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Renewable Energy and the City

Introduced by Peter Droege, Member of the Chairmen Committee of the World Council for Renewable Energy (WCRE)

The large-scale and inevitable shift away from the fossil- and nuclear-powered towards a renewable energy based economic model will create a new and hopeful era for the quality of life in cities. This document discusses these by looking at the impacts on and of one of the greatest accomplishments of 20th century culture: global urbanization, modern cities and urban life. Technological implications, urban form impact, policy dimensions, institutional ramifications, and cultural issues all are challenges confronting decision makers worldwide at local, regional and global levels.

Summary: Renewable Energy for Sustainable City Programs

We live in a rapidly urbanizing world, to a large extent due to the overwhelming role of fossil fuel, its economic influence and technological power. Because of this fossil fuel dependence, cities and city regions are central and fertile settings for effective energy policy, programs and projects. Cities are not only powerful potential markets for the introduction of renewable energy technologies but also the national and regional seats of political power, and the core settings of cultural discourse and technological innovation. They form the very frameworks for development: local government, planning structures and the powerful civic organizations that are so important in many cultural contexts.

Cities face extraordinary opportunities in their gradual but inexorable change from the risky and costly systems of fossil power reticulation to a world of sustainable, affordable, diverse and ultimately ubiquitous energy management. The hope is one of growing choice in scales of operation and levels of technological sophistication. Fundamental changes in urban power regimes that are in keeping with sustainable development practices promise to revitalize regional and rural development, and boost urban business and technological innovation. By pursuing energy reform strategies in keeping with globally sustainable greenhouse gas emission

levels, local urban leaders can also act globally by helping achieve greater equity and justice in international development. There is much to be done in this area, and our cities already exist on borrowed time, awaiting much-needed technological reform.

The World Council for Renewable Energy presents this position and background paper to support one of its three 2002 recommendations to Johannesburg:
"The WCRE calls for a new age in local governments, local community agendas, and proposes a city- and metropolitan wide transformation of planning agendas. To accelerate progress achieved so far and reap important benefits in quality of life improvements, civic security, human health, economic development and technological innovation it is important to supplement carbon emission reduction goals by introducing renewable energy technology introduction targets, programs and projects, in addition to efficiency and conservation measures."

Background

The age of industrialization and its great aspirations, the global scheme of world trade and its achievements, indeed, the very promise of universal progress - all have been powerfully boosted by the modern use of fossil fuels. A brilliant set of utopian visions - scientific, social, political and economic - has resulted from this, and, indeed, great achievements were made for a world-wide minority. Yet the dark sides of the fossil fuel economy have been as overwhelming as can be expected from any Faustian arrangement of historical proportions: social development inequities, urbanization crises, global military instability, local and regional environmental disasters, global climate change and associated costs and risks.

The rapid expansion of cities throughout the late 19th and the 20th centuries was a direct outcome of the fossil fuel economy. Today, the growth and operation of cities and urbanized areas absorbs roughly three-quarters of the world's fossil fuel production. This is a staggering amount given that fossil fuels supply 85% of total global commercial energy use - and their use is increasing at a rapid rate. Economic regions, nations and cities worldwide will soon be under great pressure to find alternative sources.

Because of the fatal triad of carbon emissions induced climate change, fossil fuel depletion and mounting environmental damage due to the use of oil and coal cities will have to be powered differently. The use of renewable and distributed micro-power systems is already on the rise today but the current speed of change is much too low to meet global goals in time to avert serious crises. Besides the introduction of solar and other renewable energy technologies cities will also have to be re-engineered in terms of their transport and land-use systems, their facility and urban design principles and the very use patterns they engender.

Cities, towns and other urban communities are increasingly regarded as settings for coordinated policy implementation efforts aimed at global renewable energy technology introduction and carbon emissions reduction programs. However, substantial organizational and cultural barriers militate against immediate, wider change. Among these loom large the subsidiary regard in which cities are held in the traditional hierarchical frames of international arrangements that deal with global issues. Another challenge is the short planning horizons and political uncertainties that prevail on the local level. In terms of policy development, measurement techniques and planning reality an extraordinary, even paradoxical gulf exists between the global nature of greenhouse gas impacts and fuel depletion prospects, and the local reality that represents both final impact and original source of globally experienced changes.

The Urban Setting

Two major dangers confront the world's cities and city regions well within this coming generation, threatening the global urban system as a whole: fossil fuel depletion and man-made climate change. There is little disagreement in the current literature that if these are not swiftly and effectively met their impacts will deeply affect all industrial, world and mega-city systems and hit hard the fast-growing, major urban agglomerations of the developing world, along with their economies. Still, while there is little disagreement over this matter, there is also surprisingly little discussion of it in the planning and urban development community.

