sending signals to producers and consumers. Introducing a carbon tax or some other mechanism, ensuring that prices for fossil fuels fully reflect the harm to the environment and public health, would be a potent force for decarburization. The introduction of a sulphur tax in Sweden in 1992 stimulated SO_2 abatement beyond levels achieved by existing regulation. The result was a reduction in the sulphur content of fuels by almost 40 per cent beyond legal standards. Tax differentiation between leaded and unleaded gasoline has led to a drastic reduction in lead in the European Union. Taxation is, however, always unpopular and revenue-neutral tax reform is introduced by many governments, which, in parallel to the launch of energy taxes, reduce the tax burden on labour. A green tax reform can lead to a double dividend and benefit both the economy and the environment.

There have been different mechanisms regarding energy taxes in the EU member States and there was a risk of distortion in the conditions of competition and consumer choices among energy sources or products. The harmonization of the taxation schemes of member States could offer the most efficient antidote to these difficulties. Against this background, the European Commission proposed initially in 1997 an EU Directive on a common framework for the taxation of energy products. One key element of the proposal was that EU governments, when implementing the directive, may decide not to increase the overall tax burden. The 2003 EU Directive restructuring the framework for the taxation of energy products and electricity adopts the same approach and extends the system of minimum tax rates from mineral oils to other energy products (coal, gas, electricity).

2. EU ENERGY MARKETS AND LIBERALISATION

Outstanding company mergers, advancing liberalisation and convergence of the oil, gas, electricity and service sectors are the main developments that are shaping the energy business landscape, a dynamic and expanding one. The turnover of the global energy business amounts to 1.7 to 2 trillion US$ a year. Strong pressure from institutional shareholders for rising financial returns led to merger synergies and efficiency gains, in an increasingly competitive environment. Top energy companies include ExxonMobil, Royal Dutch/Shell, TotalFinaElf and BP.

The energy sector is going through an important transition from an asset and equipment system to a trade and service business. The future of energy companies depends on issues such as shareholder value, convergence and risk. Size may not be the most critical parameter and horizontal, vertical and virtual integration of functions may be fundamental. Convergence with telecommunications can be decisive.

It is generally accepted that, in the long-term, energy market liberalisation will offer consumers a wider range of options, lower energy prices and improved products and services. The repercussions on energy companies may be very diverse. Market forces may compel large major companies to separate into smaller, highly specialised firms. Yet, some enterprises foresee no such change in their futures and expect to have the same structure and priorities in the decades to come. Other companies try to adopt a more flexible approach and open up to new opportunities.

The trend for the convergence of oil, gas, electricity and service sectors emerged with the increase of the contribution of natural gas to energy supply, driven also by public desire for cleaner energy. In the past, natural gas resources were greatly under-estimated and there was limited investment in gas exploitation. The growing demand for gas is overtaking the pace of increase in oil consumption, making gas the most attractive investment for future business.

The liberalisation of the EU Electricity Market is progressing in all member countries, in accordance with Directive 96/92, which

specified February 1999 as the target date for compliance, with a one or two year delay for some countries. Progress has been asymmetric throughout the EU. Some positive and negative effects of liberalisation are already discernible.

Increasing competition can lower electricity prices and bring more and better products and services, e.g. green electricity. It holds a challenge for new investment in cleaner technologies and energy efficiency. As new investors enter the market, such as medium-sized renewable schemes, suppliers are forced to cut costs. There may be a risk of adverse behaviour and short-term thinking by utilities. This may be to the general detriment of investment in research, technology and development and has to be seriously considered in policy agendas.

The directive for the liberalisation of the EU Gas Market came into force in 1998, establishing a minimum 20 per cent degree opening of all national markets, rising to 28 per cent in 2005 and to 33 per cent in 2010. Study of the early experience of this initiative highlights that gas prices may decrease in the short-term and lead to fuel switching and higher demand. Lower gas prices may deter investment in energy efficiency and other clean technologies and import dependency may increase, together with transmission and distribution costs.

Increased competition may make energy companies reluctant to invest in new, often more expensive and risky technologies, like renewable energy and co-generation. In Germany, liberalisation is deemed to have discouraged shift to CHP systems, which are capital intensive. There is a special challenge for government to define and fund longer-term research and technology needs, responding to the public interest.

3. INTERNATIONAL ENERGY FLOWS

The international coal market is remarkably stable and competitive, while the international oil market is a complex and high-tension one, largely in the hands of the OPEC States. Their interests and constraints are multiple, and to a large extent, divergent. Some member countries (Algeria, Venezuela and Iran) are in favour of maximising prices in the short term as they have low reserves, a large capacity for

absorbing oil revenue and a high degree of production capacity. Other producers, such as the Middle East countries, origin of 45% of oil imports, have abundant reserves and prefer to vary prices over the longer term, in order to prevent the emergence of alternative energy sources and maintain their dominant position in the world energy scene.

OPEC's efforts to control the global market led to boom and bust cycles. In 1973, OPEC quadrupled world oil prices and it tripled them again between 1973 and 1980. However, in the 1990s, OPEC's power to control oil prices declined. The main reasons included political instability, contrasting views among OPEC States on production limits, the rise of non-OPEC producers and environmental concerns. Internal tensions regarding the oil embargo on Iraq, uncertainty concerning Iran and Libya and the common position of Arab countries on the Israeli-Palestinian conflict greatly affect the smooth functioning of the oil market. The situation in Iraq may play a key role. In 1999, Iraq managed to increase production to 2.8 million barrels a day and achieve just over 5.2 billion US$ in oil exports authorised by the United Nations Security Council Resolutions under the "Food for Oil" programme.

The countries of the former Soviet Union were still among the world leading oil producers in 1989, with production of more than 11 million barrels a day. Production in this region could double over the next twenty years from 7.8 million barrels a day in 2000 to 14 million in 2020. The known reserves in the Caspian Sea basin (25 billion barrels) are roughly the same as in the North Sea and the USA. Potential reserves could exceed 200 billion barrels, i.e. 25 per cent of known reserves in the Middle East.

Improving transparency and upgrading information and consultation are essential for the smooth functioning of the global oil markets. The quality of available data is crucial in supporting a continuous producer-consumer dialogue, especially on deposit availability and price negotiation, but also about impact on the environment and use of forefront technologies for resource detection and exploitation. Transit countries have also to participate in the dialogue and safety issues have to be prominent.

The international natural gas market has its own particular dynamics. Prices are being indexed on the price of oil. Geological proximity has traditionally placed gas in the hands of oil companies.

While index-linking was valid at the time that natural gas was making a breakthrough on the markets, as an instrument for gradually introducing the new product, this mechanism has no longer any economic justification and should ultimately be replaced by a price based on supply and demand for gas. The combination of price indexing, supplies under long-term contracts and imports makes the gas market more rigid, with reduced competition between exporters, mainly Russia, which includes one-third of world reserves and is supplier of 40 per cent of natural gas to the EU, Norway and Algeria, followed by Iran and Turkmenistan. The first three exporting countries have increased their share of EU gas imports to 98% in 1997.

Major changes in the international gas market could be expected in the future. Some experts predict rises in the price of natural gas of close to 20 per cent by 2010. Under the joint effect of an emerging gas spot market in the European Union through the completion of the internal market and the escalating concern for global warming, pricing rules may change. The index linking of gas prices on oil prices may come to an end and developments may include the creation of a more open, competitive and transparent global gas market.

The European Union is geographically well situated and connected effectively to the main gas suppliers. In the future, the Middle East (Iran and Qatar, which has three times as many known reserves as Algeria and Norway) and central Asia could become major suppliers of natural gas. The expected growth in demand and the increase in intra-Community trade will generate a greater need for transport infrastructure, mainly intra- and trans-European networks and port infrastructure for liquefied natural gas. Gas transportation by both pipelines and ships poses challenging questions concerning infrastructure and cost.

Prices depend on the economic growth of trading countries, the availability of reserves, the progress made in improving consumption patterns and the enforcement of environmental protection standards. Technological breakthrough, new production and distribution techniques and the development of new fuel substitutes and technologies may bring radical changes.

Coal demonstrated admirably stable prices. The flexibility of coal contracts and the development of a spot market have allowed the price of coal to adjust constantly. Oil prices have been exceptionally low and

stable for almost two decades, following the second oil crisis. However, the last two years of the century, turbulence in oil markets generated first a collapse of prices in early 1999 to 10 US$ per barrel and then to a skyrocketing leap to 35 US$ in 2000. These extremes resulted in petrol shortages and political crises in the United States and Western Europe. September 2000 was a hot month for heavy oil users and their protests had ripple effects for all activities. Prices came down again, but remained volatile.

In 2000, 50% of the EU needs in oil were covered by imports from OPEC countries. Twenty one per cent of crude oil imports come from Norway. Russia is the main provider of natural gas, providing 40 per cent of the imports. Gas prices soared also in 2000, following continuous under-investment in gas production over the last years. The price signals encourage the development of more gas fields.

Low prices of coal, oil and natural gas throughout the 1980s and the 1990s have reduced incentives to undertake research, technology and development activities on alternative energy options and invest in the adoption of efficient technologies by households, industry and the transport sector. The liberalisation of energy markets can encourage diversification and allow new suppliers to enter the market, if they are granted fair access to the transmission grid. However, liberalisation may also increase energy demand. Taking into account the impact on the environment and public health in pricing energy, could help citizens to choose the best available option.

The current cost of electricity generation from conventional fuels (coal, oil, gas, nuclear) in large scale electricity plants in the EU could be estimated at 0.04 €/kWh. A EU supported research project (EXTERN-E), undertaken over the last ten years, highlighted that the cost of electricity production from coal and oil would double, and from natural gas would increase by 30% if external costs, such as damage to the environment and public health, were taken into account. These external costs are not included in the electricity bills paid by consumers and have to be covered by society at large (EC 1999e; EURELECTRIC 2001).

The penetration of technology in the market is critical for advancing towards sustainable energy futures and achieving targeted limits of emissions. The adoption of innovative energy technologies is often slow, since they require long lead-times for their validation and

commercialisation. Industry investments in energy equipment with improved performance are costly and only periodic for businesses. Most energy efficient technologies are more expensive than current techniques. Relatively low prices for fossil fuels make it difficult to justify replacing them from the cost perspective of an individual agent. Appropriate pricing for energy inputs are essential for achieving the best technologies.

Governments need to define long-term policy objectives and promote lifestyles and technologies that secure energy provision and alter the relationship between the supply of energy services and environmental degradation. Fundamental research on alternative energy technologies is more likely to require government support than applied research that can more easily be combined with industrial activities. The market is, in general, willing to collaborate for the development of the most profitable cutting-edge technologies. Research is needed to support efforts, e.g. in intellectual property regimes, diffusion, competition policies, education and training, and financial and fiscal policies to enhance the availability of capital to innovative firms and communication and consultation policies to increase transparency and accountability.

Technology foresight, the systematic process for assessing the scientific and technological developments and market opportunities likely to have a major impact is essential for accelerating the emergence of new energy technologies. Emerging technologies, whether they are improving the efficiency of fossil fuel use, or promoting the utilisation of alternative sources have to pass the market test. Demonstration and diffusion programmes can help make clean energy technologies more widely known and available. Verification and certification programmes can help more experimental energy technologies to develop. Government procurement programmes can steer technology development towards a sustainable path. Fiscal and financial incentives may accelerate the adoption of new energy techniques. Innovative microfinance schemes can be decisive for start-ups in domains leading to sustainable energy futures, such as renewable energy systems.

4. TRADITIONAL TECHNOLOGIES AND MARKETS

Coal faces important constraints that weaken its position in respect to its immediate competitors, oil and gas. It is a solid and bulky

ore and requires large storage areas. Even if its transport by sea does not entail the same environmental hazards as the transport of oil and gas, it is more difficult to manage. With a lower calorific value than oil and gas, coal does not have the ease of use of a liquid or gaseous fuel. It generates pollution at every stage of its exploitation and it is the main contributor to CO_2 emissions. The future of coal will depend largely on the development of techniques, which make it cleaner and easier to use, like gasification, and minimise its environmental impact, such as improved combustion technologies and CO_2 sequestration.

Coal production in Europe serves primarily regional and social policy objectives. The low cost of imported coal, the diversity of outside suppliers and the stability of prices compared with oil and gas are factors which offset, to a certain degree, the considerable constraints. In the European Union, some countries, such as Denmark, Germany, Greece, Ireland and the United Kingdom (producing more than 45 per cent of electricity from coal), still use coal as a main source of energy in power generation. Fluctuations in hydroelectricity have considerable impact on coal consumption, especially for countries like Austria, Sweden, Portugal, Finland, Italy, France and Spain. In 1996, the shortage of hydroelectricity in Northern Europe and repairs to French nuclear facilities created an additional demand for coal. In other Member States, coal is often used as a back-up fuel.

Oil is an essential component of energy supply responding primarily to an almost exclusive demand for traffic. Many oil fields are in decline or have reached the stage of needing remedial action to maintain production. New investments are indispensable to access the exploitable oil remaining in the reservoirs, after the easier recovery has come to an economic end. Newer secondary and tertiary recovery techniques are expected to develop as long as oil remains a valuable commodity.

Technology dramatically increased the amount of available oil. Seismic surveying technology and sophisticated remote sensing have advanced mainly through competitive private sector research and technological development. Exploration drilling expands, since oil and gas habitats cannot escape notice. As pipeline infrastructures extend across oil-producing basins, the economics of development can be satisfied for incessantly smaller discoveries. Research is now focusing on improving the resolution of targets, fine-tuning expensive drilling of and recovery from exploratory producing oil wells.

The replacement of coal by natural gas is advancing in the European Union. Investments in combined cycle gas turbines continue. It is expected that by 2010, thermal power stations operating on natural gas will account for about two-thirds of the increase in demand for electricity. The extrapolation of current market trends highlights that almost half of electricity in 2020-2030 will be produced by natural gas.

The pace at which gas resources will be exploited and depleted depends also on the price of oil and gas in global markets. Higher oil prices may induce more companies to invest in gas prospecting and production and improve exploitation techniques. Research targets the decrease of the transport costs and the safe large-scale natural gas storage.

5. RENEWABLE ENERGY SYSTEMS AND THE MARKET

Renewable energy sources hold much potential for the security, diversification and sustainability of the overall energy supply (IEA 2000a). The realisation of this potential requires new structures. Significant initial investment is often necessary, as was the case for other energy sources, such as coal, oil and nuclear energy, which benefited from considerable state aid. Governments may utilise various measures to encourage the use of RES-E, including tax exemptions or reductions, direct price support, and investment aid. Direct price support schemes are widely used in member States, whereby renewable electricity producers receive financial support in terms of a subsidy per kWh provided and sold. There are two main ways for the use of this scheme, the quota-based system and the fixed-price system.

The quota-based system, used in the UK, Ireland and the Netherlands, is built on establishing a price via competition between RES-E generators for available support, through either a green certificate mechanism or tendering schemes. The green certificate mechanism requires all consumers to use a specific level of electricity from certified RES-E producers. Under a tendering procedure, the member state sets tenders for the supply of RES-E, which is then supplied to the local authority on a contract basis at a price decided by the tender. A specific levy on the electricity to end-consumers is used to counteract the extra

cost generated by the purchase of RES-E. The fixed price system, used in Germany, Denmark and Spain, establishes a specific price for RES-E that electricity distributors must pay to domestic renewable electricity generators (IEA 2003b, 2004a).

It is imperative that there is a mechanism that identifies RES-E within the internal electricity market. A guarantee of origin is required that will reassure consumers that the electricity they purchase is indeed from renewable sources. Until an EU-wide certification plan is established, individual States are responsible for the guarantee of the RES-E origin. In order that confidence exists between the certification schemes, governments have to initiate methods to ensure the credibility of the certificates and prevent fraud.

The administrative and planning procedures, with which potential RES-E generators must act in accordance, may bring multiple obstacles. The EU Directive suggests that the assistance to renewable electricity producers should be improved. The existing administrative and planning procedures should be thoroughly investigated to identify any aspects that may reduce the regulatory barriers for RES-E generators. For example, a fast-track planning procedure or more specific planning guidelines could facilitate green power investments. It is also intended that a report is published to outline the decisions reached from the above action, in a maximum of two years after the adoption of the directive.

Provisions have also to ensure that RES-E generators, particularly small-scale suppliers, are easily able to connect to the transmission grid. Renewable electricity generators, predominantly those with remote wind farms, may be required to use expensive installations to feed their electricity into the grid. This results in higher investment costs that may limit the advancement of renewable energies. Furthermore, once connected, the grid may need to be strengthened with the installation of new or upgraded power lines. It has been suggested that the grid operator takes on these costs, but this is unlikely to be considered appropriate. Although mandatory regulations on cost sharing are not proposed, a set of principles is provided that member States should comply with. First, the transparency of the total costs and benefits of new RES-installations should be assured. Second, the future costs and benefits to the grid system should be considered. Finally, rules should be established for future compensation payments if subsequent persons connecting to the

grid benefit from grid improvements paid for by the first connected supplier.

National, regional and local regulations need to be adapted in order to give clear priority to the installation of generation plants for electricity from renewable energy sources. Support to research and development can be decisive. The UK climate change policy, designed to reduce greenhouse gas emissions, includes a scheme for the promotion of renewable energy. The projects to be financed under this scheme can involve fundamental research, industrial research and pre-competitive development activities. The system also aims at encouraging the development of an international competitive renewable and sustainable energy industry.

At the city level, the "Aachen Model" provides an interesting example. In the early 1990s, two feasibility studies showed that the overall wind energy potential was sufficient to cover 10-12 per cent of the city's needs, while efficient solar panels on all the south-facing roofs could supply 55% of these needs. Owners of wind or photovoltaic equipment receive a guaranteed payment per kWh for 15-20 years. The overall cost is included in the cost calculations of the municipal power utility and it is passed on to all consumers. This resulted in one increase in tariffs amounting to just 0.005 €/kWh (Energie-Cités 2001).

Another promising case is the Soltherm Europe Initiative, a pan-European action network that aims at catalysing the strong growth of the solar collector market in the field of solar thermal in Europe. The market growth reaches 10% per year. The Soltherm Campaign Guidelines Handbook was designed to provide all stakeholders with methodologies and best practice approaches.

Chapter 5

TOWARDS BRIGHTER ENERGY FUTURES

This chapter sheds light on the potential of all energy options, from the traditional fuels to renewable energy sources and nuclear fusion, which can form part of a less unsustainable energy future, for there is no single energy source which has the potential to cover all energy needs in the near future. Last but not least, the chapter reviews outlooks and scenarios for the possible energy futures.

1. PROSPECTS FOR TRADITIONAL FUELS AND TECHNOLOGIES

The future of traditional fuels depends on technologies that promote their production and use without impact on the environment. The abundance and accessibility of coal, compared to that of other fossil fuels, social policy objectives and the wide geographical distribution in politically stable regions, could justify its continuation as provider of energy. But continuous exploitation may be acceptable only when advanced coal technologies, offering a range of options for accessing coal's energy with near zero emissions, are proven to work at a competitive level.

Promising options for coal poly-generation strategies stem from the initial production of synthetic gas, syngas ($CO + H_2$), from coal by oxygen-blown gasification and the production of by-product pure CO_2

which can be diverted into underground storage in suitable aquifers. Until major markets for hydrogen develop, syngas could be employed in power generation, co-producing electricity, process heat and synthetic liquid fuels.

The discovery of new oil deposits, at present oil prices, during the last ten years, is around 10% to 15% of oil discoveries during the sixties. As the lifetime of oil wells is around forty years, oil production may be expected to decrease by 2010-2015. To keep up or increase oil production, new oil deposits, where oil extraction is more expensive, could be brought into production. This will require huge investments for oil exploration and production in deep seas and difficult environments. Tar sands and oil shale represent the liquid hydrocarbons of last resort, only to be developed in the unlikely event that the costs of much cleaner alternatives fail to be reduced in the next fifty years.

Four decades of vigorous development of offshore oil have left behind ageing oil platforms and support structures in the shelf seas, the de-commissioning of which poses special environmental challenges. Addressing chronic safety problems, including tanker catastrophes and oil slicks offers a good opportunity for risk governance.

Natural gas is attracting new investments. Conventional natural gas reserves are large but could approach depletion in the fifty year time horizon, if present trends continue. Interest is growing on the exploitation of unconventional natural gas deposits, very large amounts of which are expected to be trapped at the deep sea-bed in the form of methane hydrates ("clathrates"). Companies are being formed to enhance auxiliary sources of natural gas. Injection of CO_2 into deep coal formations beyond the reach of mines can lead to the preferential exploitation of this gas. Both the hydrate and the coal-bed methane technologies are immature and will need fundamental and pre-competitive research, before they can be commercialized.

Transportation cost is the main barrier to the wider use of natural gas. Breakthroughs in pipeline technology, which can considerably lower the cost of unit volume per kilometre transported, create new prospects. New niches may be developed for alternative markets. Prosperous coastal cities, deprived of indigenous supplies of natural gas, and willing to prevent solid fuels-related air pollution, may, for example, embrace the relatively higher cost option of cryogenic liquefaction.

2. POTENTIAL OF RENEWABLE FORMS OF ENERGY

Producing electricity from renewable energy sources is essential for a sustainable energy future and technological development is critical. Renewable energy technologies are maturing at different rates. Some have already penetrated the market, while others are just demonstrating their potential (EUREC 2002; IEA 2003b).

A Communication from the Commission to the Council and the European Parliament, issued in May 2004, recognised that the measures adopted in the member States will not allow achieving the 12 per cent target, but rather a share of 10 per cent. The shortfall compared to the target is caused by sluggish growth of renewable energy sources for heating and cooling (EC 2004c). The World Renewable Energy Conference (Bonn, June 2004), asked for the dramatic promotion of renewable energy across the globe as a means to combat climate change, secure energy supply and reduce poverty (ICRE 2004). As three main policy priorities for renewable energy have been proposed: establishing policies for renewable energy markets, expanding financing options and developing the required capacity.

2.1. Wind energy

The European Union is blessed with excellent wind resources. Private sector competition, within a government-led enabling framework, achieved rapid technical progress that has boosted innovation, performance and competitiveness. Companies like Denmark's Vestas manufacture wind turbines that can compete on the open market. The wind energy developments in Europe demonstrate that when governments create the culture and structure within which the natural energy of technical and commercial competition can flourish, progress can be dramatic.

The wind energy market needs to be rewarded, at the early stages, with adequate financial incentives, such as concessionary pricing and fiscal and capital grant incentives. These can later be reduced or eliminated when the sector has achieved full competitiveness. Experience

in EU countries, which encouraged wind energy policy, indicates that publicly-funded financial incentives, such as fiscal measures, concessionary pricing and capital grants, are easier to implement than internalizing the external costs of coal.

Recent studies on possible wind energy developments in the coming decades suggest continued rapid growth. Onshore, very large wind power plants are being developed (USA) or are under discussion (China). The future of the wind energy industry depends on technological progress, institutional change and market dynamics. For several countries where the market stimuli make wind power attractive, the main barrier is the difficulty of obtaining land use planning consent. The role of local and planning authorities is very important, since a great number of projects fail at the stage of request. In the Netherlands, about two thirds of all initiatives fail in getting building permits (EWEA 2001).

The world is now gearing up for the next major phase, as there is increasing interest in exploring the potential wind energy offshore. The best EU wind resources are offshore and are largely undeveloped. Offshore wind farms are at a cost disadvantage, but as they cause near-zero scenic impact, construction of large wind farms becomes possible without objections from local communities. The greatest challenges include cost-effectiveness, confidence in design, reliability and best use of existing knowledge and technology, including coastal engineering and power electronics. Their large scale could offset the cost disadvantage. Projects developed in the UK (4 MW), Denmark (40 MW) and Sweden (10 MW) provide lessons and models.

The introduction of power electronics is seen as a major technological feature. Design of larger wind turbines, systems optimisation, very large grid-connected wind farms, synergy with other energy carriers, e.g. natural gas and hydroelectricity, transmission and storage systems, such as compressed air storage, are promising areas for research and technological development.

2.2 Solar energy

Technologies to harness abundant but diffuse solar energy are less mature than those for wind energy. Solar photovoltaics and thermal power generation are both recent and state-of-the-art renewable energy

technologies and present high investment and operation costs, significantly higher compared to conventional fuels. Solar energy has a recognized potential and may present a real chance for distributed energy in developing countries, where micro-power is often cheaper than extending the grid. However, high costs restrict presently, solar energy to niche applications, such as telecommunications, leisure, lighting, signalling, water-pumping and rural electrification (EUREC 2002).

Photovoltaics are attractive because of their high reliability, long lifetime, modularity and low maintenance costs. Solar cells present currently practical efficiencies of 15 - 20%. To achieve the EU target for doubling the share of renewables in energy supply from 6% to 12% in 2010, the installed PV capacity has to increase from 250 MWp to 3 GWp. This growth is translated into an annual increase of 25% to 30%. Even if the present rates were sustained and this is achieved, 3 GWp would still only represent 0.2% of the current electricity production. National programmes, like the German 100,000 roofs, may achieve progress towards a European scenario of 4 GWp and provide 84,000 new jobs.

Photovoltaic electricity generation has a low energy density per surface (around 1 GWh per hectare per year) and efficiency does not depend on the size of the plant. Photovoltaics can be used in stand-alone, hybrid and grid-connected systems. The intermittent character of PV electricity generation, depending on solar radiation, is influencing their integration into energy supply. In the case of connections to the grid or a mini-grid, the latter may serve as back-up for the PV system. In stand-alone applications, a storage and conditioning system has to support the PV system, which can also be combined with small power systems as fuel cells. PV systems would fit well into a concept of decentralized energy production. Research and technology development, policy, legal and fiscal measures, marketing of the PV added value and promotion of an attractive image would be necessary for photovoltaics to realize a great part of their potential.

