

Training Materials

For Implementing Smart Cities in Asia and the Pacific
for Inclusive, Resilient, and Sustainable Societies



Smart Eco-Cities

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Training Materials

On Smart Eco-Cities

For Inclusive, Resilient, And Sustainable Societies

Prepared by Justin Hyatt

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Abbreviations

AI – Artificial Intelligence

COP – Conference of the Parties

EDAP – Energy Descent Action Plan

EST Forum – Environmentally Sustainable
Transport Forum

EU – European Union

EV – Electric Vehicle

GDP – Gross Domestic Product

GHG – Greenhouse Gas Emissions

GI – Green Infrastructure

HDI – Human Development Index

LEZ – Low Emissions Zone

NMT – Non– Motorized Transport

MAAS – Mobility As A Service

MoD – Mobility on Demand

MRT – Mass Rapid Transit

SAR – Special Administrative Region (Hong
Kong)

SDG – Sustainable Development Goal

SUDs – Sustainable Drainage System

SUMP – Sustainable Urban Mobility Plan

UN – United Nations

UNCRD – United Nations Centre for
Regional Development

UNESCAP – United Nations Economic and
Social Commission for Asia and the Pacific

UNESCO – United Nations Educational,
Scientific and Cultural Organization

Forward

A very basic recipe for developing a smart eco-city could be as follows: do more good and do less bad. In other words, create a range of actions and policies that put nature, the climate, and human flourishing at the receiving end of action, investments, and regulations within urban leadership. Curtail or eliminate the actions and policies that lead to environmental destruction, carbon emissions, habitat loss, and social degeneration.

This is of course easier said than done. Developing a smart eco-city will always be challenging, and there is the need to manage multiple tensions, as different institutions and stakeholders often have widely different agendas and values. While acknowledging that it is difficult, these training materials offer a way forward, with both practical guidance and an important conceptual framework.

The materials provide a host of guidelines that can support any city, region, or urban project to evolve in the direction of an eco-city. They are the result of an extensive literature review and the careful elaboration of key concepts and best practices today. While there are many key insights into the structures and technicalities of a smart eco-city, importantly, these materials also shed light on the way that we think about cities in general, our relationship to the natural world, and how our own contributions can make a difference.

As planners, designers, architects, academics, decision-makers, civic leaders, urban managers, and consultants – if we seek to engage on a path of transformation toward a more sustainable future, then nature must be embedded in our own approach and philosophy towards cities, the environment, society, and the economy. These materials intend to spur our thinking in new and creative ways.

All of the chapters together provide a detailed review and knowledge base concerning the eco-city framework. Eco-city components can be pursued and realised on their own, or they can be taken in sum to render the full picture of what a smart eco-city is or can be.

Please refer to the recommendations at the end. That section contains a list of fundamental principles concerning eco-cities. Beginning to act on those principles can create a pathway towards greater sustainability and ecological resonance.

This is an exciting time to be working with cities. The state of affairs for renewable technology has advanced significantly. As we find ourselves in the ‘decade of action’ on sustainable development goals (2020-2030), there is ever more momentum and resolve to bring about real change. Urban knowledge, best practice, and a growing cadre of creative practitioners in the urban sector means that we can expect to see important and ground-breaking development in cities in the coming years.

Everyone is invited to take part in learning about, and then embracing a change of culture and an openness to rethinking and redefining our relationship as humans to nature, animals, and the whole living ecosystem. This will be helpful for ordinary citizens, while government leaders, employees, and decision-makers have a real opportunity for setting new ecological standards and demonstrating leadership.

In line with the above, it should be mentioned that it is not always technical solutions which are needed in the first place. What is in fact needed is a conceptual container and a way of thinking and learning that will help to identify the best approach, set of tools, a mental model, and exploratory

path for embarking on an eco-city journey. Selecting a mix of solutions and a process should only happen after a rich and engaging exploration of the topics and terrain related to eco-cities has taken place.

Every location has a different starting point and mix of features and needs; but there is a general framework for eco-cities as well as a rich body of information and knowledge that can greatly support any city working towards these goals.

This training pack complements the Training Materials on Smart cities for Asia and the Pacific, previously published by UNCRD. If the aspiration is to develop a full-fledged eco-city and combine that with the smart-city framework, then it would be advised to make use of both packs of training materials.

The UNCRD welcomes any comments or requests concerning these materials, and encourages their widespread use.

A Challenge for Readers

Decision-makers and urban practitioners are encouraged to pick up a challenge along the way: by learning from the materials and knowledge contained in this resource, you are invited to identify and select areas for growth and transformation – not only in the physical sense of the urban environment, but also in the way that we think about our roles and place in the nexus of urban development and nature. Author and biologist Daniel Christian Wahl encourages us to “*redefine how we see ourselves and our relationships to each other and the rest of community of life on Earth. Only by changing our cultural narrative can we transform our vision of the future, and heal our relationship with life as a whole.*”¹

• 1Wahl, D.C. (2016), Designing Regenerative Cultures



Illustration 3: Climate Protest Dhaka

Introduction

Creating a balanced pathway for human and urban development

It is of fundamental importance that we bring all aspects of urban planning, city life, and environmental protection into balance. Our best chance at preparing for a future where humans and all of life are able to flourish is by creating an equilibrium between the economy, ecology, social, and political systems. This entails openly confronting and delineating any frictions between environmental protection and economic development. Where there are underlying tensions, it is helpful to acknowledge those, while keeping in mind that complex systems will always include a level of uncertainty and unpredictability.²

The vision and underlying principles of the ecological city of the future includes a framework for economic development that is inclusive and supports all parts of the population, in a way that the Human Development Index (HDI) and the Sustainable Development Goals (SDGs) constitute the more important indicators of success, as opposed to the limited framework of Gross Domestic Product (GDP).

Thus, circular and green economic principles, as well as a ‘net positive’ business culture (see section 3.3.2) should be linked to a robust eco-systems and a concerted climate resilience approach along with a decarbonisation trajectory.

In order to actively pursue this path, we may apply the smart eco-city model as the blueprint for achieving the multiple and linked objectives of climate resilience, environmental protection, robust economies and societies, and human flourishing.

In today’s Anthropocene period, industrial practices and capitalist based economic activities have brought us to the limits of what our ecosystem – our life-support system – can handle. It has become painfully obvious that there are planetary limits to economic growth, and we are living in the age of ecological overshoot: when demands made on nature exceed its regenerative capacity. Therefore, any approach that does not include an ecological framework and environmental protection principles is bound to fail.

But we have a choice. If we place ecological principles at the heart of planning and the urban agenda, then it allows a holistic and systemic approach to steer our society and planet in a far better direction; as more cities pursue this agenda, the task becomes easier, helped by success.

These are big questions, and the next chapter in the story of humankind has not yet been written. We are however, facing a critical junction in this story, and a lot depends on how we act now, the steps we do (or don’t) take, and what values and principles we choose to collectively embrace as a society.

Hopefully, the gravity of the situation is gradually being understood, and together with our political leaders, decision-makers, urban planners and creative thinkers, we are coming to the conclusion that

• 2Wahl, D.C., Designing Regenerative Cultures (2016)

the only real way forward is one that is intimately linked with an ecological agenda, based on environmental and climate principles.

The Effects of the Industrial Revolution

In order to understand how humanity in general, and the oftentimes disastrous state of affairs in cities in particular, came to be where they are today, it is necessary to appreciate the effects of the industrial revolution.

The current age in which we live is often called the Anthropocene era, which highlights the human-made consequences of development and environmental degradation. During the industrial revolution, with its origins in Europe but then spreading all over the world, systems of industry and economy expanded rapidly into a capitalist economic system. This involved the terms of production and labour, and facilitated a population explosion, and then the rapid growth of cities, factories, and human settlements. The by-products of pollution as well as conflict and social upheaval were immediately felt, as the previously rural ways of life entered the urban age.

During the initial period of the migration to cities, vast stretches of rural populations were dispossessed through land concentrations, famines as well as wars, with large parts of the population moving to informal settlements on the edge of what evolved into continuously expanding mega-cities. Many of the old industrial cities in Europe and North America have now de-industrialised and shifted to less polluting service and hospitality sectors, yet industrial activities moved to developing economies in South America and Asia. In many parts of the world, the processes of urbanisation and associated human hardships have never abated.

Today, all over the world, landscapes have become fragmented due to expansive human activity and industry: cities keep getting bigger, gobbling up the countryside; more and more roads and highways are built; commercial infrastructure, airports, farms, and factories continue to spread, destroying ecosystems and often adding extra pollution to the waterways. As a consequence, woodlands or wetlands may be surrounded by newly built up areas or arable land and thus lose their connection to the larger wildlife mosaic. The result is habitat and biodiversity loss, as well as a compromising of ecosystem services, which are essential for human populations. All the while humans end up further and further from the natural world.

Therefore, when considering the liveability and sustainability aspect of cities, what needs to be understood are the direct impacts and consequences of unfettered economic, urban, and industrial growth. In many places, this has led to critical levels of supplies and resources, affecting water provision, disaster protection, waste treatment, food production and air quality, among others.