Sustainability: Challenges of Discourse

The discourse on the urban environmental condition has difficulties embracing the underlying fundamental fossil fuel dependency of contemporary life. This is generally taken for granted as an 'ambient given', and disregarded as an externality such as the presence of air, or the reign of the market.. Much of the relevant literature on discusses urban sustainability in terms of a diverse set of disparate phenomena: air pollution, soil pollution, water contamination, noise, crowding issues and biodiversity. Even Ann Whiston Spirn's classic text on urban sustainability, The Granite Garden, has trouble grasping the chains of fuel dependency. Her final chapter, on the 'Urban Ecosystem', deals in part with the difficulties architects and other urban professionals have in becoming professionally knowledgeable about or even aware of environmental impacts of their work. Here she decried the absence of a sense of 'connectedness', or a systematic understanding of urban ecological dimension, yet shied away from drawing out a theory of impact hierarchies, eco-damage chains and hence the root causes of urban environmental crises. In the end, she called the 'complexity of the urban ecosystem _ bewildering' (Spirn, 1984, p. 239).

Urban sustainability discourse and concomitant urban practice very much operate in a conceptually nested sense today. Local or isolated sustainability action rests comfortably within the larger, massively unsustainable urban reality, shielding many proponents and actors from discomfort. Since the 1970s and 1980s the prospects of fuel depletion have only slowly and indirectly begun to enter general urban planning discourse and development frameworks, largely as energy efficiency and conservation issues. In part due to the stark disciplinary divisions involved, relatively few texts dared to cross boundaries and make clear observations on the historical 'fossilist' condition of cities in the late 19th and throughout the 20th century. One example among these is David Morris' 1982 manifesto, 'Self-reliant Cities'.

In terms of climate change communities have only during the 1990s begun to recognize that all greenhouse gas (GHG) emissions are directly or indirectly generated locally, through production or consumption. This has provided a boost to the role of local places in the debate since GHGs can be allocated and made understood locally and hence form the basis for specific policies, programs, plans and projects. Despite the significant hurdles energy issues have begun to take center stage in the reality of an increasing number of cities and towns around the world. Some pioneering communities have embraced locally, nationally and regionally supported programs, and many have come to realise that the agenda of action is enormous due to the central significance of cities in national economies. As socially, politically, economically and culturally significant settings cities face increasingly intense local action, in their communities' search for improvement of the local environment, and in a rising movement to combat global warming well before that time. In a growing number of cities business, industry, science, technology and governmental groups are being challenged to respond and deliver solutions. It is

here where a growing number of new urban action and development initiatives are being readied to link local agendas and national frameworks to international challenges and resources.

Major Urban Energy Issues

Due to their structural fossil fuel reliance, most current capital outlays in new buildings, infrastructure and other urban facilities are virtually condemned to early obsolescence, since any urban area or systems element that is inherently based on fossil fuel will be rendered dysfunctional within only a few decades. All basic urban communication infrastructures, both traditional - such as roads, rail, air and sea ports - and advanced - such as telecommunications - have been nurtured in a world of near-absolute fossil fuel dependency. Indeed, the internet, a vital global and largely urban network of networks, relies largely on fossil-fuel operated hardware, conduit-based webs, and wireless communication systems. If global communications are to be sustained beyond the middle of this century, they must be powered by distributed, ubiquitous and redundant renewable power supply systems.

More significantly, the form of energy dependence has triggered a long chain of other environmental damages, a fact recognised in the 'energy circuit' approach towards urban ecological sustainability measurements - an important policy feature of the late fossil fuel age, addressing energy efficiency and conservation.

Fossil Fuel Depletion and Cities: Mechanisms of Denial

Urban dwellers are generally thought of as risk-averse, even timid creatures. Yet urban civilization as a whole is high-risk business, defiantly accelerating business as usual in the face of impending doom.

The single most important means of maintaining a high-risk societal posture is collective denial. Several denial mechanisms suppress the urge to take up action. They are based on a belief in salvation by technological innovations yet to come; on a relegation of problems and their resolution to others, most frequently the developing world or to future generations; and on the localization of global problems. This last mechanism creates delusions of meaningful action that can be summarized under the motto 'think globally, act locally', such as local recycling campaigns, greening of streetscapes, or the changing of light bulbs. These are all important measures but globally represent a drop in the proverbial bucketfuls required to douse the brushfires of unsustainable conditions.

All modern cities have mushroomed on their rich fossil nutrient supply, and especially voracious and dependent are the largest, most rapidly growing urban agglomerations. The very logic of their global rise and regional spread is founded on the availability of powerful, centralized and inexpensive fuels: coal, petroleum and natural gas - yielding fossil urban structures and patterns based on fossil transport, fossil construction machinery and fossil industrial systems and manufacturing processes. Intensive economies and labor markets clustered around the centralized and networked city regions, anchored by heavy investments in infrastructure: power, transport and communications. This has boosted the primacy of cities over - and ultimately detachment from - agrarian hinterlands.