The main barriers that PV systems still have to overcome include the high investment cost, which has to be reduced by a factor of more than four or five, but also technological limitations of crystalline cells, acceptability of thin-film technologies and electricity storage technologies. To ensure competitiveness, the present levels of efficiency should increase by 30% to 50%. The smart incorporation of PV modules

in building roofs or facade structures can minimize visual intrusion and significantly reduce the cost of the systems to 1-1.5 €/Wp. The role of the architect in meeting aesthetic, functional, environmental and financial requirements is essential. At the module level, much research is still required towards achieving a module cost of 0.5 €/Wp. Improvements should be brought to crystalline silicon cells and devices, thin film cells and modules, high level concepts, such as the use of tandem cells, and advanced system technologies, like intelligent control applications.

Concerning solar thermal power systems, main barriers include physical constraints, due to the requirements for direct radiation, the high installation and production costs, performance and reliability. For power markets, the technology niches include remote and village power applications for dish/Stirling (less than 1 MWe/farm) and decentralized and centralized power (10 to 2,000 MWe/unit) for trough and tower systems. A study undertaken by the World Bank in 1999 concluded that the potential market is large and could reach an annual installation rate of 2,000 MW. Spain is already committed to achieve one tenth of this capacity by 2010.

The European Commission has given support to the three first thermal solar-only plants in Europe on a pre-commercial basis, two in Spain and one in Greece. The European strategy to promote concentrated solar thermal energy highlights also the importance of technical demonstration of improved performance and reliability, research development for achieving reduced installation, operation and production costs and co-operation for defining and planning common targets.

At the international level, the IEA SolarPACES agreement moved across a major threshold, the creation of business projects. Consortia are being formed to enhance opportunities and benefit from early entry into an emerging market segment. The projects selected by the World Bank and the Global Environmental Facility are integrating solar energy into conventional power plants. Hybrid systems can decrease the risks and augment the potential introduction markets (IEA 2001e).

2.3 Biomass and biofuels

The EU targets for biomass and biofuels are most ambitious. In the framework of the aim for doubling the share of renewable energy sources by 2010 to 12 per cent, bioenergy should contribute 7 per cent of total consumption (EC 1997c). It was stressed, however, that such a target could only be reached if member States make a firm commitment to achieving the objective of the White Paper for 2010, and a target of 20 per cent of all fuel substitutes in 2020. The gap between the prices of biofuels and competing products should be reduced by measures which, initially, could be of a fiscal nature. Oil companies should undertake to organise large-scale distribution of biofuels by voluntary agreements rather than Community regulations (EC 2000g).

Bioenergy has to achieve a cost reduction by a factor 2 to 3 in order to become competitive with conventional fuels. Research has to address technical and non-technical barriers of the most promising biomass supply-use chains, especially on combustion technologies with multiplied options, gasification technologies, including biogas for electricity and syngas production and biofuels for transport. Continued research and demonstration into appropriate gasification equipment and processes is a promising avenue, with potential for wide application in the rural developing world and also in large industrial sectors, such as paper and pulp sector generating wood waste (IEA 2004b).

In 2001 the European Commission presented a communication on alternative fuels to replace petroleum in road transport. It highlighted the need for decreasing dependence on oil and for switching to alternative options. The communication suggests that biofuels present the most powerful option for the short and medium-term, followed by natural gas for the medium and long-term and hydrogen for the long-term. In 2003, an EU Directive on the promotion of the use of biofuels or other renewable fuels for transport introduced a compulsory share of all diesel and petrol sold to be biofuels (currently mainly bioethanol and biodiesel). The percentage ranges from 2% in 2005 to almost 6% in 2010 and flexibility is awarded to member States regarding the instruments.

2.4 Fuel Cells

Fuel cells are electrochemical devices that convert the energy of a chemical reaction into electricity and heat. They produce energy from hydrogen and oxygen in a much more efficient and clean way than conventional combustion engines. Unlike batteries, they do not store energy, but support a continuous flow process. Sir W. Grove constructed such a cell in 1839, with oxygen and hydrogen reacting on platinium electrodes to produce electricity. However, the development of fuel cells has only taken off in the last 25-30 years. The main breakthrough has been the radical reduction of size of the fuel cells needed to run a small car. It is expected that fuel cells will replace, in the medium and long term, a large part of the current combustion systems in industry, buildings and road transport. In the long term, fuel cells and hydrogen are expected to form an integral part of RES based energy supply. This may lead to a significant international market for fuel cells in transportation and stationary applications (EC 2000f).

The fuel choice for fuel cells is an important issue. In the long term, hydrogen from renewable sources is the ideal fuel. In the medium term, fuels for fuel cells will have to be derived from fossil fuels such as natural gas, biomass and possibly coal. The drawback of CO_2 emissions related to fossil fuels can be avoided by CO_2 capture and underground storage. The energy generation process is intrinsically clean and efficient. The conversion produces only water and, if a fuel processor is required to reform a hydrocarbon fuel to hydrogen, only small amounts of CO and NO_x are produced. Efficiency is high, because the electrochemical conversion process is not limited by the same physical laws of thermodynamics that govern combustion processes.

In general, fuel cells are composed of an electrolyte, which performs the electrochemical reaction. Hydrogen gas is released at the side of the anode, and oxygen at the cathode and the generated energy forces the released electrons into an external circuit. The resulting electrical energy is produced as a direct current and an inverter converts the unregulated output into a regulated alternating current supply. The main by-products of this process are heat, which can be reclaimed if a combined heat and power system is used, and water. In general, fuel cells produce approximately 0.7-0.8 volts per cell, with power outputs of tens or hundreds of watts. To generate a substantial output, fuel cells are arranged in stacks with parallel electrical connections.

Fuel cells vary depending on the type of electrolytes used, for example Alkaline or Direct Methanol Fuel Cells, and the stack's operating temperature. On the whole, fuel cells can be distinguished as belonging to low-temperature and high-temperature cells. Low-temperature cells operate at temperatures below 100°C and have a short start up time, but have very specific fuel requirements. High-temperature cells have a long start-up time and often need heat insulation, they are, however, able to utilize an extensive range of fuels (Kordesch et al 1996).

Different types of fuel cells have had varying success in penetrating European Union markets. High-temperature Phosphoric Acid Fuel Cells (PAFC) were already in 1996 at the demonstration stage. At least eleven PAFC plants of a capacity of 200 kW and 4 PAFC plants of a capacity of 50 kW have been operating for several years. This type of fuel cell is, however, hindered by its high cost. High-temperature Molten Carbonate Fuel Cells (MCFC) require one third to one quarter of the costs of PAFC, and Europe is currently the leader in this technology. Low-temperature Solid Polymer Electrolyte Fuel Cells (SPFC) have recently experienced a rapid burst in their capacity for greater power density and specific power, for both mobile and stationary applications. Within the EU, many companies are highly active in the development of SPFC technologies, including Siemens, Dornier, and Rolls Royce Associates.

The characteristics of the fuel cells are influencing their applications. For example, for use in industrial applications and large-scale electricity production, the high efficiency of MCFC make them the most obvious choice. The Proton Exchange Membrane (PEM) cells are being developed for use in stationary applications for power generation. PEM technology based on hydrogen from natural gas led to the P2B 250 kW prototype currently used in the European Field Trial Programme. Six field trial programmes provide valuable experience. PEM technologies are the most widely applied type of fuel cells in transport, where fuel cells are expected to end the era of internal combustion engine.

International interest for fuel cells is strongly increasing with car manufacturers, electricity companies and equipment industry. Car manufacturers like Ford, General Motors, DaimlerChrysler, Honda and Toyota are particularly active. Toyota has already rented fuel-cell cars to the Japanese government and American universities. Bus companies

started running tests, as in Munich and Erlangen, in Germany, and ten European cities are about to try the experience (Hart 2001). Developments such as the Californian zero-emission laws, which require 2 per cent of vehicles sold to be powered by hydrogen fuel cells, may hasten the movement. The HyperCar or the hyper-green power car of the near future can bring a true revolution if linked to smart electronics and energy Internet.

More research is needed to achieve a cost reduction of about a factor of ten for transport and of two to three for stationary applications in buildings and decentralized electricity production. The competitiveness of the EU industry is a major issue, since US and Japanese fuel cell companies far exceed EU fuel cell manufacturers in number, size and years of experience. Public spending for fuel cells in Europe is currently much lower than in the US and Japan, where public funding amounts to 150 million €/y and 100 million €/y respectively.

2.5 Hydrogen

Hydrogen is a key fuel in a future sustainable energy economy. It is abundant and perfectly clean. It provides a unique pathway for gradually reducing today's dependency on fossil fuels and increasing the contribution of renewable energy sources. Used in fuel cells, it combines with oxygen electrochemically, without combustion, yielding electric current, heat and water vapour. A fuel cell will continue to generate electricity as long as hydrogen and oxygen are fed to it. Hydrogen can be used in fuel cells for all end use applications, where it is highly efficient and intrinsically clean and in gas turbines for large scale electricity production.

Hydrogen can be produced from fossil fuels such as natural gas, by electrolysis of water with electricity from renewable energies such as hydropower, wind, solar thermal and, in the long term, from photovoltaic electricity. In a long term energy supply with a large share of renewable (and nuclear) energy, hydrogen is to play a key role in adapting future energy supply, predominantly produced in the form of electricity, to the energy demand (IEA 2003b).

Demand for industrial hydrogen is rising because oil refineries need to produce cleaner petroleum-based liquid fuels. On its own,

hydrogen cannot yet compete with conventional fuels in energy markets. This would change if new markets ascribe a higher value, and if production costs decline. Efficiency gains through fuel cell technology would enhance its value. The commercial potential of hydrogen is boosting private sector competition, among car manufacturers and oil and energy companies. The regulatory environment for air quality can be decisive. If near-zero emissions become mandatory, the potential of hydrogen becomes crucial.

An important objective is to reduce the cost of hydrogen production to make it competitive with currently used conventional fuels. For the medium term, hydrogen from natural gas is the most likely route to achieve cost-effectiveness. To that end the cost of these production processes will have to be decreased by a factor of two to three. The drawback of CO_2 emissions will be addressed by capture and underground storage. Hydrogen can also be produced from water by electrolysis. Here it is crucial to have cheap electricity from renewable sources, such as hydropower in Iceland, as the cost of electricity accounts for 80 per cent of the cost of hydrogen production by electrolysis. Nuclear power is also being investigated as a possible source of hydrogen production, either as provider of electricity for water electrolysis or as supplier of high-temperature heat for the thermo-chemical decomposition of the water.

Cost-effective transport, distribution and storage of hydrogen are major issues, together with the creation of an appropriate infrastructure. Regulation and standardization of hydrogen infrastructure on a European level are crucial. Research has to address the clean cost-effective production of hydrogen from fossil fuels and by electrolysis from renewable and nuclear energy. Hydrogen infrastructure, distribution, storage and utilization are subjects of technological development. The potential of the storage of hydrogen in carbon nanofibres is deemed to provide fuel cell vehicles a large autonomy.

An EC Communication on alternative fuels for road transportation proposed that hydrogen covers 5% of the energy needs in road transport by 2020. In Brussels, during the celebration of the car-free cities event on 22 September 2003, a prototype bus, equipped with fuel cells functioning with hydrogen, circulated along the public transport routes. It is about offering citizens meaningful options of sustainable mobility. Such events highlight perfectly the most important links among

energy, transport and the environment. EU demonstration projects can be decisive for making them every day reality. They are very important for quality of life in cities, places most threatened by congestion and local nuisances generated by traffic.

2.6 Other renewable energy sources

Recurring energy sources include also geothermal, tidal and oceanic energy. Geothermal energy flows from the hot interior of the earth to the surface, where it is lost by radiation into space. Global geothermal resources, using today's recovery and utilization technology, contribute 1.6% to the global electricity production, just after hydropower and biomass. In the EU, electricity generation from geothermal resources in Italy accounts for 1.7 per cent of the total production.

The annual direct growth rate and growth rate for installed geothermal electricity generating capacity averaged 9.7% and 8.6% compounded respectively over the last thirty years. However, during the last years, these two figures slowed to 4.9% and 3.2%, mainly due to the low worldwide cost of fossil fuels.

In Europe, about 95,000 dwellings are heated by geothermal energy. It has the capacity to generate about 1,000 MW of electric power. The EC-supported "European Hot Dry Rock" project, bringing together partners from France, Germany, Italy and Switzerland, tries to enhance widened natural fracture systems. It injects water at high pressure which is then heated and returned to the earth's surface through various production wells. A heat exchanger transfers energy to a second circuit that drives a turbine generator to produce electricity. Europe is currently the world leader in this technology. The European test site is located in Soultz-sous-Forêt, France.

Oceanic energy is expensive to extract and subject to storm damage. Tides have a large potential of energy, but the ocean proves to be a difficult energy source to harness. Well defined and selected wave and marine pilot projects and more detailed resource assessment could be decisive for the future of ocean energy.

The European teams developing tidal current devices, which extract energy generated by tides, are world leaders. Two systems,

producing 300 KWe each, are currently being tested. The European teams developing wave energy devices, which convert the movement of waves into usable energy, are also world leaders.

The EC-supported research project "Wave Dragon" in Denmark, is the world first offshore wave energy converter producing electricity for the grid. Moored in water, the 237 tonne Wave Dragon recuperates energy that is generated by overtopping waves. The water is initially stored in a reservoir and then passed through turbines which produce electricity. The prototype is a quarter of the size of the full system and the new technology is competitive comparing to traditional hydroelectric power stations.

3. HARNESSING THE POTENTIAL OF NUCLEAR ENERGY

Exploiting the full potential of nuclear energy is one of the aims of the research and technological development supported by the European Union. One of the objectives is to radically decrease risks (probability x consequences), convincingly address societal concerns and feed a thorough public debate. The reduction of real risks is a necessary but not sufficient condition for the decrease in the perceived risks. Risk assessment and management have a prominent role. In the 1980s, research had a largely technical focus, while throughout the 1990s, greater attention was given to broader issues, especially concerned with social perception of risks and public participation and acceptance.

Many EU-supported projects aim at developing more efficient and effective approaches for risk governance. They set up informal networks bringing together European decision-makers, academics, experts and stakeholders and promote dialogue and interactions through a series of seminars. Selected topics for special debate include the role of specialized agencies for expertise and governance, the implementation of the precautionary principle, the practicalities for the participation of stakeholders in the decision-making process and the impact of risk governance in liberalized markets (EC-STCE 2001).

The Chernobyl catastrophe demonstrated that a major accident cannot be ruled out, but the safety requirements imposed on nuclear

technologies in the European Union offer a level of reliability that few industrial sectors have attained. The safety of existing installations is a major targeted field of research. It involves establishing common standards for the remaining life of nuclear plants, improvement of inspection and surveillance methods and strategies for the prevention and mitigation of accidents. Research on radiation protection addresses safety questions of operators and staff handling nuclear fuel and during decontamination of affected areas.

By 2025, more than sixty of the EU nuclear reactors are due to be decommissioned. Decommissioning a nuclear power plant is a long process involving a cool-down period, in order to return the site to an environmentally acceptable situation according to the highest safety standards. The process may take up to sixty years and cost 10% to 15% of the original cost.

The management and storage of waste, the technical feasibility of deep underground storage and the exploration of innovative concepts offering advantages in terms of safety, cost and durability are essential. Current research, such as on partition and transmutation, sets out to reduce the presence of long-lived elements. Research focusing on waste management has to explore a range of options and integrate public acceptance issues concerning safety, from generation through to storage and disposal (EC 2000d).

Developing consensual approaches for improved decision-making in siting waste facilities has been the aim of the EU-supported COWAM project. Particular attention is being given to the local, regional and national context and the participation of all social actors and stakeholders. The project intends to establish a European platform for dialogue involving local communities from places where waste management facilities are located or may be located. Case studies will help to elucidate issues and assess factors, which determine the credibility, effectiveness and legitimacy of the decision-making process. The RISCOM II project aimed at reinforcing transparency and improving approaches to site selection for waste disposal facilities. It involves experts, universities, regulatory bodies and waste management organizations from five European countries. The earlier developed RISCOM model is being used to assess transparency and accountability, in particular with respect to scientific results and normative issues.

The nuclear expertise developed by the Joint Research Centre of the European Commission offers benefits for other sectors, especially industry and medicine using radiation for diagnosis or therapy. At the high-flux reactor at Petten, in the Netherlands, European medical teams are performing on-site the first clinical tests into the use of boron neutron capture therapy for treating brain tumours. The Institute for Transuranium Elements at Karlsruhe, Germany, has also produced a radionuclide that has been specifically adapted for new alpha-immunotherapy tests, conducted by two medical teams from France and USA, for treating leukaemia and bone marrow cancer. These achievements may contribute to change public perception of risks associated with nuclear fission.

4. PROSPECTS FOR FUSION ENERGY

Controlled thermonuclear fusion holds an enormous potential, since it leads to a virtually unlimited source of cleaner and safer energy. It constitutes a frontier technology which requires substantial and sustained effort, not only in research, but also in international co-operation, socio-economic modelling of options and financing. Fusion research spans across various disciplines and lies on poly-innovations, achieved by cutting-edge developments in many scientific and engineering areas. Progress is being achieved by successive long steps that gradually lead into the next stride.

In Europe, research and development activities on fusion include studies and evaluation of alternative concepts of magnetic confinement, in particular by completing the construction of the Wendelstein 7-X stellarator and exploiting existing installations in the Euratom Associations, and co-ordinated activities in fusion technology, in particular research on fusion materials. Socio-economic aspects of fusion, especially economic costs and social acceptability, are under continuous research together with safety and environmental aspects. Member States co-ordinate their civil research activities on inertial confinement and possible alternative concepts and support the mobility and training of researchers. There is a permanent exchange of information and key results and achievements are disseminated to the public.

Efforts towards the major international next step, the experimental reactor ITER, began in 1985 with a partnership bringing

together the European Union, the then Soviet Union, the USA and Japan. The conceptual and engineering design phases led to an acceptable detailed design in 2001, underpinned by research and development by the ITER parties to establish its practical feasibility. USA opted out of the project between 1999 and 2003, while new parties included Canada, China, Kazakhstan and Korea. The project is expected to cost 10 billion US$ over its complete life.

The Agreement on the Engineering Design Activities of ITER (EDA-ITER), signed in 1992 under the auspices of the IAEA, between the European Union, Japan, Russia and the United States (joined later by Canada and Kazakhstan) has been instrumental. The successful completion of the work carried out under this agreement can lead to the joint implementation and construction of ITER.

The construction of ITER seems imperative, in order to demonstrate the scientific and technological feasibility of fusion power production. It could be followed by a demonstration reactor capable of producing significant quantities of electricity. A net energy production in magnetic confinement fusion requires both fusion power amplification and a fusion burn of long, and if possible, continuous duration. Conceptual studies on the potential of fusion indicate that electrical power could be generated in units of several hundred MWs. However, to be economically efficient, units in the range of a thousand MW would be required (EFDA 2001).

The design of ITER, presented in 1998, was intended to produce some 1,500 MW of fusion power for about 1,000 seconds. Following a reassessment of the financial capabilities of the remaining ITER-EDA parties, it was agreed that a smaller and less powerful but more affordable device, the ITER-FEAT, could still permit burning plasmas to be studied in conditions relevant to energy production. ITER-FEAT has the objectives of extended burn with ten-fold power amplification, demonstrating generation of 400 MW of fusion power over about 400 seconds.

The realisation of the next step is expected to mobilise important human and financial resources. The preliminary estimate of the direct capital cost for the construction of ITER-FEAT would be in the range of about 3.5 billion €. The breakdown of the project costs between the

international partners will depend on the decision about the host country and the location of the programme of technological development.

Time scales are long and depend on the magnitude of investments. Initial scheduling studies indicate that slightly more than eight years would be necessary between the start of ground excavation and the first plasma. The construction of ITER could start around 2005 and last about ten years. It would be followed by an exploitation phase lasting about twenty years and a de-activation phase lasting about five years. Annual operating costs in the first ten years would be site-dependent and could amount to about 220 million €, while decommissioning costs could reach 200 million €.

Following international negotiations on the legal and institutional conditions of the establishment of an ITER Legal Entity, the European Union conducts negotiations for joint implementation, including construction, operation, exploitation and decommissioning.

A decision on the site for ITER will allow the project to move on to its construction phase. First Canada and then Japan proposed candidate sites for the construction of ITER, while the site of Cadarache, France, has been suggested as the European site for ITER. The two latter sites are at the centre of intense international negotiations which are expected to be decisive for the future of fusion energy.

The commercial feasibility of fusion energy has to be ensured by market penetration. Based on present knowledge, models indicate costs which should make fusion competitive. Although fusion offers to expose the public not to any major risk of accidents and to cause little long-lived radioactive waste, ethical issues are given great importance. Social acceptability is a prerequisite for the exploitation of fusion energy and requires, as any new technology to be applied at large scale, intensive efforts.

5. OUTLOOKS AND SCENARIOS FOR THE ENERGY FUTURE

The projections on possible world energy futures are founded on scenarios that begin to take into account measures to address climate change. The IEA global outlook 2000-2020 is based on a reference scenario that considers policies against climate change enacted or announced up to mid-2000. Projections highlight that no major break of trends is likely to occur within the next twenty years. World energy consumption and related GHG emissions will continue to increase steadily. Fossil fuels will account for 90 per cent of the world primary energy mix by 2020, with oil maintaining the lion's share and gas growing robustly. Coal's share is declining and the 2/3 of its additional demand is expected in China and India. The global primary energy mix is expected to be composed from coal (24 per cent), oil (40 per cent), natural gas (26 per cent), nuclear (5 per cent) and renewables (5 per cent). Non-hydro renewables constitute the fastest growing primary energy sources, but, starting from a low basis, their overall contribution to commercial energy supply will remain modest (IEA 2000a).

Global final energy demand is expected to increase at an annual rate of 2 per cent during the twenty first years of the millennium. Growth is much faster in transport than in all other sectors. The OECD share of the world energy demand is expected to decline from 54 per cent in 2000 to 44 per cent by 2020. CO_2 emissions are expected to increase a little higher than energy demand, averaging 2.1 per cent per annum to 2020. Developing countries, presently responsible for 40 per cent of CO_2 emissions, will be emitters of half of CO_2 in 2020 and transition economies of 10 per cent. Power generation in developing countries is expected to account for nearly one third of the increase in global emissions by 2020. Nuclear power is expected to increase only in few countries, mostly in Asia, and decline after the expected retirement of a number of existing reactors (UNDP, UNDESA, WEC 2000).

The IEA Reference Scenario illustrates that in the absence of strong government intervention on energy supply and environmental protection, existing fossil fuel technologies would easily occupy and dominate the foreground of new energy investments over the next twenty

years. The resource base for coal, oil and gas would sustain another generation of new capital investment in energy supply plants, the last of which would close down in the 2040s. Other scenarios explore the conditions to achieve a complete switch from fossil to renewable energy supply sources. This outcome would require technical progress, strong policy intervention, e.g. carbon and energy taxes to promote renewables and efficiency improvements, and unprecedented levels of international co-operation (IEA 2000a, 2003a).

The EU POLES model, a world energy partial equilibrium model which can simulate energy demand, supply and price formation for the main fuels and energy forms, provides some interesting projections. According to this model, global CO_2 emissions will more than double in the next thirty years (Figure 23). It seems that there will be a clear regional differentiation from today and an OECD citizen will no longer emit seven times but four times the amount of the emissions produced by a citizen of the developing world.

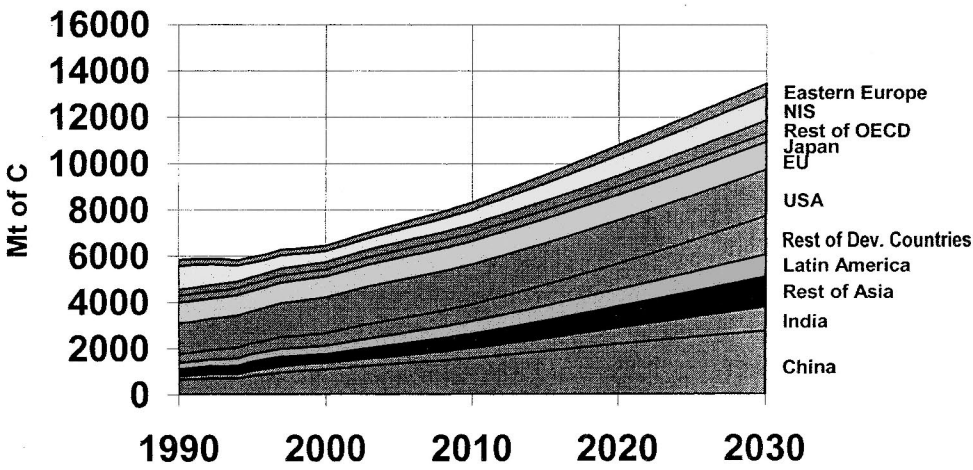

Figure 23. Projected World CO_2 emissions (POLES model). Source: EC

The EU Energy Outlook to 2020, elaborated in 1999, is based on policy assumptions along a business as usual pattern. It considered that there will be further integration and liberalization of electricity and gas supply in the EU, continuous improvement of energy efficiency and support for renewable sources of energy and co-generation of heat and

power, stringent regulation of acid rain emissions and extension of the life time of nuclear power plants to forty years. This scenario did not take into account any policy specially designed to address climate change. It concluded with some interesting projections (EC 1999b).