The Eco-city model

If an eco-city framework brings with it the promise to address many of the problems that originated in the industrial revolution, how can we best understand an eco-city? An initial definition was provided by Richard Register in 1987, who described it as *an urban environmental system in which input (of resources) and output (of waste) are minimized*³. Since then, as the concept of eco-cities

3 Register, R. *Eco-Cities: Building Cities in Balance with Nature*; Berkeley Hills Books: Berkeley, CA, USA, 2002.

has gained more traction, the application of the concept and the range of initiatives and projects labeled as eco-cities have expanded. An eco-city is envisioned as a human settlement modelled on the self-sustaining, resilient structure, and function of natural ecosystems⁴. Such cities integrate natural ecosystems into urban areas to accommodate local wildlife and enrich the urban public space experience⁵. The goal of an eco-city is to minimise ecological footprints (biophysical) and maximize human potential (human ecology). This means restoring and supporting the processes that sustain life in the built environment. The eco-city attempts to reduce the impact of human activities on the environment while creating conditions that allow its residents to thrive and reach their full potential. This involves initiatives to restore natural ecosystems, promote sustainable practices (food production, urban mobility, building design), and enhance the well-being of the community. Eco-cities promote a harmonious equilibrium between environmental sustainability, economic prosperity, and social well-being for its residents. This model of urban development is well supported by thoughtful planning, human scale, environmentally-friendly design, and functional development strategies, backed up by eco-city principles.

The smart eco-city

The concept of a smart eco-city was crafted through a fusion of ideas from eco-city, smart city, and the circular city, incorporating natural eco-city elements along with the technical advancements of smart city initiatives, the circular economy, and the principles of sustainable urban development. According to eco-city project developed by the group of five nations including the UK, the Netherland, P.R. China, Germany and France, “*the smart-eco city is defined as an experimental city which functions as a potential niche where both environmental and economic reforms can be tested and introduced in areas which are both spatially proximate (the surrounding region) and in an international context (through networks of knowledge, technology and policy transfer and learning)*”⁶.

The smart eco-city concept serves as an umbrella term for a diverse array of urban-ecological, urban technological, and circular economy ideas for sustainable urban development. This model emphasises the use of renewable energy sources including but not limited to solar, wind, and geothermal energy, design principles, green infrastructure, low-carbon transport and green economic principles, ecological and cultural diversity, as well as environmentally sound policies⁷.

Another reason for using the composite framework of a smart eco-city is due to the fact that the best results can happen when complementary guidelines and frameworks are joined and create a multi-pronged approach and a set of strategies. Taken on their own, both the smart city approach and the eco-city model are rich in content and provide guiding principles as well as actionable items. Taken together, a composite framework has the ability to bring any city to new heights and to create a powerful model for delivering a new paradigm of a competitive and prosperous city, with a built-in

4 <https://ecocitybuilders.org/what-is-an-ecocity/>

5 <https://www.urbanecology.org.au/about/vision-of-ecological-cities/>

6 [https://www.smart-eco-](https://www.smart-eco-cities.org/?page_id=12#:~:text=The%20SMART%20DECO%20project%20has,surrounding%20region)%20and%20in%20an)

[cities.org/?page_id=12#:~:text=The%20SMART%20DECO%20project%20has,surrounding%20region\)%20and%20in%20an](https://www.smart-eco-cities.org/?page_id=12#:~:text=The%20SMART%20DECO%20project%20has,surrounding%20region)%20and%20in%20an)

7 Bibri, S.E.; Krogstie, J. Generating a Vision for Smart Sustainable Cities of the Future: A Scholarly Backcasting Approach. Eur. J. Futures Res. 2019, 7, 1–20.

efficiency and a thriving ecological abundance. It will be up to each locality to determine the right mix of approaches and supporting frameworks.

It should be noted that the overall smart city framework and toolkit has been covered in UNCRD's published training materials for Smart Cities. That can be [accessed here](#).

While the smart city framework is referred to in certain places, the main substance of this training pack concerns eco-city concepts. Therefore, in places the term eco-city is used on its own, but it should be remembered that the overall design and planning can be complemented by smart city concepts.

Decoupling Economic Growth from Fossil-Fuel Consumption

Once we begin to see that many urban areas around the world face complex problems, while at the same time there is a global urgency to combat climate change – while over half of the world's population lives in cities – it can then be seen that a sensible approach would be to tackle these problems at the local level. This provides a way to address local problems, while simultaneously mitigating anthropogenic climate change.

This is where the transition to smart eco-cities, with the stated goals of safety, resilience, liveability, sustainability, and inclusive and dynamic communities, will play a major factor in improving the state of the world's cities as well as the lives of millions of people.

But it is too early to congratulate ourselves, as the adoption of the eco-city model is not a done deal. The detrimental effects that lead to climate change are closely tied to the ongoing burning and consumption of fossil fuels, which has established itself as the principal motor of economic growth, and is difficult to displace.

In order to approximate the eco-city goals, economic activity and industrial production will need to be decoupled from fossil fuel consumption. Yet in spite of globally binding commitments (Paris agreements at COP, among many others) and the fact that scientists the world over are calling for the phase-out of fossil fuel use, this is an industry that is very well funded and is fighting to continue on as long as possible: exploring new resources to extract; new means of extraction; mining and depleting resources; then delivering these in the global energy supply chain, where they get burned and release additional GHGs and other harmful substances.

The political influence of the fossil fuel industry is also quite substantial, with lobbying influences seeking to derail climate and biodiversity initiatives and legislation. In 2022, The Guardian news organisation revealed that the oil and gas industry has reaped a total of \$2.8 billion of profit every single day in the past fifty years. According to the quoted professor Aviel Verbruggen, author of the analysis, such sums of money could “buy every politician, every system” and delay action on the climate crisis.⁸

Climate urgency and the need for a breakthrough moment

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1. [8https://www.theguardian.com/environment/2022/jul/21/revealed-oil-sectors-staggering-profits-last-50-years](https://www.theguardian.com/environment/2022/jul/21/revealed-oil-sectors-staggering-profits-last-50-years) (last accessed July 4, 2024)

Unless we can achieve a breakthrough moment, current practice is hurtling the globe on a crash course leading to GHG emission levels of 450 parts per million (ppm) or higher. This will take global warming beyond the critical level of 2 degrees Celsius. After that, a whole host of interconnected threats unfold. This includes biodiversity and habitat loss, food scarcity, loss of land, mass migration, spread of diseases, extreme weather patterns and sea level rise. This type of disruption to life as we know it would be severe and cause social instability.⁹

There is thankfully a much greater level of knowledge and understanding of climate change today than there was even ten years ago. There is also a wide movement and numerous organisations that are developing ever stronger tactics to disrupt the fossil-fuel based regime. It is often people power, with sometime brave acts of resistance, where pressure is being applied ever more vigorously to make the necessary changes away from unsustainable practices. Yet even the Catholic Pope and the UN Secretary-General have been most vocal about the need to end consumption of fossil fuels. The good news is that renewable energy has also been advancing and has become more affordable and accessible.

The training materials for policymakers, planners and urban leadership

This pack of training materials has been designed as a roadmap and a helpful companion to walk you through all of the details, as well as provide a bird's eye view of smart eco-cities and an explanation of how the underlying methodology can lead to break-through moments in human settlement planning and in creating more robust and resilient cities – better equipped to handle the uncertainties of the future and provide its residents with a higher quality of life.

There is a lot of information contained here on specific aspects of smart eco-cities. This will surely help anyone interested in establishing projects and programmes that incorporate eco-city principles. The hope is that the training materials will function as a compass pointing unmistakably in the direction of a sustainable, ecologically sound framework for creating or managing urban systems and urban development. Each module is structured around a main theme or clustered set of topics. After defining the theme and the purpose of the module, key learning points are provided. Following this is the main treatment, divided into sections. Each module concludes with a set of thought-provoking questions.

There is a logical progression of knowledge, chapter by chapter. Every thematic module builds on the following one, providing the reader with a comprehensive panorama of a smart eco-city model upon completing the final chapter. The **Introduction** establishes the context and explains the necessity and urgency for adopting an eco-city model. **Module 1 – Core Concepts** this module provides an overview of the core concepts of an eco-city, including its constituent features, and the need for a post-carbon road map. **Module 2 – Resilience** discusses resilience as a mainstay of planning for eco-cities, demonstrating an adaptive urbanism model for climate adaptation and mitigation. **Module 3 – Transition** illuminates the objectives and catalysts of an eco-city, and provides a trajectory and a conceptual link between the green industrial transition and an ecological landscape, where the balance is restored between humans and nature. **Module 4 – Integrated Planning** goes deeper into the planning process of a smart eco-city. It provides guidance on the

• ⁹Chatterton P., *Unlocking Sustainable Cities* (2019)

integrated planning approach, while offering an overview of several important schools of thought of relevance to the eco-city model. **Module 5 – Circular Economy** provides an overview of the circular economy, including its key principles. **Module 6 – Circular Economy Action Framework** goes deeper into the Circular Economy concept, providing action items and a springboard for launching circular economy conditions. **Module 7 – Energy and Infrastructure** provides additional details on infrastructure as the backbone of a smart eco-city. It also lists the benefits to the climate and the local population that reaching an advanced stage of an eco-city will bring. **Module 8 – Case Studies** provides best practices related to eco-city concepts, from Asia-Pacific and around the world. The **Recommendations** section is the final chapter, providing a useful and concise list of principles for advancing the smart eco-city model.

For any decision-maker, responsible bureaucrat, elected official, planner, or technician, who has the conviction and the determination to see a real progress made in this area – the good news is that the tools already exist, and a pathway can be created to advance any city in the direction of an eco-city. The basic requirement is to show bold leadership and a steadfast commitment, placing the needs of the community (both local and global) at the forefront of decision-making and policy. If this is done then positive results, at least at the local level, are practically inevitable.

