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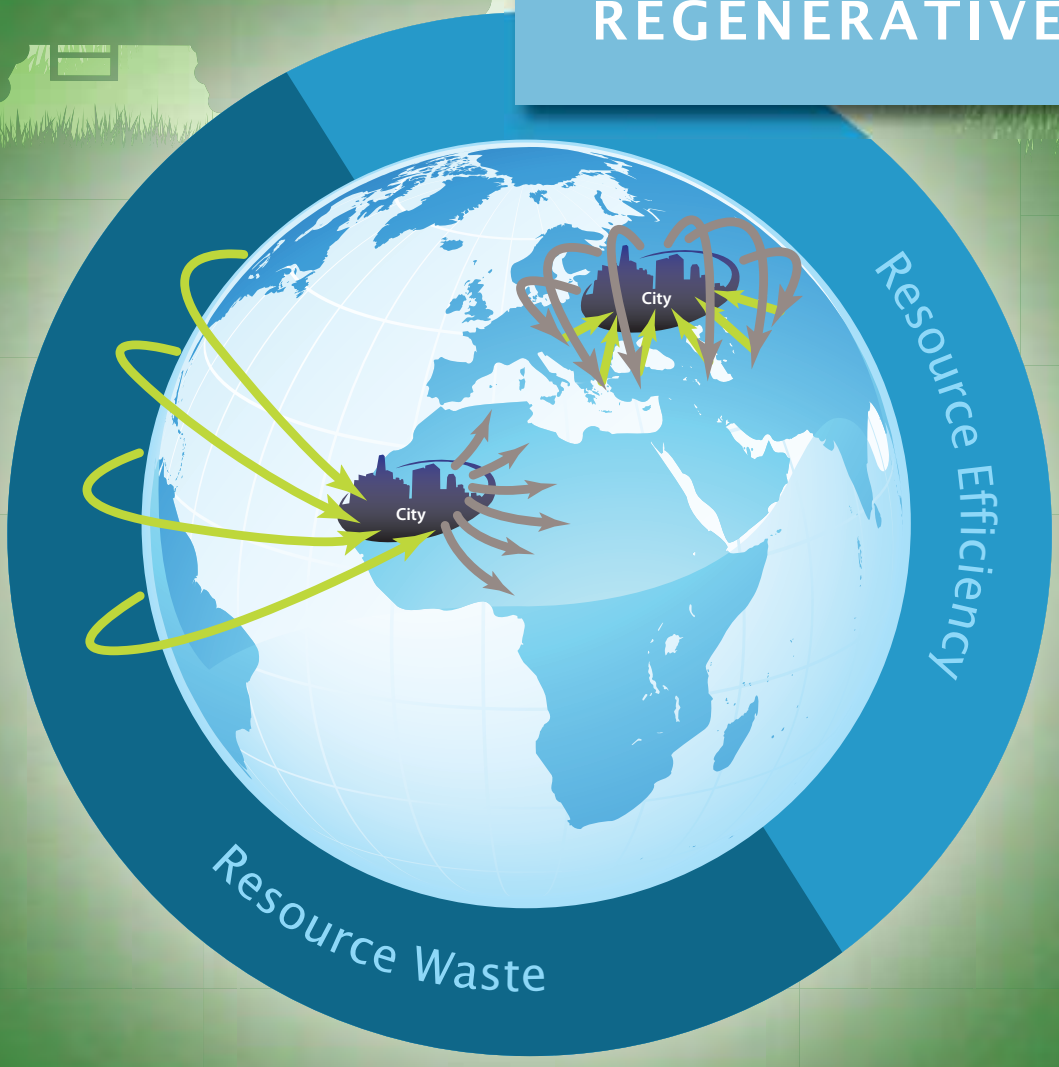
CLIMATE AND ENERGY COMMISSION

TOWARDS THE REGENERATIVE CITY



VOICE OF FUTURE GENERATIONS

Written by Herbert Girardet for the Expert Commission on Cities and Climate Change of the World Future Council
Co-authored by Stefan Schurig, Anna Leidreiter and Fiona Woo

The World Future Council brings the interests of future generations to the centre of policy making. It addresses challenges to our common future and provides decision makers with effective policy solutions.

Expert Commission on Cities and Climate Change

The World Future Council together with HafenCity University Hamburg (HCU) established the international Expert Commission on Cities and Climate Change, whose members strive to identify best policies for future urban development. The commission aims to steer public awareness towards the responsibilities of cities in the age of climate change, identify the main obstacles to progress, and facilitate the exchange of knowledge. They also seek to encourage the widespread implementation at local, regional, national and international levels of effective policies that accelerate regenerative urban development worldwide. The Commission advises city authorities and governments worldwide.

Commission coordinator: Stefan Schurig (World Future Council)

Commission members:

Tatiana Bosteels
Head of Responsible Property Investment, Hermes Real Estate

Prof. Peter Droege
Professor, UrbanSCAPE/Institute of Architecture & Planning, University of Liechtenstein
Chair, World Council for Renewable Energy (WCRE), Asia Pacific

Prof. Dr. Hans-Peter Dürr
Nuclear physicist and philosopher
Member of the World Future Council

Bill Dunster
Managing Director, ZEDfactory

Herbert Girardet
Co-Founder, World Future Council

Prof. Dr. Hartmut Graßl
Professor Emeritus, Max-Planck-Institute for Meteorology

Prof. Dr. Jeffrey Kenworthy
Professor, Curtin University Sustainability Policy Institute, Curtin University of Technology

Ashok Khosla
Member, World Future Council
President, Development Alternatives
President, IUCN (International Union for Conservation of Nature and Natural Resources)

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TABLE OF CONTENTS

Executive summary **4**

1. Introduction **5**

2. Resource use in an urbanising world **5**

2.1. Beyond sustainability 7

3. Redefining urban ecology **7**

3.1. Agropolis: The city and its local landscape 7

3.2. The rise of Petropolis 8

4. Ecopolis: the regenerative city **9**

4.1. Energy for cities 10

4.2. Food for cities 11

4.3. Water for cities 11

5. Case studies **12**

5.1. Energy for cities 12

5.1.1. Germany's 100% renewable energy regions 12

5.1.2. Concentrated solar power 13

5.2. Waste management and elimination 14

5.2.1. Oakland: Towards zero waste 14

5.2.2. Symbiotic Kalundborg 15

5.2.3. Waste management in Accra 15

5.3. Food for cities 16

5.3.1. Cuba: From crisis to opportunity 16

5.3.2. Urban agriculture in New York and Detroit 17

5.3.3. Prioritising farmland: Shanghai and Beijing 17

5.4. Water management 18

5.4.1. Calgary: Capturing nutrients and energy from wastewater 18

5.4.2. Singapore's quest for water self-sufficiency 19

5.5. Regenerative urban transformations 20

5.5.1. Reinventing Adelaide: 2003-2013 20

5.5.2. Urban renewal in the Ruhr Region and Hamburg-Wilhelmsburg 21

6. Rate limiting factors for regenerative urban development **22**

7. From Petropolis to Ecopolis: A Roadmap **23**

7.1. Enabling policy frameworks 23

7.2. Bold steps 24

7.3. New forms of collaboration 24

EXECUTIVE SUMMARY

This report is about operationalising and implementing the concept of regenerative cities, first outlined in the World Future Council's 2010 report 'Regenerative Cities'. As the majority of humanity lives in cities, we need to find ways to

- Develop an environmentally enhancing, restorative relationship between cities and the natural systems whose resources they depend on, and
- Foster urban communities where people benefit from this process.

The planning of new cities as well as the retrofitting of existing ones needs to undergo a profound paradigm shift. The urban metabolism must be transformed from its current operation as an inefficient and wasteful linear input-output system into a resource-efficient and regenerative, circular system.

This report seeks to define what is *necessary* and then show that we can expand what is politically and culturally *possible*. The case studies on urban production, consumption and management of energy, waste, food and water show the new directions being taken by cities around the world. Factors limiting the rate of regenerative urban development are also presented here. Regenerative urban development is still outside the usual remits of most policy makers and beyond the horizon of most members of the public. The report ends with a roadmap towards creating regenerative cities which effectively entails a major redesign of urban systems enabled by supporting policy frameworks. Regenerative urban development is a win-win-win scenario with significant environmental, social and economic benefits, and is essential for both the people who live in cities and the natural systems they depend on.

The path towards the regenerative city must be supported and institutionalised by the city authorities. It is crucial, therefore, for cities to have dedicated departments concerned with a holistic vision that takes a cross-sectoral approach to combine their findings into integrated decision making processes.

One of the most obvious conclusions from the case studies in this report is that the goals, the roadmap towards them and the implementation have to be fully backed and institutionalised by the city authority. It is crucial, therefore, for city authorities to have dedicated departments concerned with a holistic vision and understanding and to combine their findings into integrated decision making processes.

This challenge is more difficult in cities where the privatisation of urban services such as water, energy and waste management has reduced their capacity to create well integrated urban systems. It is all the more important, therefore, to prove that restorative planning and management of cities presents major new opportunities for reviving urban economies and creating new businesses and jobs.

1. INTRODUCTION

The vision of regenerative cities is not just about the greening of the urban environment and the protection of nature from urban expansion – however important this is. It is, above all else, about the greening of urban systems of production, consumption and construction. Across the world, a wide range of technical, management and policy solutions towards this end are already available which have ecological, social and economic benefits.

Life on earth is robust and has the ability to regenerate. However, the collective ecological footprint of humanity now significantly exceeds the regenerative capacity of the earth. Cities are major contributors. We are eroding the natural capital and thus resilience of the earth, rather than living off its regenerative income. Under current trends, humans will require the biocapacity of two Earths by 2030.[1]

This report is about the major challenges that cities are dealing with. In their current form cities are entropic and tend to downgrade and deplete the resources they depend on in the process of using them. In many parts of the world the existential basis of cities is becoming increasingly precarious, with the depletion of fossil fuel reserves, falling water tables, deforestation of watersheds, loss of biodiversity and ecosystem resilience, soil erosion and landslides, loss of nutrients and carbon from agricultural land, air pollution downwind from cities, floods and sea level rise. These are all externalities that do not show up in the prices we pay and that affect the long-term viability of both cities and life on earth. These issues need to be addressed by suitable policy measures as well as behavioural changes of urban citizens.