Energy demand in the EU is expected to continue to grow at a rate of around 1 per cent per year throughout the years up to 2010 and 0.4 per cent per year thereafter. The scenario highlights that this increasing demand will be primarily satisfied by fossil fuels, whose contribution to the primary energy mix is expected to be at the same levels as today (80 per cent). Oil appears to maintain its present dominant position (41 per cent), while the use of solid fuels is decreasing and the share of natural gas is increasing. Natural gas remains the fastest growing primary energy source, followed by renewables (Figures 24-25). The additional contribution of renewable energy to overall EU primary energy supply is however likely to be small (~+ 30 Mtoe).

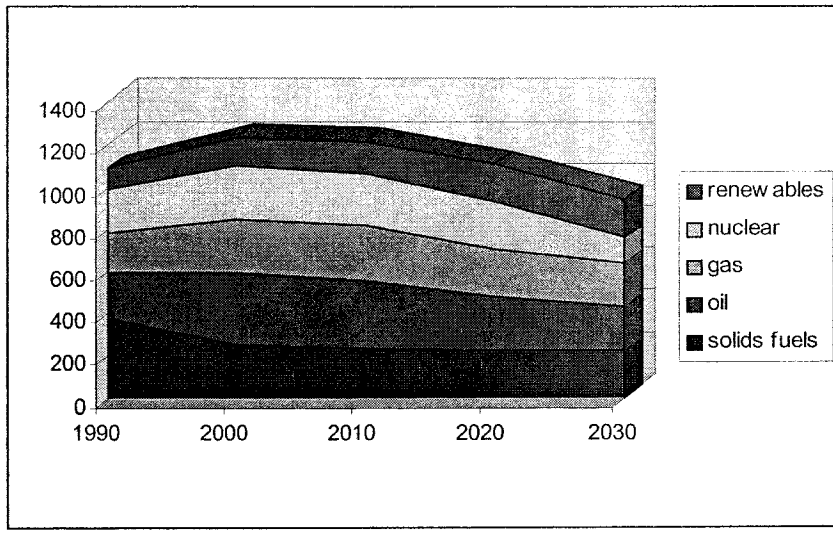

Figure 24. Projected primary energy mix by 2030. Source: EC

Energy markets are expected to become more competitive and average electricity prices are projected to decrease by 15 per cent in 2010-2020. The Outlook highlights that, without strong climate change policies, it would be unlikely that the EU meets its Kyoto engagements. In fact, CO_2 emissions are likely to increase by an average of 0.6 per cent per annum up to 2020. In 2010, CO_2 emissions are projected to exceed the 1990 level by 7 per cent. However air quality is expected to improve,

since emissions of acidifying gases SO_2 and NO_x from the energy system are likely to decline.

An additional scenario designed for the achievement of 6 per cent reduction of CO_2 emissions by 2010 compared to 1990 levels, highlights that nearly half of the reduction could come from improved efficiency and the other half from the intensified use of less carbon-intensive fuels and renewables. Power and steam generation appear as the fields that can adjust most cost-effectively to the required CO_2 emission reductions by 2010.

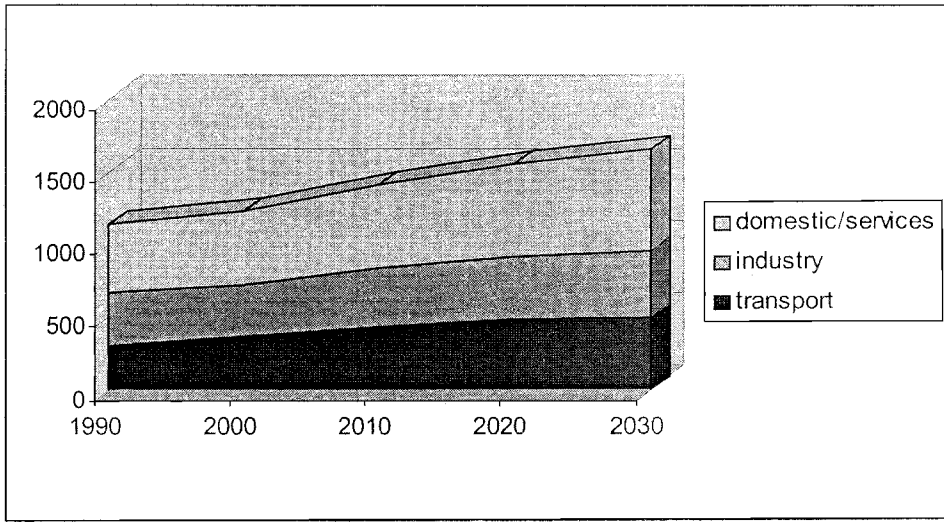

Figure 25. Projected final energy demand by sectors for 2030. Source: EC

Socio-economic research is crucial in exploring energy options and technologies of the future. Modelling is essential for evaluating various energy policy paths. Scenarios are founded on various hypotheses about economic growth and socio-environmental developments and provide the prospects for supply and demand for technologies and energy systems, strategic policy and market changes and technology absorption. The Economy-Environment-Energy modelling framework offers ample opportunities for energy systems analysis (EC 1999b).

POLES and PRIMES are two important models at the EU and the world level respectively. They assess the impacts of various factors (enlargement, nuclear phasing out, renewable energy sources, electricity

targets, flexible mechanisms to achieve the Kyoto objectives) in shaping the energy future. The PRIMES model includes forecasts of CO_2 emissions according to the implemented policies. The projections included in the POLES project helped the European Community and the Member States to establish the emission targets for their Kyoto commitments. Various models offer estimates of the costs for reaching the Kyoto targets. The OECD GREEN model and the EU PRIMES-POLES-GEM-E3 model provide good indications of the costs for meeting the Kyoto commitments with or without emission trading. EU-wide trading among all sectors is proving to reduce compliance costs by 10 per cent comparing to EU-wide trading among energy producers and energy-intensive industries.

Among the main results of the socio-economic research activities, it is worthwhile to mention the support for EU policy-making provided by research on external costs. The ExternE project, which was undertaken by researchers from all EU Member States and USA, was designed to quantify the socio-environmental costs of electricity production (Figure 26). It tried to assess plausible financial figures against damages resulting from different forms of electricity production (fossil, nuclear and renewable) for the entire EU. ExternE offered a scientific framework for issuing the EU guidelines on state aid for environmental protection. The NewExt project intends to further improve the quality of the estimates for the external costs (EC 1999e).

Country	Coal & lignite	Peat	Oil	Gas	Nuclear	Biomass	Hydro	PV	Wind
AUT				1-3		2-3	0.1		
BE	4-15			1-2	0.5				
DE	3-6		5-8	1-2	0.2	3		0.6	0.05
DK	4-7			2-3		1			0.1
ES	5-8			1-2		3-5*			0.2
FI	2-4	2-5				1			
FR	7-10		8-11	2-4	0.3	1	1		
GR	5-8		3-5	1		0-0.8	1		0.25
IE	6-8	3-4							
IT			3-6	2-3			0.3		
NL	3-4			1-2	0.7	0.5			
NO				1-2		0.2	0.2		0-0.25
PT	4-7			1-2		1-2	0.03		
SE	2-4					0.3	0-0.7		
UK	4-7		3-5	1-2	0.25	1			0.15

* : biomass co-fired with lignites
** : sub-total of quantifiable externalities
(such as global warming, public health, occupational health, material damage)

Figure 26. External costs for electricity production in EU-15. Source: EC-ExternE 2001 *(in €cent/kWh)*

Enhancing the contribution of science and technology is essential on the verge of a knowledge-driven era. Excellence does not grow overnight. It often results from a long strengthening of structures for fundamental science-oriented and interdisciplinary research. Last but not least, the dialogue with society has to be reinvented. Science and technology represent very powerful forces in shaping societal evolution. Society has to master therefore these forces. This is not an easy process, given the frequent technical complexity of scientific issues. On the other hand, there is growing recognition of the importance of societal implication in the definition of the research agendas and the follow-up of technological activities. Science has to have a conscience and generate far more hopes than fears.

The energy modelling research includes the SAFIRE (Strategic Assessment Framework for rational use of energy) model, which has furnished the tools to establish the target of renewable electricity to achieve in 2010 at the EU-level indicated in the directive on the promotion of electricity from renewable energy sources. It analyses the impact of different modes of energy consumption, the introduction and spread of energy technologies and energy policies on a number of indicators. The model was also used to make projections for impacts on employment. A study, carried out under the European ALTENER programme, focusing on the penetration of renewable energy sources in urban markets, highlights that about 900,000 new jobs may be created from the renewable energy industry and a further 515,000 jobs in the agricultural industry to provide the biomass fuels (EC 2001c).

The ALTENER programme for the promotion of new and renewable energy sources for centralised and decentralised production of electricity and heat and their integration into the local environments is one of the four parts of the EU support programme "Intelligent Energy - Europe" (2003-2006). This is the main instrument for non-technological actions especially in the field of energy efficiency and renewable energy sources. The aim of the programme is to reinforce the contribution of energy to sustainable development and help achieving the general objectives of security of energy supply, competitiveness, and environmental protection. The other three fields of the programme include: SAVE, for the improvement of energy efficiency and rational use of energy, in particular in the building and industry sectors; STEER for the support of initiatives relating to all energy aspects of transport; and COOPENER for international co-operation initiatives relating to the

promotion of renewable energy sources and energy efficiency in the developing countries. The programme insists in optimising the current use of existing technologies and removing market barriers to the increased use of energy efficiency and renewable energy sources.

Chapter 6

THE SOCIO-ECONOMIC VITALITY OF CITIES

This chapter sheds light on the socio-economic vitality of cities. Competitiveness and employment, equity and social justice, living conditions and public health touch the very heart of cities and impact their potential for sustainability. Solidarity and cohesion are key principles. The chapter ends at the back scene of most urban theatres where, according to J.P.Sartre, the developing world begins. It also reminds that the most productive investment for sustainable development on the planet is the education of women in Africa.

1. URBAN ECONOMY AND COMPETITIVENESS

Cities are not only the theatres of socio-economic operations, but genuine protagonists and powerful players. Economists regard them as both the mediators and the creators of the dynamics that are released by agglomeration economics and positive externalities, the mutual reinforcement of activities which cluster together (O'Sullivan 1996). Cities are the main generators of wealth of the nations, which enhance their position in the international sphere (Jacobs 1985).

In a knowledge-based economy and society, cities have to meet special challenges. Traditionally seen as strongholds of production, cities

become cross-roads of exchanges, the very places where economic flows can be decoded, condensed, converted, metabolised and intensified. More than ever, the performance of the urban economies depends on infrastructures and institutions. Deficiencies in infrastructure, the heavy cost of inappropriate urban regulatory policies, financial and technical weaknesses of municipal institutions are important constraints, whose cumulative effects may drain the potential for urban economic development.

At the beginning of the urban millennium, globalisation brings an extraordinary hurricane of transformations. Since 1960 world trade has increased fifteen-fold. Technology and hypermedia develop at a torrid pace. Globalisation does not simply affect and integrate economies, but it impacts on societies, lifestyles and cultures. A global economy gives many more cities the opportunity of becoming parts of a global city, but this world conglomeration might have strong central quarters and weak peripheral ones. Globalisation leads to the modification of the criteria for the adherence to a city and may affect the capacity of cities to choose development paths that respond to local needs and identities. With advancing globalisation, shifts may be swift and lethal for cities that are unable to innovate and drive change (Sassen 1994).

Sustainability offers cities the opportunity to become new democratic spaces between the world macro-regulations and the micro-regulations of the local communities. Cities must create an environment in which economic prosperity, social cohesion and citizenship can blossom. Their competitiveness can be configured as a triangle formed by the schools and universities, the enterprises and the municipal institutions. Cities must be capable of injecting vision and dynamism into the operation of the system. Universities are often regarded as the single most important resource of cities. Education and research can instill a culture of continuous improvement.

The competitiveness of a city depends on a multitude of factors, including the macroeconomic environment, economic and commercial performance, openness to trade and investment, flexibility of the labour market, adequacy of physical and digital infrastructure, level of education and training, ability to create and innovate. Improved competitiveness does not only result from increased productivity. Higher performance may result from better quality products or greater involvement and stimulation of a trainable workforce. The information society provides

new horizons and opportunities to be exploited. More and more cities recognise that increasing competitiveness cannot come from compromises in social matters and environmental practices. Education is probably the most important single factor and inward investment is recognised as a decisive parameter.

Strengthening the management of urban infrastructure, reinforcing institutional capacity, improving the financial and technical capacity of municipal institutions and the regulatory frameworks are essential preconditions for a better urban productivity. Governance is very important, since macro-economic performance cannot guarantee that the profits are equitably shared among citizens. Improving productivity depends on the successful balancing of the various elements of macro-economic policy managed at the national and the city level. It also requires leadership, openness and flexibility (ACDHRD 1995).

The EU White Paper on Growth, Employment and Competitiveness had recognised, already in 1993, Europe's failure to match its wealth creation from 1970 to 1992 (73 per cent) with employment creation (7 per cent for the same period). It highlighted the need for re-examining social costs and transferring tax burdens from human to natural resources through eco-taxes. A new measure of progress should be invented and introduced to balance the two factors of production, natural capital and labour, and reorient research and development in order that future productivity gains are achieved by the utilisation of natural resources. Last but not least, the white paper had recommended to consolidate enriched forms of solidarity between North and South, East and West and to revitalize cities, which have been long at the mercy of old models of planning (EC 1993b).

Since the industrial revolution, industry has been a key element of urban landscapes. Manufacturing industries are now being restructured and relocated to generate productivity gains and meet the demands of international competition. The major trends include the constant decrease in industry's contribution to the gross world product and the creation of clean tertiary sector businesses, linked to the knowledge-based economy and society. Advanced technologies, resulting in significant productivity gains and new forms of organisation of production, together with relocations at the global scale, have impacted on employment. Managing the conversion process rather than promoting further growth has become a major concern for most cities. The challenge is to simultaneously

achieve technical modernisation, economic reform and environmental improvement. Former industrial areas provide land resources in need of a new future. Restructuring, landscaping and new multifunctional purposes are the main responses by cities.

In the context of increasing global interdependence, many metropolitan cities have become control and command centres. The role of enterprises in the shift from goods handling to information handling is essential. Cities and enterprises have to become more open, innovative, flexible, and inventive and make the optimal use of new technologies. Cities traditionally have a much longer time and much shorter space than enterprises. Long-term political goals versus short-term economic profits are the core trade-off of many urban policies and each city gives its own answers. Large enterprises may lead to the edge city, but SMEs have potential in revitalising urban fabrics. Cities often act as facilitators and establish free zones, specialised business areas, micro-enterprises, start-ups, capital risk companies and micro-financing mechanisms. The social economy, a popular and informal form providing for 4-5% of Europe's overall employment, and the knowledge-based global perspectives may meet in creative partnerships.

The Bremen declaration "Business and Municipality: New Partnerships for the 21st Century" adopted in 1997, focuses on local, national, regional and international framework conditions for the sustainable development of communities and economies. According to the declaration, businesses seek from municipalities favourable locations, low taxes and fees, preferential treatment and social recognition as a significant employer. Municipalities seek from businesses employment for citizens, tax revenues and investment in and sponsorship for EU projects. At the crossroads of these requirements, win-win investments and benefits are numerous. The Bremen initiative strives for excellence on city-business partnerships and includes awards to stimulate innovative action.

An EC-supported Pilot Action of Excellence for Innovative Start-ups (Paxis) aimed at improving entreneurship and creating innovative enterprises in Europe. Launched in 1999, the project progressed with thematic networks formed by fifteen European cities and regions, which had already demonstrated success in fostering new enterprises. The best known examples are probably Munich and Cambridge. They suggest that Silicon Valley is not the only place where innovative enterprises can

flourish. Emilia Romagna is another innovative region, rich in networks of small and medium-sized enterprises.

The economic sustainability of a city depends on the endogenous capabilities of producing its own wealth. SMEs, industrial establishments, retailers, services or offices with less than five hundred staff members, can provide the economic activities most compatible with the sustainable city. The constitute 99% of all enterprises and two thirds of employment. The EU White Paper on Growth, Employment and Competitiveness (1993) had already recognised SMEs as leading providers of new jobs in a Europe plagued by unemployment. Destruction and creation of employment seem to be related to the size of the enterprise.

Small and medium-sized enterprises are considered to be propellants of innovation in Europe. The rise of a global information economy coincided with the decline of the large factory. Regions with traditional industries faced difficulties, while the European public began to demonstrate an increased environmental awareness. International developments favoured transformations in the production system, including industrial relocation and redeployment, subcontracting and functional integration within firms.

The SME is flourishing in this new and changing environment because they often consist of a single, adaptable establishment and are capable of a high degree of specialisation. Their relatively uncomplicated industrial relations and management patterns may ease their functioning. In addition, SMEs rarely require the specific location conditions needed by larger businesses, and thus have an ease of mobility. The most important criteria for the location of SMEs are the demand for its products in a particular area, the availability of auxiliary services, the proximity of sub-contractors, the socio-cultural profile of the region and the quality of the available labour force. The type of technology used by the SMEs determines the relative importance of each of the above factors, and may also introduce new considerations.

Cities appear as propitious environments for the development of SMEs. The essence of urbanisation, the geographic concentration of people and their activities, offers a diversity of resources needed by both entrepreneurs and consumers. The economic features of a city favourable to SME growth are not limited to the availability of services,

complementary producers and a market for their products. Access to human resources is also significant, both in terms of a high number of specialists and of high levels of immigrants. Cities can also provide the necessary knowledge basis and advanced services, especially in the field of finance. The proximity of other producers, enhancing competition and thus stimulating innovation, may also confer benefits, as consumers flock to districts offering a wide range of opportunities. SMEs concentrating in craft activities based on skill, high-technology industries and production and financial services are particularly well suited to capture urban advantages.

SMEs can provide competitive products and services while offering a variety of employment opportunities and fostering the development of a diversified economic fabric, resistant to fluctuations. Additionally, SMEs produce positive ripple effects. Their presence can stimulate the development of subcontractors and auxiliary services and lead to the formation of robust supply chains. As a result of intense contacts with each other, SMEs can spark the creation both of new original services and of new forms of co-operation. Though their mortality rate is high, and financial difficulties and an increasingly complex legislative and administrative environment may prevent SMEs from functioning at full speed easily, integrated programmes to support their growth could help overcome these obstacles.

Innovative schemes to support SMEs are often necessary, since they most often lack resources and expertise on environmental performance. BEST, established by Bradford City Council in 1994 to assist SMEs, runs the Bradford Business Environment Forum providing local businesses with information on environmental legislation and opportunities, innovative action and best practice. BEST is responsible for running the consultation process for Bradford's Business Local Agenda 21 and has worked with a number of organisations to produce an environmental training package for use within the national network of Business Links. The emphasis is on brokering, helping businesses communicate among themselves and with the regulators. The over-arching principle of the initiative is the belief that social, economic and environmental policy objectives are complementary.

Cities open to technology and innovation invest in providing innovative urban services through highly performing websites. The European "eCity Award" organised by Munich-based Eckart and Partners

assessed one hundred and thirty European city websites. The appraisal criteria included usefulness to citizens, business and tourists, quality of design and inventiveness. Scandinavian and German cities were judged to have the best websites. Copenhagen was the overall 2003 winner and deemed also to have the best website for citizens. Berlin presented the best website for businesses and Stockholm the most tourist-friendly website.

2. EMPLOYMENT, THE ACHILES' HEEL OF CITIES?

Since 1980, the world employment structure is characterised by a dramatic decrease of the share of agriculture and heavy industry in favour of services. Even if at the global level, 50 per cent of the economically active population still work in agriculture, this percentage is only 5 per cent in the developed regions. Women's employment rates have increased and patterns are moving closer to those of men. More than three thirds of the female population work in the service sector, while male population dominates industry and, to a lesser extent, agriculture. 250 million children are working world-wide. Children work less as income rises, but child labour levels are still very high, and also assumed underreported in the developing world. The implications of an ageing population resulting in a shrinking labour force are important for sustainable development.

The OECD Employment outlooks provide a good insight into the employment developments of the last twenty years. Both labour force and employment levels in OECD countries had an average increase of around 1% during the last decade. Employment in the business sector has expanded encouragingly. Japan seems to be the only country with decreasing employment for the last years. Norway and the United Kingdom start having negative projections for employment growth rate. Ireland had the highest employment growth during the last decade, peaking at 8.4% during the year 1997-98. Comparisons to the growth rates of Asian economies led to be known as the "Celtic tiger paradigm". During the same year, Ireland had a labour force growth of 5.4%. Mexico ranked second, with an increase of 4.9% and 4.3% for employment and labour force respectively.

New flexible, high-performance work practices gain ground both in terms of job design and delegation of responsibility. Part-time work arrangements have expanded greatly over the last decade and concern mainly the female population. Interim jobs represent 2.8% of jobs in large companies. Many debates focus on the potential incompatibility of employment protection legislation with labour market flexibility. Life-long learning and a highly skilled workforce are considered to be primordial for meeting the challenges of quality employment and social inclusion.

In Finland, the continuous building of the welfare state by the changing governments had reached (in the late 1980s) full days of paid work, two-provider families, owner-occupied flats for more than 80% of the families, and high levels of taxation and social transfer of income. In the beginning of 1990s, Finnish economy declined rapidly and unemployment rose to 18 per cent. The centralised welfare state had to adapt and become more fragmentary and flexible. When the unemployment rate increased, working time per employee was reduced, notably with the introduction of the "6+6" model, seen as a tool to share work and decrease unemployment.

The labour and education levels of urban populations tend to be superior to those of the rural ones. Rural regions present a deficit in jobs comparing to residents having employment and this imbalance is partially corrected through commuting, especially across regions. Employment in agriculture represents a very limited part (less than one fourth) of the total employment in rural areas. As in urban areas, the main employment growth, since 1980, happened in the service sector. Tourism appears as an important source of employment in rural regions. Participation of women in tourism activities is more important in rural than in urban areas.

Unemployment, the share of the labour force that is without work, but available for and actively seeking employment (the ILO definition of standardised unemployment rates) doubled since 1975 in OECD countries. It remains, however, two percentage points lower than in the European Union. Unemployment peaked in 1993 and is slowly decreasing since then. In January 2004, the standardised unemployment rate for the OECD remained at 6.9 per cent, 0.1 percentage point lower than a year earlier. In the Euro area, the standardised unemployment rate remained at 8.8 per cent, 0.1 percentage point higher than a year earlier.

For the United States and Japan, the standardised unemployment rates were 5.7 per cent and 4.7 per cent respectively. Over the twelve months to January 2004, the standardised unemployment rate rose in France from 9.1 per cent to 9.5 per cent and in Germany from 9.1 per cent to 9.2 per cent.

Growth in youth and long-term unemployment has been one of the most troubling developments. In many countries, one out of two unemployed is looking for a job for more than twelve months. During the transition of Central and Eastern Europe from planned to market economies and after an initial rise in early 1990s, long-term unemployment tapered up and stabilised or started declining. It now resembles or even exceeds levels in Western Europe. In the EU, the latest Euro-barometer survey confirms that unemployment is one of the main concerns of the citizens of the European Union, along with environment, health and safety.

The OECD Jobs Strategy, a comprehensive blueprint for labour market reform, introduced in 1993, had already concluded that economic growth is only a factor among others for reducing unemployment. Beyond its cyclical component, unemployment comports also a structural component that subsists even in period of recovery. Structural unemployment is considered to result from incapacity of the economies to adapt to new situations and drive change. It results from the inadequacy of educational and training systems to provide a well-trained labour force in sectors demanded by the labour market. In the globalisation era, skills erode quickly and lifelong training is important to maintain employability.

In developed countries, two thirds of the unemployed population resides in urban areas. Unemployed citizens and degraded environments represent untapped socio-economic opportunities and drain the potential of cities for development. Unleashing underused sources of growth and renewal may make more resources available to be possibly invested in environmental enhancement and better integration with socio-economic objectives. It may lead to advanced awareness and appreciation of environmental goods by the local community and growing willingness to pay for environmental quality. Culture, social values and lifestyles seem to be a strong factor.

Employment is the cornerstone of the European social model. The European Employment Strategy is considered to be a key component of the EU Lisbon strategy for making the EU the most competitive and dynamic knowledge-based economy of the world by 2010. The need to move from unemployment assistance towards work incentives for the future worker is widely recognised and promoted. Rehabilitation and renewal works, cultural tourism, landscaping, resource (including waste) management, nurturing biological diversity, enhancing indigenous flora and fauna, and promoting a sounder urban metabolism and neighbourhood management may be important sources of employment. Invisible and intangible, more preventive rather than corrective approaches, usually following a failure, can provide quality employment. They also promote a sense of place, of identity, of belonging.

OECD studies indicate that whenever environmental protection measures have been implemented there has been a positive impact on employment. Existing data suggest that the number of direct and indirect jobs in the environment field represent 1-3 per cent of the total number of jobs. Environmental programmes have created thousands of jobs in the domains of prevention, counselling and services, de-pollution industry, research and development linked to the environment, construction industry and resource and waste management. The range of activities and the number of jobs is expected to increase.