What is our biggest challenge? It is to take real action and to steer our cities towards a more ecologically viable state. This will involve decarbonising our urban societies and economies to a greater extent than has happened so far. It will involve long-term and structural changes, which will fundamentally alter the form and function of the way we live our lives. While that may be unsettling for some people, it is also an extremely important task that we face, and an opportunity to make significant progress towards a safer, healthier, happier, and stronger society.

Knowledge Insight: Biodiversity

Why is biodiversity important? This is a familiar, everyday term. Many people recognise it as a main pillar of the UN Sustainable Development Goals. But perhaps because it has been heard and repeated so many times, it is easy to forget what the term means, or why we need it.

Biodiversity implies the abundance of many different species of living organisms, from the plant and animal worlds. All species are interconnected and a part of the ‘web of life’ and need each other to survive. The greater the variety and diversity of species in a given area, the better the conditions are for survival and maintaining healthy habitats. The opposite of biodiversity can be seen in depleted landscapes, where deforestation or desertification has taken place, as well as in agricultural areas with mono-cropping and fertilizers. These areas have low-grade soil and support fewer species.

Biodiversity is important to the entire living world, and for humans biodiversity is of fundamental importance. We rely on the living world to sustain our own human habitats as well as source food, medicine, and clothes. Forests and vegetation are needed to stabilise the climate. Our economy is dependent on a rich biodiversity. Bees, beneficial insects, and other natural pollinators are essential to our food security. The human sphere is intimately linked with the natural ecosystem. Often it

only takes one link to be removed and cascading effects will kick into motion, with far-reaching consequences.

Yet there is a loss of biodiversity and degradation of ecosystems that is happening at an alarming rate. According to the World Wildlife Fund (WWF) one million plant and animal species are threatened with extinction, and forests are lost at the rate of 27 football fields every minute. Wildlife populations have dropped by 69% since 1970.¹⁰ While the conservation efforts including reforestation, have picked up in recent years, it is not happening fast enough and there continues to be a real urgency, which amounts to a call for action. In many cases, policies and laws urgently need updating, while a tighter regulation of industry is also required. A recent positive example of this is a landmark ruling of the European Union in 2024 that requires the restoring of 20% of the European Union's degraded natural areas by 2030. This includes reversing the decline of pollinator populations (like bees). It also stipulates the planting of 3 billion trees.

We urgently need to protect biodiversity, and this includes in natural spaces in cities as well as outside of cities. Forests, rivers, streams, meadows, parks, flowers, insects, and all variety of animals – when they flourish and have healthy habitats, so do we. Biodiversity and ecosystems are covered in more detail in section 3.6.



Illustration 5: Path leading to the Asia Cultural Centre (Korea)

Module 1- Smart Eco-City Concept

1.1 Purpose of the Module

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- 10WWF website <https://livingplanet.panda.org/causes/> (accessed June 19, 2024)

The main aim of this module is to provide an overview of the smart eco-city concept and its chief constituent elements. It is necessary to understand the underlying values related to the ecological, social, and economic dimensions of a smart eco-city. The adoption of an eco-city model also involves the transition to a post-carbon economy.

1.2 Key learning points

1. An eco-city is defined by a number of key features. These include proximity and local connectivity, where most goods, services, and destinations are nearby; sustainable transportation, with active travel being the easiest way to get around; bio-diversity and the abundance of green spaces; ecological approaches to buildings, construction, and energy.
2. The history of the eco-city goes back to the Garden City model from the early Twentieth century. This inspired many city developments later on, while the eco-city idea became more and more popular towards the end of the Twentieth century. Most larger-scale eco-city initiatives are still in the early stages, while on the neighbourhood scale there are more advanced cases.
3. In order to tackle the threats associated with climate change, an urgent transition process is required to decarbonise the economy and radically reduce emissions. This involves a ‘new urban energy deal’ on the international, national, and local levels.
4. Cities need to engage and prepare an emissions reduction roadmap. This can be a part of a ‘post-carbon challenge’. This entails scrutinising each sector of development and carefully analysing current investment strategies and policies, while seeking to divest from fossil fuel related projects and reinvest in renewables and green infrastructure.
5. The constituent aspects of a smart eco-city, as covered in this chapter and throughout these training materials include green building and green space; local and sustainable material use; urban history and cultural heritage; low-carbon, sustainable transport; better public space; compact land use; sustainable patterns of energy, water and material consumption; good urban governance and leadership; protected landscape, urban ecology, biodiversity and coastal areas.

1.3 Background

An eco-city thrives on nature and green infrastructure. It derives its inspiration and value system from ecology. It is naturally green – with trees, parks, abundant vegetation, and is rich in biodiversity. It also contains blue infrastructure such rivers, lakes, and canals. There are numerous attributes of an eco-city, including renewable energy and a strong pushback against pollution, carbon emissions, unsustainable practices (such as an over-reliance on motorised travel) and predominantly grey infrastructure (conventional buildings, concrete).

When thinking about an eco-city, we should realise that the term ecology and its companion term economy together envelop pretty much every aspect of life. There is an endless wealth of ideas, initiatives, room for growth and for transformation. Dealing with the topic can range from involvement in a small, one-time project to a lifelong dedication to environmental protection or working towards the highest manifestation of an eco-city.

Eco-cities make up a rich and exciting subject matter, in addition to being a growing field of action and work. Humans will continue to devote time and effort to realising eco-city objectives for many years to come. Hopefully, numerous meaningful achievements and milestones will appear as bright spots along the way.

1.4 Eco-city Vision and Values

Understanding the basic definition of an eco-city (as discussed in the previous module) points to an eco-city having all of the right things – like green infrastructure and an abundant presence of nature, while systematically removing destructive and harmful practices – such as toxic and polluting industries, the negative externalities of transportation or fossil fuel consumption. Embracing ecological values and implementing green initiatives bears the hallmarks of an eco-city philosophy.

Yet an eco-city is more than just the aggregate of all of its green elements. An eco-city is defined by key values that are purposefully chosen, in addition to a number of basic features.

According to Ecocity Builders, a US based organisation that is one of the strongest global champions of the eco-city movement, a defining feature of an eco-city is *proximity*. That is, residents can reach all important destinations easily, and within a short time. Organising society and the economy on the local level, thus at a small scale, is a promising start for an eco-city, allowing for resource consumption to be kept modest.

Hand-in-hand with proximity is sustainable transportation. In an eco-city the most common way to get around is by foot, by bicycle, or by public transport. A well-designed eco-city makes it simple and cheap for residents to do their daily business, get to work or school, do shopping or connect to leisure areas, all without needing to use the automobile. As will be explored later on, an eco-city prioritises active mobility, public transportation, and high-quality public space, with ample pedestrian zones and green areas.

At the heart of an eco-city is a healthy, vibrant community. When planning for an eco-city, the health and well-being of its residents needs to be a central theme, as well as the resilience of social systems and amenities. The hardware of a city – its infrastructure and service provision – is only meaningful if a strong community life has been facilitated, and the given population has all it needs in order to flourish and lead dignified lives.

Once these pieces are in place, there are a whole host of other factors that complement and round out the smart eco-city framework. This includes food production and food security, energy production and consumption, as well as decarbonisation and net zero standards. Biodiversity, abundant green spaces, and the human co-existence with other species are all central features. Likewise, ecological construction practices, the heating and cooling systems of buildings, as well as climate change adaptation measures and resilience are all important components. The capacity to defend against and respond to natural disasters is crucial, with the management, containment, and provision of water and precipitation a key feature.

All of these principles and more are featured in this guide. What stands out is an approach and vision that starts with an ecological foundation, a respect for nature, and a balancing of human and

natural systems. This comes with a reduction or removal of the harmful factors caused by and negatively affecting human civilization.

It is stepping away from business as usual, and from the standard practices of unsustainable urbanisation, and moving towards a more sustainable model, which helps to establish the factuality of the term and attribution of 'eco-city'.



Illustration 6: The Matrimandir, in Auroville, India

1.5 A brief history of eco-cities

We can trace an early example or influence of eco-cities to the Garden City movement, which was spearheaded by the pioneering urban planner Ebenezer Howard, in the early part of the Twentieth Century. The original objective of the Garden City model was to create cities with ample green space, as well as greenbelts between satellite towns. The hope was to include the natural benefits of the countryside while still providing medium-dense cities, and avoiding many of the negative externalities of the polluted cities of the day.

The Garden City movement had first developments in the UK, with Letchworth (near London) becoming the first Garden city. The ideas of Ebenezer Howard and his associates influenced the New Town movement, while numerous cities around the world incorporated Garden City concepts. This ranges from Yamato village and Omiya Bonsai village in Japan, to Da Lat in Vietnam, Zlín in Czechia, Wekerletelep (a suburb of Budapest) in Hungary, several suburbs of Cape Town, in South Africa, and many more locations throughout the world.

In the middle of the Twentieth Century, other conceptions of eco-cities began to take shape. One noteworthy pioneer in this field was the Italian-American architect Paolo Soleri, who was called

one of the godfathers of the eco-city movement¹¹ and who created the experimental and futuristic town Arcosanti, in the desert in Arizona. Arcosanti was designed to be car-free and close to nature. While the population was never very high, it attracts a lot of visitors and students from around the world.

Later on towards the end of the Twentieth century, and the early part of the Twenty-first century, many new eco-city initiatives sprang up. In particular the PR of China has seen a large number of announcements of eco-city developments. Notable among them is Caofeidian, 250 km south-east of Beijing. A well-known example from the Middle East is Masdar City, in the United Arab Emirates. In 2021 Saudi Arabia announced the development of The Line, which was initially designed to be 170 km long, with a population of 9 million, and no cars or streets, and zero carbon emissions.