In recent years there have been many urban regeneration initiatives in the shrinking cities of industrialised countries. Europe and the US have their fair share of these, particularly in former coal mining regions such as the Ruhr region or South Wales. These initiatives aimed first to restore the urban fabric. Some have also been concerned with restoring peri-urban areas – for example, turning brownfield sites such as coal slag heaps or derelict factory sites into landscape parks or housing developments. These kinds of regeneration projects have received much funding and media attention and have improved the lives of millions of people.

The concept of *regenerative cities* goes further by addressing the linkages between urban systems and ecosystems. Significant damage has already been done to the world's ecosystems through urban resource consumption and waste disposal, and new ways of thinking are required to reverse the damage. We need to start thinking of *regenerative* rather than just *sustainable* urban development. The time has come for cities to take specific measures to help regenerate soils, forests and watercourses rather than just sustaining them in a degraded condition.

While urban regeneration is about restoring damaged urban environments, this report argues that regenerative urban development is about creating a fairer, restorative relationship between cities and the world beyond, utilising appropriate technologies, policies and business practices, and building vibrant new local economies in the process.

There are two main challenges:

- Cities need to take active steps towards making efficient use of resources;
- In addition, looking beyond urban boundaries, cities also need to find ways to develop a mutually beneficial relationship with their surrounding regions.

Across the world, different cities are at very different stages of development and invariably face different challenges. In industrialised nations, urban growth is very limited and the primary task is to retrofit existing urban systems. In rapidly urbanising countries, urban development strategies need to include high standards of resource efficiency and renewable energy as key components. Those cities with privatised urban services such as water, energy and waste management face reduced capacity to create well-integrated urban systems. It is all the more important to recognise that restorative planning and management of cities presents major new opportunities for reviving urban economies and creating new businesses and jobs.

Some national governments have already introduced important policies such as waste disposal regulation and taxation, carbon taxation, energy efficiency ratings and feed-in tariffs for renewable energy which are primarily implemented at the local level. Zero waste policies and support schemes for sustainable local food production are also in place in some countries. But much more needs to – and can – be done to ensure that the triumph of the city does not end up as a global environmental tragedy.

2. RESOURCE USE IN AN URBANISING WORLD

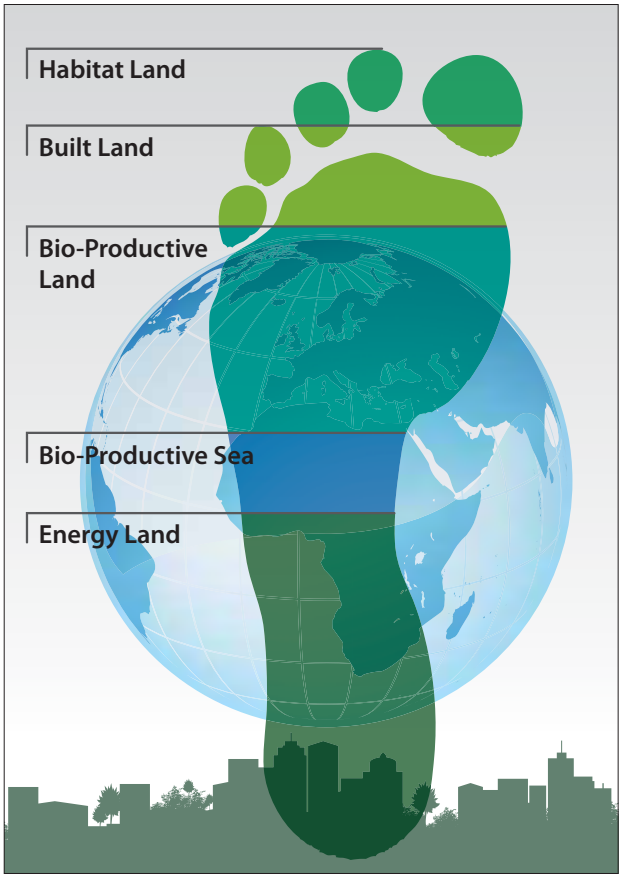
Modern cities are an astonishing human achievement. They are the hubs of human creativity. They are centres of economic activity and intense human interaction. The technical complexity of their buildings and infrastructure systems is unprecedented. Their transport and communication systems reach all the way across the globe. They offer a vast variety of services at comparatively low per capita cost.

1 WWF, Living Planet Report 2012, *http://awsassets.panda.org/downloads/1_lpr_2012_online_full_size_single_pages_final_120516.pdf*

An urban revolution is sweeping the planet and is transforming the lives of billions of people. Cities dominate human economic activities and, amplified by new communication networks, they are at the heart of global human interactions. And in order to exist, cities require vast amounts of energy, water, food, timber and many other raw materials. Yet knowledge and prioritisation of assuring the long-term availability of these existential supplies is lacking in cities.

"We are living as if we have an extra planet at our disposal. We are using 50 per cent more resources than the Earth can provide, and unless we change course that number will grow very fast – by 2030, even two planets will not be enough".[2]

As cities become larger and richer, they increasingly draw on nature's global bounty rather than on resources from their own local hinterland. Whilst urban areas constitute three to four per cent of the world's land surface, their ecological footprints, which measure the amount of productive land and water needed to produce the goods consumed and to assimilate the resulting wastes,[3] cover most of the productive land surface of the globe.



Apart from a near monopoly on the demand for fossil fuels, metals and concrete, an urbanising humanity now consumes nearly forty per cent of nature's annual primary production. By way of example, the footprint of London, England is about 125 times the city's surface area of 168,000 hectares (ha) – a figure which does not even account for food waste, pet food production[4] and marine fishing grounds.[5] The challenge is to find ways to significantly reduce our ecological footprints.

In addition to ecological footprints we also need to account for ecological rucksacks. Ecological *rucksacks* measure the total quantities of materials disturbed in their natural setting when resources are extracted for the goods or services we consume. They describe the total material inputs required to generate a given product, minus the weight of the product itself. Ecological rucksacks represent the degree of stress exerted on the environment by the process of resource extraction. For example, mining one kilogram (kg) of steel carries an ecological rucksack of 21 kg. One kilogram of aluminium has an ecological rucksack of 85 kg. Mining one kilogram of gold typically disturbs 400,000 kg of materials. One kilogram of diamonds carries an astonishing ecological rucksack of 53 million kg.[6]

The ecological, economic and social externalities of our urban systems need to be addressed in new ways. The ravenous appetite of our fossil fuel-powered urban lifestyles for natural resources has enormous consequences for all life on earth – including human life. In the last 100 years the process of urbanisation has become ever more resource intensive, and it now significantly contributes to climate change, loss of soil carbon and of the natural fertility of farmland, and the depletion of biodiversity across the world.

Large modern cities are dependent systems. Can they continue to exist if and when the world's stores of non-renewable resources have been emptied?

2 Ibid.
3 Mathis Wackernagel, William Rees. Our Ecological Footprint. (Gabriola Island, BC: New Society Publishers, 1996)
4 Helmut Haberl, Karl-Heinz Erb, Fridolin Krausmann, The Encyclopaedia of the Earth, *http://www.eoearth.org/article/Global_human_appropriation_of_net_primary_production_%28HANPP%29*
5 Herbert Girardet, Creating Sustainable Cities, Schumacher Briefing nr 2. (Dartington: Green Books, 1999)
6 Hari Srinivas, "What Are Ecological Rucksacks," The Global Development Research Center, *http://www.gdrc.org/uem/index.html*

2.1 BEYOND SUSTAINABILITY

A comprehensive approach beyond established parameters of sustainable development is needed. Sustainable development has been a global orthodoxy ever since it was agreed as a guiding principle for collective human action at the Rio Earth Summit in 1992, and enshrined in its flagship documents, the Rio Declaration and Agenda 21. *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* It seems obvious that we should not live today as though there were no tomorrow. But since Rio, sustainable development has become like a rubber band that can be stretched in all directions. Its meaning has become utterly vague and is open to a wide spectrum of interpretations.
Humanity is facing an acute planetary emergency and the time has come to think beyond sustainability and to actively work towards regenerating soils, forests and watercourses by aiming to improve rather than simply sustain their currently degraded condition.

The concept of regenerative urban development aims to assure that we develop comprehensive strategies for an enhancing, restorative relationship between an urbanising humanity and the ecosystems which we draw resources from for our sustenance.

But implementation will not happen automatically. We need appropriate national, regional and local incentives to ecologically retrofit our cities, to minimise their dependence on fossil fuels, to boost the deployment of renewable energies, to transform urban waste management, to mainstream wastewater reprocessing and nutrient capture, and to help regenerate our ecosystems.

3. REDEFINING URBAN ECOLOGY

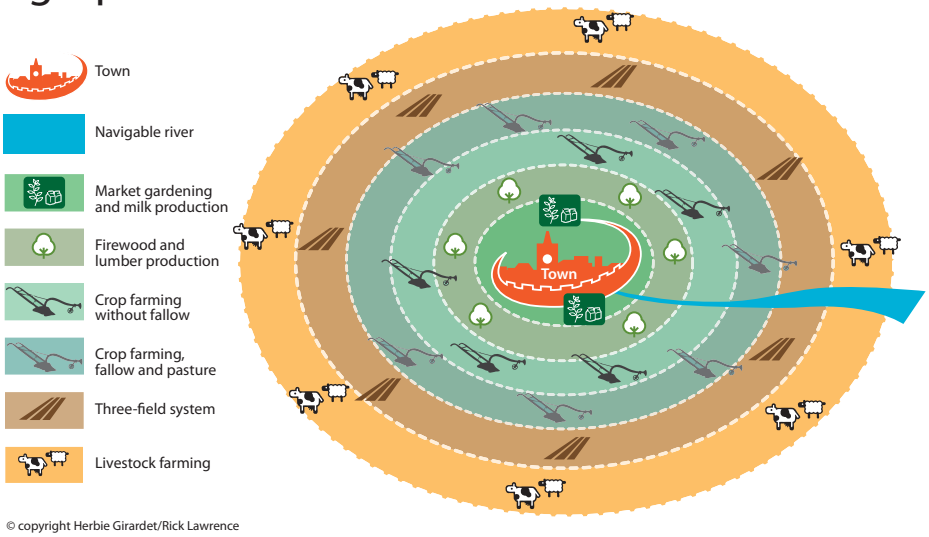
Urban ecology is the scientific study of how living organisms relate to each other and their surroundings in an urban context. Its traditional focus was on ecological processes within cities. But as urbanisation has ever farther-reaching impacts on biodiversity, biogeochemical cycles, hydrology and climate, the horizon of urban ecology expands to include all the territories involved in sustaining urban systems in order to help clarify how regenerative urban development can be implemented in practical terms.