The search for sustainability focuses on environmentally friendly processes, products and services and this is expected to increase the positive impact on employment. Well-targeted, integrated environment and employment policies should focus not only on quantitative considerations but also on qualitative ones, especially on qualifications, training and sustainability of jobs. Fiscal reform and the introduction of economic instruments may create double dividends, with taxation moving from labour to the environment. Eco-taxes, especially on energy production, may induce structural changes in industry, from energy-intensive sectors towards employment-intensive fields, especially in labour-rich but resources-poor World regions like Europe.

Innovative actions on job creation in cities have often been conceived and implemented in countries and during times with the highest unemployment rates. In Ireland, the Dublin inner city partnership in the early 1990s, a few years before Ireland moved from the highest-unemployment countries to the most dynamic economies, represented a

local area-based response to long-term unemployment. The "Living over the Shop" project was also recorded as a prime example encouraging and assisting shop property owners to convert their upper floors into residential spaces.

The world's greatest snow castle in Kemi, Finland, provided many opportunities for creative new jobs. In Rinkeby, Sweden, a project demonstrated the importance of the merging of social services and the support for starting working in a community highly dependent on social welfare. The project combined meaningful training, an incubator of SMEs for immigrants and creation of new jobs in activities ranging from crime prevention and drug abuse prevention to theatre production (EFILWC 1993, 1996c).

The preparation of Local Agendas 21 has been a source of employment for many governments. Urban renovation offers multiple opportunities for a wide variety of professional and artistic skills. In Spain, the "Escuelas Taller" (municipal technical schools/workshops) train young people in urban regeneration jobs, which are demanded by the local markets. A study on urban regeneration programmes in Portugal shows that for the same budgetary expenditure, twice as many people on average were employed in rehabilitation than in new construction. Housing improvements may also be promising in terms of job creation, since they are highly labour-intensive. Energy savings in housing have proved to generate employment. A programme aimed to reduce energy consumption in heating by 30 per cent throughout Denmark would create thousands of jobs over twenty years.

Enhancing the creative skills of the unemployed is critical. The creation of innovative journals by the unemployed gave rise to a series of practices which expanded in many cities. Some of them are exemplary in linking employment generation with the escalating major problem of homelessness in European cities. The Finnish social system, over a period of ten years, managed to reduce by half the number of people with no fixed abode. In the UK, a notorious first experiment which gave the opportunity to homeless and unemployed to exert their creative writing skills has been "The Big Issue" in London. Launched in 1991 with the support of the "Body Shop" the "Big Issue" quickly became London's fastest growing publication with a circulation of 80,000 copies per issue and 1,000 vendors. It became soon self-financed and expanded in many British and European cities (EFILWC 1993).

3. SOLIDARITY AND SOCIAL JUSTICE

Urban distress is a serious problem deserving priority attention. It occurs when the capacity of urban systems to innovate and drive change is over-stretched, or when neighbouring spaces develop at various paces. Urban cell renewal slows down. The symptoms are visible. Distressed neighbourhoods suffer environmental degradation, physical isolation, obsolete infrastructures and neglect of public spaces. Very often, transport infrastructures, whether operating or disused, reflect development fractures, breaking continuity and denying access.

Distress often results in urban schizophrenia, the dichotomy between spaces and functions. The social characteristics of these areas are unemployment, poverty, lack of investments and access to education, information and markets, poor quality housing, low mobility and participation. The OECD research programme on distressed urban areas shed light on both quantitative and qualitative characteristics of such areas and proposed actions for prevention and regeneration. Prevention is, once more, of sovereign importance.

A quartered city mirrors multiple divisions. Even in the most prosperous European cities, there are urban islands where environmental degradation and social exclusion reinforce each other. More or less extended zones in run-down city centres or chaotic peripheral zones, where the disadvantaged spatially concentrate, invite for tearing down the walls and creating true urban spaces and life. Places of functional impoverishment, with poor housing and insufficient equipment and facilities are usually areas of poverty, delinquency and crime, high unemployment, low mobility, little access to information, education and training. Egalitarian policies may assist, but the role of equity and social justice is unparalleled. D. Harvey reminds us that "there is nothing more unequal than the equal treatment of unequals."

At the turn of the century, the EU counted 57 million people living below the poverty level, 31 million dependent on social aid and 2.7 million homeless. It is estimated that 7% of Europeans are persistently poor. Governments and cities, increasingly homes of the excluded, try to prevent and fight social exclusion, main obstacle to the creation and

distribution (spatial, social and intergenerational) of wealth. Unequal distribution of wealth has draining effects on the vitality of urban activities and it is a source of both unsustainable lifestyles and obstacles to cultural change. European cities that are showcases of financial power will never become sustainable if they hide social micro-jungles. Inequality must not be seen as the ransom to pay for success, but as an obstacle to sustainable prosperity. Cities of tomorrow must regenerate all these micro-jungles, their spatial webs and their social fabric (Galbraith 1996).

Globalisation, economic restructuring, competition between companies, cities, regions and nations, and the restructuring of welfare states are the factors at the origin of the processes of social exclusion. Exclusion is a dynamic and multi-dimensional process, interconnected to labour markets, housing, health, education, welfare systems and citizenship. Poverty-trap conditions of low income, low investment and subsistence-based economic structures can exacerbate exclusion. Increasing social exclusion and growing financial pressures, in a complex and fragmented institutional environment, have to be tackled through the horizontal and vertical integration of decision-making systems and the optimisation of the capacity, contribution and commitment of the public, private and social economy sectors (Parkinson 1998).

Social justice is a fundamental precondition for the creation of sustainable wealth. It is the fundamental ethos of the social architecture of a city. Preventing and fighting social exclusion is essential for cities trying to achieve sustainability with integrity, a human face and a good society. The social city, the city of solidarity and citizenship, cannot be perceived without equity. Otherwise it will be the poly-segmented city (M. Moss) or the city of "forced solidarity" (E. Durkheim). New structures are being created to help improve action and promote social justice with joined-up solutions to joined-up problems.

Youth, the future of society, often constitutes the most vulnerable part of society and the most acutely affected by economic crisis and unemployment. Underprivileged youth most often grow up in difficult neighbourhoods. Youths living in the streets without projects for the future may act violently against the society that has neglected them. The integration process encompasses simultaneous interventions in all problem areas and in all aspects of daily life, education, employment, housing, family structures, etc. Dropping out of school is considered as a

first step towards exclusion. The educational system has to meet high expectations, since respect for each other and for the community is to be imparted in addition to knowledge. Sports are powerful forces for forging common links among diverse communities.

The role of public administrations and associations is crucial in assisting socio-professional integration of youths and proposing the sharing of values which make all members of the community stronger. Special mediation schemes for street children, facilitating the return to home or school whenever possible, and/or programmes for adolescents, often helped by older youths have special urban dimensions. For youths over fifteen, the integration process consists mainly of meeting, listening and following up in order to help define personal goals. Job scarcity often restricts true economic integration. Many training schemes try to broaden the spectrum of work opportunities and integrate personal trajectories in the development of the community. Local society has to teach youth how to live in equality and harmony while maintaining their distinct cultural identities.

Women, the other half of the sky (Elytis), constitute another most obviously decisive for sustainability, social group. Women are disproportionately represented amongst the poor but are usually closer to everyday life considerations. Beyond the divides of cultural incomprehension, the conscience of being part both of a community and of the world is often cultivated by women. Gender and sustainability at the global level have also special links. The single most productive investment for sustainable development on the planet is considered to be the education of women in Africa (Harvard University 1994).

Gender mainstreaming is considered to be an important step forward, compared to traditional equal opportunities policies, often seen as a separate social policy field for preventing and fighting discrimination toward women. Gender mainstreaming can be perceived as a strategy, integrated in all areas of public and private decision-making, for achieving the goal of equality. According to the Council of Europe, gender mainstreaming entails the reorganization, development and evaluation of policy processes, so that a gender equality perspective is incorporated in all policies at all levels and at all stages, by the actors normally involved in policy-making.

Integrating this principle in city politics means that all proposals and decisions in all urban activities and policies must be considered from an equality perspective to determine the impact on women and men. A detailed analysis of the gender equality implications sometimes reveals that different measures are required for women and men and at different levels. Urban security has been highlighted as a domain where measures may differ considerably. The Cities' manifesto for "Safety and Democracy" shed light on violence perpetrated against women and suggested that urban safety measures integrate gender-specific approaches (EFUS 2000).

Women, notoriously rooted into everyday realities, could bring an element of balance in city life. Women politicians are often more sensitive to schemes reconciling work and family life. Many innovative urban projects are due to the enthusiasm and effort of women architects, scientists and politicians. The Athena project in Sweden and the Frauen project in Vienna-Donnaufeld are exemplary housing programmes, which aim at creating housing units conceived by female architects and responding to women's needs. In Finland, the Top Toijla project, initiated by a woman architect, achieved considerable improvement of the Rautala housing area, out of a modest budget. The communicative enthusiasm of the initiator of the project has been decisive in creating a momentum for change (EFILWC 1996c).

The European "Charter for Women in the City" issued in 1995, proposes exemplary actions conducted by women in cities. They include neighbourhoods designed by women in Vienna and in the Netherlands, flexible women-oriented housing units in Germany, schemes to increase safety, institutional initiatives, knowledge-based schemes and master plans from the point of view of women. A declaration for moving towards a gender-conscious city highlights the active participation of women as a cornerstone of all sustainable development-related policies (EC 1995c).

4. HARMONY, HEALTH AND SAFETY IN CITIES

Harmony is cardinal for European cities desiring not simply to invest in a better environment, but to be recreated as CIVITAS, places of

civilisation. It is meant to bring back quality of life to cities suffering from schizophrenia and, in many cases from a deep divide between the historic core of the high-density apartment, public transport, traditional city and the diffused-homes, dispersed-jobs, car-dependent satellite suburbs. It cannot be perceived without an overall rethinking of the city, its form and its functions, its physical and mental health (Ansay et al 1989).

Alarming findings about public health have often the potential to generate policies for the improvement of the urban environment. It is estimated that around 20-30 per cent of the burden of disease in industrialised countries can be attributed to environmental factors, with the bulk of this affecting children and vulnerable groups. Many European cities experience unacceptable public health problems, such as short-term peak levels of ozone during summer and photochemical smog episodes exceeding WHO guidelines. Even if the valuation of the environmental determinants of health is very complex, it seems that the environment has a greater impact on health than medicine has.

The European Environment and Health Strategy and Action Plan 2004-2010, aimed at achieving a better understanding of the complex relationship between environment and health and identifying, preventing and reducing diseases caused by environmental factors. The interaction between the environment and the human genome represents one of the new scientific frontiers and research should help to clarify the complex links between environment and health. Special emphasis will be given to the most vulnerable groups, in particular children. The strategy includes five key elements: science, children, awareness, legislation and evaluation. The first cycle, 2004-2010, will focus on four health effects: childhood respiratory diseases, (asthma and allergies), neurodevelopment disorders, childhood cancer and endocrine disrupting effects.

Health is not merely the absence of disease or infirmity, but it is a state of complete physical, mental and social well-being. Although the WHO Constitution has been modified several times since its creation in 1946, the definition of health has not changed. Public health and quality of life are highly interconnected and there is no single fact or policy concerning the urban environment that does not have a direct or indirect impact on health. A healthy city is a city that is committed in placing health high on its political agenda and creating a structure and process to achieve it. Over 1,000 cities and towns from more than thirty countries of

the WHO European Region are involved in the healthy cities movement, considered by WHO as a global resource (WHO 2003). During the last fifteen years, healthy cities have developed and implemented a wide range of policies including city health profiles and city health plans and strategies through intersectoral cooperation, community initiatives and programmes that address the needs of vulnerable groups, lifestyles, environmental health and Agenda 21 (WHO-OECD 1996).

Public safety is another major challenge for governments, cities and regions. Traffic accidents and delinquency seriously affect quality of life. One hundred and twenty citizens die everyday in the European Union. Road safety can considerably be increased through improved vehicle design, road planning and monitoring, together with regulations on drinking and driving and the wearing of seat belts. The European Union strives to cut at least by half the heavy human road toll.

Crime, one of the factors that most affect urban liveability, is in some cases, in linear relationship with unemployment. It seems also linked to the size of human settlements. Many cities declare zero tolerance to delinquency and national plans assist setting up innovative direct or indirect crime prevention plans. Danish cities prepared action plans targeting the involvement of residents and the strengthening of the area consciousness for the creation of a better housing environment. Guardian angels and street negotiators in Belfast make the city more human. Citizens engaged in improving the everyday quality of life constitute voluntary safety chains in the neighbourhoods of Barcelona.

The "Cities' manifesto for Safety and Democracy" adopted by two hundred and fifty cities in Naples in 2000, expressed the firm will for quality cities, defined as safe, vital places of harmonious development and immune to insecurity and fearfulness, violence and fanaticism, as a condition for making the EU a space of freedom, safety and justice. The exchange of experience and co-operation are judged essential for guaranteeing the legitimate right to safety (EFUS 200, 2003).

Art for all in the street was at the turn of the previous century promoted by "sgraffiti", decorations which can still be admired on often decaying murals of art nouveau houses in Brussels. More recently, graffiti attacks, beyond any form of artistic expression, seem to be the post-modern way of attacking public spaces and private property. Transport enterprises are the ones most affected as public transport sites

and equipment are privileged targets. Cleaning graffiti represents a high cost for local authorities and property owners. The enterprise for the co-ordination of public transport in Paris set up a specific service for the prevention of graffiti attacks through research on the attackers and more efficient ways of preventing and repairing damage.

An innovative integrated approach to preventing and fighting graffiti in public spaces has been developed in Maastricht. The project included extra means to identify the offenders, education programmes to improve the skills of the graffiti artists and an anti-graffiti bus with formerly unemployed people specialised in removing graffiti. The city made a wall available to citizens wishing to express themselves through the means of graffiti. The project proved very successful and led to the dramatic decrease of the graffiti pollution in Maastricht. The identification of wrongdoers and the conditional or alternative punishment had a noticeable effect on preventing recidivism. Moreover, former offenders trained in the framework of the project, have become creative graffiti artists (EFILWC 1993).

5. HOUSING, SECOND ONLY TO EMPLOYMENT

The cities of the future need sound living cells. The deterioration of housing environments had often dramatic consequences for the strength and health of the urban fabric. Mass public housing has often been a sad failure on the urban fringe: remote, uniform, collective, reactive, anonymous, devoid of management, generating social tensions and conflicts. In many European cities, housing is now beginning to be self-regulated, local, personal, with corporate neighbourhood space and responsive management. It has to provide proof of vitality of work and enterprise and to allow personal identification. Vibrant local communities are replacing depressed neighbourhoods. Many disadvantaged poor estates are going through a radical rethinking of space and social significance. The present environmental requirements create new needs for landscaping and for energy efficiency. A new human face is judged necessary in most of the estates built quickly and cheaply after the war, as if they were to house interchangeable people.

From Hällefors to Reggio Emilia, there are many best practices on rethinking and improving public housing spaces and functions. The

Mascagni development in Reggio Emilia shows how a multifunctional urban space can be created from a rigid series of anonymous buildings, a functional marriage between old and new, with integrated public services and schemes to create local business. In Hällefors, in Sweden, the transformation of the housing area Klockarskogen, through selective demolition, provided opportunities for the creation of a sculpture park to cover empty ground while generating skills (EFILWC 1996c).

In Finland, the Top Toijla project tried to activate and strengthen the commitment of tenants in the improvement of the Rautala housing area. Ambitious renewal has been achieved with a modest budget. A community theatre has been created to identify and solve problems and nourish visions and actions. In Vienna, the Urban Gürtel Plus project aims at improving living and income conditions in the western Gürtel area, where more than one third of the population are immigrants. The revitalisation of the local economic structures and the creation of new jobs are considered to be a must.

Government initiatives, such as City Challenge in the UK, played a decisive role in kick-starting innovations in housing regeneration. The renewal of the Holly Street Estate provides an interesting case. The estate, constructed during the 1960s and 1970s as a series of slab and tower blocks, replacing the traditional two-story East London row houses, had become notorious for its state of deprivation, crime and delinquency. The Borough Council recognised that the only means of dealing with the problems of Holly Street was through its demolition and reconstruction and the renewal project was initiated in response to the Government's Comprehensive Estates Initiative. The redevelopment process tried to break the cycle of welfare dependency and poverty. Pleasant Victorian-style houses have replaced the tower blocks, generating greater home identification (EFILWC 1993).

Intelligent resource-saving buildings expand. The Solar Village created by the Social Housing Association in Greece is an innovative residential village for low-income households. The architectural care and the social features merit special attention. The ecological design and planning of the area constitute the best practice in optimising the physical parameters. Social housing should not be synonymous to poor architecture and neglected environment.

Ecovillages, including clustered housing, public spaces and a common centre and a number of ecological features gain ground. The Danish co-housing concept offers an innovative approach, reconciling the need for new housing with the demand for sustainable development. There are about many decades co-housing communities in Denmark, each comprising twenty to fifty households. They form self-sustained communities, consisting of individual and owner-occupied houses, each one of them designed by the owner. Public spaces and services, including a communal house, a playground, an organic garden for bio-cultured local products and wind turbines for electricity generation, complete the community.

Homelessness is an increasingly worrying urban phenomenon and is inextricably linked to the problem of underused urban space. Around 30, 000 unused premises lie vacant every year in Brussels. Legal squatting could be a short term answer to the housing crisis. The adventure of an abandoned hotel in the most prestigious avenue of the Belgian capital can provide some lessons. After several years of decay, the hotel is now occupied by a group of citizens after having reached a verbal agreement with the owner. They pay a small monthly rent and are ready to leave when plans for the property are drawn up. Living together in a derelict environment requires a multiple effort and collective endeavour. The Housing 321 Brussels squatters not only strive to create acceptable housing conditions, but also host exhibitions and art workshops to heighten life.

6. PERIPHERY: AT THE EDGE OF CITIES

At the back scene of most urban theatres, there are sprawling, formless and disconnected peripheries, which challenge the very notion of the city. They are the by-product of the development of agglomerations like drops of oil, without proper extension plans endowing the areas with adequate infrastructure. This model of growth is not unrelated to the conditions in which industrial production developed during the last century. According to J.P. Sartre "the developing world starts at the European urban peripheries". The periphery is a zone of great uncertainty and tensions, where people do not know if they are in or out (Touraine 1997).

Bringing the city to the periphery becomes a noble aim. Many European and national programmes try to create multicultural and civilised places deserving pride and attachment out of loose and anonymous peripheral spaces. Living in the periphery should be seen as a chance and not as a curse (DIV 2004). In Vienna, the Urban Gürtel Plus project aimed at improving living and income conditions in the western Gürtel area, where more than the third of the population are foreigners. The revitalisation of the local economic structures and the creation of new jobs have been considered essential ingredients.

The concept of urban villages, reconciling the intensity of a city with the intimacy of a village, has been thought and debate provoking. Integrating and balancing public interaction and private environments can be very stimulating for politicians, designers and citizens. An edgeless city should grow by multiplication of its vital cells, its neighbourhoods, and not by over-expansion of its central core. Each neighbourhood should bear the DNA of a city, its specific unique identity, the result of osmosis between the people and the places. No city is a monolithic organism but a whole of unique places and events. Urban functions and services necessary for ensuring prosperity and quality of life should be found within every urban quarter (Neal 2003).

Many European URBAN projects try to recreate urban life in disadvantaged peripheries. The Helsinki-Vantaa programme focuses on the eastern periphery of the Greater Helsinki metropolis with a population of 45,000 inhabitants. The area, which hosts the highest number of ethnic minorities in Greater Helsinki, is threatened by long-term unemployment, reliance on welfare benefits, illness and crime. On the other hand, the area has extensive recreational potential due to its abundant green spaces, a well organised public transport system, a strong sense of community and good prospects for affordable housing. The programme aims to tackle this situation on two major fronts. First is business and employment in order to improve the level of services and diversity of the area, safeguard existing jobs and create meaningful new ones. Second, support for citizens' participation and social inclusion, in order to promote community development and capacity building as well as support for families in difficulties, drug addicts and the long-term unemployed and immigrants with health problems.

In France, the city policy ("Politique de la Ville") marked years of efforts for the revitalisation of urban areas in distress. Thirty two per

cent of young people in France live in collective housing estates in distressed suburbs. Many problematic peripheries are classified as first priority areas and are object of measures to radically improve housing and environmental conditions or are being designated for future action (DIV 1995). Outstanding measures include special care for the youth, a second chance offered to indebted households and the creation of tax-free zones to attract enterprises. The use of new technologies is highly promoted to increase access to information. In 2003, the three major objectives included urban renewal, support to local actors and solidarity actions. Special contests "Talents de cités" reward successful initiatives by young entrepreneurs (DIV 2003).

The cost of doing nothing for the peripheries of the European cities may be huge and totally incompatible with a sustainable future.

Chapter 7

THE CULTURAL ENERGY OF CITIES

Heritage and culture define urban identity and make the interactions between the body, mind and soul of a city. Citizens project their hopes and desires into the urban reality and legend. Public spaces can promote collective life and local democracy and bring added value to places. Symbolic and structural projects can become beacons of the urban future. Urban renaissance is a challenging objective for cities which desire to be recreated as places of civilisation.

1. CULTURE AND HERITAGE

Cities are the epicentres of cultural energy. Each city is a unique civilisation, plural and singular, with a particular physiognomy and expression. Each one has its own body and soul, symbolic significance and power of suggestion. Citizens project their hopes and desires into the urban reality and legend. Cultural spaces have high existence and bequest values. Cultural heritage and activities indicate how citizens and communities have transformed the places they live in, how they have responded to their environment and how this is etched into the landscape. They constitute what F. Braudel called the artistic geology of a city. Art is the aesthetic expression of individual and universal ethics. It enriches and heightens human and social capital.

Cities are not interchangeable. Cities have always been shaped by the ebb and flow of historical, socio-economic and cultural events. Any

discussion about the European psyche inevitably leads into issues about the similarities and the differences among European national, regional and urban identities. The notions of Euroculture and Euroaesthetics are not considered to have any substance. Cities, strongholds of civilisation, solidly anchored in local traditions but open to the world, can promote intercultural understanding

Cultural sustainability asks for the integration of cultural policy objectives with socio-economic and environmental requirements. Many governments and citizens are deeply convinced that investing in culture is the investment with the greatest and the highest long-term return. Investments range from education in matters of heritage to the rehabilitation of the cultural hardware and software of the cities. Monuments, historic buildings and landmarks, with their complex sets of associations, play a role of catalyst as vectors of common memory and generate new dynamics for participation and citizenship. Functional mix and diversification may assure the continuity of a city and its projection into the future, as a live city versus a museum city.

Heritage is priceless and irreplaceable. National and international declarations stress the role played by monuments and sites in the cultural identity of nations and in the strengthening of trust, friendship and co-operation among them. Monuments of local, national and international importance, specific and universal, are all witnesses of human civilisation. It is the responsibility of all citizens to ensure their protection. Very often, it is not enough to protect the physical construction but is also necessary to preserve the history and atmosphere, which form its mental environment. Integrated protection is not genuinely effective unless wholeheartedly accepted by the citizens.

The work initiated by the European Architectural Heritage Year (1975) highlights that the viability of the conservation projects depends on their integration in modern life. The maintenance, preservation and development of monuments and sites are determined by economic, social and cultural change. Thus, great effort must be made to harmonise the economic and social demands of a contemporary city life with cultural heritage.

Urban biographies suffer from the absence of detailed historical inventories, intelligent and imaginative projects and illuminating public debates. The living past of many cities is in danger as many private

projects ignoring the collective culture are being carried through almost everywhere. The resistance by citizens is often powerful and effective, especially in cities with a strong democratic tradition. Examples of rejection and preservation abound.

The "Survey of London" undertaken by the association English Heritage, offers an authoritative and comprehensive account of the city's buildings, now in forty five volumes. The aim is to guide the management of the historic environment in an informed and sustainable way. Many studies try to shed light on neglected building and site types, such as hospitals, prisons and caserns. In 2004, the city of Moscow decided to pull down the largest hotel of the city, a large block representative of the Soviet architecture with a capacity of tree thousand rooms. The building, very near to Kremlin has been judged a poor neighbour of the old city and a symbol of a bygone era.

Participation in cultural life is a human right, which includes the enjoyment and educational benefits of monuments and sites. For this purpose, governments, organisations, associations and citizens must join in efforts to increase public awareness of the values of cultural heritage. Moreover, the sound preservation of monuments and sites helps to preserve traditional technologies and crafts, to create new services and generate employment. It could be a policy for urban and regional development.

Historic and monumental sites can be enhanced by tourism, a human activity with economic, social, political, cultural and educational significance. As with any other physical resource, tourism demand on cultural heritage may be excessive and thus negative. In many cases it can have an irreversible impact. There is a growing international interest in the cultural impact of mass tourism on archaeological sites and monuments. The interaction can be made beneficial, if well planned and managed. Cultural tourism can provide new opportunities for linking conservation to socio-economic development and for creating spaces of harmonious coexistence between visitors and inhabitants.

Cultural tourism tries to bridge conservation and tourism and improve the quality of leisure by providing a resource which gives scope for individual and cultural fulfilment. Heritage is often used as a cultural alibi by the tourism industry. Archaeological research and conservation works may be in conflict with tourist activities, while citizens try to profit

from the presence of tourists, often with a multitude of uncontrolled services. Public use and physical development of heritage sites should be limited to those activities and facilities that are necessary and appropriate to fulfill visitor understanding and enjoyment of the sites without detriment to the cultural resource. With increasing visitor use, care should be taken to ensure that human erosion is not added to the erosion caused by nature.