The new cities of the 19th and 20th centuries - and the very cultures they engendered - were a product of the rising combustion economy. London exploded with coal-fired power, and Lewis Mumford called the phenomenal urban transformations taking place in industrializing countries

between 1820 and 1900 'Coketown', or 'Paleotechnic Paradise'. Pre- and post-World War I modern city innovations in the Soviet Union, the United States, Europe and across Asia alike were jump-started by the electrifying jolt of the new energy technologies. Today, a rising car dependency in most cities combined with the rise of the electrified ocean of suburban households under spreading continental power grids delivers the broadly accelerating decline in what we today regard as urban sustainability.

It is appropriate to refer to contemporary urban constructs as fossil cities, today more so than ever before. The logic of global urbanization becomes transparent when considering the ready availability of inexpensive fossil power for all urban infrastructures: building construction, lighting, air conditioning, computing, telecommunications and massive freight and human transport systems on surface, sea and air. These new bundles of infrastructure at once link cities globally and drain their regions. As a consequence globalized urban systems are inherently more vulnerable to the inexorable decline of global fossil fuel supplies than those that rely more on their local and regional human and land resources. Yet prevalent international aid ideas still nurture the credo of developing countries and their sprawling cities moving through the bygone stages of fossil electrification based on the by now antiquated power plants and continental grid schemes that the industrial world has moved through in the past 150 years.

There is a powerful culture of local environmental action, nurtured over more than a generation of broadly publicized global environmental threats. Yet local action that is not squarely focused on tangible outcomes and measurable targets that are both locally and globally meaningful is tangibly only useful in maintaining community sanity. The risk is that it can produce a sense of security brought about the satisfaction that is derived from in small personal advancements.

While a few local urban systems may seem relatively safe from a terminal fossil fuel shock through their reliance on hydro-electric, nuclear or bio-energetic power, no currently utilized alternative energy source alone can keep operational the vast majority of cities. Also, the interconnectedness of the global system makes it impossible to seriously contemplate the survivability of regional pockets of self-sufficiency. The only viable option to secure the continuity of urban civilization in this century is a system-wide turn to a broad portfolio of renewable energy sources based on an overwhelming availability of solar, wind, wave, hydrogen based and other renewable forms of energy. The alternative to this path lies in a massive military build-up as its is already being prepared by some leading economies. A global and open escalation of the simmering war over regional fossil resources, currently contained largely in local and regional conflicts is inevitable without a broad and world-wide introduction of renewable energy sources. Cities and city dwellers would bear the brunt of such conflicts. However, the impending evaporation of fossil fuels is not the only threat to the survivability of the modern global urban system.

The Fossil Machine Age and the Form of the Built Environment

As a cultural, economical and technological system the form of the built environment is fundamentally determined by the nature of ist fuel supply. Fossil fuel powered industrial transformations that underpinned broad urban structure change were celebrated by the leaders of the great Modern design movements, from the beginning of the 20th century (Droege, 2000). Italian Futurism, Constructivism in the early Soviet Union, De Stijl in the Netherlands, the Bauhaus in Germany, the declarations of the International Modern Architecture Congresses (CIAM - Les Congrès Internationaux de l'Architecture Moderne, 1928-1956) and the International Style that spread from the United States throughout the industrialized world. The

fossil machine age is an outgrowth of earlier stages of the Industrial Revolution when water power was a main driver of textile mill operations. Boosted by the industrial application of coal and electricity it gave rise to Frederick Winslow Taylor's (1856-1915) and Henry Ford's (1863-1947) ideas about the mechanization of manufacturing (Gideon, 1948). In their wake the increasingly urban and automated global production-consumption systems of the advanced industrial age boosted global power use at an exponential rate. But industrialization as powered by electricity, coal-fired steam engines and petroleum combustion motors also meant the rapid growth of cities, driving the search for innovation in urban form. As far as new urban traditions are concerned, a rash of utopian premonitions spread as a result, as revolutionary as the technological changes they were triggered by. Peter Kropotkin's (1842-1921) and other anarcho-syndicalist influences on ideas about ideal communities were a direct outgrowth of this era. And so were Sir Ebenezer Howard's (1850-1928) concepts and the rise of the Garden City movement. The genesis of the Regional Plan Association of New York and its seminal plan of 1929 were of this lineage, and so was Frank Lloyd Wright's (1869-1959) Broadacre City (first described in his 1932 work The Disappearing City). Ludwig Hilbersheimer's (1885-1967) mass housing concepts and General Motors' 'Futurama' pavilion at the 1933 'Century of Progress' World Exposition in Chicago, boldly anticipated the gloriously car friendly cities to come. Brasilia, Canberra and all of the British New Towns are fossil fantasies come true. And so are the modern suburbs. Early ex-urban subdivisions sprung up as aspiring new communities along the tracks of electric tramways, while soon thereafter the combustion-engine driven vehicle created a new urban reality altogether: the new car suburbs expanding along motorways. Mass-media driven promotion of a new fossil-fuel based lifestyle spawned the automobile and petrochemical product craving industrial civilization after World War Two. This new vision became endemic, even more so than the heroic visions of humanity's redemption by machine had promised before the war, and expressed in a new set of urban form aspirations. Many of these early premonitions proved to be very much practical concepts: already very early in the 20th century the great electric inventions of the telephone and the elevator opened the door to skyscraper cities, first as utopian visions and soon as pervasive reality. Modern carbon culture arrived in stylised landmarks, with the epitomizing work of migrant Bauhaus architects such as Walter Gropius and Mies van der Rohe. Le Corbusier's ideas about the radical modernization of cities are by many regarded the most influential of these, brazenly calling for the razing of pre-fossil cities, as exemplified by his tabula rasa concepts: Plan Voisin, La Ville Radieuse, a famous lone pilot project for a mass housing block, Unite d'Habitation and in some realized urban projects such as in the Alsatian town of St. Dié. His plan for Chandigarh, the joint capital of the Punjab and Haryana established in 1953, looms large in the fossil city hall of fame. The introduction of this simple yet revolutionary doctrine in cities in the United States, United Kingdom and countries around the world combined the power of the new with a good dose of basic speculative opportunism. It brought urban destruction and blight through wholesale urban renewal projects in what was identified as inner city slum areas: the neighborhoods of the poor and disenfranchised and the pre-fossil relics they inhabited.