A look at the relationship between traditional human settlements and their connection to their local landscapes may be useful. Villages and towns tended to emerge in places of resource abundance, in areas of rich soil, on the banks of rivers and lakes and on sea shores.

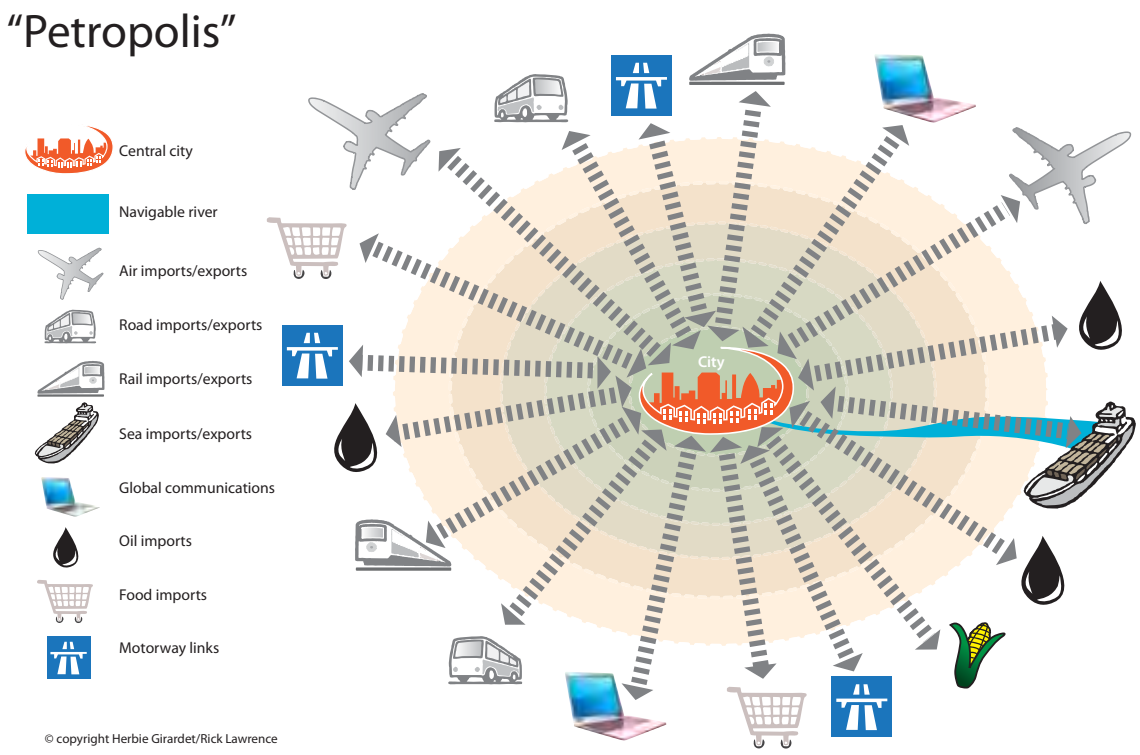
3.1 AGROPOLIS: THE CITY AND ITS LOCAL LANDSCAPE

In his book 'The Isolated State' the prominent 19th century geographer and economist Johann Heinrich von Thünen described the way in which human settlements, in the absence of major transport systems connecting them to the outside world, were systemically embedded in their local landscape through various logically arranged modes of cultivation. They maintained their productivity and fertility by crop rotations and by returning appropriate amounts of organic waste to it. This traditional settlement type could be called Agropolis.

"Agropolis"



In many parts of the world, villages and towns had this kind of systemic relationship to the landscapes they emerged from. They depended for their sustenance on nearby market gardens, orchards, forests, arable and



grazing land and, of course, local water supplies. Until recently, many Asian towns were still largely locally self-sufficient in food as well as fertiliser, using human and animal wastes to sustain the fertility of local farms.[7] Their only energy sources were firewood, muscle power and, perhaps, small amounts of wind and water power. What can we learn from these traditional arrangements for the future while utilising modern methodologies and technologies?

3.2 THE RISE OF PETROPOLIS

The industrial revolution caused an explosion of urban growth that continues to this day. Steam engines and their successor technologies enabled the unprecedented concentration of industrial and commercial activities in urban centres. Cities increasingly declared independence from their local hinterland and became centres of consumerism as well as global economic and transport hubs. This globalisation process, based on new modes of transportation, has made it easier to supply food, raw materials and manufactured products from ever greater distances.

The phenomenal changes in human lifestyles that have occurred are reflected in new concepts of urban land use planning, particularly for accommodating the road space needed for motor vehicles. The modern city is a Petropolis: All its key functions – production, consumption and transport – are powered by massive daily injections of fossil fuels. But there is growing evidence that the resulting dependencies are ecologically, economically and geopolitically precarious, particularly since fossil fuel supplies which modern cities depend on are finite.

What goes in must come out again: Petropolis is a dependent system. Whilst relying on external inputs for its sustenance, it also discharges vast quantities of solid, liquid and gaseous wastes without adequate concern for the consequences. The challenge now is to reduce this systemic dependence before the risks of food and energy insecurity, storms and sea level rise start to undermine the very existence of this urban archetype.

In recent years the most dramatic growth has occurred in coastal cities, particularly in Asia and Africa. With the expansion of global trade, coastal populations and economies have exploded on every continent. Of the 17 megacities of over ten million people around the world, 14 are located in coastal areas. Forty per cent of the world's cities of one to ten million people are also located on or near coastlines. Careless development practices have damaged or destroyed important habitats such as wetlands, coral reefs, sea grass meadows and estuaries. With substantial sea level rise expected by 2100, major coastal conurbations such as London, New York, Shanghai, Kolkata, Dhaka and Lagos will become the primary victims of global greenhouse gas emissions, impacting not only property values but also the existence of the cities themselves.

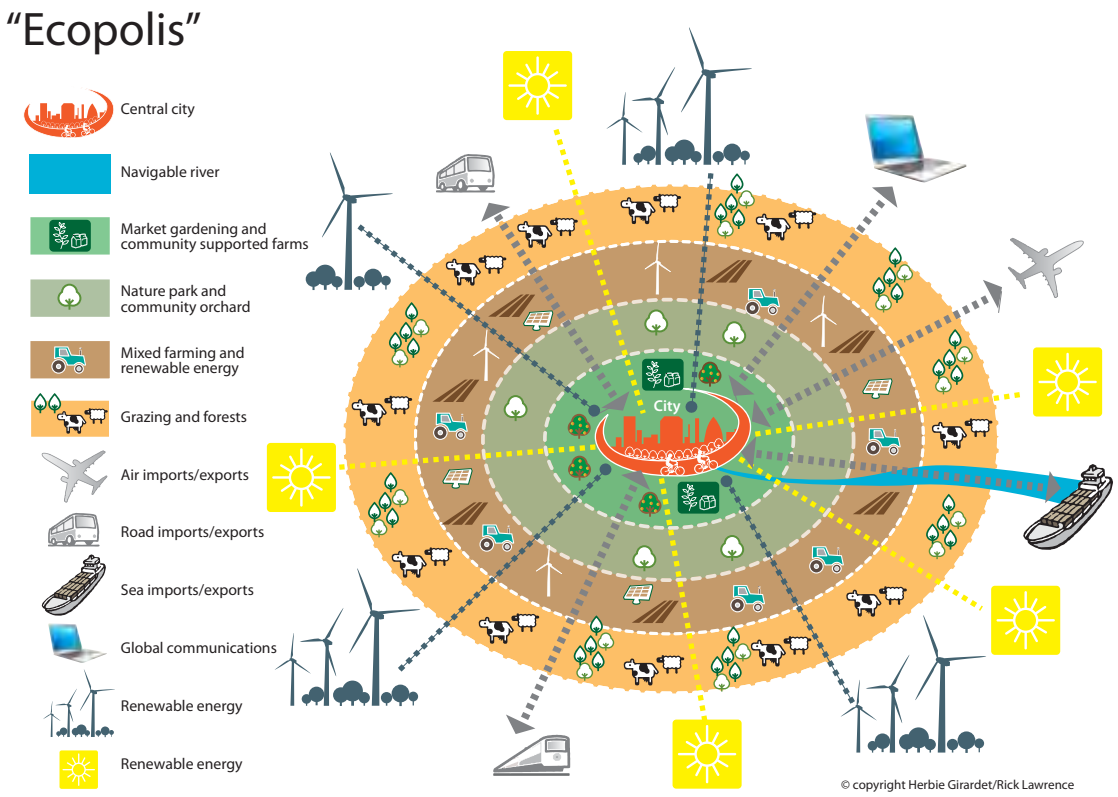
7 F. H. King, Farmers of Forty Centuries: Organic Farming in China, Korea, and Japan. (Courier Dover Publications, 1911)

4. ECOPOLIS: THE REGENERATIVE CITY

The systemic changes required to address these existential challenges would transform the modern Petropolis into a regenerative city – an Ecopolis. Ecopolis reintegrates itself into its surrounding environment, not only drawing on regional biologically productive land but also developing the potential for regional renewable energy supplies. Of course, the options for this vary greatly according to the unique locations and conditions of cities. Since cities today tend to be much larger than traditional human settlements, their reintegration into the local hinterland is a major task. The fact that far more people live in cities today than in the days of the Agropolis must be taken into account in developing appropriate concepts and strategies. The case studies in this report illustrate, however, that major initiatives are already under way.

For Ecopolis to become reality there must be a focus and understanding on urban *metabolism* as well as form and land use. Most modern cities have a linear metabolism: Resources flow through the urban system without concern about their origin or the destination of waste by-products. Inputs and outputs are treated as largely unrelated. Fossil fuels are extracted from rock strata, refined and burned, and the waste gases are discharged into the atmosphere. Raw materials are harvested and processed into consumer goods that ultimately end up as rubbish which cannot be easily or beneficially reabsorbed into living natural systems. Trees are felled for their timber and pulp and often forests are not replenished. Similar linear processes apply to food: Nutrients and carbon are removed from farmland as food is harvested, processed and eaten. The resulting waste – with or without treatment – is discharged into rivers and coastal waters downstream from population centres and usually not returned to farmland. Rivers and coastal waters all over the world are 'enriched' with sewage, toxic effluents and mineral run-offs.