It is still too early to assess the success of many of these developments. Some have had to change course after their initial planning, and others (like Masdar) are growing slowly.

The town of Auroville in India is noteworthy, as it was specially planned to serve as a retreat from crowded, modern civilization, and exist for idealistic persons, and to achieve human unity. It also sprang out of the Garden City movement, and it contains abundant green space.

One successful example from Germany is the largely car-free neighbourhood of Vauban, in the city of Freiburg. This urban development has come to be seen as one of the most successful modern town developments that incorporate eco-concepts, car-free design, and other features.

Finally, it should be noted that the organisation Ecocity Builders (founded by Richard Register), based in San Francisco, serves as the best-known international organisation that is concerned with furthering the cause of eco-cities. Ecocity Builders has been continuously organising international summits since 1990.

1.6 Putting in motion a transition process

While most climate scientists stress the fact that it is not too late to change course, the vast majority are urgently trying to warn humanity that the current trajectory, involving the unsustainable consumption of fossil fuels, must be transitioned away from rapidly, if we are to avoid the climate spiralling out of control and the increasing frequency of environmental catastrophes, including hot weather events, flooding, and super storms.

In terms of the UN's Sustainable Development goals, the current decade has been described as 'the decade of action'. This is based on the fact that enormous changes to industry, energy, transportation, urban management, and daily life are urgently needed in order to prevent the worst scenarios of climate change from becoming reality, while also fundamentally grappling with urgent issues facing humanity, including poverty, health issues, conflict and the basic requirements to living sustainably and prosperously.

Kevin Anderson of the Tyndall Centre for Climate Research (UK) is a long-term advocate for radical emissions reduction strategies. According to the research, at the current levels of economic growth (1-2 percent) it would require huge leaps of efficiency to offset embedded emissions. Since

11 Mollela, A., Eco-city Update: From Idea to Reality, <https://invention.si.edu/eco-city-update-idea-reality>

this is not very feasible, the challenge is to develop a steady-state, or even de-growth, economic agenda into a palatable social deal that still ensures relative levels of prosperity.¹² The implication of this is that the kinds of urban decarbonisation required would radically transform current social and economic systems. At the end of the process, the emerging system will be very different from the one left behind.

A new urban energy deal is urgently required, if we are to tackle the challenges of climate breakdown, resource scarcity, social injustice and ensure a good level of development for a growing human population. The experience with the Covid-19 pandemic demonstrates the fact that resources can be harnessed and swift action taken in order to combat a public health emergency and disruption of high magnitude. That level of mobilisation and even more are required now.

Paul Chatterton, professor at Leeds University (UK) and author of *Unlocking Sustainable Cities*, put the task in these terms: ‘post-carbon city challenge’. This involves an energy challenge that goes significantly beyond technical or infrastructure tweaks. The post-carbon city will need to embrace wide-scale change at the level of politics, culture, economy, and organisational structure. Energy will need to be wrapped up in a different set of values. Energy systems should create a common good and a flourishing of life for all, and not continue to be attached to a non-renewable energy regime that benefits wealthy multi-national companies or powerful global elites.¹³

1.7 Emissions Reduction Road Map

In 2013, the Intergovernmental Panel on Climate Change (IPCC) laid down the scale of the challenge through global carbon budgets. Humanity should only emit a further 800-1,200 billion of tons of carbon, to stay within safe limits of global temperature increases. That computes to 50 billion per year, which means that by approximately 2038-2040, the energy transition needs to be completed.

The post-carbon challenge for cities implies the need for each city and region to introduce emission reduction road maps. These road maps need to insure that GHG emissions are reduced to 350 ppm, or by 100% by 2050, relative to the 1990 baseline. These should harmonise with any existing nationally binding commitments and targets.

A big part of the challenge involves a concerted drawdown of fossil fuel use. This is why a road map is necessary, since the adoption of new technologies and transitioning to a post-carbon economy takes time yet requires a firm policy in place with a continuous improvement being recorded and yearly targets being met.

Another part of the road map is the economic analysis of municipal budgets and the related fiscal policy. The financing of the diverse portfolios has to be scrutinised. In those instances where investments are heavily entrenched in fossil fuel related activities, these need to be re-thought. Subsidies and exemptions involving fossil fuels need to be targeted for revision, with finances freed up for reinvestment in the renewables sector and the circular economy.

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- 12Chatterton P., *Unlocking Sustainable Cities* (2019)
 - 13Chatterton P., *Unlocking Sustainable Cities* (2019)

1.8 Fundamental pillars of an eco-city

The remainder of this module explores the many benefits of the eco-city model, in relation to fundamental pillars (key areas) of the eco-city. It is helpful to categorise the aggregate benefits into three broad categories: A) Reducing emissions, B) Creating a healthy and liveable city, and C) Increasing ecological design and biodiversity. These three categories of aggregate benefits are applied to a number of eco-city pillars, such as the built environment, transport, heritage, governance, and ecology.

Table 1 Pillars of an Eco-city and their Potential Impacts

Potential impacts are listed as Very High / High / Medium. The weighted impacts are indicative and may vary, based on local conditions, instruments used, and quality control

	Reducing emissions	Healthy and liveable city	Ecological design and biodiversity
Green Buildings	<i>Very High</i>	<i>High</i>	<i>Very High</i>
Local Materials	<i>High</i>	<i>High</i>	<i>Very High</i>
Urban History and Heritage	<i>Medium</i>	<i>Very High</i>	<i>Medium</i>
Low-carbon Transport	<i>Very High</i>	<i>Very High</i>	<i>High</i>
Better Public Space	<i>High</i>	<i>Very High</i>	<i>High</i>
Compact Land Use	<i>Very High</i>	<i>High</i>	<i>Very High</i>
Energy, Water, Materials	<i>Very High</i>	<i>High</i>	<i>Very High</i>
Urban governance, Leadership	<i>High</i>	<i>Very High</i>	<i>High</i>
Urban Ecology	<i>Very High</i>	<i>Very High</i>	<i>Very High</i>

1.8.1 Green Buildings

Next to transportation, buildings make up one of the most carbon-intensive aspects of cities. Buildings require energy to power, heat and cool. Many buildings are also highly inefficient in their operations and use of energy. Additionally, the construction process of buildings is highly polluting. However, the built environment is one of the most exciting areas for innovation and for creating better cities. Ecological methods of construction can be used and there are numerous ways for improving the energy metabolism of buildings.

1.8.2 Local and Sustainable Material Use

The most organic and carbon-neutral way to provide materials for buildings as well as for other products is for them to be prepared locally, using sustainable materials. This is the hallmark of a local economy. In this way, the transport emissions can be reduced or completely removed, by no longer needing to import bulk materials from distant areas. The benefits to the local population are large, with artisans, merchants, and consumers all able to profit from a strong local economy.

1.8.3 Urban History and Cultural Heritage

The history of any urban area is made up of the people who live there. One of the biggest needs of cities today is to embrace a more inclusive model of planning, one that ensures that all parts of the population, including racial, religious, and cultural minorities, as well as every socio-economic class, are equally well served and supported. Beyond that, cultural heritage and values can play an important part in revitalisation projects, and in allowing for the local culture to flourish. The importance of a strong local culture feeds the resilience that a community has and fosters stronger social ties.

1.8.4 Low-carbon Sustainable Transport Development

Urban mobility is an area where changes to the system can bring immediate effects. A smart and sustainable eco-city will be marked by low-carbon transport. This means that cycling and walking should be the easiest and simplest ways to travel for short distances and public transportation serves as the preferred way to reach destinations further away. An important co-benefit of active travel is having a more physically robust population, with lower incidences of sickness. Private automobile use should be kept to a minimum in an eco-city, and where possible, discontinued.

1.8.5 Better Public Space

The flip side of switching to sustainable modes of transport is the fact that a lot of space can be reclaimed from automobile use and provided as public space. It is also an opportunity to convert grey concrete into green spaces. The provision of quality and inviting public space and urban greenery is what makes any area liveable and pleasant. It makes local community life vibrant, and it makes a city attractive, which can also be a boon for tourism. There are dual benefits of improved streets and public space, such as allowing for ecosystem services and the elimination of the heat island effect, urban canyons, or the better management of flooding. Public space is also where the introduction of blue and green infrastructure can take place: parks, meadows, trees, forests, rivers, lakes, canals, and more.

1.8.6 Compact Land Use

As a part of the transition to an eco-city, the land use plan needs to be upgraded in a way that removes a number of inefficient practices – such as providing parking spaces to automobiles that are parked for 95% of the time. Compact land use, with a given threshold of population density is required to organise adequate public transportation systems, as well as enable shorter distances. This is where the 15-minute city can be easily achieved. It should be noted that parking and road

use for automobiles is the least efficient and most expansive form of land use, which will need to be curtailed in the transition to smart eco-cities.

1.8.7 Energy, Water and Material consumption

The energy *inefficiency* of the current building stock has already been mentioned. There are many avenues for opening up the landscape to renewable energy. It is necessary to support a balanced system with an energy metabolism that includes the natural energy and is responsive to weather fluctuation. Cities in the modern era have tried to insulate inhabitants from nature and the outside world, whereas the goals of the eco-city would have its inhabitants live in greater union with nature. Water is particularly important, as many cities have inadequate provisions for water supply or for dealing with incidental flooding and weather-related disasters. There are ways to address this in harmony with a post-carbon approach while limiting risk and extra costs.