The post-war years in Europe saw powerful expansion plans hatched among the spreading webs of electrification that crisscrossed former farmlands. The Greater London strategy, the satellite city concepts and the Stockholm and Copenhagen finger plans gave bold plan form to a wider, world-wide turn to life in cities, driven by structural shifts and opportunities brought about by the rise of the fossil fuel economy and its promises.
Yet the gleaming new vision of renewed and more orderly, healthier and socially more equitable cities did not escape the Faustian energy reality of advanced industrialization. With the burning of fossil fuel arrived sulfur dioxide, nitrous oxide and a host of other toxic gases as well as carcinogenic airborne combustion particles, creating the smog and air pollution crises of the

1960s and 1970s. Today, with the exception of the greenhouse gases themselves, these have partially conquered as hazards in the industrialized world but still plague most large cities, particularly those of the developing world. Calls for more concentrated and transit-oriented forms of urban development (Calthorpe, 1993) were signs of this declining stage of the fossil-fuel economy when savings in energy conservation and fuel efficiency were identified as the cheapest, fastest and most immediately useful means to reduce emissions. Denser cities were shown to be more fuel-efficient (Newman and Kenworthy, 1987). Car dependent, low-density urban structures incapable of sustaining public transport came to be understood as a major hindrance to achieving sustainable urban life. It is clear that in the long run, however, efficiency and conservation measures are not sufficient to halt the powerful world-wide rise in emissions. Massive substitutions of conventional energy technologies will be needed, such as those powering the making, operation, maintenance and upkeep of military machinery, and systems of passenger and freight conveyance with renewable systems of energy supply and use. In order for these new technologies to be in place in time to be of significant use they need to be widely introduced now. In this sense, transit-oriented development and recent attempts at recreating pre-industrial urban patterns such as 'neo-traditional design' and other approaches of 'new urbanism' are important interim measures - but fossil-fuel derived urban form phenomena in themselves nonetheless. The nature and form of buildings, too, were deeply affected by the development and spread of the revolutionary new fuels and the industrialized manufacturing processes they engendered. As a consequence architecture changed radically in the new fossil age, logically breaking with all earlier traditions. The Modern Movement provided aesthetic and ethical refinement to mass applications in electricity, ubiquitous machinery, air conditioning, industrial steel products, advancing glass technology, mass produced curtain walls, prefabricated building systems and a number of other highly energy-intensive technologies. The new thinking about buildings, highlighted by the International Style, applied to aesthetically refined, ornament-free, skeletal, industrialized and largely corporate structures. It became the new global aesthetic of the possible as the advanced fossil age dawned in cities around the world. Buildings became disconnected from their climatic and cultural context due to the end of local resource dependency. An interest in vernacular form and regionalism emerged, as a counter-reaction and an attempt to recapture the local language of form: the regional building traditions that had been lost in industrializing change. This movement remained a stylistic artifice since it failed to address the fundamental dynamics of design and development under conditions of unsustainable energy resource practice. In a hopeful vision, the zero-emissions house that functions without fossil energy supply, once the exclusive domain of eccentrics and university research laboratories, would become a living reality for a majority of dwellers. Yet to be addressed, however, remains the question of how to reduce the large amount of energy that is embodied in the building materials themselves, the services contributing to their making, and the energy implications of the very form and design of neighbourhoods and cities. Indeed, the energy household of cities is made up by more than buildings and the infrastructures that service these. It is the sum total of all goods and services measurably consumed in a given location.