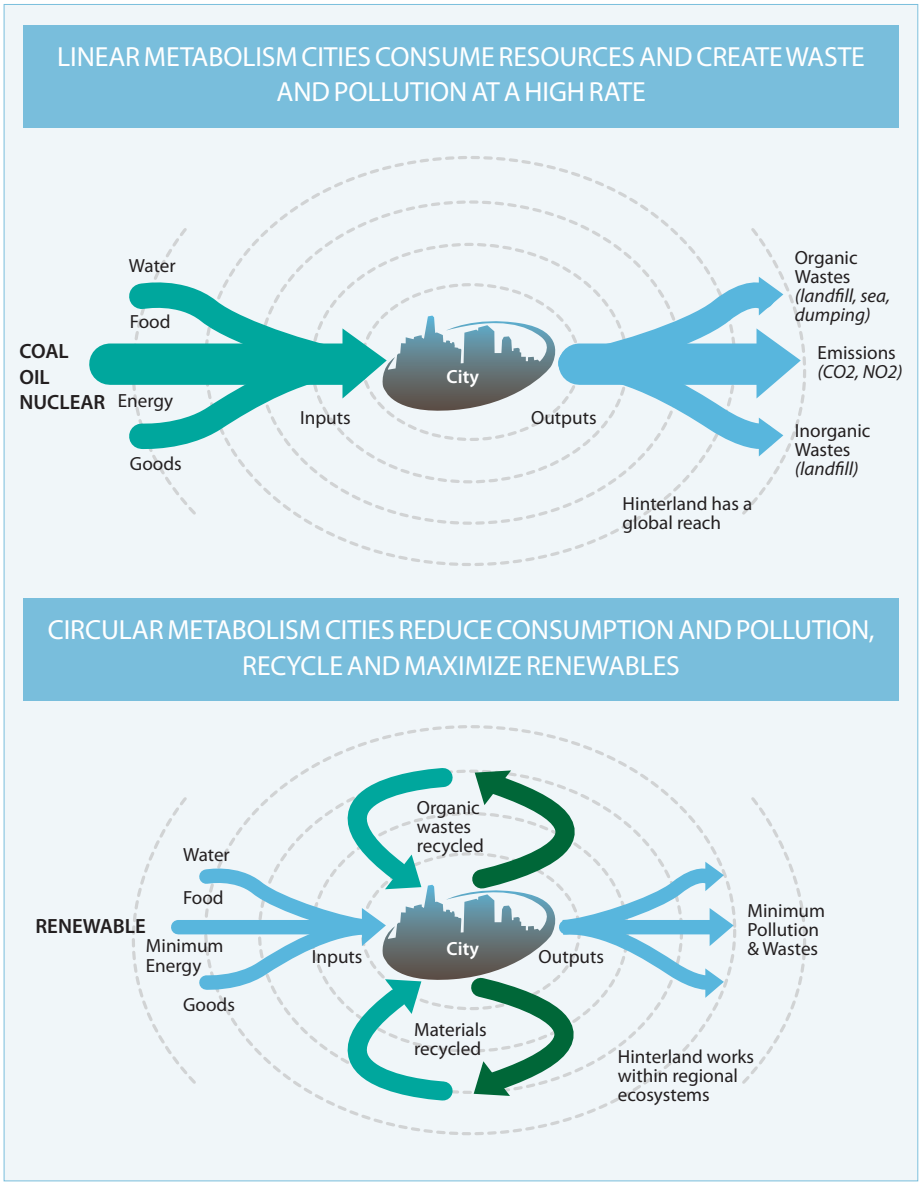
Ecopolis, aiming for long-term viability, systemically addresses the environmental externalities associated with urban resource use. It does this by mimicking the *circular metabolic systems* found in nature: In nature, all wastes become organic nutrients for new growth. Similarly, urban wastes can become valuable inputs into local and regional production systems. In recent years, the recycling of paper, metals, plastic and glass has made substantial progress in many cities, but much more needs to be done. One key aspect is the redesign of products themselves to ensure that they end up as useful technical and biological 'nutrients'.[8] It is also particularly important to convert the vast quantities of urban organic waste into compost, and to return the plant nutrients and carbon they contain to farmland that feeds our cities.



8 Michael Braungart and Bill McDonough, Cradle to Cradle; Remaking The Way We Make Things. (Vintage, 2002)

4.1 ENERGY FOR CITIES

What can cities do to minimise their dependence on fossil fuels and to assure high energy efficiency? In industrialised countries, urban areas account for over 75 per cent of energy demand. Much of this is used to heat, cool, light and power residential and office buildings. Not surprisingly, a lot of attention is being focused on retrofitting existing buildings and energy-efficient design for new buildings. In industrialising countries, as urbanisation continues apace, cities will account for most of the increasing national energy demand. The implications are clear: Invest in energy-efficient buildings today, reduce fossil fuel dependence, and pay much less tomorrow.



Credit: Herbert Girardet.

Appropriate policy measures must be taken in order to achieve successful results. In particular, there need to be strong incentives for property developers – particularly rental property developers – to adopt best practices. They have to be encouraged to help their tenants save on energy bills whilst reducing local air pollution and CO2 emissions at the same time.

Can modern cities – the product of combustion technologies – be powered by renewable energy (RE) instead? There is good news: In recent years, rapid strides have been made with the development and utilisation of RE technologies, particularly wind and solar.

Decentralised renewable energy production at the city and region levels can be provided by a wide range of technologies – wind, solar, biogas and, in some places, geothermal. It makes cities and national economies less vulnerable to fluctuating oil and gas prices and more resilient to natural disasters; creates local jobs which benefit the local economy; promotes a greater understanding of energy production, leading to smarter use; can help to stimulate innovation through use of off-grid and mini-grid systems; and reduces air pollution as well as urban carbon footprints.

Solar energy rooftop installations are particularly suitable for use within cities for producing electricity as well as hot water. China is a world leader in this technology: A quarter of its buildings have solar water heating systems, often in households that have hitherto not had the benefit of hot water. By 2010 the number of solar water heaters installed in China equalled the thermal equivalent of the electrical capacity of 40 large nuclear power plants. Solar hot water technology has also been used for many

9 Sunderasan Srinivasan, "Transforming solar thermal: Policy support for the evolving solar water heating industry," Refocus 7 (2006): 46-49.

years in the Mediterranean and is now becoming common place in less sunny countries as well. Globally, solar water heaters on buildings could produce as much energy as more than 140 nuclear power stations.[9]

Government policies have been the enablers of many RE technological breakthroughs. Denmark was the first country in the world to introduce feed-in tariffs for wind energy in the 1980s. At that time, 50 kilowatt (kW) wind turbines were the norm, but by 2010 their output had increased a hundredfold to as much as 5,000 kW. In countries with long coastlines such as Britain, large scale wind farm development is underway. The London Array in the Thames estuary, when completed, will be the world's largest offshore wind farm with a capacity of 1,000 megawatts (MW). By June 2013 its 175 turbines were generating 630 MW which sufficiently powers 750,000 homes.[10]

Solar stadium, Kaohsiung. This remarkable multi-purpose building, designed by Toyo Ito, is both a stadium and a solar power station. To date it is the largest solar installation in Taiwan, Province of China.

4.2 FOOD FOR CITIES

In most of the world's cities food supplies are largely taken for granted. Yet cities usually depend on large amounts of food being brought in from outside the land they actually occupy, from an increasingly global hinterland. London, for instance, has a surface area of 159,000 hectares (ha), but it requires over 50 times its own surface area – around 8.4 million ha – to feed it. Much of that land, of course, is located in countries far away from where the food is actually consumed. The majority of the land required to feed cities in industrialised countries is dedicated to grain and animal feed, such as maize and soya beans, in order to meet the demand for meat. As the world urbanises and becomes increasingly affluent, demand for land to feed our population continues to grow.

Pressure on global farmland can be significantly reduced by a revival of urban and peri-urban agriculture. While large cities may still require some food – particularly grain – from other places, food production should be regarded as an important component of urban living. We need to find efficient and environmentally enhancing ways of feeding ourselves.

As with inefficient energy and water usage, waste of food in urban areas puts unnecessary strain on the limited capacity of natural ecosystems. In industrialising countries it is primarily an issue of inadequate food storage, but in industrialised and highly urbanised countries the main problem is the wasteful consumption of food. The Food and Agriculture Organization (FAO) of the United Nations estimates that one-third of all food produced worldwide – worth about US $1 trillion – is lost or wasted in production and consumption. A study by the UK's Institution of Mechanical Engineers puts this figure even higher and estimates that half of global food production – equivalent to two billion tonnes – ends up as waste every year.[11]

4.3 WATER FOR CITIES

Cities could not exist without adequate water supplies. Water scarcity and poor water quality can gravely affect human health, especially in rapidly growing urban centres. While experts argue over appropriate governance and pricing structures to address the looming urban water and sanitation crisis, few are asking why fresh water is being used for flushing toilets.

Each person needs about 5 litres (L) of drinking water per day. Of the daily average of 300 L consumed in many cities, typically 30 L are lost through leakage, 70 L are used to flush toilets, 150 L for washing and cleaning, and up to 50 L for gardening. No city in the world would be seriously challenged to provide enough drinking water per person per day. Most cities could also easily treat 70 L of daily sewage per person. Very few cities, however, have found cost effective solutions to treating sewage mixed with grey water.

10 London Array, accessed 3 June 2013, *www.londonarray.com*
11 Institution of Mechanical Engineers, "Global Food: Waste Not, Want Not," *http://www.imeche.org/docs/default-source/reports/Global_Food_Report.pdf?sfvrsn=0*

Grey water can easily be treated for reuse twice at the neighbourhood or building level: Once for cleaning and gardening, the second time for sanitation. The result would be a two-thirds reduction in the volume, cost and energy required for sewerage treatment and up to 90 per cent reduction in fresh water demand. This begs the question: Are cities faced with a water *supply* crisis, or is it actually a water *management crisis*?[12]

Another overlooked issue is that of organic nutrients contained in sewage. Our cities discard vast amounts of nitrogen, phosphates and potassium through their sewerage systems, the main macro-nutrients needed for growing food crops. The human metabolism only absorbs only a fraction of these nutrients contained in the food we consume. They are essential for sustaining our food production systems. Limits on available nutrients constrain how well plants can grow and how much carbon dioxide they absorb.