1.8.8 Good Urban Governance and Leadership

Quality urban governance and stewardship allows inhabitants to reap the benefits of a more sustainable and amenity-stocked system, with benefits accruing for everyone. The hallmarks of good leadership can be seen where ideas catch on and are replicated in other cities and countries. Bold leadership means that the right measures can be taken and implemented even if there is initial opposition. This is where creating political capital is necessary to push change. But it should also be understood that the best format of governance is not command and control, but participatory, welcoming the active involvement of citizens, and encouraging participation and feedback. This greatly supports the model of adaptive capacity and fine-tuning numerous aspects of urban planning in an iterative development process. The reason for this simple: there is a greater quality and quantity of information and shared intelligence with meaningful feedback loops.

1.8.9 Protected Landscape, Urban Ecology and Biodiversity

What would an eco-city be without the preponderance of nature areas and urban ecology? This is where the integration of human society and the natural world can take shape. The current ratio of green areas in cities is woefully inadequate. In an eco-city the direct proportion of natural areas is of great use and value. This is especially important for coastal areas, as these experience heightened risk related to climate change. Decarbonising society is especially significant here, since the extent of sea level rise and the intensity of disruptive weather incidences and storms is directly related to the carbon emissions levels. Furthermore, all natural systems as well as biodiversity, including plant, mineral, and animal life, need full protection. In those areas where nature has been degraded, a regenerative approach, centred on nature restoration, is the key planning co-efficient.

1.9 Questions for Trainers

1. What are 3-5 key features of a smart eco-city?
2. What are the main reasons that proximity and urban transportation are central features of an eco-city definition, and are key levers to transitioning to an eco-city?

3. Of the known eco-city examples, which one stands out most and why? What can we learn from the slow process of bringing eco-cities to maturity?
4. Why is a decarbonisation plan urgently needed, and how can that be integrated with a city's urban planning process and investment cycles?
5. What are the underlying values of an eco-city and how is this different from current practices and policies in cities around the world?
6. How is good governance and leadership essential for achieving a sustainable eco-city model? Why should participation be included in the governance model?



Illustration 7: Bioswale (photo by Erica Fischer)

Module 2 Eco-city and Resilience

Bouncing forward towards the great street of the climate change era needs to be one of the central goals of urban resilience and requires planning for both the movement and place functions of streets.

2.1 Purpose of the Module

The aim of this module is to explore the concept of resilience, and how a newer approach to resilience planning can benefit communities as well as the climate. Using the methodology of adaptation urbanism, streets serve as the focal point of intervention, in particular related to green and blue infrastructure. The combined goals of climate adaptation and climate resilience are a part of this framework.

2.2 Key learning points

1. An updated version of the concept of resilience helps us to see that following disruptions it is better not just to bounce back to the way things were, but to be able to bounce forward to a more desired state.
2. Adaptation urbanism is the approach to urban planning that factors in resilience, and places dual emphasis on climate adaptation and climate mitigation.
3. The street is the level of urban infrastructure that is best suited for interventions that can make a neighbourhood or a city more resilient. Chief areas of intervention relate to transportation and water management.
4. Coastal cities around the world face an especially high level of risk, uncertainty, and precarity. With the current predicted levels of sea level rise and climate-related weather disturbance, coastal cities will be impacted severely.
5. A climate mitigation and adaptation approach of resilient streets, based on the upgrading or instalment of new green and blue infrastructure, can have profoundly positive effects on the future of all cities, and in particular coastal cities.
6. In order to be well prepared for the future, cities should engage in scenario planning, taking into account global climate and biodiversity related trends as well as local conditions, needs, and opportunities for increasing the levels of urban resilience and sustainability.

2.3. Background

The traditional approach to resilience planning involves setting up frameworks to prepare an urban system for being able to deal with shocks and disruption, enabling it to return to a steady state as soon as possible once the disruption has been dealt with. However, newer definitions of resilience include more than just being ready to face natural risks and unpredictable events.

According to updated versions of resilience planning, it should also be possible to *bounce forward*. Following a disruption to the neighbourhood order, be it an earthquake, flood, or health pandemic, once a reconfiguration of the system has taken place, it might not be so attractive to bounce back to the state things were at before (which might include polluted and broken infrastructure,

• 14Fields B., Renne, J.L., Adaptation Urbanism and Resilient Communities (2021)

unsustainable traffic volumes, etc.). Cities and neighbourhoods could instead bounce forward to a more desirable state.

This would help to make local neighbourhoods more liveable places, and is fully in line with a smart eco-city philosophy. Dr. Billy Fields and Dr. John Renne (2021) have centred the level of analysis for resilience planning on that of the street. This is where urban infrastructure intersects with policy and planning: implemented policy changes for urban design could have significant impacts on local liveability and sustainability, as well as net benefits for climate mitigation.

Resilience planning at this level provides the opportunity to rethink the role of streets in the urban fabric. Fields and Renne have termed this process of planning as ‘adaptation urbanism’ which is responsive to both climate mitigation and adaptation.¹⁵

2.4. The Precarity of Coastal Cities

Coastal cities are increasingly finding themselves in a tight place. At a time where climate change impacts are being felt in many parts of the world, coastal cities face a particular threat: sea level rise, as well as other water related issues, in particular storms, cyclones, and tsunamis. No further proof of the severity of the threat is needed than to consider the case of Indonesia. In 2017 the Indonesian government announced that it would relocate the capital from Jakarta, threatened by sea level rise, to a new capital city – Nusantara, on the island of Borneo. Numerous Pacific islands are currently facing the threat of sea level rise and potential submersion. In the USA, the most precarious city from this perspective is Miami, Florida.

There have been calls for measures to contain global warming to a 1.5°C average increase in global temperature by 2030–2052 (IPCC 2018). This corresponds to a rise in sea levels of 30–60 cm by the year 2100 (IPCC 2019). However, this goal will not be reached without wide-scale adoption of low carbon lifestyles.¹⁶

The policy challenge for coastal urban planning is to adapt cities to withstand projected sea level rise (and other climate impacts) while also targeting the decrease of greenhouse gas (GHG) emissions. According to a study of US cities, rapid and significant drops in carbon emissions would ensure that many hundreds of US coastal cities steer clear of extreme climate change scenarios. In the same way, many more coastal cities around the world would likewise escape the worst-case scenarios.

At this point in time extreme weather events are rapidly increasing every year. According to the NOAA National Centers for Environmental Information, the ten warmest years in the 174 year record of measuring global temperatures all took place between 2014-2023.¹⁷ Not only has the average global temperature been increasing every year, so have the number of extreme weather events, including super storms and floods.

As it is becoming increasingly obvious, the differences between various possible outcomes related to global warming should be taken very seriously. In many cases, it could mean the difference

• 15Fields B., Renne, J.L., *Adaptation Urbanism and Resilient Communities* (2021)

• 16Chatterton P., *Unlocking Sustainable Cities* (2019)

17 <https://www.climate.gov/news-features/featured-images/2023-was-warmest-year-modern-temperature-record>

between life or death, or major disruption to urban areas, plunging a region into turmoil, and unleashing new waves of climate migrants. When these scenarios are properly understood, the implications for setting appropriate policy frameworks and decarbonisation laws should become clear.

2.5. Mitigation and Adaptation

Resilience planning, as a part of adaptation urbanism, is a way to combine climate change mitigation with climate change adaptation. This policy approach displays tangible benefits at the street level, namely at the nexus of water and transportation.

For instance, if low-carbon transportation options incorporate green and blue infrastructure and provide public spaces with enhanced pedestrian amenities and with technical solutions to minimise flooding, then this creates a beneficial scenario for the city as well as for local residents.

According to Fields and Renne: *“These changes achieve important climate policy goals and, importantly, create new neighbourhood amenities that improve the quality of life for residents. ... if this process is strategically managed with broad citizen engagement, it can help to create the political capital necessary to create momentum for change. We define this movement as adaptation urbanism, where streets and public spaces are redesigned to manage and minimize climate impacts and enhance urban quality of life.”*¹⁸

Within this framework, resilient streets (treated in the next section) act in a way that can decrease GHG emissions, and these are coupled with adaptation measures. It is highly beneficial to include and link both adaptation and mitigation in the same policy framework and planning agenda. Without adaptation measure in place, cities will be ill prepared to handle many of the exacerbated effects of climate change. Yet mitigation measures are equally needed in order to stave off even worse climate impacts.

2.6. Resilient Streets

Resilient streets have a movement function that should be designed to limit GHG emissions (climate mitigation) and a place function that helps to create more liveable communities that better manage water, heat, and other changing environmental conditions (climate adaptation). The design challenge for streets is to provide the safe movement of people and limit GHG emissions, while also creating liveable places that help to manage water through green and blue infrastructure.

There are many kinds of interventions available within a resilient street framework. The starting point should be with transportation, with active forms of mobility (cycling and walking) to be prioritised. Inclusive design methods ensure that active travel modes cater to all parts of society – the elderly, children, people with handicaps. Enhanced street safety features, such as wider berths for pedestrian flows, lighting and signage can all contribute to this. Automobile parking spaces should be limited, and best kept to the periphery of neighbourhoods, so as to discourage driving.

• 18Fields B., Renne, J.L., Adaptation Urbanism and Resilient Communities (2021)

Cycling routes should be ample in width and well connected to all parts of the city. Both walking and cycling spaces should have easy access to public transport nodes.