Cultural Shifts Towards Sustainable Urban Energy Development
Globalization, Urban and Regional Development and Energy Linkages

Modern globalization, as a complex set of global economic, communications and cultural changes (Sassen, 1991), is very much driven by the profoundly fossil energy mode the world operates in. Global supply lines secure oil, coal and natural gas from the limited number of highly productive fields in production. The mining, shipping and processing of the raw material and its world-wide distribution has necessitated a vast network of logistics, military management,

security arrangements and diplomatic agendas - as well as specialized economic systems. Many armed conflicts are also resource wars. The specter of violent global strife over the control of regional and global fossil fuel supplies rises in the short and medium term (Scheer, 1999).

The great 19th and 20th century industrialization and modernization drives accompanied the rise of a globally dominant fossil culture with its rules, values and powerful images, structuring collective and individual desire. Their unique behavioral patterns are generated by the characteristics of supply and demand in a global fossil fuel fired economy. Seen in this light, the global media, information systems and telecommunications networks play an ancillary role in the processes of contemporary globalization. The technologies of globalization are the at once centralized and globally active power generation and petrochemical resource systems tethered to geographically limited and hence geo-strategically critical energy resource and mineral deposits. International trade rules and interpretations of national security are based on and very much support this global regime.

The result is a single terrestrial system, rapidly growing and fed by tenuous yet distant, even global supply lines. As a consequence, an increasing number of local urban areas is surrounded by formerly productive but now either suburbanized or relatively impoverished, disconnected rural and semi-rural regions. These new 'globalization hinterlands' are the former supply regions of pre-fossil villages and towns, now increasingly defunct, with their population streaming to the rising, brightly lit and comfortably powered, globally networked urban centers.

The deployment of renewable energy technologies has a potential to help bring about a time of differentiated globalization, marked by a distinction between largely local supplies of food and elementary goods on the one hand and the global trade in services on the other. Postglobalism as engendered by non-fossil production modes would be characterized by a rise of regional economies in support of urban centers, based on regional resources such as productive land for food, biomass and wind energy production. New ways of re-knitting central cities with their regional economies and related spatial structures are already being pursued by a number of communities. These are based on age-old principles of rural urban support economies, boosting the primary sectors of agriculture and forestry: cities around the world are beginning to make concrete links between their renewable energy needs and potential regional resources capable of meeting that need. This movement is also beginning to help spawn new indigenous manufacturing and advanced industry sectors in renewable energy production, supply and services.

On the industrial side current initiatives fall into two categories; that of new technology development on one side and on market uptake of applications on the other. Technology push and supply from the 1970's through the 1990's were limited to a number of limited-scale industry efforts and pockets of largely government-sponsored research and development projects. This history is often marked by a mismatch with market demand, especially given the powerful subsidies granted to the fossil energy sector. However, the international and domestic policy and pricing environment of the early 2000s is changing fast, heralding massive urban technological and practice changes and a natural integration of technology development and markets.

Energy, Cities and Technological Innovation

Cities face the new challenges largely without national guidance and some seek to go beyond individual technology applications, single structures or limited urban areas. They hope to trans-

late international and national agreements onto the local level, despite the institutional constraints of the inherited sectoral systems. Increasingly, urban leaders seek to grapple with the issue of technological innovation, absolute and globally equitable emissions targets, the prospect of urban carbon trading and the pursuit of full integration with mainstream urban management systems.

The most hopeful visions describe entire cities as net renewable energy producers. This idea requires a rethinking of urban-regional alliances as well an adoption of increasingly firm industry promotion practices. The Australian city of Melbourne, as an example, is in the process of investing in renewable energy producers with the dual aim to reduce its fossil fuel dependency and to promote the development of more advanced industries that one day will be capable of competing nationally as well as internationally.

As motivating force subsidies and selective pricing, in the absence of a true deregulation of energy markets, can provide a lasting boon for technological innovation. In a technologically advanced renewable economy energy supplies no longer exclusively depend on large, centralized supply models but can unfold in a more diverse and differentiated manner, in keeping with the contemporary culture of convergence. Indeed, emerging conditions are characterized by a blurring of conventional distinctions between production and consumption. Traditional appliance and facility users can become net energy generators, for instance through solar systems or zero-emission, renewable-source based hydrogen fuel cells in vehicles, capable of powering homes and external machinery.

Systems convergence dynamics point to a merger of information technology, telecommunications and energy systems. While some electric utilities already lease their grids for information transmission purposes, emerging technology goes much further: future energy systems are ubiquitous and pervasive. Operating on the level of individual units, be they consumer appliances, households, neighborhoods or even city-regions, the long-range energy management paradigm is grid-free, self-sufficient and renewable.