Cultural heritage can be decisive for the enrichment of the tourist patterns and the development of regions rich in monuments and sites but neglected by the tourist industry. The spatial contribution of the cultural heritage is important. The enhancement of neglected sites and landmarks in abandoned areas can serve to redirect tourist waves. Local projects founded on the revitalisation of the ancient space can lead to the upgrading of tourism standards. Cultural tourism cannot be perceived without assessing the potential of cultural monuments and sites both for cultural development and the tourist supply (infrastructure, accommodation, access, itineraries and services). Preservation for tourism, even in small projects, requires long-term policies, given the importance, scope, diversity and complexity of monuments and sites, in their developing surroundings and changing context.

The protection and the enhancement of European cultural heritage, covering the broad range from cultural landscapes to artworks are among the main actions of the EU Culture 2000 programme, initially covering four years. In 2002, the launch of the EU Prize for Cultural Heritage / Europa Nostra Awards aimed at promoting high standards of preservation work and providing lessons for exemplary rehabilitation. In 2003, the winning entries included the Grainger Town project in Newcastle upon Tyne, UK, for the cooperation which led to the spectacular renovation of this 18th century historic centre and the Yria and Sangri archaeological sites on Naxos, Greece, for their enhancement and integration in the natural environment.

Venice (Figure 27), the most emblematic European city, offers the epitome of conflicts between local population and tourists and provides lessons about the carrying capacity of places which should always be respected. The city's environmental equilibrium is already threatened by industrialisation, urbanisation and agriculture. The level of the sea has risen by approximately 11 cm since the beginning of the century, while the land has sunk by 12 cm because of a process of

subsidence accelerated by the extraction of underground water for urban and industrial use.

The Venetian lagoon has a surface area of 550 km^2, 60 of which is wetland. The hydrological system is very complex as it includes streams and their connections, ancient canals and beds of ancient water courses. Centuries of human activities have shaped a unique yet fragile anthropogenic organism. Over the centuries, the form and character of the natural morphology of the lagoon have been altered by human intervention. Progressing degradation of the quality of the lagoon water and the biotic system are mainly due to urban, industrial, agricultural and other discharges, including port activities, as well as problems of ship traffic.

Figure 27. A representation of Venice, the archetype of the dual live/museum city. Source: The author's exhibition of Artworks on Siren cities, European Parliament 2004

The process of subsidence is under relative control, but the rise in sea level due to climate change is seen as very serious since it is estimated that in the absence of drastic measures, a 30 cm rise in sea level

would flood St Mark's Square some 360 times a year. Plans for a defence by means of tide gates at three openings of the land barrier separating the lagoon from the sea were completed and other measures include rehabilitation of the lagoon morphology, environmental clean-up, restoration of the shore line, creation of a sewage and rainwater drainage system and restriction of port traffic.

Venice is well shielded from automobile pollution. All urban transport is on foot or by water. The aquatic environment has always played a very important role in the urban history and life. 1966 marked the history of Venice as the year of the "acqua grande" when floods highlighted the fragility of the city as an ecosystem. Since then, the city has suffered a demographic haemorrhage, with its population falling from 123,000 in 1966 to 72,000 in 1996. Concurrently, there has been growth in tourism activities, and in the number of jobs, while the declining population of school-age children has been counterbalanced by the increased numbers of university students.

Venice's geographic isolation protects it from cars but cannot shield it from the modern conquistador of so many historic places, tourism. The invasion by tourists has many interesting dimensions. The average tourists, staying a few days in Venice, represent just a small percentage of the population that enters Venice every day. The main invaders of Venice are more than 8 million commuters per year and as many excursionists (one-day trippers). Tourist pressure has crowded out both population and economic activities other than tourism. Massive exodus of the local population led to urban decline due to radical transformations in the use of the city now strongly dominated by the tourism industry. The upkeep of the buildings and houses is minimal and in many cases virtually at a standstill, which adds risk factors to chemical-physical deterioration.

The unique natural and built environment makes Venice an unbeatable destination but local inhabitants, although often profiting from tourism, feel that the overall impact on their city is negative. Despite their appreciation of art, they appear to regard the Biennale, other international Mostras, and even the Carnival (whose revival in 1980 has extended the tourist season) as invaders of the city. Much debate has gone into the idea of imposing fees on tourists visiting Venice. However, many politicians object fiercely, arguing that a toll is always a bad experience and they do not want Venice to become another Disneyland of Europe. Offering more

than the admission (e.g. unlimited use of "vaporeti" or entry to museums) could lead to a more acceptable option.

2. PUBLIC SPACES AND LANDMARKS

Public spaces belong, by definition, equally to everyone. They are the places where people come together to celebrate and to protest, to express joy or indignation. R. Koolhas describes them as fortresses of freedom. Noble, safe, attractive and enjoyable public spaces, promoting collective life, bring added value to places. They have great potential as islands of civilisation in the archipelago of the city. Open spaces can facilitate the flow of energy throughout the city and promote interactions and synergies.

The Agora, the focus of civic life in the ancient Greek polis (City-State), constitutes a powerful archetype for the central public space. The polis has been a complex and fascinating universe, recognised as the single greatest innovation of the ancient Greece. It has been reputed for its form, adapted to the natural landscape and the human scale, and its noble public spaces, bastions of collective life and democracy. Harmony, proximity, mix, safety, citizenship were inherent in those cities-states, where the assembly, the vouleutirion, the theatre, the stadium, the sanctuaries all had the noble aim of promoting the physical and mental well-being of citizens. The first planned Agoras were designed by Hippodamus, the first city planner. The Spanish Plazas Mayores constitute a most honourable descendant of these centripetal places (Figure 28).

Agora and citizenship are intrinsically linked. Attractive public spaces may foster citizen participation and democracy. Public space is highly charged, with multiple risks of conflicting interests. In many cases it cannot rise to the challenge of being a space for negotiating democracy and becomes instead an arena of confrontation and of exclusion. It should not be space remaining after the definition of the built places. It should be given major importance as a civic space and shaped as a matter of priority. Special care has to be taken for public spaces to include everybody.

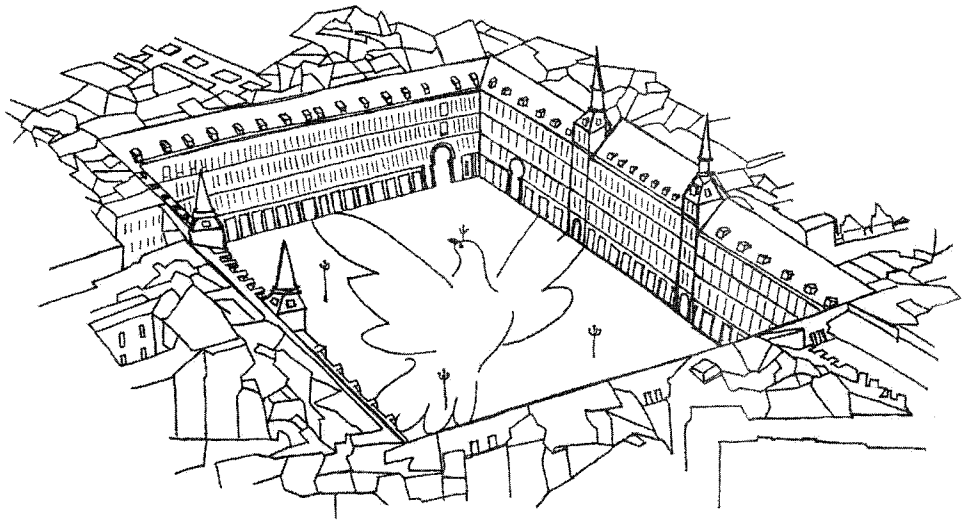

Figure 28. A Representation of Madrid, Plaza Mayor. Source: Idem

Recovering underused space after the removal of architectural and derelict barriers and designation for public purposes, such as green belts like in Madrid, undoubtedly promote collective life. In the previous turn of century, many European cities, at the example of Vienna had their walls demolished to give way to large motorways, circling city centres. Stimulating the flow of urban energy necessitates sometimes little effort and action. Symbolic cases such as the example of the Virreina Palace in the Ramblas of Barcelona, used for administrative purposes, may inspire. One of the two doors of the building, the back one, was closed for years creating a barrier, a cul-de-sac. A simple key has not only transformed the character of the building, but has made a highly appreciated public passage between the Ramblas and the Boquería. Sometimes keys lock imagination and energies which can be released without any cost and conduce to optimal benefit.

Environmental and cultural landscaping of public spaces is very important in forging identity. Qualitative recommendations for the functional and aesthetic character of squares, roads and pavements, roadside plantations and public lighting have been developed and implemented in many cities. Brussels (Figure 29) and the Manual of Public Spaces provide a good example.

Historic public spaces are sites that invite to journeys in space and time. Athens and Rome, cradles of European civilisation, followed an analogous procedure for reorganising their millennial heritage into cultural parks. The ancient Forum in Rome and the monuments surrounding the Acropolis, have been enhanced to become the focal points of urban archaeological parks, the natural and cultural lungs of the two capitals. In cities like Siena, with a planning tradition of seven hundred years, the medieval heritage becomes the principal resource for future visions. This does not consist solely of the built capital, but also of the traditional "Palio" the local celebration par excellence.

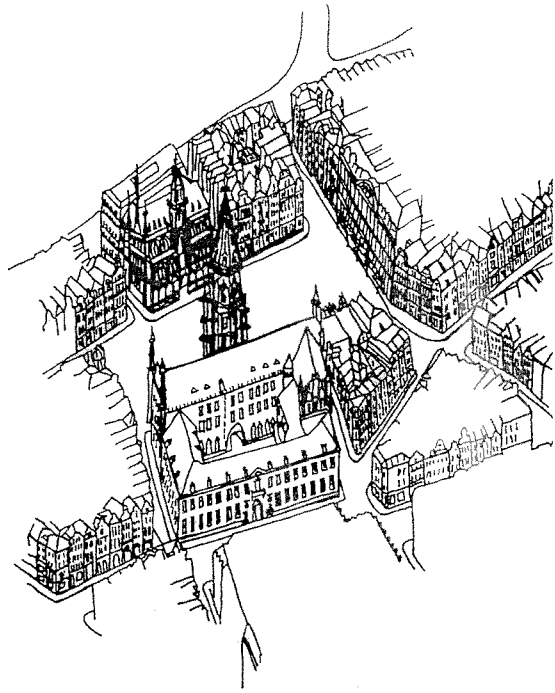

Figure 29. A Representation of Brussels, Historic centre. Source: Idem

Cultural parks and itineraries are two components of cultural tourism that involve public spaces and merit particular attention for sustainability. They have great potential in becoming worthy tourist alternatives to massive destructive projects. The design of cultural parks is based on a precise inventory of all relevant historical monuments of a

city, their analysis according to historic, geographic and aesthetic criteria, real estate analysis and the study of their integration in the urban environment.

The creation of cultural parks has to be completed by a sustainable mobility and accessibility plan and study of additional facilities. The management and financial planning of a cultural park has to reflect its belonging in two different times and include measures for positive interactions between the conservation works and the enjoyment of the space by visitors and citizens. Many of these steps have been followed for the cultural parks of cities like Rome, whose green and cultural space are being given special attention in its sustainability plan.

Atmospheric pollution and the pressure of crowds of tourists, concentrated in time and space, lead to the deterioration of the public urban cells. The private car, considered today to be the sole most destructive urban element, has a particular impact on heritage. The study of mobility in the historic centre of Toledo identified the origin and ownership of all cars parked in public spaces. Once parking was prohibited, these exceptional places regained their splendour. This is also the case of many historic city centres handed over to pedestrians. Even in Naples, a city without a reputation for urban discipline, the restriction of cars in the city centre, permitted historical sites like the Piazza de Plebiscito to get back to their former magnificence.

The concept of cultural itineraries is not unknown in the EU. Already in 1984, a recommendation had highlighted the importance of European pilgrim routes (taking the pilgrim's route to Santiago de Compostela as a starting point), and co-operation with the Council of Europe encouraged cultural tourism along these routes. A resolution on the establishment of trans-national cultural itineraries was issued in 1986. In 1987, the European Parliament's Committee on Youth, Culture, Education, Information and Sport gave a new dimension to cultural itineraries with an opinion on creating historical and cultural itineraries in Europe, as an instrument of regional policy.

Creating cultural itineraries on a common theme could create urban-regional partnerships and tackle regional policy objectives by enhancing historical and cultural heritage, particularly in regions currently ill equipped for the promotion of cultural assets and eco-tourism. The recognition of the area and the creation of additional

infrastructure, services and new job opportunities, can provide regions with a decisive boost for sustainable development. The necessary measures for the creation of such itineraries include plans for environment friendly transport and the restoration and preservation of monuments, measures for revitalising craft industries, creation of museums and adequate accommodation facilities. Partnerships with chambers of commerce are important in order to gain the support of tourist companies, promote the itineraries and communicate eco-cultural messages to the public.

Each city should be enjoyed as a masterpiece of art (Olsen 1987). Art always creates new possibilities to discover an urban body and mind, to appreciate a city's soul and to listen to its heartbeats. Urban itineraries can be metronomes of desire in quest for urban beauty. Long rejected as a sign of frivolity and elitism, the beauty of cities, made up of asymmetries, paradoxes and contradictions, is returning to the urban stage. Art can create much urban added-value. The 1% rule in Amsterdam indicates that one per cent of the cost of the new buildings should be invested in art, while The Hague's 1998 sculpture city provided a creative environment for its citizens.

Encouraging a cultural understanding of public spaces is critical if a rich culture is considered an important resource for cities. Promoting art and culture can be a joyful and purposeful means of participation and co-action. Forms that evoke memory and stimulate imagery may foster local communities. The events organised around the European Cities of Culture, the Nights of Heritage in French cities or the light festivals in Helsinki invite citizens and children to rediscover urban environments of their everyday itineraries. They can foster European identity founded on shared values. The white nights in Rome constitute a unique overnight cultural offer. Carnival seasons disrupt everyday life and bring local fun to its apogee. The beggar's festival in Amsterdam helps to dispel stereotypes (Landry et al 1995).

The concept "European City of Culture" (renamed "Cultural Capital of Europe" in 1999) was created in 1985, after an initiative by the Greek Minister of Culture, M. Mercouri, a great believer that culture, art and creativity are no less important than technology, commerce and economics. The outcome is a series of successful events promoting cultural excellence on the stage of Europe. Athens has been the first capital of culture. M. Mercouri campaigned for the return to Greece of

the Parthenon's marbles, acquired in disputed circumstances at the beginning of 19th century by Lord Elgin and kept in the British Museum in London. The new Acropolis museum keeps its most beautiful room empty, awaiting the Marbles' return to Greece

Culture and education are very powerful forces for change. Art workshops, organised in many cities, aim at sensitising young people, in the importance of heritage preservation and renewal. An incredibly diverse array of art festivals enrich night life in summer in many European cities. Parallel projects in Swedish and Finnish cities stimulate young students by cultivating their memory and their roots in the Europe of tomorrow.

3. SYMBOLIC AND STRUCTURAL PROJECTS

Symbolic and structural projects can offer significant landmarks and have the potential to shape territories. They may act as catalysts for the future of the cities and the regions. They usually stem from high-scale government plans or unique international events, such as Olympic Games, Universal Exhibitions and high-level fairs. The creation of these projects is often an enriching process which draws on international expertise and the best available experience. Examples include the re-development of the Tokyo Station Area and the Tokyo Waterfront, presented by the Japanese National Policy Research Council as vehicles for introducing private capital to public-sector projects. From la Défence to Villette and Bercy, the 1989 landmark projects in Paris on the anniversary of two hundred years since the French revolution, resulted from a well-determined effort to realise the symbolic potential of the capital of the light, to re-equilibrate the urban fabric, and improve cultural life throughout the city.

Long-term planning, flexibility, forecasting and communication are necessary for the success of these projects. Flexibility is imperative for adapting high-scale projects to market fluctuations, while continuity is linked to a vision for the future of the infrastructures. The stable financial structures for the realisation of major projects are of the highest importance, while the cost of land and infrastructure is a key issue for economic equilibrium. Consultation and partnership become important on several levels, vertically and horizontally. The success of the projects

greatly depends on a constant and affirmed political determination, capable of withstanding changes in elected representation (METROPOLIS 1996).

From medieval San Gimignano to post-modern Kuala Lumpur, tall buildings and towers marking urban skylines have always been inspiring symbols of cities that strive to surpass themselves. The Petronas towers of Kuala Lumpur, the currently world's tallest buildings, epitomise ingenuity, determination and courage. An urban and national icon of a height of 452 m, they constitute an unparalleled engineering feat. Their realisation implied the transfer of the most advanced techniques and technologies at the global scene. Their design derives from the Islamic geometric form of two interlocking squares symbolising unity, harmony, stability and creativity.

Unique, once-a-lifetime events bring special opportunities for cities, regions and nations. The Sydney Olympics endowed the city with a sustainable new organic part. The 1992 Olympics have been a key catalyst for the transformation of Barcelona. Following the opening of the city towards the sea and the creation of the Villa Olimpica the whole urban fabric has changed, with the injection of key improvements. The rehabilitation of the Ciutat Vella, a whole of four quarters in the historic centre, has been an unprecedented event, in terms of dimension, time and civic spirit. Selective renovation, rehabilitation, construction, pedestrian precincts, civic centres and green public spaces are the visible elements. The invisible elements that made everything happen are the strong neighbourhood groups that have been partners with the authorities and played a pioneering role in the allocation of new housing and services and the improvement of everyday life in the city centre (Ajuntament de Barcelona 1995).

In Seville, the island of Cartuja, seat of the Universal Exhibition of 1992, now welcomes new activities. EXPO '92 gave the city the opportunity to become an urban laboratory and a symbol for urban innovation. Seville has itself been on exhibition, as the mirror of a multicultural past, a magnifying glass for the present and a telescope for the future, during the expo. A thematic park opened just eight months after the closure of the exhibition and has rapidly become third in the world, according to its number of visitors. A technological and business park occupies the rest of the space of the Expo. The Confederation of Andalusian Employers was the first to establish its seat there, an example

followed by many firms which bought remaining pavilions and planned new activities there (EFILWC 1994a).

Lisbon grasped the opportunity offered by the 1998 "World Exhibition on The Oceans" in order to re-develop a significant stretch of the waterfront chosen as the location for the Expo. A derelict urban area, which had played a role in the past life of the city but went into decline as its activities became obsolete and marginal, was transformed into a site for innovation and modern creation. The project was not confined to the exhibition precinct of 50 hectares but aimed at creating a whole new resourceful city of 330 hectares, to be completed by 2010. Bioclimatic conditions were enhanced to the maximum and advanced energy management concepts have been implemented from the initial stage. An eco-efficient distribution network for thermal energy, heat and cold, was set up, together with an observation and monitoring system. The adopted standards were far above the required ones by the national regulations (EC 1998d).

The Athens 2004 Olympics have endowed the city with an integrated Olympic Public Transport System (Metro, Tramway, Suburban Rail, Light Rail, Buses), after the radical restructuring of the transport network throughout the greater Athens region. High priority has been given to minimising the impact of transport operations on traffic and environment. Bus lanes have increased from 16 km to 100 km. The legacy of the 2004 Olympic Games to the Greek capital includes 120 km of new roads, 90 Km of upgraded roads, 40 km Suburban Railway (reaching the Athens International Airport Eleftherios Venizelos), 40 fly-overs, 7.7 Km new Metro lines, a 23.7 Km Tram network, modern train stations and a new state of the art Traffic Management Centre. The Olympic village will be transformed into high quality homes for low-income working families selected by draw. All these developments are expected to lead to better environment and quality of life in the Greek capital.

The 1990 Glasgow edition of the cultural capital of Europe has been a magnificent ground-breaking event, which further transformed the city. Glasgow refused to die. Its definition of culture was all-encompassing, incorporating not just music, drama, theatre, and visual arts, but everything that characterises Glasgow as a unique, dynamic city: architecture, design, engineering, shipbuilding, education, religion and sport. Glasgow provided a prime model for a strategy where the arts act

as a catalyst for urban regeneration. The city became a thrilling international stage and hosted over 3,400 public events and 1,901 exhibitions, involving performers and artists from all over the world.

4. URBAN RENAISSANCE

Urban renaissance is a challenging concept for cities, which desire not simply to invest in urban renewal and healthy socio-economic development but to be recreated as poles and magnets of civilisation. The recreation of cities as "civitas" highlights the reconstruction of the "urbis" a universal space on a local territory, which is increasingly functional and diversified (Tagliaventi et al 1992).

Expressions like the martyr city, symbol of distressed urbanity, or even urban genocide are significant, but experts remind us that the city is the only living organism which has the capacity to renew itself. Harmony is an essential value in cities striving for dynamic balance among co-evolving policy objectives. O. Bohigas claims the virtues of metastatic planning, which, along with homeopathic planning, offer valuable suggestions for the overall renaissance of the urban web.

European capitals invest in urban renaissance projects, which often have the potential to transform the entire fabric and create new prospects for the future. Copenhagen has been a pioneer city is investing in urban renaissance. The 1989 regional plan for Greater Copenhagen expressed the new common attitude forward promoting a better city instead of a larger city. The ongoing urban renewal in Copenhagen, described as the largest recycling project in Denmark, is based on principles of quality and equality and aims at ensuring sustainable development in relation to natural, cultural and human resources (Figure 30).

Berlin, the recycled city of European history, strives to create a new future out of an emotionally charged past. Fifteen years after the fall of the wall, the city tries to preserve its unique alternative character even after massive renovations. The traces of the wall on the ground fade less slowly than in the minds. The building boom that followed reunification made the city seem like a gigantic construction site with hundreds of major projects and thousands of smaller sites clustered in the city centre.

The urban core has been re-designed for people and flagship projects are being enriching the urban fabric.

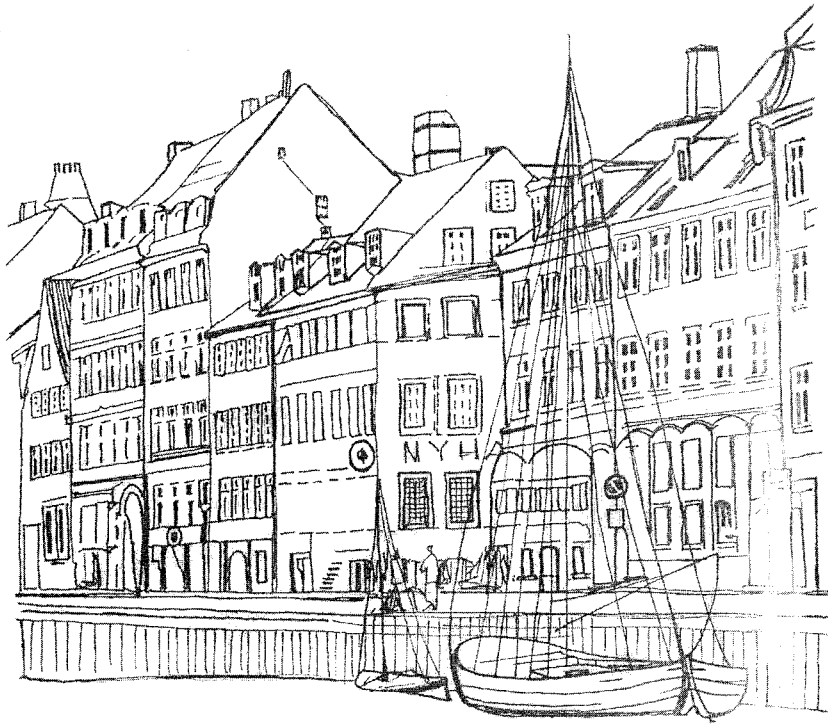

Figure 30. A Representation of Copenhagen, Royal channel. Source: Idem

Berlin (Figure 31) demonstrates that urban renaissance does not only concern the physical spaces. It creates symbols for the future. The 1 km long part of the wall exhibited in East Side Gallery may serve as a metaphor of the many mental walls that have still to be turned down. The cupola of the Reichstag offers a symbol for visibility and transparency.

Berlin strives to become a cleaner, greener and friendlier metropolis. Potsdamer Platz, once the hub of social life, the busiest crossroads of Europe and later the broken heart of divided Berlin, is becoming once again a centre of attraction. The Sony Centre, conceived as a multifunctional complex assembling all of the elements of a downtown neighbourhood within a single spatial structure, constitutes a forum open to all citizens.

Figure 31. A Representation of Berlin. Source: Idem

In Amsterdam, urban renaissance has been linked to the vision of a diverse and consolidated city optimising land and water resources. Until the Second World War, Amsterdam had developed in a series of concentric rings, forming a semi-circle. The 1950 General Extension Plan added lobes like the fingers of a spread-out hand (Pastor 1994). During the reign of the private car, some concentric canals have been filled in with soil to make more space available to traffic. Sustainability actions lead to the reopening of canal rings in places where they were filled in to cope with the increasing need for roads and the intensification of the land use. The water environment of the city is being rediscovered. Many Dutch cities, such as Leiden, worked hard to create mixed-use and citizen-friendly environments, including pedestrian and bicycle bridges spanning canals.