According to Fields and Renne, Vision Zero (no traffic deaths) can be incorporated with green infrastructure to produce resilient streets, as the graph below shows.¹⁹



Figure 1: Resilient Streets model by Fields and Renne

Blue-green infrastructure is an essential feature of resilient streets and climate adaptation and mitigation. As this fits to the infrastructure backbone of cities, it is discussed more thoroughly in Module 7. Yet blue-green features are multi-dimensional and are essential to the development of an eco-city. As thus, discussion of blue and green elements appear in numerous places in this manual.

2.7. Community Engagement

There is no one perfect, technical solution to street interventions, but instead a process of engagement where communities co-create policy solutions that fit local conditions and create places with long-term cultural value. This can be called ‘negotiated resilience’ which is a long-term approach towards creating and shaping urban spaces in a collective manner and with benefits to the widest possible population.

This is also supported by the concept of ‘topophilia’ which is the affinity for and the love of place – one’s street, neighbourhood, or city. Carlos Moreno, who is credited with originating the ‘15-minute city’ concept, explains that “topophilia as a collective tool is an instrument which allows us to channel our affections towards places, around a common frame of life ... because by thus being aware of where we come from, we then help shape where we are going”²⁰

A city with residents satisfied and proud of their cultural heritage and their streets will make the task of urban management and cohesive community life much easier to manage. The community are natural allies for the local administration and can help to facilitate the introduction of new policies, and at the same time contribute to its social cohesion. These are good reasons for investing in topophilia.

Furthermore, there is a wealth of information with the community. Individuals and communities know best what functionality they require, and what type of infrastructure they are attracted to. It

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- 19Fields B., Renne, J.L., *Adaptation Urbanism and Resilient Communities* (2021)
 - 20Moreno, C., *Urban Life and Proximity at the Time of Covid-19* (2021)

might be parks, waterfront development, playgrounds, sports facilities, or tranquil spots that have a soothing and restorative effect on the visitor. If the local government or developer is listening to the community and involving them in the process, the delivery of green infrastructure or other amenities will be far more successful. By involving the community, the planning fallacy of mistaken assumptions about what the citizens will in fact use can be avoided.

2.8. Scenario Planning

Another important feature of resilience is to engage in scenario planning, which is akin to advanced planning strategies, where various future climate change and local resilience scenarios are taken into account, and are paired with a range of interventions. with knowledge of local conditions and needs.

Scenario planning should include the stated commitments and objectives that relate to policy features and future goals. Every area has a different starting point, thus the knowledge of local conditions are paramount, as well as the current place on the trajectory of a city’s development. This range of planning operations builds confidence and helps a city and local communities to foster a sense of being prepared for an uncertain future.

The topics and areas for intervention listed in Table 2 can be useful for inclusion in scenario planning. There are certainly others that could be added. It is finally up to each city and region to target the most important sectors that require advanced planning.

Table 2 Scenario planning

SECTOR	SCOPE FOR INTERVENTION
Climate mitigation strategies	Decarbonisation and curbing emissions, renewable energy, porous surfacing, green infrastructure
Climate adaptation and disaster preparedness	Contingency planning, multi-sector interoperability, smart early warning systems, water retention and Sustainable Urban Drainage Systems (SUDs)
Social justice and inclusiveness	Community resilience strategies, health and economic inclusiveness audit, job training programmes, community place-making and urban commons approach, participatory budget
Vision Zero (no traffic deaths)	Street transformation and safety upgrades, traffic calming, circulation plan, pedestrian zones, active travel plans
Local economic resilience	Sustainable food and local agricultural programmes (urban farms), sustainable tourism programmes, cooperatives, co-creation hubs
Decarbonisation plan	Renewable energy, Energy Descent Action Plans (EDAP), Civic energy, Low Emission Zones (LEZ)

Eco-city and green agenda goals	Green Infrastructure (GI), Biodiversity agenda, rewilding, multi-sensory natural environments
Smart city elements and efficiency	Smart electric grid, variable energy production and storage, smart civic information and communications system

Climate change scenarios need to be carefully studied. Even as there is uncertainty on the global scale as to what the exact nature and extent of changes will be to the earth’s biological systems, weather systems, and planetary well-being, it is important for urban management to prepare for the full scale of possible outcomes.

There are various ways of planning for possible future scenarios, and many practitioners have devised systems or frameworks. David Holmgren, permaculture pioneer, detailed transition strategies in relation to climate breakdown and the end of cheap fossil fuels. He explains how different scenarios ensue, with some worse than others, if climate change is more severe, or if countries, cities, and communities do not prepare adaptation strategies well enough or delay too long. As one of the threats of climate change is the resulting social conflict, scenario planning can help to identify opportunities to limit the worst effects.

According to Paul Chatterton, scenario planning is now widespread, but it is important to realise that such approaches always reflect inbuilt assumptions and ideologies, as well as associated theories. It is thus important to work with scenario planning that most closely matches shared values and that have proven useful over time.²¹

As can be seen from this, fostering resilient societies and social cohesion is just as important as having renewables technology for energy, and technical solutions for dealing with disaster events.

2.9 Resilience Planning and Disaster Preparedness

Ways to deal with natural disasters and unforeseen events are a part of resilience planning. One of the key concepts of resilience planning is to be in a good position well in advance of any unforeseen events. Thus, a good starting point for being prepared and able to mitigate the potential damage and severity of such events is through preemptive urban design.

For example, extreme heat events are becoming more and more common around the world, leading to public health problems as well as drought, food shortages, water scarcity, fires, and more. An early stage mitigation plan could include redesigning streets with porous paving, installing more parks and greenery, and thus reduce the heat island effect. This will in turn reduce the public health threat of extreme heat, and also mitigate the emissions and provide further amenities.

As extreme heat events in particular have become more common, the importance of shading should be mentioned here. Trees provide natural shading, while canopy shading can also be set up streets with lots of pedestrian activity, or market areas. Shading can help lower the on the ground temperatures, while also reducing the possible health consequences for vulnerable people. In

• 21Chatterton P., *Unlocking Sustainable Cities* (2019)

particular, outdoor playgrounds require shading – not only in hot climates, but even in temperate climates that have hot summers.

Further resilience planning for unexpected events can borrow from smart city concepts. Sensors as well as fast communication and early warning options are all ways to create a greater level of resilience and preparedness. It is important for the city government to set up communication channels with the population at large, using well-established formats that are trusted by the population and easy to use.

Additional resilience comes when multiple departments and agencies are able to work closely together. The following agencies or institutes should be easily accessible to each other, while also coming together on a regular basis as a part of sub-committees or working groups. Note that this is an indicative list:

- Mayor's office
- Weather and meteorological institutes
- Fire department
- Police
- Hospitals and emergency responders
- Parks and Recreation
- Municipal Urban Planning department
- Smart City department
- Water management
- Transport management
- Climate scientists

Disasters and unforeseen events will always occur. It is important to realise that with the right foresight and preparedness, these situations can be planned for, and once they happen, a response can take place quickly, with damage to person and property kept to the minimum.

2.10. Questions for Trainers

1. What are some of the direct benefits for a city that adapts a resilience model on 'bouncing forward' in the event of recovery from a natural disaster?
2. For a city to be fully equipped to face future uncertainties in a changing climate, why would a combined approach of climate adaptation and climate mitigation be of service?
3. Given the goal to transform the function and design of a street or neighbourhood, what are five possible interventions, related to either transportation or water management?
4. How could supporting a greater cultural attachment and identification by the local community with their neighbourhood and city help to develop a higher degree of resilience?
5. How would undertaking the project of mapping out possible future scenarios and preparing an appropriate level of response for each scenario benefit a community as well as its leadership?



Illustration 8: Gardens by the Bay, Singapore

Module 3 – Pathway to an Eco-city: Objectives and Catalysts

My reasons arise from my delight in the marvels of nature, its richness and its limitless capacity to surprise; from the sense of freedom of the thrill that comes from roaming in a landscape or seascape without knowing what I might see next, what might loom from the woods or water, what might be watching me without my knowledge. It is the sense that without these animals the ecosystem is lopsided, abridged, dysfunctional²² – George Monbiot

3.1 Purpose of this Module

In the transition to an eco-city there are several interlinked and overlapping stages that correspond to specific themes and action areas. These are: A) Green economic transition B) Ecological landscape and C) Human-nature balance. Each of these areas has its objectives and catalysts that

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- 22Monbiot, G. (2013) *Feral: Rewilding the Land, Sea and Human Life*

enable the progression towards a mature eco-city. In supporting this transition, the regenerative approach and a focus on biodiversity play fundamental roles.

3.2 Key Learning Points

1. There is an immediate need to transition to a green economy, which entails decarbonisation on a massive scale of industry and economy. The effects of this will be seen in the reduction of greenhouse gases and a restoration of ecosystems and human health.
2. Economic programmes like the Green New Deal or key legislation initiatives have the opportunity to incentivise green economic activity and directly fund major projects.
3. An eco-city is defined by the close proximity of nature and the built environment, with green and blue infrastructure featuring prominently. Biodiversity is at the heart of this program, delivering multiple benefits to all of society.
4. The full scope of a smart eco-city, beyond biodiversity and blue-green infrastructure, includes a number of key supporting components. Such as: active mobility and network of paths and streets for walking and cycling; security and safety; resilient communities and active citizen networks.
5. Given eco-city conditions, a new human-nature relationship emerges. This is where biophilia comes in, which allows for a newfound love for nature, including the many benefits that brings, including to human health, a lowering of stress levels, and much more.
6. Biodiversity is under threat due to different factors, in particular intensive agriculture and mono-crop farming, as well as excessive grazing. A full-fledged biodiverse landscape is needed to create healthy ecosystems, which benefit humans and the climate.
7. Rewilding is the process of bringing back nature and species into places where that has been lost (due to deforestation, industrial and farming uses, etc.). This is a promising opportunity for cities, and one of the most direct paths for increasing biodiversity.