Ubiquitous energy management is a hopeful notion that in a renewable-energy based economy a myriad of small and medium-scale providers of energy services could replace the system of large-scale centralized ones. In an urban system this could operate both at the high end described, but also at low levels of technological sophistication. Possible high technology directions contain features derived from information technology and telecommunications mergers, or the blending of these new technologies with energy production and consumption modes residing everywhere, in applications from personal apparel and equipment to cars and facilities. At the lower end of the scale, in a distributed yet low-cost and low-maintenance environment, small hydro-power and solar systems are seen to be capable of leveraging access to global information network for small remote communities in developing nations.

Another technological dimension of the impending energy revolution is the role the internet plays in the energy sustainability of cities. The 1992 United Nations Conference on Environment and Development held in Rio de Janeiro has firmly associated the term sustainability with a global action agenda, connoting international processes of working towards sustainability aims, especially in an urban context. The tradition of sister city arrangements was a rudimentary beginning of inter-urban networks in particular, while activist non-governmental organizations such as Greenpeace pioneered work in global networks as means for local action, giving rise to an age of 'think locally, act globally'.

A number of international networks operate today in the area of energy and the 'sustainability' of cities, and many explore the best manner in which the nature of the internet and the world wide web can be applied to productive ends. It is good to remember that the internet itself, a vital global infrastructure, is entirely dependent on fossil fuel. It may call for a strategic action plan to base it on renewable and sustainable energy sources, through the introduction of suitably distributed, even ubiquitous power supply systems.

Finally, there is a number of ways in which the technologically sophisticated management of environmental information such as local, community or point-of-emission accounting data is crucial in the making of policy. Integration of currently available information, modes of visualization and analysis (Droege, 1997), the massive networking of personal computers - these are all technologies and techniques advancing at national or international levels but remain woefully unavailable or inadequate locally.

Climate Stability in Development

Local policy environments during the late 20th century were marked by a lack of commitment to planned urban energy practice, due to the investment in existing centralized power arrangements. Another reason lies in the pervasive process management culture in many local administrative structures without clear accountabilities and in the absence of local levers, incentives and practical means of allocating or influencing emissions. As global agreements are bound to become firmer under mounting pressures to resolve the greenhouse challenge, and as nations and trading units such as the European Union begin to establish clearer greenhouse, energy and environment frameworks, the pressure will mount to arrive at unprecedented arrangements in urban emissions and energy practice.

In a world in which cities emerge as global emissions performers, distributed energy managers and even credit trading entities, a science and engineering practice emerges that interprets cities and city regions as power systems, resource flow units and point-of-emission entities. The most visible of current community planning models are based on relative improvement targets and selective means of accounting for greenhouse gas (GHG) emissions.

A number of place-based emissions allocation techniques and action approaches are currently in use. They include the United States Environmental Protection Agency's support that is made available to states in compiling GHG inventories, in producing action plans and in staging demonstration projects. They also include the pragmatic approximation system developed by Ralph Torrie and others for the Cities for Climate Protection (CCP) program operated by the International Council for Local Environmental Initiatives (ICLEI). This system does not account for all emissions, yet it is in experimental use in four hundred communities world-wide. And there is the system based on the behavior of large geographical units - one degree of longitude by one degree of latitude - developed by the Association of American Geographers in a program called Global Change in Local Places (Kates et al, 1998). Other systems are in development and being promoted as well. There is the potential to apply aspects of the Advanced Local Energy Planning approach developed under the International Energy Agency's (IEA) Building and Community Systems program, or the physical model of the economy developed by the Australian Commonwealth Science, Industry and Research Organization. Another ambitious model is a total-flow, end-consumption and value-based accounting system (Lenzen, 1997). It also aims to compare, evaluate and advance a range of methods.

While most GHG emission sources and mitigation efforts are inherently local, their effects and

most easy modes of measurement are global. However, the identification of globally diffused GHG levels carries little practical local meaning. In order for cities to become active and integral participants of any global action program, they need to opt for one or the other GHG accounting or allocation method that reliably links local practice to global aims. A persuasive argument holds that only systems directly applicable to reliably measuring contributions to climate stability are valid, and more specifically approaches that embrace a 3.3 ton of a 1990 carbon dioxide-equivalent target by 2050 (Byrne et al, 1998). This target is based on a fundamental equity calculations: that on a per-capita basis each person has only an annual 3.3 ton emissions 'allowance', if oceans and forests are to be allowed to neutralise excessive carbon emissions. In contrast, Australia and the United States approach 30 tons per annum per person, while most developing countries, including India and Cina, lie well below this level.

An ideal method has not yet been arrived at, and in pursuing it, cities and their supporters need to apply certain performance criteria. To be informative, universally acceptable and suitable as a basis for coordinated climate stable practice such model would need to be comprehensive, precise and accurate. To be useful it has be pragmatic, affordable and easily replicable across a large number of communities or geographic units. Another challenge lies in avoiding a new information poverty barrier. It could develop were local carbon trading to be introduced as based on highly sophisticated and expensive forms of data gathering - poorer nations have less capability to cope with the technical challenges involved in measuring current emissions performance, let alone reliably monitor its progress over time.