Potash is available in large amounts from mines in many parts of the world. Nitrogen fertilisers are mostly synthesised from nitrogen gas in the air by the use of fossil fuels. Phosphorus, however, an element without which crops cannot grow, is a much more limited resource. Ninety per cent of global supplies are available from mines in only six countries - Morocco, Tunisia, Saudi Arabia, China, Russia and the US. Within a few decades, this critical resource could be depleted if we do not reclaim the phosphorus discarded in urban sewage. The challenge now is for cities to close the human phosphorus cycle.

Fortunately a number of companies around the world have realised that a potential phosphate scarcity is a major new business opportunity. Dutch companies, in particular, have developed technologies to turn phosphate from sewage sludge and municipal organic waste and manure into fertilisers and soil improvement materials. The European Union is developing legislation for both recycling phosphate and its more efficient use in agriculture.[13]

All in all, it is critical to minimise nutrient outflows from our cities. Wastewater processing and recycling can help to fertilise peri-urban farmland as well as reduce the ecological damage caused by discharging nutrient-rich effluent into aquatic and marine ecosystems.

5. CASE STUDIES

Cities and regions from all corners of the world are already addressing issues of their relationship with the ecosystems they rely on. The following case studies present the policy tools and driving forces that pave the way towards realising Ecopolis. They demonstrate that regenerative urban development is not a utopian pipe dream but is becoming a reality across the globe.

5.1 ENERGY FOR CITIES

5.1.1 GERMANY'S 100% RENEWABLE ENERGY REGIONS

Credit: Phoenix Solar
Solar farms are appearing in many parts of Germany due to the policy stimulus of Feed-in Tariffs.

12 Herbert Girardet, Stefan Schurig, Nicholas You, "Towards the Regenerative City," UN-Habitat Urban World, *http://www.unhabitat.org/downloads/docs/UW-RegenerativeCityCC.pdf*
13 Janez Potočnik, European Commission, *http://europa.eu/rapid/press-release_SPEECH-13-212_en.htm*

Renewable energy is a key ingredient in the regenerative development of human settlements. In this context the opportunities for smaller communities to generate the energy they consume locally and even become energy exporters to neighbouring towns and cities are increasingly becoming a reality.

Across Germany there are over 100 regions that have implemented – and even, in some cases, already exceeded – a 100 per cent renewable energy (RE) target. These so-called 100 per cent RE regions encompass about a quarter of the country's population.

Municipalities have played an important part in developing renewable energies in Germany and will continue to do so in future. In the energy sector, they are the driver of the transformation process towards an Ecopolis. They have far-reaching instruments of control with regard to RE authorisation and installation, enabling local implementation of national energy policies. Local governments and citizens partially fund the installation of RE systems and may be involved in their operation as lessors through their public works departments. Increasingly, communities are adopting their own renewable energy development goals, forming cooperatives or seeking to attract companies active in the industry to invest in them.[14]

Feed-in tariffs especially have played a key role by acting as a connecting framework linking people, policy, energy and economy. Germany hereby shows that a regenerative city region, actively involving the local community, is a cornerstone in implementing a national energy transition policy.

One of the main lessons learnt from Germany is that the pride of ownership cannot be underestimated. When local citizens have a personal financial stake in RE projects, social acceptance of these projects tends to be greater, and barriers to progress are more easily eliminated.

With active national government support, potentially everyone can participate in the decentralised development of RE, particularly with public or community-based wind farms or solar systems. Local farmers can produce not only food but energy for sale as well. The installation, maintenance and operation of RE systems can mostly be carried out by local businesses like tradesmen, technicians, and farm and forest workers. In other words, many small and medium-sized enterprises have the opportunity to benefit from RE development while promoting regional added value.

A successful national RE policy comprises a wide range of measures:

- Priority for RE access to the grid;
- A feed-in tariff that compensates RE producers who feed electricity into the grid to recover investment and running costs, plus a reasonable profit;
- Low-interest loans that accelerate adoption of RE and efficiency improvements;
- Strong building insulation standards and labelling of efficiency performance for buildings;
- Support for the development of RE storage options and smart grid technologies;
- Promotion of efficient technologies, power saving light bulbs, and efficient appliances
- Eco-taxes on petroleum and conventional power use; and
- Automobile emission standards that encourage fuel efficiency[15]

With strong national policy frameworks in place over the past decade, several towns and regions have already surpassed a 100 per cent renewable electricity target. One example is the town of Lichtenau in Westphalia which produces a 27 per cent surplus of renewable energy and is exporting electricity into the national grid.[16] The country as a whole reached its 20 per cent RE target in 2011 and is on track to reach 35 per cent by 2020 and 80 per cent by 2050. The German Federal Environment Agency has set an ambitious target reaching 100 per cent overall RE by 2050.[17]

Credit: Abengoa Solar. The three concentrating solar power stations of the Solucar Complex, outside the village of Sanlúcar la Mayor, produce 183 megawatt of electricity, enough to supply most of Seville's electricity needs.

5.1.2 CONCENTRATED SOLAR POWER

Across Europe, regional peri-urban RE installations are rapidly growing in number and size. A pioneer of concentrated solar

14 Anna Leidreiter, Diane Moss, Markus Groth, "From vision to action: A workshop report on 100% Renewable Energies in European Regions" (2013).
15 Ibid.
16 "Auf dem Weg zur Energiestadt Lichtenau," Lichtenau Stadtinformationen, *http://www.lichtenau.de/42-Stadtinformation-Stadtmarketing-Wirtschaft/427-Energiestadt/430-Energiestadt-Lichtenau/8627,%84Auf-dem-Weg-zur-Energiestadt-Lichtenau%93.html*
17 Thomas Klaus et al, "Energy Target 2050: 100% Renewable Electricity Supply," Federal Environment Agency Germany, 2010, *http://www.umweltdaten.de/publikationen/weitere_infos/3997-0.pdf*

power (CSP) technology is southern Spain, with its almost permanently blue skies. So far the most notable examples are the CSP stations built by the Spanish company Abengoa near Seville. They feature arrays of mirrors that focus beams of sunlight onto the top of a tower through which liquid is circulated and turned into steam, thus powering turbines and generators. The latest versions of these installations can store solar heat in a molten salt solution, which enables them to produce electricity for up to eight hours after dark. Seville is well on its way to become the world's first large city to be powered mainly from solar power stations in its hinterland and installations within the city.[18]

The breakthroughs in CSP technology are not confined to Spain. Solana, one of the largest solar power plants in the world, is a 280 megawatt parabolic trough plant with six hours of thermal storage currently under construction in the US. The plant will be located 113 kilometres southwest of Phoenix, Arizona. Solana began construction at the end of 2010 and will begin operation in 2013. It will permanently employ some 1,700 people.[19]

5.2 WASTE MANAGEMENT AND ELIMINATION

5.2.1 OAKLAND: TOWARDS ZERO WASTE

The concept of zero waste goes beyond recycling discarded materials: It starts with a thorough analysis of the vast flow of resources through our society, and the potential to use wastes that cannot be avoided as inputs elsewhere.

The City of Oakland, California, set a goal of Zero Waste in its 2006 strategic plan, effectively changing a linear metabolism into a circular approach by initiating comprehensive policy frameworks. Oakland acted according to both the Alameda County and the California-wide Integrated Waste Management policy, mandating the city to achieve a 75 per cent waste reduction requirement.

The first step in this city of 400,000 residents was to reduce the annual tonnage to landfill from 400,000 tonnes to 291,000 tonnes in four years by returning waste materials to the local economy for reuse and recycling, applying the *reduce, reuse, recycle and compost* waste hierarchy.

Oakland's waste management principles emphasise a closed-loop production and consumption system. They move step by step towards the goal of zero waste by:

- Pursuing 'upstream' re-design strategies to reduce the volume and toxicity of products and materials, and promote low-impact lifestyles;
- Improving 'downstream' reuse/recycling of end-of-life products and materials to ensure best possible re-use; and
- Encouraging re-use of discarded products and materials to stimulate local economic and workforce development.

According to the city's decision makers, the major opportunities to reduce landfill lie in two key areas: capturing organic waste for composting, and increasing recovery of recyclables from waste materials hauled by private interests, especially the construction industry. In 2008, organic materials representing 48 per cent of Oakland's total landfill disposal were by far the largest remaining recoverable material type in all sectors. In addition, 26 per cent of Oakland's total annual landfill disposal, consisting mainly of construction and demolition debris, originates from the non-franchised direct sector, and is hauled to a number of landfills within and outside the county.

In its 2006 agenda report the city council analysed the key challenges that need to be addressed in order to achieve zero waste. It showed that waste management was very fragmented and that regulations were incomprehensive. Options for delivering better solid waste management – whether franchised, contracted or unregulated – were examined. The analysis resulted in five policy recommendations:

1. A single franchise for citywide garbage and organics collection services capable of maximising diversion of organics and minimising landfill disposal of garbage;
2. A single citywide collection and recycling franchise focused on maximising recycling;
3. Landfill capacity procured separately from collection and processing services to attract the broadest pool of franchise proposers by eliminating landfill ownership as a barrier;
4. A permit system to regulate long-established independent recyclers to enforce new best practice standards; and
5. A non-exclusive franchise system to regulate construction and demolition debris hauling activities to stimulate broader use of mixed debris processing in the region.

The example of Oakland shows the complexity of interconnected policy initiatives. While solutions and best policy examples exist, barriers to implementing effective policy frameworks due to a lack of vertical coordination still need to be overcome.[20]

18 "Spain," Abengoa Solar, *http://www.abengoasolar.com/web/en/nuestras_plantas/plantas_en_operacion/espana/PS10_la_primera_torre_comercial_del_mundo.html*
19 "United States," Abengoa Solar, *http://www.abengoasolar.com/web/en/nuestras_plantas/plantas_en_construccion/estados_unidos/*
20 "Informational Report On Status Of Zero Waste System Design," City of Oakland Agenda Report, *http://www2.oaklandnet.com/oakca/groups/pwa/documents/report/oak030643.pdf*

5.2.2 SYMBIOTIC KALUNDBORG

What does a circular metabolism mean in practice? The town of Kalundborg, Denmark, is an example of what can be done when energy and waste are used as a resource rather than treated as a nuisance. In Kalundborg, 20 companies and the municipality cooperate and mutually benefit from using each other's waste and by-products. Over several decades they have developed a symbiotic, circular system in which each step of the chain makes a profit. The exchange is advantageous to the municipality and the local companies in several ways:

- One company's waste is a cost effective resource for another company;
- Efficient consumption of resources benefits the local economy; and
- Reduced discharges of wastes reduce environmental pollution.