Urban renaissance is also high in the planning agenda of many small and medium-sized cities. The regulatory plan of Siena is an example of creating modern life in an old city where cultural associations (Conrade) have a power parallel to that of the elected administration. The latest plan of Toledo offers a good diagnosis of the city's strengths and weaknesses. It aims at achieving a vital dialogue between the historic and modern city. The enhancement of the cultural legacy, consisting of historic buildings, vernacular architectural spaces and the fabric of the streets, the accessibility and the optimisation of the city's potential, the coexistence of functions in the historic centre and the promotion of the functional mix among university, administration and tourism are organic parts of the plan.

The medium-sized city of Alicante implemented a comprehensive series of urban renaissance actions. The pivotal projects were the rehabilitation of the historic heart, the renewal of the waterfront and the development of a new urban quarter on a troubled residential area, the Barrio de Mil Viviendas. The two first projects, successfully accomplished, have transformed the city. The project of Mil Viviendas aimed at reconverting a degraded neighbourhood into a vital community through the creation of self-regulated, personal and proactive housing. The local authority had designed an ambitious plan, with the participation of the inhabitants, and was committed to engaging unemployed residents in the reconstruction of the quarter. Modern, intelligent, open and accessible-to-all spaces, locally managed, were about to replace the old rigid structures when, following a change in local municipal elections, the project was interrupted. In presenting the unfinished project in a conference, the former mayor recognised that, if such a project stops, without overwhelming public protest, the mistake lies with the authority which initiated the project without the full commitment of the inhabitants. This highlights the importance of community support as a prerequisite for undertaking ambitious innovations (EFILWC 1996a).

Chapter 8

TOWARDS BRIGHTER URBAN FUTURES

This final chapter examines crucial questions and issues towards brighter urban futures. They range from strategic planning and sustainable regeneration to citizenship and institutional and civic alliances. They are of key importance for cities wishing to seize the opportunities emerging with the civilisation of sustainability. For cities are always "Built Politics", as Aristotle defined them in the IV century BC.

1. GOVERNANCE AND CITIZENCHIP

Governance is the science and art of co-governing societies with the participation of societal actors. It is increasingly recognised that policy options cannot be based on artificial system management, but on the evolving dynamics and preferences of society. In most policy areas, a new civic contract is being sought with civil society, which is expected to invigorate the debate between governments and the constituencies they represent, increase public transparency and accountability and enhance capacity for reflection and decision. In the era of globalisation and sustainability, interactive communication can considerably stimulate public awareness and chart the way forward to closer citizen involvement.

The move from government to governance is fundamental for citizens wishing to envision and build, individually and collectively, a sustainable future, offering better opportunities for all. The channels of representation and participation can get enriched with new instruments and methods, like action planning and schemes, dialogue and consensus workshops, bringing together different, traditionally opposed, actors, on neutral grounds and on equal terms. Citizens' juries, and other intermediary platforms, can provide more permanent and effective interfaces among experts, policy-makers and citizens (Healey 1997).

Citizens are the political stakeholders and society truly the ultimate frontier. Governments should allow as many voices as possible to be heard, and as many values as possible to be represented. Residents, users of public infrastructure and services, wish to be better informed on important emerging issues, policy options and technologies. Decision-makers should invest in a better understanding of what people appreciate in urban services. Making the community, especially the under-represented social groups, more knowledgeable, aware and willing to participate are not unrelated to scientific progress and technological diffusion. Projects must not only be scientifically robust, but also socially acceptable (EC 1997d).

The political vigour of cities depends on leaders able to ponder fundamental forces and real opportunities and well informed citizens, able to judge among various possibilities according to their values and principles. The search for sustainable development introduced a multiplicity of complex issues, spanning a variety of areas and actors. Democratising expertise and stimulating citizen involvement and public debate need an array of concerted actions. An EC study highlights that access to sound information and knowledge, transparency and accountability, effectiveness, early warning and foresight, plurality, independence and integrity, have to reinforce scientific excellence. Technology foresight must be accompanied by social foresight, in order to have both better quality decision-making and public trust in the scientific foundation of policies (EC 2001d).

Urban democracy, representative and direct, is a key element of the existence of cities and of their capacity for sustainability. Democracy can increase considerably the collective credit of a city. Cities have promoted open democracy since the age of Pericles, long before acid rain affected the Parthenon marbles. In ancient Athens (Figure 32), true

citizenship meant being an active member of a city. According to the "Epitaphios", the famous funeral oration and epitome of the Athenian national consciousness, Pericles urged citizens to become lovers of the city (Thucydides).

Figure 32. A Representation of Athens, the city where democracy was born. Source: Idem

Mass effects never constituted a characteristic of the Greek civilisation. The population of a city was always regarded as a total of unique individuals. Democracy meant more than equality of privileges under the law for all citizens ("isonomia"). An interesting link between democracy and sustainability may be found in an old Athenian custom. Before becoming a fully-fledged citizen, every young man had to promise to leave the city richer and better than when he first became part of it.

At the dawn of the civilisation of sustainability, there is a clear trend from a class-based ideological representational system of

democracy to a more interactive participatory democracy. Grassroots movements ask for direct contacts between the governed and governors. Representative democracy faces the challenge of the duly constituted authorities, linked to the representative role of local groups. Democracy should provide forums to exert sound judgement and help citizens to be transformed from mere consumers into city actors, sharing values, visions and actions (Abbott 1996).

Citizenship means participation. It permeates all aspects of urban activities. Citizens are increasingly invited to act as partners rather than protesters. Empowerment has become ethically correct and practically advantageous. Urban projects, ranging from the improvement of exceptional vernacular architecture in Pilion to the tracing of the new metro lines in Valencia, have been crowned with success thanks to the extraordinary active participation of residents (EFILWC 1996a, 1998c). It is not a coincidence that many innovative projects happen in places like Emilia Romagna, a region with traditional openness and the paradigm of small and medium enterprises. R. Putnam charts the powerful influence of civic involvement to buttress his model of institutional performance. He asserts that the region is not populated by angels, but the social capital and the cultivation of the civic community promote strong and responsive collective action (1993).

Local democracy needs an everyday reconfirmation of civic values, an ongoing reinforcement of the civic bond. The Barcelona "Civic Agreement 2002" has been a partnership between the city and the main citizen associations. Efforts for citizen consultation on the gestation of visions and plans expand. Bologna was the first European city to organise a referendum on the closing down of its historic centre to private cars. In Brussels, the consultation procedures for planning introduced new participation concepts. Reggio Emilia invited citizens to participate in the compiling of the city budget. In Amsterdam, two referenda held in 1997 sought the population's views on the new metro line and the extension of the city.

The charette method is being used to bring together the richness of diverse opinions and ideas and build communication while projects are still on the drawing board. The case of the resort town of Saltsjöbaden, in Sweden offers a convincing approach. A proposal for a new modern hotel had been the cause of strong public reaction. Citizens decided to put forward alternative plans respecting the physical historic and cultural

landscape of the waterfront, organise public hearings, exhibitions and option evaluation reports and decide on a pragmatic new vision for the future of the area. The committee formed by all interested parties put together a plan for a multifunctional leisure and living area, with respect for tradition (EFILWC 1996c).

The Finglas Enlivenment project, in the periphery of Dublin, exemplifies the potential of citizens to improve cities. The main characteristics of the area were the extensive public housing estates, built cheaply to accommodate inner city slum clearances and population growth and the dependence on outside agencies to change the course of destiny. But the community decided to act. The Finglas Planning team, set up to synchronise the forward planning and development control functions, identified local key individuals and groups and promoted consultation to enhance the positive aspects of the area. The first project initiated with the local chamber of commerce involved the improvement of public spaces, a shop-front competition and the redesign of the historic town centre. Impressive results were achieved with modest funds. A sculpture offered by a local sculptor, composed of models of hands of all the citizens of Finglas, serves as an allegory for the project (EFILWC 1993).

Action planning and workshop schemes involve the organisation of carefully structured collaborative events, which liberate creative individuals, articulate a sense of vision and create a momentum, a thrust for the future. From London to Moscow, action planning weekends nourished visions for the renaissance of sites ranging from redundant railway lands to abandoned docklands (PWIA 1996).

2. "CITY IS BUILT POLITICS"

A city is something more than the simple addition of its people and spaces. It is a matrix of relationships and conflicts, a place of synergies and tensions, of myths and legends, where the whole always exceeds the sum of the parts (Calvet 1994). The creation of the quintessential city of the future demands the masterful interweaving of all registers – scientific, artistic, sociological- and can only lead to prototypes (Mega 1997).

City planning for sustainability faces multiple dilemmas. The New Charter of Athens, issued by the European Council of Town Planners in 1998, indicates a clear shift in prevailing planning principles. The 1933 Charter of Athens had introduced functionalistic principles in planning, demanding the separation of spaces for work, living, leisure and communication. Emphasis is now being placed in achieving human settlements for all, based on true involvement. The charter advocates for planning which promotes socio-economic progress and environmental enhancement and safeguards traditional elements and identity. Mobility and access, variety and diversity and health and safety are essential for the human settlements of the 21st century and new technologies offer additional opportunities (ECTP 1998).

The pursuit of sustainability will always take place in a climate of uncertainty. Priority should be given to the factors that enhance the capacity of regions and cities to respond quickly even to conditions that are impossible to forecast. Vision-making exercises can offer a view of what is desirable and possible. Alternative visions, emerging from consultations and reflecting the pluralistic values of the communities, could assist decision-makers to design and implement policies and programmes adapted to local needs and opportunities. They can be introduced through small-scale, incremental and, if possible, reversible innovations.

A culture of continuous evaluation and improvement is important for the readjustment of policies. Many past policies have failed and their evaluation is important in order the revise objectives and instruments. Mechanisms for dealing with public policy and market failures should always appraise their acceptance by citizens. Regulation or command and control, institutional reform, allocation policies, removal of damaging subsidies (grants, soft loans and tax allowances), assignment of property and development rights, emission charges and taxes and voluntary approaches have important repercussions on citizens and interest groups. Last but not least, the dynamic and soft effects including capacity building and inducement for developing better policies should not be forgotten.

Price mechanisms are powerful tools for integrating environmental and economic imperatives and send the right signals to producers and consumers. There is a growing use of economic instruments for environmental management, consisting mainly of taxes

and subsidies. The political acceptability of economic instruments is a delicate question, since they are often perceived as licences to pollute. Transparency and accountability should ensure that revenue from taxes or charges are invested in the local environment and quality of life. Economic instruments are not a panacea and should not be used as an alternative to other instruments, but in combination with them. Integrating environmental taxes with broader fiscal reforms and shifting the burden of taxation from labour to the environment while keeping the total fiscal burden unchanged is considered to be an acceptable alternative. It would be destructive for the civilisation of sustainability to suggest that everything has a price, or, in other words, that money is the highest of all values (Schumacher 1980).

Voluntary approaches with the active participation of industry are most important. They can be exemplified through the Japanese experience. Thousands of agreements have been made between local communities and their businesses, where the latter have agreed to achieve particular objectives, often with the local government acting as mediator and guarantor. The Rhine contract, between the municipality of Rotterdam and polluting industries of the Rhine is also a prime example.

Volunteers constitute a most precious urban human resource. Barcelona demonstrates what can be achieved with passionate and committed citizens. In preparing for the Olympic Games, the city created and trained a body of forty thousand volunteers. After the great voluntary support during the Olympic Games, it was clear to the local authorities that this body was a living asset and should be offered new opportunities. The municipality conferred prestige on the group and helped its self-organisation and development. The most active group of volunteers created an association – "Volunteers 2000" – which manages the whole voluntary body. Today, the city has fifty thousand volunteers assisting in all types of projects, safeguarding the functioning and minimising the cost of every action.

In Athens, following the call for volunteers by the organisation "Athens 2004" responsible for the 2004 Olympic Games, 160,000 international applications have been submitted and 55,000 volunteers were selected and trained in order to offer their services during the games. The municipality of Athens organised a dedicated body of volunteers to help visitors to find their way in the city. Many of them assisted tourists in discovering a new image of the Greek capital. Not all

of the volunteers were Greek. In a spirit of openness, Athens invited foreigners to participate in equal terms.

Amsterdam, the European capital of tolerance, has been one of the best examples, from its golden age onwards, of how openness and willingness to accept and integrate strangers can bring prosperity and progress to a city. Political emigrants, ex-colonials, workers and intellectuals of every race and belief have always lived side by side with the local population. Plurality, a key element in European civilisation, has played an important role in the development of the city and the formation of its grassroots.

When in the early seventies, the construction of the underground railway system meant the demolition of many old streets, the local population of Nieuwmarkt, in the heart of the former Jodenbuurt, tried every form of peaceful protest. Public opinion was on their side and even art was used as a weapon. When the demolition squad came, residents resorted to physical violence to obstruct the workmen. The decoration of the completed metro station was assigned to the former demonstrators and the entire vault of the Nieuwmarkt station has been turned into a graphic account of the district's tumultuous history.

In the sixties and the seventies, the Provos and the Kabouters institutionalised the voice of protest whenever the social fabric of the city was threatened. In the 1980s, aggravation of the housing problem caused violent clashes between the police and squatter communities evicted from houses destined for high profit use. Transport and housing improvements continue to be key issues and the object of referenda. Urban renewal is not always sufficient to fulfill housing needs and there are usually few obvious sites for new housing. Artificial islands are created to house urban units and provide both rented and owner-occupied housing for a wide range of income brackets. Ecological organisations however protested that development would disturb bird species having their habitat on the coast.

Citizens who are proud of the cities they live in are the precious resource for any city. In Brussels, the ARAU (Atelier de Recherche et Action Urbaines) Association brings together aware citizens and local residents who care and struggle for the enhancement of their urban heritage. Since 1969, this group has been outspoken in its calls for high-quality design in the reconstruction and development of Brussels. The

outrageous demolition of some important buildings, like the "Maison du people" by Horta in the 1960s, spurred the unity of citizens willing to do something more than simply protest. The challenge is to live and to act as responsible citizens. ARAU organises guided tours offering an alternative view of Brussels, as shaped by historic, economic, social and political factors, allowing citizens and visitors to (re)discover the often hidden common wealth of the city and re-evaluate urban life.

Children are at the very heart of sustainable development. The well being of children is a litmus test for the present and future of the society as a whole. In Finland, the "Children as Urban Planners" project in Kitee aimed at educating active citizens in environmental awareness and responsibility for their built and natural environment. In Helsinki, hundreds of schoolchildren studied the urban history of their capital and then redesigned Helsinki city centre (Figure 33). Hundreds of municipalities are creating municipal councils of children to promote civic awareness of the citizens of the future.

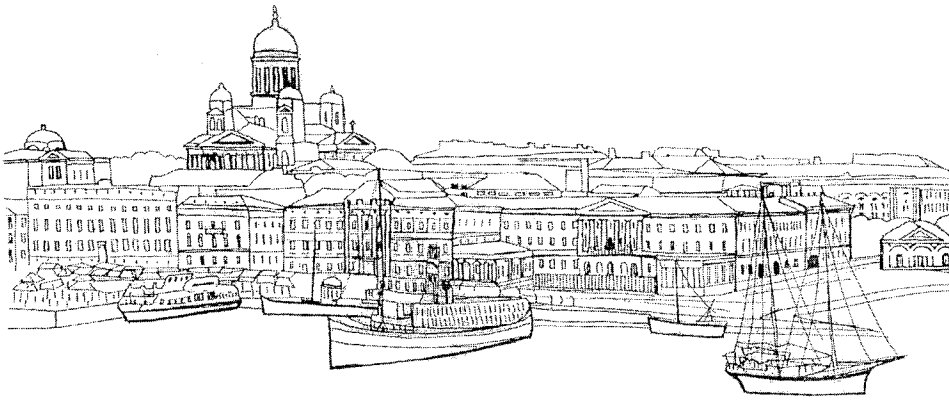

Figure 33. A Representation of Helsinki. Source: Idem

Science museums and eco-stations organise special events to raise awareness among young people and engage them in creative action towards sustainability. The fifty-fifty project in Hamburg involves all schools of the city, committed in reducing by 59 per cent energy and

water consumption. Science weeks include structured pedagogical actions for youth to initiate better consumption patterns.

Recognising excellence and rewarding the best can be decisive and exemplary. In Copenhagen, the "Royal Awards for sustainability" aim at improving the environment through the creation of thematic award platforms. The 2003 Poster competition invited young pupils to design posters in relation to agriculture, energy and tourism. The Royal Awards travelling exhibition "Children in Europe" illustrating the present and future environment presents the many visions of young Europeans towards a human face for the urban environment.

3. COMPACT, MIXED AND DIVERSE CITIES

The relative compactness of the settlements and consequently the overall urban density are critical indicators for sustainability. Compact settlements imply a clear definition of the urban/ rural boundary to discourage sprawling processes, regeneration of open and derelict spaces, and functional diversification of land uses at the neighbourhood level and the environmental improvement of the external sub-centres, well served by public transport. The Danish model of decentralised concentration highlights the importance of all these components, while the Dutch compact city policy is based on the principle of spatial multi-functionality.

The expansion of the cities into surrounding green areas has been one of the fundamental trends of the 20th century and during periods of rapid economic growth and technological progress. Sub-urbanisation brought increased pressure on land resources and drastic change in land use patterns. Even if this general trend slowed down in Europe during the last part of the century, through greater intensity of land use and the conversion and reuse of abandoned or contaminated land (brownfields) and buildings, de-concentration seems irreversible.

Most cities opt for renewal rather expansion, for consolidation of the urban fabric and improvement of the suburbs. The soft urban renewal in Vienna includes block improvement schemes, enhancement of public spaces and ecological measures. The social criteria insist on avoiding

segregation. Soft renewal allows inhabitants to remain in place and avail of a range of resident-friendly measures.

The paradigm of the compact city, in contrast to the diffuse city, is considered to be most conducive to sustainability. Compact cities have the potential to mobilise huge amounts of resources at remarkably lower levels of energy consumption, resource use and waste, comparing to diffuse cities, rural settlements and dispersed populations. Higher population concentration means a reduced demand for land per person, while concentration of production and consumption means a greater range of possibilities for efficient use of resources. The compact city has the advantage of providing shorter distances between home and work or leisure and offering better prospects for public transport.

There are, nevertheless, many contentious areas about the merits and defects of the compact city. The compact city might not necessarily respond to lifestyle preferences (Breheny 1992). Experts suggest that a sustainable urban form on a regional scale would contain many relatively small settlements, some clustered to form larger conglomerations. It would consist of compact settlements, probably of linear or rectangular form, where people could live and work (Owens 1986).

The interrelated questions of density and compactness are of prime importance. High density should be distinguished from high rise. C. Correa suggests high density / low rise as the preferred composition. Various studies suggest that while high density may convey the illusion of chaos, it bestows the benefits of social and spatial stability. Mixed uses are a guiding principle for many city plans (World Bank 1995a).

The cities of the future must reflect a true urban and social intermixture. There is an increasing unanimity about the need for urban mix, a desire for a little of the city everywhere in the city. Functional zoning seems an anachronism from the bygone industrial era. In many cases, it created more problems than the ones that it was supposed to resolve and often destroyed the complex cultural, economic and democratic structure of a city. The reintegration of urban functions should reinforce identity and openness. The concept of the open block promoted by the architect Ch. de Portzamparc advocates for the interaction and harmony at the scale of each neighbourhood.

Diversity and mixed land uses are linked to the city's unrivalled character as a cultural and racial melting pot and the remarkable coexistence of harmony and anarchy. Cities like Amsterdam consider urban mix as a valuable attribute of the inner city heritage and try to strike a balance among housing, offices, commerce, services, tourism and leisure. Since 1965, a pedigree sustainability principle has been followed. The new plan was based on the idea that cities should not continuously expand but concentrate on consolidation and renewal. The compact city policy, introduced in 1985, aimed at enhancing space as efficiently as possible, decreasing distances between home and work, creating diverse residential environments and reducing the overall environmental burden. The implementation of the compact urban policy has been a real struggle with scarce space.

In the south of Stockholm, the Huddinge Centrum offers a successful experiment in transforming a suburban shopping centre into a town square, focal and meeting point for the community. The location, next to the train station, generated the creation of new offices and apartment units and the whole area has been reshaped after the model of the old medieval city of Stockholm. Some cities introduce mixed use developments at the scale of one complex, typically comprising a shopping mall, offices and apartments on the top. Oslo offers an interesting example. In Galway, the main shopping centre includes a part of the discovered ancient wall, the shopping malls, offices and, on the top terrace, a complete housing estate for citizens who wish to live in the city centre and yet enjoy their individual homes (EFILWC 1993).

The full integration of functions at the neighbourhood level has an important condition which is difficult to guarantee: that each inhabitant is able to find a job near his home. This is a condition that no plan can pledge. S. Markelius, prominent member of the Stockholm avant-garde, had prepared a plan for the new satellite residential units to provide jobs for as much as one-half of the resident population. This failed to happen and in some cases, 75 or 85 per cent of the population commuted from the beginning of the project (Hall 1995).

Many new towns and cities have incorporated functional mix in their core planning principles. Columbia, Maryland, conceived in the 1960s according to a master plan in form of urban villages for a total population of 100,000 inhabitants, to be built step-by-step and village-by-village over the next thirty years. Each village has a community centre,

an array of mixed housing, a swimming pool and a primary school, an inter-faith centre (an ecumenical concept for a variety of religious organisations), high schools, cultural and athletic facilities, the Columbia Mall, the lakefront area and a concert arena. An important element of the success of this planned community was the integration of business with residential activities and the establishment of clean industries and services in business parks and office complexes (EFILWC 1997g).

4. GREEN AND GREY PARKS

Green parks are the lungs of a city, the places where the natural and man-made environments meet. They provide space for outdoor recreation, they distress the urban fabric and they contribute to the preservation of biodiversity. The amount of green area per inhabitant is a common indicator of living standards in cities, often assessed in conjunction with accessibility patterns. Parks and green spaces are usually treasured places in urban regions and hundreds of citizen organisations are involved in the preservation of the green spaces in urban regions. Maintaining land for green purposes is often very challenging, in cases where the financial development of the land is very high.

Many European cities own large forests accessible to all citizens by public transport. Vienna provides a prime example. At the very heart of the Stockholm metropolitan area, the National City Park of Haga-Brunnsviken-Djurgården-Ulriksdal, offers an example of a national cultural heritage, very important for urban ecology, recreation and biodiversity. The protection of this very unique green urban area, popularly called the Stockholm Eco-park, is the result of intense dialogue between the central and local governments and also NGOs and citizens (EC 1996c).

In Brussels, the Forêt de Soignes, considered as a jewel second only to the 16th century Grand Place, accounts for 60 per cent of the green spaces of the region. It acts as a huge green lung of 4,400 hectares and has a very high recreational value. It welcomes as many visitors per year as the inhabitants of the city. A protected landscape, the forest is a unique ecosystem. Sixty five per cent of its surface is covered by towering beeches growing on average 5-10m higher than they do

everywhere in the world. Beeches are typically felled for timber when aged more than one hundred and twenty years. Citizens protested and asked for keeping the majesty of the forest intact with each tree standing as a living monument. The Brussels Institute for Management of the Environment, in control of the 38% of the forest, undertook, when preparing a management plan in 2000, public consultations and canvassed the opinions of forty ecological associations. A clear majority favoured the preservation of half of the forest as beech and this has been incorporated into the Management Plan of the Brussels Region. The remaining half would be transformed into a more diversified forest to stimulate biodiversity in accordance with the international biodiversity agreements.

Grey parks, including science, technology ("technoburbs"), industry and business parks, technolopes or edge cities, are mushrooming throughout the world and may be seen as the brains in cities. The wave of grey parks started when manufacturing industries, traditional motors of growth, have been supplanted by the services sector. The need for common infrastructures, research and development activities and services has been the major reason for the organisation of science parks, some of which evolved into science cities. Teleports, parks providing high technology infrastructure for businesses that are heavily dependent on telecommunications, have also expanded. From Tokyo to Barcelona, and from Malaga to Athens, former industrial estates have been reshaped to provide infrastructure enabling them to attract grey investments.

The edge cities of the nineties, especially in USA, developed as new suburban cities always located closer to major highways and hosted glistening office towers and huge retail complexes (Garreau 1991). "There were a hundred thousand shapes and substances of incompleteness, wildly mingled out of their places, upside down, burrowing in the earth, aspiring in the earth, mouldering in the water, and unintelligible as in any dream" wrote C. Dickens on London in 1848 and J. Garreau, who coined the term of "edge city" calls this quote the best one-sentence description of edge city extant. In Europe however, a new generation of science, technology and business parks exhibits sustainability principles by turning brownfields into healthy areas and by connecting them to major public transport exchanges.

Sustainable grey parks often provide interesting cases of public-private partnerships for turning deprived areas into healthy spaces and

areas of positive environmental and economic profit. Stockley Park, a former derelict rubbish tip, within the green belt to the west of London, is an inspiring example. A partnership between the developer, the local authority and the university created an international business park and public parkland including recreational facilities. In exchange for the right to construct the business park over 36 hectares, the developer guaranteed the reclamation of the whole site (140 hectares), removal of groundwater pollution, environmental enhancement and landscaping. At all stages of the construction of Stockley, local residents were involved in the process through extensive community consultation (EFILWC 1993).

In Germany, the IBA Emscher Park has been an important pole for urban and regional development and ecological renewal within the northern Ruhr district. European experts together with the cities and industries of the Emscher region worked for the modernisation of coal mining settlements and the creation of new housing, the development of fallow land and the promotion of attractive locations for industry and services. The preservation and re-use of industrial sites, the landscaping of the Emscher area into a park, the ecological restructuring and the protection of the water environment are leading to a healthy space. New dwellings have been created on fallow land and with new environment-friendly material. High quality locations for industry and services have been established. Contaminated areas have been insulated and re-developed. Working in the park is attractive through the enhancement of the quality of the area (IBA 1999).