The single most widely promoted method is deployed by ICLEI's CCP program. It is to be introduced by local governments as the first of CCP's five steps to better GHG performance: namely the arrival at an energy and emissions inventory, forecast, reduction target, target achievement plan and active implementation program to achieve measurable GHG reductions. At these relatively early days of the CCP program measurable success in reaching significant implementation goals has been elusive, while the other milestones have been reached to highly varying degrees. It is possible that in future rounds of development, in association with other methods and given a better understanding of the key barriers to success a break-through in implementation can be achieved. The very imperfections of the method and its omission of significant emission aspects makes the CCP system attractive in practical terms but scientifically not unambiguous to use in globally credible accounting contexts, or even for local improvement monitoring over time, when absolute performance is to be measured.

There are a number of obstacles to a transformed urban energy practice, although none of them are insurmountable in principle. The most formidable is the fact that local governance structures are not usually geared to end-state or long-range planning, and hence the adoption of any form of long-term accountings. The effective allocation of incentives and accountabilities is difficult, too. Notwithstanding the efforts described above there is the persistent question of how to convincingly disentangle resource flows in a local government area not only for carbon accounting but also for scenario modelling purposes, and how to identify agency accountabilities for savings and reduction.

The very consideration of broad energy and greenhouse action programs opens up new dimensions for government. It provides a new development perspective and can drive regional realignments, the formation of state initiatives and industrial alliances. It can mean a new sense of empowerment and the opportunity for economic strengthening, as well as competitive advantages of a more promotional nature.

Whatever the difficulties, the benefits are promising. Governments have begun to discover that energy responses can be scaled well to local development conditions and growth options. In newly industrializing countries with interest in maintaining considerable levels of autonomy such as China and India there is a good fit with local traditions and climatic and economic conditions. Local industry could get stimulated while environmental agendas are promised to find practical reinforcement. Comprehensive renewable energy practice on the local level directly reinforces broad quality of life aims, as well as healthy water, food and bio-diversity practice.

Besides meeting the possibly looming aim of responsibility devolution in pursuit of global greenhouse objectives, another government reform agenda item is being satisfied as well: better accountability in public service. Outcome-geared reform and strengthening of local governance in delivering on performance commitments could well be a direct outcome of an indexed and measurable sustainable energy practice. Local consensus, too, is expected to be forthcoming more easily as agendas become more clearly understood, and made visible in tangible improvements.

Structuring Urban Renewable Energy Research, Policy and Practice

In the absence of useful established patterns of practice a search is under way for new means of reconciling local government's sectorial concerns, technological opportunities and shifts in energy markets with global environmental imperatives. There is much to be done in this area, as the relatively sparse literature documents. Capello, Nijkamp and Pepping's 1999 volume on 'Sustainable Cities and Energy Policies' demonstrates in its conclusions, 'Policy Recommendations and Guidelines for Renewable Energy Technologies in Cities', how relatively embryonic the world of concepts, facts and policies still is in the inevitably arising realm of urban renewable energy management.

But there is a rising world of hopeful local initiatives, focusing squarely on comprehensive local action in municipal and metropolitan conversion to a renewable energy supply base.

Here are six examples.

The European Charter for Solar Energy in Architecture and City Planning

The Charter, signed by 30 eminent architects, and developed by these under the leadership of German Architect Thomas Herzog, was released in March 1996, at the Fourth European Conference 'Solar Energy in Architecture and City Planning', chaired by then Minister for Construction, Klaus Töpfer and Dr Hermann Scheer. The Charter was advanced in historical contradistinction to the fossil-age Charter of Athens, referred to above. It is comprehensive in attempting to deal with most physical planning challenges. The Charter focuses on the planners, the building site, the design and construction process, buildings in use - and the city as a sustainable planning challenge.

The Eurosolar Guideline to State Politicians: a Regional Program for Renewable Energy

Eurosolar has in 2001 issued a blueprint 'state program', for the use by regional politicians in the implementation of renewable energy. It has ten focal areas or considerations: (i) the role

model played by state government; (ii) the role of state energy agencies; (iii) the strengthening of municipal power companies and the reintroduction of energy supply into community hands; (iv) research and education; (v) renewables in regional development; (vi) strengthening of agriculture; (vii) the orientation of land use planning and building towards renewable energy; (viii) transport and traffic systems; (ix) investment and fianance; (x) state government awards for the exemplary use of renewable energy.

The White-Paper of the European Commission and its local implementation

[Details followed]

The Fifty Solar Settlements Programme of Northrhine-Westphalia (Germany)

[Details followed]

Barcelona's Solar Ordinance

An increasing number of cities searches for home-grown paths to energy sustainability. One of the most progressive of these is Barcelona. The city has calculated its very favourable solar energy supply potential and on 1 August 2000 introduced a regulatory system requiring households and industrial users to provide at least 60% of their hot water requirement utilising solar systems. The scheme is focused, specific and practical.