Kalundborg's symbiotic web starts with Asnæs Power Station. It produces both electricity and heat for 4,500 households in Kalundborg. The station also provides process steam for three companies, who have reduced their oil consumption by 20,000 tonnes per year by using process steam. Their water consumption has also been reduced by 25 per cent by letting water circulate between the individual partners. Some of the power station's cooling water is used by a fish farm that produces 200 tonnes of trout and salmon annually, as the warm water provides ideal conditions for the fish.

The 80,000 tonnes of ash produced by the power station is used in the construction and cement industries. The 200,000 tonnes of gypsum produced in its sulphur scrubbers is sold to Gyproc, enough to supply its annual plasterboard production. Excess lime is sold as fertiliser for 20,000 hectares of farmland. Novozymes, Asnæs Power Station and Kalundborg Municipality have a joint wastewater treatment facility, with only minimal discharges into the Baltic Sea. Newspaper, cardboard, rubble, iron, glass, green waste and kitchen wastes from the waste stream of Kalundborg and its various companies are all recycled and turned into new products in a cradle-to-cradle production system.

The Kalundborg symbiosis came about through voluntary action by companies primarily for commercial reasons. Other cities have adopted similar resource use strategies using a combination of markets and regulation as the main organising principles. The key issue is to create viable end-markets for remanufactured waste products. This can be facilitated by suitable regulation, development of economies of scale, and provision of adequate information.[21]

5.2.3 WASTE MANAGEMENT IN ACCRA

Accra, Ghana, like most major African cities, has a serious waste problem. Until recently, waste management in the city region of 600,000 people had been limited to collection and dumping. But the existing landfill sites had exceeded their maximum capacity, resulting in a severe environmental crisis from improper waste disposal.

An integrated solid waste management system was identified as a solution for Accra by an alliance of national and city governments and international donors. As a result, the Accra Compost and Recycling Plant (ACARP), is being built as a public-private partnership. The ultra-modern facility uses Chinese-German technology and is designed to treat half the daily waste collected from the metropolis. Only a small fraction of waste will still be landfilled. Municipal solid waste will be recycled and organic waste converted into compost. A faecal waste treatment plant will also be built to capture plant nutrients for the thriving urban agriculture sector. When fully operational, the facility will employ some 500 people with thousands more job opportunities through the supply chain. In addition to developing scientific and technical know-how, ACARP will also share its expertise through a variety of waste management training programmes.

Credit: Herbert Girardet. Solar cooking is being practised across Ghana. The country receives plenty of sunlight while deforestation has caused a lack of firewood for cooking.

21 Kalundborg Symbiosis, *http://www.symbiosis.dk*

The facility will improve sanitation in Accra by reducing the health hazards created by present anarchic waste dumping practices, which are regularly causing blocked drainage channels and major flooding problems in the city. ACARP will provide an effective means of recovering recyclable materials to supply local recycling companies with raw materials and compost. The organic compost will reduce the need to import inorganic fertilisers and improve the soil quality on local farms.

ACARP will have both ecological and economic benefits. Unsanitary conditions in Accra are a serious problem for Ghana's economy. Improved sanitation will directly contribute to economic growth: Reduction in medical costs for the city's population due to lessened waste exposure will allow more funds to be channelled into economic ventures. Furthermore, the productivity of Accra's workforce will be boosted as the loss of working hours through sickness is reduced. It will also contribute to the achievement of Ghana's millennium development goals.[22]

5.3 FOOD FOR CITIES

5.3.1 CUBA: FROM CRISIS TO OPPORTUNITY

Cuba has been a world-beating laboratory for intra-urban organic agriculture since the early 1990s. Its story vividly demonstrates how a major crisis can be transformed into a new opportunity through innovative policy and public participation.

Between 1960 and 1989, a national policy of intensive specialised agriculture had turned Cuban farming into high-input monoculture in which tobacco, sugar and other cash crops for export were grown on large state farms. Following the collapse of the Soviet Union in 1989, food security in Havana and other cities became a major concern. Cuba lost 85 per cent of its export earnings and the US trade embargo caused further economic hardship. When the lack of fertilisers, pesticides, and fuel for tractors and lorries caused serious food shortages, the government decided to think outside the box. The force of necessity caused it to encourage people to practice agriculture within cities. Soon gardens sprouted up everywhere – on wasteland, at housing estates, schools, community centres, hospitals and factories.

Cuba's urban agriculture program aims to provide each person with at least 300 grams of fresh vegetables per day, a figure considered by the FAO as appropriate for maintaining good health. Among the most popular crops are tomatoes, sweet corn, lettuce, onions, cabbage and carrots. Urban food growing is a source of employment for many people, and provides fresh produce with zero transportation costs. By 2002, more than 35,000 hectares of urban land were used for the intensive production of fruits, vegetables and spices. Some 117,000 people work in the urban gardens which produce over half the vegetables grown and consumed in Cuba.

Havana in particular is a world leader in urban food production, as agriculture was decentralised from large mechanised state

Credit: Herbert Girardet: Jac Smit, the founder of the international Urban Agriculture Network, at an 'organoponico' garden in Havana.

22 Accra Compost and Recycling Plant, *http://www.acarpghana.com*

farms to urban cultivation systems. The largest city in the Caribbean, with nearly 20 per cent of Cuba's population, Havana today grows more than half of its own fresh produce using organic compost and simple but effective irrigation systems. The workers in many state enterprises grow their own food. The government has also helped hundreds of thousands of people to set up vegetable gardens, and to plant fruit trees and raise pigs, goats, chickens and rabbits.

Urban farming takes three main forms: state-owned research gardens *(organicponicos)*, private gardens *(huertos privados)*, and popular gardens *(huertos populares)*. Organic crops are mainly grown on raised vegetables beds, which make very efficient use of whatever plot of land is available. The main source of compost is bagasse trucked in from Cuba's sugar cane fields. Ironically, the sugar cane is grown with artificial fertilisers, but the bagasse is composted and effectively becomes an organic growing medium. Cuba's urban agriculture programme provides good quality seeds, and advice on composting, crop rotations, use of earthworms, and on dealing with bacterial and fungal diseases without relying on chemical pesticides.

Cuba's 200 biotechnology centres have opened a significant new export market by offering advice on successful organic cultivation methods in other countries such as Jamaica and Venezuela. In Caracas, Cuban-style vegetable gardens can now be found amid the chaos of busy inner-city streets. Inspired by what he saw in Cuba, former president Hugo Chavez ordered intensive urban farming schemes across Venezuela's cities in a bid to enhance food self-sufficiency.

There are naturally obstacles to copying the Cuban urban agriculture experiment in other cities, particularly those where high land values would make large-scale cultivation difficult. This example, however, demonstrates not only that a large city of three million residents can produce most of its own food but also the significant health, economic, social and environmental benefits of doing so.

5.3.2 URBAN AGRICULTURE IN NEW YORK AND DETROIT

New York City has some of the most expensive real estate in the world. With a population of 8.3 million people, it is also one of the most densely populated cities in the US. Surprisingly, then, urban agriculture is doing well, albeit on a smaller scale than in Havana. What started as the 'green guerrillas' in the 1970s has become a mainstream movement supported by city officials, support organisations and foundations. Despite its high population density there are vacant land and large expanses of flat roofs suitable for food production. Members of the urban agriculture community identify suitable land, collect and compost food waste, start farming and gardening projects, run community food campaigns and cooking demonstrations, and train youth and unemployed people in farming skill. New York's urban agriculture community now numbers in the thousands and represents a broad swathe of the community, including farmers and gardeners, school principals, school children, sanitation workers, building owners and public housing residents. There are even commercial farms located within the city aimed at large-scale food production.[23]

The story of urban agriculture in Detroit is very different. Detroit has a surface area of 36,000 hectares - more than San Francisco, Boston, and Manhattan combined – and, once a city of two million people, with the decline of the automobile industry it has contracted to less than 900,000 people, with vast derelict areas. Significant intra-urban agriculture initiatives are under way precisely because large pieces of abandoned land have become available. The initiatives are supported by city officials, the general public and local businesses. In a recent report, the American Institute of Architects concluded that "Detroit is particularly well suited to become a pioneer in urban agriculture at a commercial scale."[24] Vacant lots, organic waste and underemployment are together an opportunity to revive urban food production.

5.3.3 PRIORITISING FARMLAND: SHANGHAI AND BEIJING

Feeding the nation's burgeoning population has been always been a priority for state authorities in modern China. The country's recent urban growth spurt is increasing food demand and consumption more than ever before, and both national and local governments are focusing their attention on securing food for their urban population. Until recently, highly intensive urban cropping systems made many cities self-sufficient in vegetables. This policy was pursued systematically by Mao Zedong and has remained barely modified since the changes introduced by Deng Xiaoping.[25] Despite China's rapid industrial development, food production is being purposefully maintained on peri-urban farmland administered by city authorities.

A metropolis of 23 million people, Shanghai is China's most important industrial, commercial and financial centre. The total land area administered by its authorities extends to 634,050 hectares (ha). About 58 per cent of this land is occupied by the city itself, while 42 per cent, mainly on the periphery, is devoted to intensive agriculture. On 12,700 ha of peri-urban land, 1.3 million tonnes of vegetables are produced annually. This meets approximately 60 per cent of the city's vegetable needs.

23 Five Borough Farm, *www.fiveboroughfarm.org*
24 Michael J. Crosbie, "RecoveryPark Offers Detroit Fresh Start with Urban Farming," American Institute of Architects, accessed 3 June 2013, *http://www.aia.org/practicing/AIAB090304?dvid=&recspec=AIAB090304*
25 Victor Sit (ed.), Chinese Cities, The Growth of the Metropolis Since 1949. (Oxford University Press, 1988)

Credit: Herbert Girardet. Pudong, which has become Shanghai's Manhattan, used to be a major farming area. In recent years, most intra-urban farms in the city have been built on and farming has been transferred to peri-urban locations.