The Donau-City project in Vienna aimed at creating a new skyline to the north-east, across the River Danube, and a new mixed waterside edge quarter. The project follows the model of La Defense in Paris and intends to create an environment attractive to enterprises. The Technopolis of Bari comprises a research centre, a training centre and international schools and services. Profits derive from the provision of services to business and public administration. The parks are designed to respond to demands for innovation and also to create a new demand for innovation with various stimuli. The IEDA Andalusian Technological Park in Malaga tries to capture foreign and national investment in new technology, to attract research centres and to give rise to the creation and development of endogenous enterprise projects (EFILWC 1993).

5. SUSTAINABLE REGENERATION

Regeneration, revitalization and even rejuvenation are concepts linked to the definition of sustainability as a search for permanent youth. All these terms converge in efforts to create attractive urban places out of anonymous and dysfunctional spaces. The aim is for cities to become vital places and strong magnets. Sustainable regeneration incorporates ecological principles in identifying the land, planning for change, co-deciding on a new purpose, recycling the area and enhancing the space. The involvement of a wider public is necessary. The inhabitants need more pride in the places where they live and work.

Revitalising an urban area entails recreating the economic diversification, the social heterogeneity and cultural diversity of the city. Studies highlight the importance for sustainable regeneration to address the unrealised potential of distressed urban areas, which are willing to re-attract social life and productive investment in healthy environments. Successful regeneration schemes address both the hardware and software of the areas and reconcile environmentally sound rehabilitation of physical structures with social revitalisation and economic enhancement.

Sustainable regeneration tries to inject new life into petrified spaces and transform idle city assets into sustainable resources and benefit generators. The Dublin regeneration programme aimed at redeveloping dilapidated core areas, halting the dramatic decline of the population in the city-centre, reversing the spiral of decay creating a climate of confidence to stimulate and win back investment. The Dublin City Development Plan, published by the Municipality in 1991, after six years of preparation and consideration of 21,000 representations and objections, provided a valuable framework. The government reacted with major initiatives, including the designation of assisted development areas, the establishment of the International Financial Services Centre in a derelict dock area and the creation of the cultural quarter of Temple Bar (EFILWC 1996b). Leisure areas have been developed along the coast (Figure 34) and disadvantaged areas in the inland.

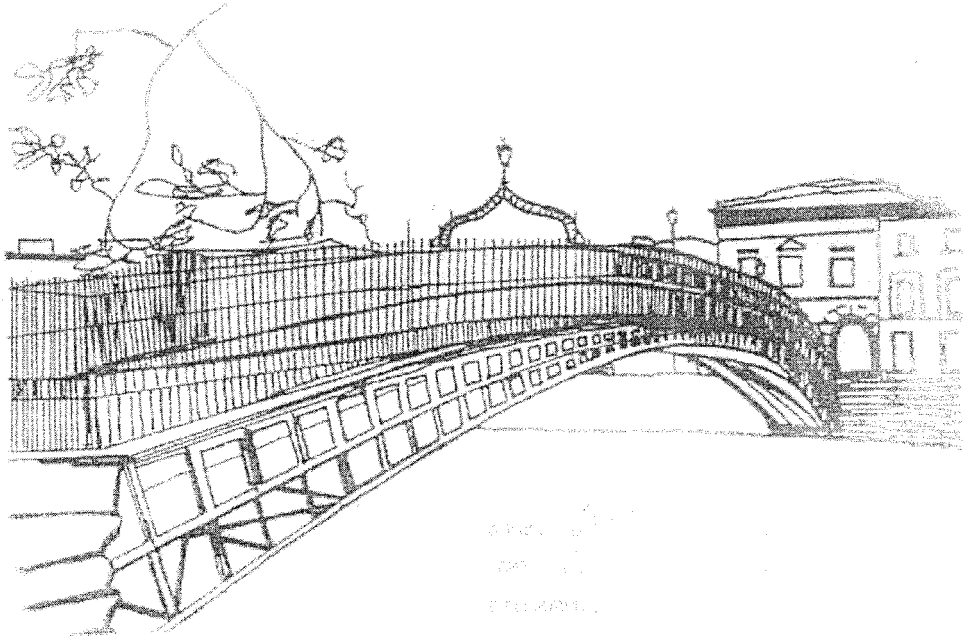

Figure 34. A Representation of Dublin. Source: Idem

Water often oriented the way that cities grow and develop. Cities depend on the waterways, while the waterways achieve significance through the cities. Rivers are mirrors of ecological awareness and cooperation among the territories that they cross. Harbour cities are shaped by geography, nature, climate, history and culture. The sustainable conversion of waterfront areas, seasides and riversides, is a key feature of many cities. As a result of economic and technological reforms over the last years, city-centre ports have disappeared, leaving behind deserted shipyards, legacies and relics of the industrial revolution.

From Turku and London to Genoa and Bilbao, disused dock infrastructures are being turned into exhibition halls, shops, craft workshops and centres for ecological, leisure, civic and cultural activities. Functional diversity is an increasingly important characteristic and public access to the waterfront is considered to be decisive for the shared ownership of the sites. Waterside promenades increasingly replace industrial dock spaces and welcome citizens. Barcelona, the city that has

always lived with its back to the sea, provides a marvellous example of how a city can get reconciled with its sea.

The regeneration of London docklands led to the thorough transformation of an area of eight-and-a-half square miles stretching across parts of the East End Boroughs of Southwark, Tower Hamlets and Newham. The London Docklands Development Corporation in charge of the project, the second urban development corporation established by the Government under the Local Government, Planning and Land Act 1980, has worked for seventeen years to bring a new face and significance to the place. An insightful account of its work is recorded in a series of nine monographs and six completion booklets. The corporation withdrew from the area gradually, starting with Bermondsey Riverside on 1994 and ending with the Royal Docks on 1998. Monographs cover the whole horizon of issues, from the initiation of urban change, the creation of the light train to central London, engineering, planning and development, the property market, employment opportunities, housing, regeneration and the arts and also the role of local communities.

Recognising waterfront heritage as a diminishing asset is crucial for encouraging selective preservation along with quality urban design. The planning of the Belfast waterfront has been driven by the strong will to create a new face for the city, a face no longer marked by violence. Spaces of hope are replacing empty shells of desolation. The integrated management of the dual city-harbour resource is essential. The renewal of an abandoned and dilapidated area in Galway, once traditional economic activities disappeared or relocated to sites outside the city, provides interesting lessons. Economic measures were introduced, promoting rehabilitation as well as new building. The regeneration respected Galway's unique character and atmosphere and promoted a functional mix, essential for the vitality of the city centre. A balance has been stricken among residential, commercial, cultural and tourism functions (BURA 1997).

The city of Stockholm developed the former abandoned waterfront industrial land, on the outskirts of the inner city, set aside for the city's ultimately unsuccessful 2004 Olympic bid. The municipality plans a new district with 10,000 flats, 10,000 jobs, cultural activities, services and parks with bioclimatic design and ecologically sound surroundings. Bilbao used to be a gloomy and rainy city endowed with an obscure river. During the last decade, it experienced such a radical

change that citizens suggest that it became even sunnier. It is now a luminous city with green and leisure spaces, a welcoming riverscape, a friendly new metro, a new tram line and the Guggenheim Museum which marked a watershed.

In Turku, the metamorphosis of an old industrial and harbour space into a new arts centre is an inspiring example. In 1987, the municipal council organised an architectural competition for a new master plan for the area and the remaining structures of closed down factories and warehouses. The winning entry "Sigyn" introduced a magnificent mixture of old and new structures in brick, steel and glass, for educational, museum and office purposes. Two massive former shipbuilding halls and a former rope factory, once designated to be the ugliest building in town, now compose a major fine arts complex, including a conservatory, the Turku School of Art and Communication and the School of Fine Arts (EFILWC 1996c).

Waterfronts constitute backbones of biodiversity. Innovative initiatives enhance the ecological value of the harbour as a habitat for fauna and flora. The Salford Quays development on the Manchester Ship Canal came about through the will to turn derelict space into the ultimate leisure area, respecting the environment and promoting culture. In La Rochelle, waterfront functions bring together trade, water recreation, fishing, tourism, ecological research, waterborne urban transport and public meetings. Aesthetics play an important role and landscaping has to enhance all activities and their interactions (EFILWC 1993).

6. REGIONAL POLICY AND STRATEGIC PLANNING

Regional development is recognized as a precondition of social and economic cohesion in Europe. Regional policy addresses spatial complexities and disparities, diversities and inequalities. It deals with the balanced dynamic development of the whole. In the European Union, regional policy has to address the emergence of new disparities, unequal competition to attract certain advanced activities and a risk of accelerated economic concentration and two-tiered development, due to the lead taken by a small group of large cities, are among the key features (EC 1995a).

Strategic planning and programming is an important instrument to achieve regional policy goals. The Copenhagen "Five Finger Plan" can be quoted as a prime example of post-war plans which try to develop not only a capital city, but promote the harmonious development of the city and the surrounding region. Sustainability principles can preserve the green wedges, consolidate the fingers and equip them with highly performing public transport.

Infrastructure planning is crucial for the development of the regions. High-speed trains bring together many regions but exclude others. Up to 1989, the North-South dimension dominated regional planning in Europe, while since then an East-West focus has emerged. New areas of solidarity should be fostered as bulwarks against the processes of fragmentation and exclusion. In all member States of the European Union, there is a tendency towards decentralisation, a marked shift towards a European approach to problems and a general awareness of issues such as urban regeneration, environment and the potential of information and communicating technologies. The European cities and regions should engage in concerted actions to achieve greater competitiveness, advance towards territorial sustainable development and ensure greater solidarity.

In the EU, at the twilight of the 20th century, the European Spatial Development Perspective has been intended as a common frame of reference and a stimulus for indicative action, in pursuing the fundamental goals of economic and social cohesion, sustainable development and balanced competitiveness of the European regions. The initiative addressed questions of common concern throughout the European Union territory, such as the creation of a balanced urban system, the access to infrastructures and services and the sound governance and sustainable development of the natural and cultural heritage. Changes in urban structures and rural functions, physical and digital infrastructure patterns and impacts on the natural and cultural heritage are impacted by thematic, structural and horizontal Community policies. The examination of a broad horizon of policy options highlighted the importance of new urban-rural partnerships and the need for integrated spatial development strategies and policies.

The European Space Development Perspective highlights the advantages of polycentric spatial development, while the Japanese approach focuses on multi-axial structures. Experts suggest that

sustainable formations on a regional scale could contain many relatively small settlements, some clustered to form larger settlements of 200,000 with more people on the sub-regional scale. The metaphor of a polycentric regional settlement pattern, encompassing a set of compact and as much as possible self-containing centres, well linked by efficient public transport and separated by green spaces, is still the subject of unresolved debate.

Policies are increasingly shared and powers interwoven among the EU, member States and regions. In the old member States, most regions are invested with the resources and sometimes the autonomy to carry out their policies and implement central policies. Nevertheless the EU White Paper on Governance pointed out major failings in the involvements of sub-national authorities in European decision-making. In the new member States, democratic transition called for the representation of populations and cultures. Moreover, multi-levelled partnerships, based on interaction and interdependency, emerge everywhere and may be valuable for efficiency, effectiveness and transparency (EC 2001d).

The third report on Economic and Social cohesion, published in 2004, has searched the impact (or "added value") of policies in bringing citizens, territories and opportunities. It highlights the increasing convergence of lagging regions in the EU, but also a substantial widening of regional disparities with the accession of the ten new member States. The cohesion policy, only EU policy to explicitly address socio-economic inequalities, is perceived not as a passive redistribution of income but as a dynamic policy aiming the realisation of the underused potential (EC 2004b).

Each member State has the sovereignty of its territorial and institutional architecture. Europeanisation does not prescribe any model for regionalisation. The European Union is not merely a coalition of States but a Union of people and territories. Enlargement is spurring regions to assess more carefully their comparative advantages and their potential. Many regions express fears concerning the delocalisation of enterprises from the old towards the new member States. These concerns are widely shared by those who see the development of European territory as a zero-sum game. Others express the view that this is more the result of ongoing globalisation than enlargement and that, without enlargement, delocalisation would be even more acute.

At the OECD level, studies demonstrate that performances vary widely in all types of regions and divisions reflect less and less the traditional dichotomy between urban and rural areas. Both urban and rural areas have a wide range of potential income and employment, social dynamism and environmental problems. Lagging areas, with poor public services and infrastructures, fragile environments, lack of private investment, inadequate access to markets and trade, low levels of employment, training and participation, are to be found in urban, peri-urban and rural areas. Rural areas are not synonymous to declined spaces. Some dynamic areas are predominantly rural. Their economy is often based on highly performing and networking SMEs. In many countries, hybrid areas, termed intermediate areas, comprising networks of small and medium-sized towns, are flourishing.

Strategic planning concerns the future of a place and not just the location of activities and infrastructures. It encapsulates visions for the longer term development, establishes objectives and prioritises actions towards the implementation of policies. Strategic plans have to reconcile thematic and territorial policy objectives and be discussed, co-decided, implemented and co-evaluated.

Strategic planning generally entails a substantial research programme and wide-ranging consultation processes. It has to elicit fundamental principles providing the bedrock for the future, to collect and analyse data to support enhancement of the resources and to ensure political endorsement from community and stakeholders. The open and transparent negotiation of a plan may take time, but can also foster a climate for permanent improvement and self-generated change. Continuous stocktaking of progress and adjustment of components should allow achievement of objectives, especially in the face of strained budgets.

Transport and land-use policy and planning constitute two strategic instruments for sustainability. Suburban garden cities or satellite new towns, which have developed around subway stations, have often been transformed into dormitory suburbs without any independent identity. Consolidation, i.e. concentration and intensified use of space and improvement of a city in a well-defined urban territory, provide advantages for the integration of urban structures. Sound development requires urban structure and patterns that minimise rates of flow per

person and lead to a drastic reduction of greenhouse emissions and depletion of non-renewable resources, maintenance of bio-diversity together and enhancement of local materials and labour skills.

Design, the graphic language and an integrated part of city planning, is a major instrument for revealing the aesthetic qualities of cities. It needs strong leaders and enlightened private developers. It should respect the city's genetic code, enhance continuity and change and realise the potential of physical and cultural assets. The form of a city should be able to reflect the aspirations of its citizens. Urban design should reconcile economic and environmental imperatives and promote the concept of social space, which most fits the essence of a city.

Local government, while recognising constraints, should not accept that the development potential of a city is fully predetermined by its physical form or other existing conditions. They should enhance the capacity of citizens to transform and enhance their cities. Urban sustainability can only be achieved through the coexistence of people and activities. This may not be sufficient but is certainly a prerequisite for constructive interactions. A functional mix does not only minimise distances that individuals need to cover, but also helps stagger the times during which this transit occurs.

Cities are chronotopes, with interconnected spatial and temporal dimensions and interrelated historical and geographical aspects. Geography is history in place, history is geography in time (Reclus). Like space and water, time is a scarce resource for cities. The time dimension does matter in advancing towards sustainable development. It introduces concerns about inter-generation distribution of capital and serves as a litmus test for the well being of individuals and societies. Time management has a potential for extending the limits of spatial planning. Diachronic and synchronic territorial dimensions start being taken into account in policy making. Some governments and cities have been pioneers in promoting local time plans strengthening places through the harmonisation of time budgets (INU-Politecnico di Milano 1997).

Historical time can be divided into various forms of movement, including geographical time, social time, and individual time. All these times coexist in the city, which is a bonum commune. Time plans in Italian cities, like Milan, Florence, Bolzano, try to optimise public services offered by cities to citizens. They have been linked to mobility

plans and led to the modification of timetables of municipal services. Women's associations have been very active in changing the time of cities and bringing them in harmony with the times of life (Zayczyk 2000). In Rome (also a laboratory for the closing certain parts of the metropolis to cars during certain days per week) the municipality, the trade unions, the city time office and the office for citizen rights signed in 1995 an agreement on the reform of the municipal time schedules. A period of experimentation with working time schedules in municipal sectors, initiated better services to citizens. The opening hours of all municipal offices have increased considerably.

Concerns about the vanishing city or the virtual city, in which technology dominates space, gave way to the theories on the ubiquitous city. The intelligent use of new technologies may be a source of individual and collective benefit. The immotique and the domotique offer new endless possibilities. Teleworking can lead to a disassociation between concentration in time and concentration in space. At the beginning of the century, four million Europeans are more or less teleworking and this figure is set to increase. Electronic commerce could soon account for one third of all banking transactions. Physical and digital infrastructures need harmonious linkages to generate a better quality of life. British cities deploy efforts towards the 24-hour city and the night-life economy, probably inspired by patterns of North American patterns. Tele-activities may lead to ubiquity and interaction, but they are just instruments, conducive either to integration or exclusion, depending on the overall policy articulation.

7. INSTITUTIONAL ARCHITECTURE AND CIVIC ALLIANCES

At all territorial levels of governments, from local to supra-national, institutional frameworks for policy articulation and design, fiscal federalism, co-ordination and regulation play a critical role in promoting efficient sustainable development policies. Territorial governance provides the framework for the administration of the regions and the interaction of policies, with particular reference to the distribution of roles and responsibilities among the different levels of government and the underlying processes of negotiation and consensus-building.

Without good governance that builds a social consensus, progress may be brittle. The most efficient and balanced allocation of functions among governmental and non-governmental bodies, both horizontally and vertically, as well as the best way to achieve it may be decisive in advancing towards sustainable development. To fulfill new mandates and ensure progress towards sustainable development, regional and local authorities should be endowed with the resources to manage the functions assigned to them. Fiscal federalism, based on the search of a balance between distribution of powers and allocation of resources, may be instrumental for sustainability.

The cornerstones of the institutional architecture for sustainability are decentralisation and shared ownership of policies, together with an adequate transfer of powers and resources. The past decade has seen considerable change in systems of governance in OECD countries, resulting largely from widespread decentralisation of government functions. Decentralisation had a dramatic effect on policy making and led to the reallocation of tasks and resources and the development of more flexible institutional structures. A wide range of governmental and non-governmental actors, including private enterprises, the voluntary sector and the civil society, gradually constitute a new and more or less formal policy network, within which policy issues are discussed and options developed.

A democratic infrastructure is being built through formal mechanisms of horizontal and vertical co-operation between government bodies and partnerships with non-governmental actors. Depending on the degree of decentralisation, local and regional authorities are creating the necessary institutional bridges among themselves, with the central government and with social partners and NGOs, in order to maximise local/regional participation in the process of policy formulation and implementation.

Governments have, in some cases, begun to promote the formation of new spatial structures, such as inter-communal frameworks, regional platforms, territorial pacts, environmental contract areas etc. These new structures promise more co-ordinated spatial planning and more coherent allocation of public resources, as well as greater transparency, visibility and accountability.

In the context of these new partnership-based institutions, the role of citizen participation is increasingly enhanced. Stakeholders are sources of precious knowledge that can be harnessed to increase the responsiveness of public policy delivery. Over the past two decades, significant policy initiatives have been designed to promote empowerment, associative democracy and stakeholder involvement towards the shared ownership of projects.

Finally, against this background, the role played by negotiation and mediation in establishing new governance structures and in transforming inefficient relationships into dynamic partnerships is becoming increasingly prominent. Many countries are reconsidering the importance of effective co-operation processes between various government departments, different tiers of government and the public and private and voluntary and civil society actors. Contract and negotiation process have the potential to articulate the richness of information available at the local level on the one hand, and on the other, the broader vision of the central government. They may lead to better and more responsive policies and to a more effective and accountable allocation of resources.

National leadership is necessary to provide a coherent policy framework and co-ordinate the work of different national ministries, to enable territorial authorities to set priorities and commit resources, to promote public-private partnerships and share the risk and cost of innovations. Leadership at the local and regional levels is necessary to define territorial needs and develop visions, design and implement programmes, mobilise public and private resources to act and develop a permanent dialogue with the other territorial authorities.

Metropolitan areas face special challenges for institutional reforms and new models of governance, enhancing their human, social, natural, environmental and man-made capital. The OECD principles of metropolitan governance highlight the importance of promoting coherency, competitiveness, co-ordination, equity, fiscal probity, flexibility, holistic and adapted approaches, participation, subsidiarity and sustainability (OECD 2000b).

Toronto offered a civic laboratory of institutional change. After having benefited from a particularly successful two-tier governance model for over forty years, the regional government and its six municipal

authorities are getting amalgamated in a single unified city of Toronto. Institutional structures try to reposition the city for growth and foster a democratic and diverse urban community, socially cohesive and environmentally healthy (OECD-Toronto 1997).

Partnerships are linked to the shift in public policies from direct interference to indirect or conditional policies, such as incubation and mediation. Public-private partnerships should work like an orchestra (private) with its conductor (public) for the overall improvement of urban functions and life. Innovative partnerships can maximize the potential of synergies, enrich content and methods of co-operation and serve as catalysts of change.

Forward-looking national, regional and local governments create innovative strategic public-public partnerships, which should be enriched with effective public-private partnerships. Public-private partnerships have the potential to reduce the social costs of projects and lead to better outcome from public and private investment. They offer ample grounds for coalitions to overcome thematic and institutional dissonance and play a critical role in the implementation of sustainable development policies.

Central and local governments have to elaborate the plans towards sustainable development, defining the respective role of the market and the administration, facilitate and stimulate the interaction of the different actors and partners, interpret the needs of the citizens and guarantee the consistency of the different options and decisions. Stockholders, the owners of the physical assets, stakeholders, having particular interests in territorial success, and outside partners, providing resources and competencies and having an interest and contribution in territorial development, may invest great energy in a particular place and open new perspectives for the future.

Strategic public private partnerships have a great potential in reinforcing objectives of short-term commercial vigour with long-term societal objectives. Policies that promote collaboration with the business energy sector, facilitate firm networking and clustering and encourage, demonstrate and diffuse technology are extremely important. The success of these approaches depends on the overall policy environment, encompassing both macro-economic and structural conditions.

Citizens, users of public infrastructure and services, may contribute decisively in creating a collective momentum for development. Policy makers should invest in understanding better what people appreciate about their regions and communities. Partnerships allow also the public to be better informed on important aspects of sustainable development. Demonstration projects and media publicity should target the participation of the under-represented social groups and open the decision-making process. Partnerships may make the community more knowledgeable, help people to shape and control their localities and promote citizenship.

The role of the social actors in shaping a sustainable future is essential. European employers are, in fact, particularly concerned with urban investments and the increase of the economic attractiveness of cities, their openness to trade and markets. Trade unions seem to be particularly keen on the quality of urban services offered to the citizen, the workers and the unemployed. The social partners can co-initiate innovations, making them grow, finance unprecedented activities, stimulate other actors, create the climate for acceptance. Their action is essential in defining the local dynamism before formulating any policy proposal, identifying and adapting actions and sharing the cost of innovations. The regeneration of depressed areas and the creation of the technology and business parks are the most outstanding examples of the partnerships with the business world. Projects promoted by trade unions include employment generation and social housing schemes.

Partnerships try to build upon a city's more broadly shared values and priorities and the commitment of many actors to act upon shared interests. Experience suggests that to be successful partnerships need a clear vision and structure, a strategic and tactic approach, a critical mass, assertive leadership and social justice, continued evaluation and assessment. Partnerships should enhance the capacity, contribution and commitment of the public, private and community sectors and increase the social capital. Sustainability means, first and foremost, sustain ability to innovate and progress.

POSTFACE: THE EU RESEARCH AGENDA ON SUSTAINABLE DEVELOPMENT

Research is a mainstay of any long-term sustainable development strategy. It should provide knowledge and technological options for the continuous creation, adoption and improvement of more sustainable systems, products and processes. The EC Sixth Framework Programme (FP6) for research and technological development (2003-2006), launched towards the end of 2002, offers a great horizon of opportunities for research on sustainable development. Priorities have been established after wide consultation with the Institutions and the scientific and industrial community. They concentrate on a number of strategic and focused activities to optimise use of resources and maximise benefit.

The major political driving force for Sustainable Development in the European Union is the Strategy for Sustainable Development, which calls for the dynamic integration of social, economic and environmental policy objectives. It is an essential complement to the Lisbon strategy for making the European Union the most dynamic and competitive knowledge-based economy of the world. The same directions are highlighted by the EC Sixth Environment Action Programme. The Green Paper on the European Strategy for the security of energy supply and the White Paper on a European Transport Policy highlight the importance of energy and transport for economic development, social well-being and environmental performance. Securing energy supply, against a background of rising energy imports, and reducing environmental impact and greenhouse gas emissions are critical.

EU research priorities followed the evolving perceptions and dynamics of sustainable development. In the previous Framework Programmes the main focus was on environmental protection and later on

the incorporation of the environmental dimension in research and policy agendas. FP6 calls for the integration of the sustainability aspects in all areas of research. The overarching aim is to strengthen the scientific and technological capacities for the implementation of Sustainable Development in the EU and to make a significant contribution to international efforts. There is an urgency to understand and monitor global change, preserve the equilibrium of the ecosystems and mitigate, and if possible reverse, adverse trends. Complying with the Kyoto and Montreal commitments and the UN Conventions on Biodiversity and Desertification is vital. The first part of the EC Sixth Framework Programme (Focusing and Integrating Research) includes, in one of its main priorities, actions on three inter-related pillars: global change and ecosystems, sustainable surface transport and sustainable energy systems.