The Solar City initiative: an approach to introducing renewable energy technology in cities.

The Solar City approach emerged from a new generation of International Energy Agency (IEA) research and development work, to seek citywide applications integral to the main planning agenda. It proposes that renewable energy technologies and other means of greenhouse gas emissions reduction and absorption are to be applied in a coherent spatial and social context, as well as within a finite and community-wide time frame. This document translates the agenda into a proposed framework for the methodical introduction of renewable energy technology in cities.

It is important to work collaboratively with local institutions, to focus on the energy supply and technology side, and work within a comprehensive town planning and design strategy that includes institutional arrangements. The development of energy technology applications and emissions accounting systems along with performance targets linked to urban development and reform initiatives is the goal. Equally important are land use strategies that are based on a consideration of urban-rural linkages and value land use and transport investment choices according to their potential contribution to long-range energy and resource self-sufficiency.

The Solar City planning concept proposes three areas of focus. They are to be advanced simultaneously. These are (a) sustainable-energy focused urban planning strategies; (b) targets, baseline studies and scenario development; (c) and urban energy technology, industry and business development.

Solar City strategies. It is important to identify local planning and development approaches that are conducive to the introduction of renewable energy technologies, within a broadly energy-conscious community development approach. To be addressed are strategy, planning tools, organizational arrangements, legislation and standards, incentive structures, public information and exemplary municipal practice.

By introducing improved ways of adopting renewable energy technologies a 'Solar City' program contributes to climate-stable practice in the building and property development industry, land-use planning and infrastructure development. It will also strengthen local governments' efforts to build enlightened community performance and household preferences.

There are five ways in which better practice in the systematic introduction of renewable energies can be promoted by cities and towns:

… direct legislation and standards;
… the provision of incentives and disincentives;
… corporate capital asset practice, power purchasing and pricing;
… institutional reform and improved strategic and general planning practices; and
… community action development, industry alliances, information and education.

This activity is to investigate each of these in detail and develop advanced means of building improved urban practice approaches, in full partnership with the participating cities.
Setting targets. The objective is to introduce, evaluate and enhance suitable approaches that help understand the role of renewable energy technologies in the broader urban energy context. It is important to include both renewable energy technology introduction targets as well as absolute climate-stable carbon dioxide-equivalent emissions measures aiming at a specific future date, such as 2050.

Planning methods based on energy technology introduction and emissions accounting methods may deploy backcasting approaches. This involves the development of alternative urban development growth and technology transformation scenarios, then 'backcasting' milestones for technology innovation and emissions in order to determine workable reduction rates over time.

Urban renewable energy technology, systems and industry development. The objective is to work with cities in advancing renewable energy technologies and systems, and to help promote the renewable energy industry, in a way that can serve as model for the rest of the national urban system. The emphasis is therefore to be on market-led approaches of technology system development and deployment, through pricing, investment, electricity purchasing policies, information, model action and other means.

Optional paths are to be developed, evaluated and implemented, suitable for the informed and broad introduction of renewable energy technology portfolios for the use by city governments, municipal utilities, businesses, industries and households. Special emphasis is to be placed on micro-generation and distributed low-energy production in buildings, facilities and urban systems. Current, emerging and potentially competing solar and other renewable energy technologies, systems and related urban services are to be assessed for their urban modification and city-wide, systematic introduction in ways that are meaningful to cities' development agendas - physical planning, sustainability objectives, organization, services - and their pursuit of targeted emissions reductions.

Results are expected to include technology, systems and industry development options, suitable for selective and targeted implementation in general and specific action plans. What can city governments in collaboration with industry and constituent urban communities do to advance the direct use of renewable energy sources? How can these be useful to residential neighborhoods, to industry and transport? How can they support the generation of electricity in quantity, such as through solar, wind, biomass, geothermal and sustainable hydro-electric power? And how can cities contribute to the development and deployment of technology development strategies in industrial and residential consumer-oriented application, such as stand-alone power generators, heat pumps, photovoltaics, solar hot water and solar cooling?

Understanding best practice. The objective here is make accessible and apply useful lessons from current and recent related initiatives domestically and world-wide. This is to be achieved by studying successful practice in integrated urban energy planning, management and projects. The activities include an identification of scope and criteria for evaluation; information gathering and documentation; study and evaluation; analysis and description; case study development; and communication and dissemination. This encompasses technologies, management practices as well as growth strategies. As a point of departure, at least three categories of case studies will be differentiated: comparable cities, urban precincts and settlement projects but also development policies and programs.

Learning from action. An important objective is to feed back program experience derived from the participating cities. This will help develop a shared understanding of the barriers to, dynamics and impacts of community, institutional, industrial and technological change, with a view towards the planned and targeted, GHG-reductions geared phasing in of solar and other renewable energy sources on an urban and regional scale. This activity will not only be useful to the participants, but of value in the application of lessons and methods across the national urban system.

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