"Shanghai has entered the fast lane of urbanisation, but the city administration also realises that that the city will not be able to develop without agriculture […] the city authorities are aiming for a considerable level of agricultural production within the city to assure a stable food supply for the urban population."[26] Some 800,000 people work on the city's peri-urban farmland, producing vegetables, fruit, milk, eggs, chicken, pork, carp and catfish.[27] A further two million work the land in the rural areas to the south of the city growing wheat and rice. The city's policy is to produce at least one million tonnes of grain locally, assuring a high degree of regional self-reliance.

In Beijing a similar approach to urban farming is observed. The city authorities there, too, administer large areas of farmland. On the one hand, the growth of Beijing to a city of 20 million people has swallowed some arable land in recent years, reducing its area from 408,000 ha to 300,500 ha between 1991 and 2001. On the other hand, the area under orchards has gone up substantially during this period, from 50,000 ha to 85,000 ha. This is because they require less water and fertiliser, making them a highly sustainable cultivation system.[28]

Throughout China, city authorities are required by the central government to assure the production of substantial amounts of food from the land they administer. This policy is being maintained despite rapid urbanisation. The Chinese authorities are also keenly aware of the importance of including agriculture in planning and building their *new* cities. A vigorous stand has been taken against urban sprawl, by designating 80 per cent of China's arable land as "fundamental farmland." To build on this land, four different authorities have to give their approval: the local, county, and provincial governments, as well as the State Council. Illegal development on protected farmland can be severely punished.

5.4 WATER MANAGEMENT

5.4.1 CALGARY: CAPTURING NUTRIENTS AND ENERGY FROM WASTEWATER

Cities, directly and indirectly, use vast quantities of water which end up as wastewater. Turning wastewater into a resource is a key feature of regenerative cities, and when it comes to innovative and regenerative wastewater management, Calgary compares

26 Yizhong Cai and Zanghen, Zhang, "Shanghai: Trends Towards Specialised and Capital-Intensive Urban Agriculture," Growing Cities, Growing Food. (RUAF 2000).
27 Evan Liu, Shanghai City Council, personal communication.
28 Joost Wolf et al, "Urban and Peri-Urban Agriculture in Beijing Municipality and Its Impact on Water Quality" Environment and Urbanization 15 (2003): 151-156.

with the best of them. While Alberta's largest city is well-known as the administrative centre of the Athabasca oil sands, perhaps the city can take more pride in its circular waste metabolism wastewater recycling system that closes the nutrient cycle.

Calgary recycles and reuses all the wastewater produced by its one million residents. The process through which this is done not only reduces the amount of heavy metals and toxic material entering the ecosystem as waste and pollution, it also creates organic fertiliser for nearby farms, returns treated water back to the Bow River and produces biogas with which to fuel the treatment plants.

Naturally-occurring bacteria break down complex organic materials into simple and stable substances, such as water, methane and carbon dioxide. The by-product of this treatment is biosolids, a nutrient-rich organic fertiliser and soil conditioner. This liquid fertiliser is transported to tankers on farms and then applied to the farmland by subsurface injection into the root zone of crop plants.

Turning biosolids into fertiliser is not only environmentally preferable to landfilling or incineration, but is also a more cost effective alternative. Every year, approximately 20,000 tonnes of biosolids are applied to 2,000 hectares of farmland, most of which lies within 35 km of the city. In addition, over 172 million tonnes of treated water are released into the Bow River. All the biogas emitted at the treatment plant is captured and used to power the sewage processing plants.

The programme operates within the provincial level framework through guidelines issued by the Alberta Environment and Sustainable Resource Development as well as the Environmental Protection and Enhancement Act. Nationally, the Canadian Council of Environment Ministers established a taskforce to develop a nationwide approach to managing wastewater biosolids.

Since the early 1980s the city has provided biosolids free of charge to local farmers through the 'Calgro' programme to help increase yields of alfalfa, canola, oats, wheat, and barley crops. In this way the valuable nutrients contained in urban biosolids are recycled back into peri-urban farmland.[29]

5.4.2 SINGAPORE'S QUEST FOR WATER SELF-SUFFICIENCY

Water efficiency, conservation and recycling are especially urgent in countries with few freshwater sources. The small island nation of Singapore, with a population of 5 million people, imports nearly 40 per cent of its water from neighbouring Malaysia. In a quest for water self-sufficiency, Singapore is trying to reduce water consumption by improving efficiency as well as boosting its three alternative sources: rainfall, desalinated water, and treated wastewater.

Credit: City of Calgary. Shepard Lagoons, Calgary.

29 The City of Calgary, *http://www.calgary.ca/*

Thanks to strong public campaigns, the city-state's per capita daily domestic water consumption has decreased from 165 litres in 2003 to 153 litres today. It has also lowered the amount of unconsumed water lost, for example, through pipe leakages rate to five per cent. Singapore collects and treats its wastewater and transforms it into high quality water that meets World Health Organization standards for drinking water, accounting for 30 per cent of the water supply. Most of it is used for industrial and air-cooling purposes, but a small percentage is combined with reservoir water before being treated for the drinking water supply. What is often seen as a waste output – wastewater – is thus reintroduced as an input and helps the city regenerate its own limited resources.

5.5 REGENERATIVE URBAN TRANSFORMATIONS

5.5.1 REINVENTING ADELAIDE: 2003-2013

An urbanising world requires major policy initiatives to make urban resource use compatible with the world's ecosystems. Metropolitan Adelaide has adopted this agenda and is well on its way to becoming a pioneering regenerative city region. New policies by the government of South Australia on energy efficiency, renewable energy, sustainable transport, waste recycling, organic waste composting, water efficiency, wastewater irrigation of crops, peri-urban agriculture and reforestation have taken Adelaide to the forefront of environmentally responsible urban development.

This process was started by a vigorous move towards efficient resource use and the acknowledgement that it could greatly stimulate South Australia's economy. The reasons are quite simple: a city region that takes active measures to improve the efficiency of its use of resource also reduces its reliance on imported resources. It re-localises parts of its energy and food economy and brings a substantial part of it back home. During a nine-week period in 2003, many seminars and events were held in which a wide cross-section of the population was invited to discuss ways in which metropolitan Adelaide could reinvent itself. The resulting report became the basis for a considerable range of new policy initiatives by the city of Adelaide and the government of South Australia.[30]

The past decade has seen Greater Adelaide adopt many aspects of regenerative urban development. The city now boasts:

- Over 26 per cent of electricity produced by wind turbines and solar PV panels;
- Photovoltaic roofs on 120,000 (of 600,000) houses, and on most public buildings;

Credit: Jeffries, Adelaide. Turning organic urban waste into compost for urban food production is essential in a regenerative city. Adelaide's zero waste policy has actively supported local companies like Jeffries Compost which have become world leaders in organics recycling.

30 Herbert Girardet, "Creating a Sustainable Adelaide," Adelaide Thinkers in Residence, *http://www.thinkers.sa.gov.au/lib/pdf/Girardet_Report.pdf*

- The world's first bus running on solar energy;
- Solar hot water systems mandated for new buildings;
- Large scale building retrofit programmes across the city region;
- 60 per cent carbon emissions reduction by municipal buildings;
- Construction of Lochiel Park Solar Village with 106 eco-homes;
- 15 per cent reduction of CO2 emissions since 2000;
- Water sensitive urban development;
- Three million trees planted on 2,000 hectares for CO2 absorption and biodiversity;
- An ambitious zero-waste strategy;
- 180,000 tonnes of compost a year made from urban organic waste;
- 20,000 hectares of land near Adelaide used for vegetable and fruit crops;
- Reclaimed waste water and urban compost used to cultivate this land; and
- Thousands of new green jobs.[31]

Former premier Mike Rann is now encouraging his successor to take further policy initiatives towards making South Australia into a model city region for the rest of the world.

5.5.2 URBAN RENEWAL IN THE RUHR REGION AND HAMBURG WILHELMSBURG

The International Building Exhibition (IBA) at Emscher Park was initiated by the government of North Rhine-Westphalia with German government and EU funding. It aimed to transform one of the most polluted and environmentally devastated regions of the world and create a wide range of new recreational facilities. The redevelopment has greened a region dominated by brownfield sites, created a more cohesive community, and laid the foundation for the growth of small enterprises, whilst also preserving the region's unique identity.

The Ruhr region covers 4,435 km^2 and is the most populous part of West Germany. Starting in the 1850s, it grew from a landscape of small farms, villages, towns and forests into an industrial centre dominated by mines, steelworks, slag heaps, tenement buildings and railway lines. From 1852 to 1925 the region's population increased tenfold, and the mining and steel industries caused previously small towns to grow into a cluster of large, independent cities. After the 1960s, however, the decline of heavy industry and coal mining in the region created huge areas of industrial wasteland.

A great regeneration effort began in 1989, and the region has been reborn since. Over a ten year period, a partnership between the state of North Rhine-Westphalia, various state agencies and the 17 local authorities facilitated the revitalisation of the region. Additional funding came from developers, private companies and non-profit organisations. The two primary objectives were to give the regional landscape a greener image and to revive old industrial buildings.

Credit: Michael Schwarze-Rodrian: The landscape around the river Emscher, which was an industrial wasteland, has been regenerated into a thriving region in recent years. Many derelict industrial buildings have been turned into cultural centres.

31 Herbert Girardet, "Regenerative Adelaide," Solutions Journal 5 (2012): 46-54.

The transformation has been remarkable. The region is now a green land and some of the previously derelict factory buildings are filled with art, music, culture, commerce and offices. Grassy recreational areas, hiking trails and climbing walls have been sculpted from the previous coal slag heaps. Paths through glades of trees and meadows which link the many different components of the park have been constructed along former industrial roads and railway lines.

A final goal of the project is to clean up the 70 kilometre-long Emscher River, which has been the region's sewer and industrial waste canal since the end of the nineteenth century. For decades the river has been biologically dead, but now underground sewers are being installed to carry sewage and industrial waste water away from the Emscher. Parts of the river have been re-profiled for better flood management and to slow the speed of the currents. Trees and native plants have also been introduced along its banks. All this has improved the water quality somewhat, but at present much of the Emscher is still heavily polluted.[32]

The 53 cities, town and villages of the Ruhr region are independent entities. Occasional attempts have been made to merge them into a single giant Ruhr metropolis but without much success. This is probably just as well, because today the area is a fascinating mix of urban and rural landscapes. Nearly 60 per cent of the territory is farmland and forest, and there are some 3,500 farms in the region.