FP6 has been conceived as a key instrument towards the European Research Area, introducing a paradigm shift to address the fragmentation and the duplication of research efforts. EU-supported research concentrates on areas where it is essential to have a critical mass sufficient to make progress and lead to new knowledge and industrial activities. It has been judged necessary for the European Union to establish a genuine networking of research actors and projects, whether national or regional, undertaken by the public or the private sector. The creation of the European Research Area is expected to enhance the European added value.

Evaluating the costs and benefits of the various policy options is difficult. Research will have to provide the solid scientific and socio-economic ground and enable decision-makers to make pertinent choices towards a sustainable future. FP6 provides for socio-economic and strategic research to shed light on the most efficient, effective and equitable policy options. It has also to analyse trends, build scenarios, quantify externalities (socio-environmental damages) and provide benchmarks.

Future scientific and technological needs have to be anticipated. Rapid response to emerging social and technological challenges is often critical. The Sixth Framework Programme includes a mechanism to address the challenges related to unforeseen developments and the frontiers of knowledge. The dialogue between science and society is also being reinforced, in order to reconcile technological progress and social values.

GLOBAL CHANGE AND ECOSYSTEMS

Achieving the Kyoto objectives requires, in the short term, a major large-scale concerted effort to deploy the best available technologies. Above and beyond these objectives, the long-term abatement of emissions calls for a sustained research effort. The aim is to ensure the availability and competitiveness of new technologies and processes for the effective implementation of sustainable development policies.

Activities in this field aim at strengthening the capacity to understand, detect, predict and manage global change and at preserving the ecosystems and protecting biodiversity. Diagnosis of problems should be followed by prognosis of trends and development of strategies for prevention, mitigation and adaptation. The sustainable management of agricultural and forest ecosystems, taking into account socio-economic and environmental dimensions, is critical. The development of common and integrated approaches is expected to strengthen national and regional efforts and boost international co-operation. Shared definitions of thresholds of sustainability and methods to evaluate and direct action can have a substantial contribution.

Research priorities focus on the mechanisms of greenhouse gas emissions and atmospheric pollutants and their implications for climate, ozone depletion and carbon sinks (oceans, forests and soil). It is important to shed light to the changes in the carbon and nitrogen cycles. The role of all emission sources and sinks, their interactions, impact and associated phenomena are of paramount importance for mitigation and adaptation.

Water is another major research priority. Understanding the impact of global change on the hydrological cycle and the quality and availability of resources is essential for sustainable water management policies. A third research priority concerns biodiversity and ecosystems. The analysis of marine and terrestrial biodiversity and the impacts due to human activities are crucial for the sustainable management of natural resources.

The mechanisms of desertification and natural disasters, including their links with climate change, are being given priority attention, in order to improve risks, impact assessment and forecasting. Sustainable land management, especially for coastal zones, agricultural lands and forests, is the core element of another set of activities. They include integrated concepts and methodologies for the multi-functional enhancement of resources and the development of meaningful policies. Operational forecasting and modelling, including global climate observation systems, are essential for the systematic analysis of the atmospheric, terrestrial and oceanic parameters, the creation of European data banks and the support of EU policies and international programmes. Last but not least, complementary research focuses on the development of advanced methodologies for risks and quality assessment of processes, technologies and policies.

SUSTAINABLE SURFACE TRANSPORT

Over the last twenty years, passenger transport demand in the EU increased by over 100 per cent, and freight transport by even higher rates, far outstripping economic growth. Increased transport demand has rendered technological improvement and fuel efficiency gains inadequate. Transport is proving to be the sector with the fastest growing greenhouse gas emissions. Trends are likely to continue, if research and policies do not produce a leap forward. The EU white paper on transport suggests that demand is expected to grow by 38% for freight and 24% for passenger transport by 2010.

Congestion of the networks, lack of effective linkages and harmonised operability among transport modes and systems, harmful effects of traffic on the environment and public health and the heavy toll of road accidents are draining the potential of the transport sector. FP6 aims at advancing significantly towards integrated and efficient surface transport system characterised by near-zero emissions and an accident-free environment.

The Sixth Framework Programme supports policies for sustainable mobility leading to balanced, competitive, safe and sustainable transport systems. The vision for the future of mobility is

increasingly taking the citizen's point of view as the starting point. New alternative transport concepts, vehicles and services emerge based on the integration and deployment of clean, safe, and intelligent, transport technologies and management systems. The vehicle of the future is expected to integrate many elements of daily life, such as work, amusement, infotainment and culture. New vehicle concepts and alternative motor fuels are the backbone of the overall research effort. Research specifically focuses on new technologies and high-efficiency systems for all surface transport modes, i.e. road, rail and waterborne, including maritime and inland water transport.

Advanced design and production technologies for surface transport are expected to improve competitiveness and quality of employment in the European supply industry. They support the rationalisation of the production systems and help develop the knowledge infrastructure to be deployed in clean manufacturing. This can produce affordable green products and their corresponding infrastructure.

Modal shifts lie at the heart of the sustainable development debate. The main efforts address the need to strike a new balance between the modes of land transport, favouring more sustainable transport means. Revitalising rail and maritime transport is essential to counterbalance the domination of the road networks. For railways, new products and services, such as the European Rail Traffic Management system, are being designed to increase rail capacity safely. Railway networks exclusively dedicated to freight services could provide environmentally safe solutions to transport of goods and deliver improved railway performance. Promoting the interoperability of the railway system is vital.

The integration of vessel traffic information systems and other on-board systems could be instrumental in rendering the European maritime systems more efficient and effective. New vessel concepts for short sea shipping operations and fast transhipment of goods can further increase the capacity of the maritime system. Research priorities also include the enhancement of opportunities offered by sea and inland waterways.

Inter-modality and seamless integration of the different modes of transport through technical and operational harmonisation is essential to deliver a sustainable multi-modal transportation system. Such an effort

will increase access to European transport for the movement of citizens and freight.

Safety, in all its aspects, is a major requirement of all transport users. Increasing road, rail and waterborne safety is a key research transport objective. The objective for road transport is to halve the number of fatalities through integrated safety strategies. Technology and innovation can be decisive in reaching targets for safety and security. The deployment of intelligent and integrated transport systems, including satellite navigation applications, can have a great contribution. Such an effort represents a major priority for all modes of surface transport. Quality of life, especially in urban and sensitive areas, can benefit from such developments.

SUSTAINABLE ENERGY SYSTEMS

Sustainable, safe, reliable, competitive and affordable energy supply can only be guaranteed by a mix of independent environment-friendly systems. Clean technologies are decisive for improving the environmental performance of the sector. They can contribute to the increase of the efficiencies of both supply and end-use systems, impact the choice of fuel used for energy production and enable the decrease in emissions, through removal of pollutants. Even if fossil fuels still form the backbone of the energy systems, multidisciplinary research and technological advances have allowed them to increase efficiency and reduce environmental impact.

New and renewable energy sources and related technologies are essential paths towards sustainable development. Although renewable sources represent the fastest growing energy source in the world, they still need to overcome many technical and financial barriers to be able to penetrate markets. Their integration into the existing systems represents an enormous technological challenge. The European Union has set the target of doubling the share of renewables in energy consumption to 12 per cent and achieving 22 per cent electricity from renewable sources by 2010. A European Directive adopted in 2001 offers a framework to promote indigenous renewable energy sources in the internal market.

The time-scale associated with the development of energy technologies is long. The short-term research actions aim at curbing unsustainable energy patterns. They target the efficient use of energy, as well as the validation and demonstration of cleaner technologies. Their integration into the existing systems in combination with conventional technologies can lead to progressive improvements. Bringing optimal innovative and competitive technological solutions to the market as quickly as possible is of prime importance. The overall EU objective calls for 18% reduction in energy demand by 2010. Research activities focus on energy savings and efficiency. Polygeneration activities improve the efficiency of combined production of electricity, heating and cooling. This is critical for meeting the community target of doubling the share of co-generation in EU electricity generation from 9% to 18% by 2010. Research also focus on alternative motor fuels, especially biofuels, natural gas and hydrogen. The 20% substitution of diesel and gasoline fuels by alternative fuels in road transport by 2020 is another ambitious and challenging target.

Longer term actions aim at preparing the conditions for the development of alternative sources and transformation methods most likely to break away from the present energy supply systems, strongly dependent on fossil fuels, in particular in relation to transport and the production of electricity and heat. The actions cover fuel cells and their applications, new energy carriers and especially hydrogen, new and advanced concepts in renewable energy technologies which have a large potential, primarily biomass and photovoltaics, and sequestration of CO_2, associated with cleaner fossil fuel systems. Research on nanotechnologies, new intelligent materials incorporating multi-functionality, intelligence and autonomy, and new production processes is another priority of FP6. It is also expected to contribute to the improvement of energy systems.

Advancing towards the competitiveness of new and renewable energy systems, carriers and technologies, is essential. The costs for electricity generation from photovoltaics and solar thermal systems are significantly higher than those of conventional fuels. The investment cost of photovoltaics has to be reduced by a factor of more than four. Intensive research is also needed to realise the potential of biomass and biofuels, given the very ambitious EU target in this field. In the framework of the aim for doubling the share of renewables by 2010, bioenergy should contribute 7 per cent to total consumption. Hydrogen is

highlighted, in parallel with clean electricity, as the energy carrier of the future. Fuel cells are one of the key priorities, since they have a higher efficiency, lower pollution levels and a potential for lower cost.

The expected integration of this broad range of technologies during the coming years will move Europe towards the distributed energy resources model. There is much potential for new energy services without geographic constraints on power transmission and distribution. Optimal integration within inter-connected European, regional and local distribution networks is expected to increase competition and enhance quality, reliability, security and safety of energy supply.

THE EURATOM PROGRAMME ON RESEARCH AND TRAINING 2002-2006

One of the key messages of the European strategy for the security of energy supply is that no single energy option has the sole capacity to fulfill all energy needs. There is a need for diversity and this has to be reflected in policy agendas and research priorities. Energy is the only research theme to straddle two treaties. Research activities to be undertaken during the next four years are not only included in the 2002-2006 Framework Programme of the European Community for Research and Technological Development, but also in the 2002-2006 Framework Programme of the European Atomic Community for Research and Training.

Research activities under the Euratom Treaty aim at exploiting the full potential of nuclear energy. Nuclear fission energy, which today provides 35 per cent of the electricity produced in the EU, offers a near-zero emission substitute to fossil fuel combustion. It generates however radioactive waste, a small percentage of which is highly radioactive, remaining hazardous for over ten thousand years. The main option for managing this waste is deep disposal in geological formations. Research in this field is well advanced. Decisions on disposal also involve social aspects. Research has to provide options for management on which consensus can be reached. This is a crucial issue for the future of nuclear energy, together with the economic viability of new generations of power stations and the prevention of nuclear proliferation.

Major priorities of the Euratom Sixth Framework Programme concern the critical issues of management of radioactive waste and radiation protection. There is significant public and private European research effort for the large-scale implementation of long-term solutions. EU action in this field makes it possible to strengthen and ensure the consistency of the various strategies. Moreover, the debate on the structure of the energy supply after 2020 may necessitate concerted research effort at the international level on a new generation of fission reactors. Education and training are of paramount importance.

Fusion is a frontier technology. It involves the fusing together of light atoms, such as hydrogen. It is the ultimate source of most energy used by mankind, since it powers the sun and all the other stars. Reproducing the energy of the stars on Earth has long been a vision, now coming close to reality after several decades of intensive efforts. It is a long-term option that could provide a substantial contribution to energy supply in the future. The integration of all EU activities in this field into a single, co-ordinated programme has contributed to Europe achieving a position of excellence. It offers a model for the European research area.

Fusion research activities focus on demonstrating the capability of fusion to contribute in the second half of the century to the emission-free, large-scale production of base-load electricity. Theoretical work and experimental studies on the existing devices world-wide, in particular on the European JET, have established the scientific and technical readiness for the construction of a project of the next generation. Research activities in fusion physics and plasma engineering, as well as in fusion technology, are considered to be necessary for the continuation of the development of fusion by magnetic confinement towards its ultimate goal, electricity production.

Fusion research is now on the cusp between two generations of experimental installations. International collaboration has progressed to the detailed engineering design of ITER, known as the next step towards fusion power. ITER, a more reactor-scale device, constitutes an essential step towards the demonstration of the scientific and technological feasibility of fusion power production. The devices in the generation after ITER will be prototypes for commercial fusion power stations.

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ANNEX: TOWARDS A MEANINGFUL SET OF URBAN INDICATORS

The suggested set of headline urban indicators which follows has been conceived following the Charter of European Sustainable Cities and Towns (ESCTC 1994). The set includes policy significant environmental, economic and socio-cultural indicators.

The environmental indicators include both indicators representing local environmental quality and contribution to national and global environmental change. The indicators expressing the territorial responsibility for the global environment (Responsibility for Global Climate, Acidification of the Environment, Toxification of Ecosystems) and Local Disturbances follow the directions of the Dutch set (Adriaanse 1993). The air quality indicator, sustainable mobility, energy and water consumption indicators and resource and waste management indicators express important aspects of the local quality of life linked to global considerations.

The economic dimensions of sustainability are encapsulated by the composite indicator of economic sustainability. It is composed out of the territorial income, fiscal deficit, environmental expenditure and pollution damage. The indicators of social inclusion and employment, housing, public safety and citizen participation have been chosen to express social sustainability. Next to these, the quality of green, heritage and public space indicator serves as a measure of the quality of spaces promoting public health, social life and cultural identity. Finally, for each city, it would be useful to assign a unique sustainability indicator representing the contribution of specific local assets, characteristics or events to sustainability (EFILWC 1998a).

The diversity and heterogeneity of territories defines the level for the development of policy significant indicators. The scale for the development of each indicator is very much dependent on its nature: global climate, acidification, ecosystem toxification or economic

sustainability indicators may be more significant at regional level, while other indicators e.g. on resource management may be more relevant at a more local level.

The following set of urban indicators has been initially developed by the author in the framework of a thesis on sustainability indicators at Harvard University and served as the basis for the development of indicators by various cities, notably in the framework of a project managed by the European Foundation in Dublin (EFILWC 1998c), before being completed and improved.

(A) GLOBAL CLIMATE INDICATOR

Definition: The contribution to global climate change.

Measure: Global Climate equivalent (GCeq) = total greenhouse gases (CO_2, CH_4, N_2O and CFCs).

Policy Direction: Decrease in the discharge of greenhouse gases, according to national and international commitments, notably the Kyoto protocol.

Components: Emitted quantities of CO_2, CH_4, N_2O and CFCs and halons.

Composition: The indicator is the sum of the quantities of the greenhouse gases, weighted according to their warming potential. The degree (N) to which each greenhouse gas contributes to the global warming process depends on its concentration in the troposphere and on its ability to absorb the heat radiated by the earth.

$Gceq = N_{CO2} \times GC_{CO2}eq + N_{CH4} \times GC_{CH4}eq + N_{N20} \times G_{N20}eq + N_{CFC\text{-}11} \times G_{CFC\text{-}11}eq$ (if $N_{CO2} = 1$, $N_{CH4} = 1/12$, $N_{N20} = 1/290$, $N_{CFC\text{-}11} = 1/3500$)

Remarks: *The target can be composed out of the targets for the emissions of each one of the constituent greenhouse gases.*

Seventeen years after the Protocol of Montreal (the landmark international agreement to protect the ozone layer signed in 1987), stipulating world-wide termination of the production and use of CFCs and halons, which disintegrate ozone when entering the stratosphere and deplete the ozone layer, more than 90 per cent of global production and consumption has indeed been phased out (the target was the 2000 horizon).

(B) AIR QUALITY INDICATOR

Definition: The number of days per year on which local attention levels defined by law are exceeded in the most negative measurement.

***Alternative definition*:** *SOx and NOx emissions.*

Policy Direction: Improvement of air quality for all, through the reduction of SOx and NOx emissions, according to local objectives and commitments.

Subindicator: Number of days per year on which alarm levels are exceeded and special traffic measures have to be introduced.

(C) ACIDIFICATION INDICATOR

Definition: The deposition of acidic components.

Measure: Acidification equivalents (Aeq) = total acidification caused by acidic compounds and deposited per hectare.

Policy Direction: Drastic reduction of deposition of acidic compounds.

Components: Deposition of SO_2/hectare;
Deposition of NO_2/hectare;
Deposition of NH_3/hectare.

(D) ECOSYSTEM TOXIFICATION INDICATOR

Definition: The emission of hazardous toxic substances.

Measure: Toxic Substances equivalent (TSeq) = total emission of priority substances and radioactive substances.

Policy Direction: Reduction of the quantity of each one of the hazardous substances released by a given territory to a level where the risk posed by each substance is negligible.

Components: Emitted quantities of cadmium, polyaromatic hydrocarbons, mercury, dioxin, epoxyethane, fluorides and copper. Emitted radioactive substances.

Composition: The indicator is the sum of the emitted quantities of priority and radioactive substances, weighted according to their toxicity and their residence time in the environment.

(E) SUSTAINABLE MOBILITY INDICATOR

Definition: The use of environment-friendly means of transport, especially for commuting and fundamental needs.

Measure: Sustainable Mobility equivalent (SMeq) = total number of passenger kilometres by environment-friendly means (foot, bicycle and public transport) per inhabitant and per year. If passenger kilometres cannot be estimated, trips could also be used.

Policy Direction: Reduction of the unnecessary use of motor vehicles, improvement of mobility patterns and the modal split and enhancement of accessibility.

Subindicators: Sustainable Mobility for Commuting (work and study) Indicator (SMCeq). Relevant subindicators may be developed according to other trip purposes (business, freight, tourism, leisure) and in elation to transport means. A "Sustainable Mobility for Children" Indicator could be most interesting.

Components: Total number of trips (and their length) by each transport means with special focus on the most sustainable transport means (by foot, bicycle and public transport).

Remarks: *The length of pedestrian areas and cycle paths over time is also a useful indication of actions to promote less unsustainable mobility.*

(F) WASTE MANAGEMENT INDICATOR

Definition: The total volume of solid waste finally disposed of.

Measure: Waste disposal equivalent (WDeq) expressed in tonnes per inhabitant and per year.

Policy Direction: Primary aim: Waste minimisation, i.e. prevention and avoidance, followed by reuse and recycling; drastic reduction of waste for final disposal.

Subindicators: Waste disposed of by incineration or in controlled landfills and in uncontrolled landfills; waste reused or recycled.

Components: Building and demolition waste;
industrial waste;

domestic waste;
commercial and service waste.

Composition: The Disposal Indicator is the sum of all waste streams ending up at the same landfill sites.

***Remarks*:** *The indicator considers only solid waste. Liquid waste can be distinguished by degree of treatment. Possible overlapping with ecosystem toxification should be considered.*

(G) ENERGY CONSUMPTION INDICATOR

Definition: The total amount of consumed energy.

Measure: Energy Consumption equivalent (ECeq) expressed in ToE (tonnes of oil equivalent) per inhabitant per year.

Policy Direction: Reduction of energy consumption through improved energy efficiency techniques and patterns. Decrease of energy dependency and energy originating from polluting sources.

Subindicators: Consumed energy according to the origin (coal, oil, natural gas, nuclear energy, wind, hydro, solar and other renewable sources).

Components: Energy for consumption by the:
Residential and tertiary sector;
industrial sector;
transport.

Composition: The Energy Consumption Indicator is the total amount of energy consumed.

(H) WATER CONSUMPTION INDICATOR

Definition: The total amount of water withdrawal.

Measure: Water Consumption equivalent (WCeq) expressed in m^3 per inhabitant per year.

Policy Direction: Reduction of water consumption through improved conservation patterns and techniques; reuse and recycling.

Components: Water for:
- domestic purposes;
- industrial use;
- building sector;
- retail services;
- public spaces.

Composition: The Water Consumption Indicator is the total amount of water extracted. Water from recycling, used mainly for maintenance of public and green spaces, is to be subtracted.

Remarks: *Quantity of water lost in mains should be estimated (5-40 per cent of the total amount). Water management represents the highest environmental expenditure in OECD countries and minimisation of water losses is essential.*

(I) NUISANCE INDICATOR

Definition: Nuisances created by noise, odour or visual pollution.

Measure: Nuisance equivalent (Neq) = percentage of the

population affected by noise (e.g. from air, road and rail traffic and industry), odour (e.g. caused by traffic, industry and services), or visual pollution (e.g. by derelict land and social degradation).

Policy Direction: Improvement of local environments by reduction of odour, noise or visual pollution.

Subindicator: It is essential to have a subindicator for the percentage of the population adversely affected by one of the above factors.

Components: Percentage of the population affected by:
noise;
odour;
visual pollution (e. g. graffiti).

Composition: The total number of people affected is the sum of the people affected by any one of these sources, after correction is made to avoid overlaps within the area of nuisances, as simultaneous exposure to different types of nuisance may occur.

(J) SOCIAL INCLUSION AND EMPLOYMENT INDICATOR

Definition: The degree of social sustainability of a city.

Measure: Social Inclusion and Employment equivalent (SIEeq) expressed by the percentage of people not affected by poverty, unemployment, and lack of access to education, training and leisure.

Policy Direction: Access to employment, income, education, training and leisure for all citizens.

Subindicators: It is essential to have a subindicator for the

percentage of the population seriously affected by lack of each one of the above components. It is also essential to have subindicators for vulnerable groups of population (youth, women, the handicapped and long-term unemployed).

Components: Percentage of the population affected by poverty, unemployment and lack of access to education, training and leisure.

Composition: The indicator can be composed after substraction of the total percentage of people affected by social exclusion, sum of the percentages of people affected by poverty, unemployment and lack of access to education, training and leisure A corrective factor has to adjust the percentage of the population affected by more than one factor.

(K) HOUSING QUALITY INDICATOR

Definition: The degree to which citizens enjoy good housing conditions.

Measure: Housing Quality equivalent (HQeq) = percentage of people enjoying adequate housing environments.

Policy Direction: Offering all inhabitants acceptable housing conditions.

Subindicator: The percentage of homeless and of those who might become homeless.

Components: Percentage of the homeless population; percentage of the population threatened by loss of housing; percentage of the population in poor housing conditions.

Composition: The indicator can be composed after substraction of the total percentage of people affected by homelessness and inadequate housing conditions.

Remarks: *The number of registered demands for good housing is an indication of the actual needs and may serve as an alternative indicator.*

(L) PUBLIC SAFETY INDICATOR

Definition: The degree to which people enjoy public safety.

Measure: Public Safety equivalent (PSeq) is the total percentage of the population enjoying public safety.

Policy Direction: Fostering public safety for all citizens. Decrease in, ideally elimination of, attacks, incidents and accidents.

Subindicator: It is essential to have sub-indicators for the total percentage of irreversible long-term injuries and for vulnerable groups of population (youth, women, the handicapped and long-term unemployed).

Components: Percentage of people attacked. Percentage of people affected by road accidents.

Composition: The indicator can be composed after substraction of the total percentage of citizens affected by lack of safety.

(M) ECONOMIC SUSTAINABILITY INDICATOR

Definition: The viability of the territorial economy.

Measure: Economic Sustainability equivalent (ESeq) = Territorial income (TI) – Territorial fiscal deficit (TFD) – Environmental expenditure (EE) – Pollution damage (PD) / inhabitant per year.

Policy Direction: Increase of economic sustainability with increase of territorial income and budget and reduction of pollution damage.

Components: Territorial income= Total individual incomes;
Territorial fiscal deficit = Territorial budget – taxes;
Environmental expenditure (for water, waste collection, sewage, transport);
Pollution damage (air, water and land).

Composition: ESeq = [TI – TFD – EE – PD]/population.

Remarks: *The territorial environmental expenditure per inhabitant per year is a good indicator of the local financial capacity and the concern about the environment.*

(N) GREEN, PUBLIC AND CULTURAL SPACE INDICATOR

Definition: The improvements needed for green, public and cultural / heritage spaces.

Measure: Green, Public and Cultural Space equivalent (GPSeq) = percentage of the green or/and public or/and cultural spaces in need of improvement.

Policy Direction: Enhancement of green, public and cultural spaces, forging cultural identity and belonging.

Subindicators: It is important for local quality of life to have the surface of green spaces per inhabitant, the surface of cultural/heritage spaces per inhabitant and the surface of public spaces per inhabitant. They are suggested as alternative indicators.

Components: Percentage of green spaces needing improvement/total surface of green space; Percentage of public spaces in need of improvement/total surface of public space; Percentage of cultural/heritage spaces in need of improvement/total surface of cultural/heritage space.

Composition: The percentage of green, public and cultural spaces to be improved is the sum of the three percentages.

(O) CITIZEN PARTICIPATION INDICATOR

Definition: The degree to which the local population participates in the decision-making and improvement of the local quality of life.

Measure: Citizen Participation equivalent (CPeq) = total percentage of the population participating in local elections or as active members in local associations.

Policy Direction: Co-governing cities in partnership with all societal actors.

Components: Percentage of people participating in local elections; Percentage of people being active members of environmental, public health and cultural associations.

Composition: The total percentage of the population active in local elections and participating in associative life.

Remark: *It is important when assessing the participation in local elections to know if participation in the elections is obligatory or not. In the EU, voting is compulsory in Belgium, Greece and Luxembourg.*

(P) UNIQUE SUSTAINABILITY INDICATOR

Definition: Indicator to be defined case by case according to the uniqueness of a city (e. g. unique climatic and local conditions) or the planning of a unique once-in-a-lifetime event (e.g. Olympic Games, Expos...). This indicator should represent the degree to which unique factors or events may lead to sustainability.

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