3.3 Background

There are many dimensions where living in close proximity to nature will bring beneficial effects to humans. In earlier times, humans lived in harmony with nature, but much of that was lost with the flight to cities and to industry as well as intensive agriculture, and it wasn't immediately understood that the loss of the connection to nature would have such negative repercussions in human society (stress, disease, crime, etc.).

Now it has become better understood and more widely appreciated: being close to nature has a restorative effect; nature ecosystems provide many needed services to human society; we are intrinsically dependent on biodiversity, so much so that the loss of biodiversity can amount to a great loss for humanity's equilibrium. Yet since the industrial times, human activity has increasingly stressed natural systems, and this has also removed humans from nature, pushing much of the world's human populations into derelict environments in unsustainable urban conditions. It is the intertwined goal of fixing our cities and mitigating the worst climate change impacts that are at the forefront of the green economic transition.

There is a logical sequence of moving through the stages towards a true eco-city. Each stage bears the hallmarks of a paradigm. Transitioning away from a carbon-intensive industrial system to a green economy will provide the necessary base from which to create ecologically rich landscapes and sustainable urban eco-systems. This in turn facilitates a greater human-nature balance, in which our relationship with the natural world can be restored. While doing this, increasing biodiversity and supporting a regenerative approach to nature will allow for the flourishing of the ecological landscape and create fuller opportunities for a better human-nature relationship.

3.3 Green Economic Transition

3.3.1 Industry and Net Zero Targets

Since industry is the backbone of the economic system, and industrial processes produce a very large share of greenhouse gases (transport, trade, factories, etc.) it is a rational conclusion that greening the economy is needed in order to achieve the SDGs, to limit GHGs, and also to create eco-cities. In fact, there is no path to accomplish any of those without embracing a green economic transition as a crucial step. Currently, most industries are heavily dependent on fossil fuels and are emitting massive amounts of carbon and other pollutants. This has a direct negative impact on human health, causing respiratory and other sicknesses and lowering the life expectancy and standard of living in many countries. On the other hand, clean air and clean living environments will be a huge success story, once the green transition makes significant progress.

However, like any complex process with an established way of conducting business and operations, such a transition has so far not been happening quickly (or quickly enough), and it won't be completed without serious efforts and the support of governments, laws and regulations, civil society, and industry representatives.

As the goal is to achieve net zero carbon societies by 2050 at the latest, there is a lot of work to be done, and many crucial steps need to be taken now, or it could cause profound negative consequences for the human civilization.

One of the original impulses for greening the economy has been the Green New Deal, which gained traction in both Europe and North America. This gained support as a mechanism and funding scheme to accelerate green jobs and a low-carbon economy, while also providing for the livelihoods of workers. While the use of the term Green New Deal was dropped in the USA, many of the key elements of the approach made their way into major US Congressional legislation. The Bipartisan Infrastructure Act of 2021 and the Inflation Reduction Act of 2022 together committed billions of dollars to fund the green economic transition

With a view to economic systems, the 'circular economy' has the widest currency among definitions of the economy that follow ecological principles and are climate-friendly. The operating principle of a circular economy is that all economic activity supports a cyclical process of using, reusing, recycling materials, so that no end-of-life waste products are generated. Consumers and companies participating in the circular economy operate from the standpoint that their activity does not generate negative externalities but supports the overall integrity and metabolism of the system.

3.3.2. Net Positive and Nature Positive Business Culture

There has also been a growing movement from within the business community to do better, and to adhere to environmental principles and take active part in a solutions-oriented matrix of human endeavour and business practices. Two related approaches worth mentioning are ‘net positive’ and ‘nature positive’.

A net positive company goes a step beyond traditional corporate social responsibility. The net positive business approach tries to create profit by fixing problems, instead of contributing to them. According to Paul Polman, former head of Unilever, net positive businesses, “by giving more than they take, and by leaving the world in a better place than they found it, they build resilience; they attract the brightest minds and unleash innovation; they serve all their stakeholders – including the planet.”²³

A part of the net positive approach includes setting the right targets. The Science Based Targets Network includes over 70 organisations. They have released a set of ‘nature targets’, building on the success of their net zero standards, which have been used by many companies. Another group, the Task Force on Climate-related Financial Disclosures helps companies to disclose their dependence and impact on nature.

In a similar way, a ‘nature positive’ business is a regenerative business that provides positive impacts on all aspects of living ecosystems. This ranges across the full realm and all aspects of life, including social, cultural, spiritual, economic, and ecological aspects. According to Sophie Wisbrun-Overakker, a Nature Positive Change Catalyst, a Nature Positive business world is “where doing more business means doing more good – is essential in helping to create a better future for us all.” Further, it involves “solving key social and environmental challenges that humanity is facing... creating ripples of positive impacts for the planet that contribute to the greater thriving of all of life.”²⁴

The Nature Positive business approach embraces the ‘web of life’ view and uses nature’s inherent intelligence, in all aspects of business (biomimicry). It also orients a business to its ‘soul purpose’ in order to create “truly regenerative, purpose-driven companies, organisations and communities.”²⁵

Whether net positive or nature positive, such ecologically sound business environments can help to foster a more sustainable and beneficial relationship between human activity (work, doing business) and a regenerative and healing approach to the natural world and the environment.

While changing the way of doing business can take time, there are already promising results. The Bank of America estimates that investments that target biodiversity are twenty times higher than previously, and will reach \$400 billion soon. The Northern Trust Corporation has launched the world’s biggest biodiversity-focused fund, with financial assets worth over \$1 billion.

Yet a collaborative effort is required across all categories. This includes partnerships with the public and private sphere, which Paul Polman refers to as ‘radical partnerships’. According to Polman, there is a funding gap for biodiversity conservation of US\$700 billion each year through 2030. But this is less than the world spends on cigarettes and soft drinks in a year. And it is also less than the

• 23 Polman P, Business within planetary boundaries, Resurgence & Ecologist, Issue 340 (2023)

24 Wisbrun-Overakker, S., Ripples of Positive Impact, Resurgence & Ecologist, Issue 340 (2023)

25 Wisbrun-Overakker, S., Ripples of Positive Impact, Resurgence & Ecologist, Issue 340 (2023)

estimated \$1.8 trillion spent annually on harmful subsidies, such as public funding of fossil fuels and industrial agriculture.

It is therefore essential that funding and capital investments become aligned with climate targets and with green economy goals. As divestments from fossil fuel related industries takes place, these can be reinvested in green industry and conservation efforts.

Apart from actively taking part in – or spearheading – decarbonisation efforts and the eco-city programme, city governments and public agencies have tasks directly related to greening the industry. This involves a thorough review of all procurement plans, to ensure that only sustainable products and companies are being partnered with. Likewise, investments need to be scrutinised from the same angle, including all assets and funds, such as pension funds. Taking things a step further, local governments can actively promote and launch projects that support the goals of the green economy.

3.4. Ecological Landscape

When visualising an eco-city, the very first thing that comes to mind is probably: the green landscape and verdant vistas in front of your eyes and all around you. Parks, forests, tree-lined streets and green rooftops are the dominant urban form. If you lived in such a place, that is what you would see whenever you leave your house, the terrain around you as you travel to work, and the images you would get if you filmed your city from the vantage point of a drone or nearby mountain top.

And this should be the quintessential point of the eco-city: the close proximity of nature and the built environment, the mixing of human society with the natural world, and the predominance of trees, parks, and natural elements, with the concrete of buildings or the hard asphalt of streets much less conspicuous, or better yet, replaced by sustainable building materials.

Another element of the ecological landscape is the presence of biodiversity, in the form of plants and animals, including their smells and sounds. An eco-city is not only green, but includes many colours and appearances, thanks to a wide variety of animals, trees, plants, flowers, and insects.

A number of new projects have emerged that show how to integrate biodiversity within city infrastructure projects. Good examples include the mixed-use Jurong Lake District in Singapore, and the Hofbogenpark in Rotterdam. These are elaborated on in the case studies section in chapter 8. Further examples from the Netherlands include the growing popularity of green roof elements.

These type of projects broadly represent examples of of blue-green infrastructure, an emerging framework for integrating and valuing natural systems within the broader city infrastructure system. Water related landscape components are combined with green infrastructure (GI).

The following is an indicative but not exhaustive list of welcome components of a blue-green city, in an ecological landscape. Many of these elements can be integrated in meaningful ways to create the most benefits possible.

Table 3 Components of a Blue-green City in an Ecological Setting

Green infrastructure	Blue infrastructure	Built environment
<ul style="list-style-type: none"> • Forested areas and larger parks • Urban meadows, wild meadows • Tree canopies, intermittent planted flowers, bushes, and other vegetation • Small-scale agricultural gardens, including community gardens, roof gardens • Grazing herbivores, such as llamas and horses • Gardens, parks, parklets 	<ul style="list-style-type: none"> • Rivers and waterside social/cultural zone • Ponds and lakes • Connected network of canals • Community swimming pools and swimmable lakes • Rainwater catchment areas including natural floodwater protection 	<ul style="list-style-type: none"> • Playgrounds • Recreational areas (also large-scale) • Pedestrian zones (also large-scale) • Greenways, for active mobility/ transport corridors • Network of footpaths • Buildings, streets and organic designs and materials

A truly ecological landscape should also be thought of in several other ways. For one, it should be characterised by an essentially quiet and restful surrounding. This is because motorised traffic and industry has been kept to a minimum, and where it exists, it is quiet. One of the defining features of contemporary cities is that of the deafening noise of traffic: cars and motorbikes (two-wheelers). This has been largely removed from the eco-city, so that one can now have peace of mind.