The IBA and Project Ruhr have never tried to enhance the connection between the cities of the region to their rural hinterland. This approach to regenerative development has been left to the farmers of the region, many of whom have developed thriving enterprises growing vegetables and fruit for local urban customers and, in some instances, developing community supported agriculture projects. Many farms also keep ponies for people from nearby cities. All in all, there is a healthy relationship between the urban and rural areas that could be further developed for mutual benefit.

Urban renewal is also underway in Hamburg, Germany's second largest city. From 2007 to 2013, the district of Wilhelmsburg is being transformed by IBA Hamburg into a cutting-edge and diverse urban environment for living, working, and leisure. It aims not only to offer improved living conditions for its 50,000 residents but also to set the highest possible environmental standards.

In the past, its residents acutely felt the disjointedness that characterised Wilhelmsburg: only a few minutes' journey from the main train station, highways and railway lines cut across the area, leaving a gaping hole. Now Wilhelmsburg Central is one of Europe's largest construction projects and aims to revitalise this inner-city district. The master plan implements a diverse mix of housing, offices, retail, hotels and leisure facilities, dovetailing water, green spaces, trees, and footpaths on 30 hectares of land. In addition to residential buildings and event venues, services include sports facilities, medical clinics and a senior citizens' centre. The new government headquarters of the State Ministry for Urban Development and the Environment will also add to the revival of the core and send a clear signal that the "Leap across the Elbe" is well underway.[33]

This project was also designed to be a showcase for urban energy efficiency and renewable energy. Objectives include:

- Increasing the proportion of renewable energy and energy generated in a move towards '100 per cent renewable';
- Improving energy efficiency through combined heat and power plants as well as a local and regional integrated network management system;
- Reducing energy consumption through high standards of technical building equipment; and
- Involving citizens through comprehensive communication measures and by providing economic incentives for participation.[34]

Research shows that local renewable energy can meet the electricity requirements of all Elbe Island buildings by 2025, and that by 2050 almost all of heating demands can also be met. The IBA projects are a step-by-step conversion to 100 per cent renewable energy that will culminate in a climate-neutral Elbe Island. In the meantime, any energy imports into the city, for example for industrial needs, come from the region rather than distant sources to ensure that income and jobs remain in the area.

The IBA projects for new energy efficient buildings, renovation of existing buildings and the generation of renewable energies are the first steps towards implementing the comprehensive climate protection concept of 'Renewable Wilhelmsburg'. This route, especially the sponsoring of energy rehabilitation in existing buildings, must also be consistently pursued after the IBA ends, so that the vision of a climate-neutral district as a model for the future of the metropolis will become reality.

6. RATE LIMITING FACTORS FOR REGENERATIVE URBAN DEVELOPMENT

32 "Emscher Park: From Dereliction to Scenic Landscapes," Danish Architecture Centre, accessed 3 June 2013, *http://www.dac.dk/en/dac-cities/sustainable-cities-2/all-cases/green-city/emscher-park-from-dereliction-to-scenic-landscapes*

33 "Wilhelmsburg Central," IBA Hamburg. *http://www.iba-hamburg.de/en/themes-projects/wilhelmsburg-central/projekt/wilhelmsburg-central.html*

34 UBC Commission on Environment - Good Practice Database, *http://www.ubcwheel.eu/index.php/gpdb/article/1457*

It is clear that citizens and urban decision makers need to develop a new understanding of the global nature of urban impacts: We all need to realise that *urban* boundaries in a urbanising world have effectively become *planetary* boundaries, that every city needs to preserve and help regenerate its natural resources base, and that there are tangible benefits to be gained in the process.

The above-mentioned case studies are excellent examples for certain aspects regenerative urban development. However, creating truly regenerative cities is an, as yet, unaccustomed challenge for urban, planners, architects administrators and educators. Implementation tends to fall outside the usual remits of most urban policy makers. It is also beyond the horizon of most members of the general public.

The path towards the regenerative city must be supported and institutionalised by the city authorities. It is crucial, therefore, for cities to have dedicated departments concerned with a holistic vision that takes a cross-sectoral approach to combine their findings into integrated decision making processes.

This challenge is more difficult in cities where the privatisation of urban services such as water, energy and waste management has reduced their capacity to create well-integrated urban systems. National governments have to work with city authorities and other urban decision makers to ensure that the triumph of the city does not end up as a global environmental tragedy. Non-governmental organisations play an important role in raising awareness of the critical importance of a reciprocal give-and-take relationship between cities and natural systems, and to stimulate and support the introduction of appropriate policy frameworks.

Due in part to short-term mandates, the action horizons of policy makers and urban administrators and planners tend to be relatively limited. The primary factors limiting the rate of regenerative urban development that need to be overcome are:

- Lack of local knowledge about global urban impacts;
- Departmental silos and inadequate financing arrangements;
- Limited efforts to integrate solutions into existing systems;
- Lack of awareness of new opportunities;
- Privatisation of services companies;
- Political and financial short-termism;
- Low priority for environmental concerns;
- Exclusion of externalities in product pricing;
- Overlap or conflict in mandates between different government levels;
- Lack of consumer pressure; and
- No consistent mechanisms for cities to source solutions.

There is, however, also plenty of evidence that much can be done to bring substantial sections of urban economies 'back home', particularly by more efficient water, waste and energy management, and widespread use RE technologies.

7. CONCLUSION: A ROADMAP TOWARDS THE REGENERATIVE CITY

Cities are a tremendous asset and are often cited as places where solutions to the world's environmental and climate problems can most easily be implemented. As places where people live closely together, cities have the potential to make efficient use of resources. Can we create spatial structures that satisfy the needs of urban citizens while also assuring their ecological and economic viability? Can we create prosperous, just, secure and clean habitats that enable positive human interactions with natural systems?

A fundamental rethink of urban systems design is required to shift from urban systems that damage and degenerate ecosystems to ones that renew and sustain the health of ecosystems on which they ultimately depend.

Creating parameters for appropriate action will involve both political and business decisions – from transnational to national and local levels of decision making. It involves drawing up novel legal frameworks as well as addressing the profit logic of developers and other commercial enterprises.

It is in cities where creativity flourishes and people can interact and engage most vigorously in the search for solutions. The primary task is to find cost-effective ways to make our cities function in an environmentally responsible manner and for long-term perspectives to prevail.

7.1 ENABLING POLICY FRAMEWORKS

In order for regenerative cities to be a reality, enabling policies are needed on all levels of government - local, regional and national. The following recommendations aim to help cities set the required governance parameters to move towards regenerative urban development.

On the local government level:

- Set ambitious and realistic goals;
- Make use of cities networks to learn what cities of comparable size, culture or natural endowments have achieved;
- Set out a roadmap and regular revision of targets to ensure implementation of policy measures. Ensure regenerative development achievements are measured and documented;
- Integrate regenerative urban development measures in all urban policy fields and set up a specialised body or working group to oversee this integration process;
- Aim to get successful policies replicated. Cities should aim for spreading successful policies and actions;
- Make use of a combination of formal, informal, market and organisational instruments to engage as many stakeholders as possible;
- Establish a revolving fund to finance regenerative urban development policies;
- Involve the highest level of local government, such as the city council, and try to lift policy above party politics; and
- Develop public-private partnerships for large regenerative development projects such as major changes in infrastructure systems.

On the regional and national government levels:

- Recognise the important role of cities in the regenerative development transition;
- Provide climate financing for cities, for example by providing funding for innovative model projects on the local level;
- Establish a national regenerative development coordination body that coordinates local, regional, national and international level activities; and
- Establish policy measures such as feed-in tariffs, landfill taxation, green taxes and energy efficiency standards to spur local action.

7.2 BOLD STEPS

Renewable energy, urban agriculture, resource efficiency and renewable energy are all part of the story of creating truly regenerative cities which help to reduce the dependence of on distant ecosystems. If the vision of Ecopolis seems difficult to realise for cities as a whole, green districts are a useful first step. There are quite a number of cities that already have 'eco-districts' as examples of what could be done on a larger scale.

The regenerative development of ecosystems serving large cities and megacities is a tall order that must be pursued with vigour. It is an existential matter to regenerate run-down ecosystems, including watersheds, forests, top soils, and marine ecosystems. As cities continue to burn fossil fuels, they need to find ways to sequester their carbon dioxide emissions through biosequestration in soils and forests.[35] However, the carbon dioxide output of cities is far too large for trees within their territories to be able to absorb. Every year over ten billion tonnes of carbon are discharged,[36] of which four to five billion tonnes are not being reabsorbed but which are instead accumulating in the atmosphere as the primary cause of climate change.

The world's nineteen megacities of over ten million people accommodate less than ten per cent of the world's urban population. The ecological footprint of these vast megacities will invariably extend far beyond their immediate hinterland. They have little intrinsic biocapacity and must rely upon territories elsewhere. A key question which we still need to find answers to is whether these footprints can be reduced to reasonable proportions while, at the same time, cities endeavour to take responsibility for them.

7.3 NEW FORMS OF COLLABORATION

Internationally, cities are increasingly working together in many different organisations and associations to develop and implement policies for sustainable development across the world. There is a growing number of networks, alliances and organisations dedicated to and engaged with these issues, including the World Mayors Council on Climate Change, the International Council for Local Environment Initiative (ICLEI), Energy Cities, C40, and European Climate Alliance, to name but a few. The concept of regenerative cities is implicit in some of their initiatives. The next steps include having regenerative development adopted as a principle integrated in all urban policy decisions in order to future-proof our urbanising world.

There is no doubt that cities cannot possibly act alone to undertake the crucial task of regenerative urban development. Feed-in tariffs, landfill taxation, circular economy legislation, building insulation policies and other policy measures are helping cities to act at the local level. Ultimately, these need to be reinforced by national and trans-national policies and legislation.

35 Herbert Girardet, Miguel Mendonca, A Renewable World. (Dartington: Green Books, 2009)
36 Global Carbon Project (2008). "Global Carbon Emissions Speed Up, Beyond IPCC Projections," ScienceDaily, accessed 3 June 2013, *http://www.sciencedaily.com/releases/2008/09/080925072440.htm*

World Future Council Foundation

Head Office, Hamburg
Mexikoring 29, 22297 Hamburg
Germany
0049 (0)40 3070914-0
info@worldfuturecouncil.org

UK Office, London
100 Pall Mall
London, SW1Y 5NQ, UK
0044 (0)20 73213810
info.uk@worldfuturecouncil.org

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