Furthermore, a true eco-city is clean: the air, the waterways, and the ground have all been cleaned up. As polluting industries have gradually disappeared, nature protection has been elevated to an important pillar of society. Clean air and intact nature serve as the foundations of an eco-city; these should also be the expectations of the local inhabitants – for city dwellers, living in polluted environments should become a thing of the past.

Due to the transformation of the urban mobility system, the easiest way to get around in an eco-city is by foot or by bicycle. There is a rich network of walking paths and bicycle paths, many of them on greenways, which makes it possible to easily get to any destination by one's own volition. While this might seem like a far-fetched idyll today, it will hopefully become a hallmark of commuting in the city of the future: walking or cycling through an urban forest to get from your home to your work place or a social event.

Another dimension of the ecological landscape is security and safety. Since the aspect of resilient communities has been included, there is a vibrant outdoor life, where most members of a community know each other, and crime levels are low to non-existent. This is the result of more than just better public lighting or safe intersections. It relates to the fact that communities have been empowered to be present and active in the life of their neighbourhoods, and local residents have a lot at stake in the present and future of their community. The eco-city residents have become fond of their eco-lifestyles and invest a lot of their time and themselves to keep it that way. This is a hallmark of topophilia, introduced in section 2.6.

3.5 The Human-Nature Balance

The ascendancy of an ecological landscape brings with it the requirement that humans learn to forge robust and meaningful connections with the natural world. This has implications in how the type of landscapes (as detailed in the previous section) can be inhabited, as well as how the lifestyle of humans may need to adapt.

Being a part of a living environment means that the relationships and habits that ensue must be paid attention to. If a gardener does not water and cultivate the plants, they will shrivel. The human inhabitants of an eco-city will need to learn to live in close proximity to nature. While this involves some amount of work, the benefits far outweigh any inconvenience involved.

Biophilia – which means the love of nature – is a frame through which to see the evolving human-nature relationship. A biophilic city is one where not only can nature be enjoyed, but where it produces warm feelings and leads to a sense of happiness in people²⁶. A major co-benefit of a biophilic regimen is lifestyle stress reduction.

In essence, biophilia denotes the connection to nature, through direct exposure: natural views, crisp air, the presence of water, natural light, and other natural effects on the senses. Even if the phrase ‘connecting to nature’ has been heard many times, studies have proven the fact that people are happier when they spend more time in nature, and that nature has a restorative effect on the human spirit. In this way, the presence of nature can play an important role in cities for achieving greater levels of well-being.

From the perspective of biophilia, the natural world includes animals, and where they share space with humans, these have also been shown to increase levels of well-being, while otherwise carrying out other services, such as grazing and supporting biodiversity. It should be noted that while grazing can be beneficial, over-grazing in some landscapes is just the opposite, and will prevent the flourishing of forested areas.

There has also been an increasing interest in rewilding. The concept of rewilding is one of bringing nature back into cities where it was once present, and re-introducing many species and ecosystems that have been lost in urban areas as humans began to crowd them out. The philosophy behind rewilding involves not only more biodiversity in cities, but also states that cities can be locations for rugged nature, which can be a wild meadow or a thick forest. By the same token, every stretch of grass along a traffic corridor doesn’t have to be mowed frequently but can be allowed to grow freely. Additional aspects of rewilding are treated later in this module.

Every citizen should also have access to a garden, where they can grow vegetables or crops. Fresh soil can be a place for edibles to grow, and residents of an eco-city will naturally have access to growing possibilities, either on roof gardens, private plots, or community gardens.

3.6 Biodiversity and the Regeneration of Nature

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- 26Beatley T., *Biophilic Cities: Integrating Nature into Urban Design and Planning* (2011)

This section explains the threats to biodiversity and the causes that lead to habitat loss and then goes on to detail the beneficial conditions that allow biodiversity to thrive.

3.6.1 The Causes of Habitat Loss and Biodiversity Destruction

Biodiversity is at the heart of an ecological landscape and a healthy flourishing of wildlife. As explained previously, biodiversity is the preponderance of many different natural species, and their ability to create habitats and contribute to the overall ecosystem. Since biodiversity is of such fundamental importance to a sustainable and healthy landscape (and planet), this topic requires our careful attention. We need to be aware of the causes and practices which have exacerbated the destruction of biodiversity in order to reverse them.

It should be noted that while ecology is managed differently in the wild, as opposed to in human settlements, biodiversity is present everywhere. Our goal should be to create the ideal conditions for biodiversity to thrive in cities as well as in the countryside – and bring as much nature and wildlife into the urban areas as possible. And it should be noted that having a rich, biodiverse nature zone surrounding the city will bring great benefits to those located in the city.

Human activity is the chief culprit, the origin of the greatest damage to ecosystems and to biodiversity. We first need to identify the causes which have led to habitat destruction and then reverse the trend, by abandoning the destructive habits and assuming a pro-biodiversity approach to regenerating ecological systems. Elsewhere in these materials the detrimental effect of burning fossil fuels has been covered (climate change, acid rain, landscapes depleted by extraction). It should be noted that road building and the development of new cities and neighbourhoods can encroach upon existing habitats and precipitate their destruction. Thus every building or roads programme needs to take the mitigation of habitat loss extremely seriously. Where the impacts would be too high, finding alternative locations should be explored. If there are no suitable locations for a project, then canceling it altogether should be included as an option, or radically rethinking the type or scale of the project.

Protecting habitats and biodiversity is not only for the sake of ‘doing something for the environment’ as there are real costs to human lives, to the quality of life, and to the economy when the environment is not protected. It is a misguided and ill-informed tradeoff to promote economic development at the expense of the environment.

There is another area that must be listed as a threat to biodiversity and ecological systems: grazing, farming and mono-culture landscapes. The exact opposite of biodiversity is a landscape with only one predominant function. Among the least biodiverse landscapes in the world: mowed lawns of suburban back yards and large-scale commercial farms with single crops, like wheat or soya. Overgrazed land (by sheep, for instance) causes soil to degenerate and often prevents the growth of new trees and other vegetation.

According to environmentalist and author George Monbiot, in addition to all of the direct effects mentioned above, monoculture causes a *de-wilding* of people and places. It removes diversity of life

and creates a monotone landscape. This limits the human engagement with nature, offering ‘ecological boredom’ and a greyer world.²⁷

3.6.2 Beneficial Conditions for Biodiversity to Thrive

A healthy landscape, with plenty of biodiversity, will help to control floods, reduce erosion, and perform ecosystem services. In areas where there is a lot of rainfall, vegetation can be a life-saver. Thick vegetation on hills will absorb rainfall, and through a gradual release supply it to lower areas. However, when these trees and vegetation are removed, heavy rainfall will lead directly to flooding. This has been observed in places like Nepal, where deforestation has precipitated soil washing off of the slopes of the Himalayas, even leading to the formation of an island in the Bay of Bengal.²⁸

Among the objectives of any ecological programme, environmental restoration and rewilding could play a major role. This will involve introducing species that may have been missing for even hundreds of years but were once a part of the ecosystem. Some animals are considered keystone species, which means they bring greater impacts to the environment than their numbers would suggest.²⁹ Wolves and beavers both belong to this category. Their behaviour creates beneficial conditions for other species to thrive, improving the overall vegetation and wildlife.

The management of ecological systems is an art in of itself, and something that conservationists, biologists, and ecologists traditionally perform. It is important to appreciate the complexity and the interlinkages between systems, as sometimes well-intended actions may lead to unforeseen consequences.

It is therefore important to note that not every conservation programme is informed by solid evidence. One important shift in perspective is the understanding that ecological systems do not need to be over-managed. If the conditions are present for an ecosystem to thrive, then it often requires little additional management. Nature has its own best solutions, and wise stewardship is primarily needed from humans.

The principal support from conservationists and management companies will be to protect the related infrastructure and in particular keep out unwanted pests: grazing herbivores (they should have their own meadows to inhabit), invasive or exotic species, logging or illegal clear-cutting, environmental degradation due to industry (runoff water, contamination, etc.)

3.6.3 Steps to Protect Biodiversity and Support Rewilding

There are many things that can be done to support biodiversity, regeneration of nature, and rewilding. Tree-planting is at the top of the list. With the help of different planting techniques, trees can be incorporated into high-density urban areas, as well as in ecologically poor areas. There are many tree-planting programmes around the world. The Land Use Plan of Singapore in 2013 called

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- 27Monbiot, G., *Feral: Rewilding the Land, Sea and Human Life* (2013)
 - 28Monbiot, G., *Feral: Rewilding the Land, Sea and Human Life* (2013)
 - 29Monbiot, G., *Feral: Rewilding the Land, Sea and Human Life* (2013)

for all citizens to live within 400 metres of a tree. New York City has a Million Trees NYC programme, while London also aims to add a million trees, to improve the liveability of the city.³⁰

Intensive agriculture and mono-crop farming should be better regulated, and where possible converted into mixed systems. Large swaths of land dedicated to a single cash crop is harmful to the environment, to biodiversity, and quite likely linked to deforestation and the encroachment of animal and human habitats.

It is important to not over-manage natural systems. For example, dead trees do not need to be removed – they provide a habitat for numerous species, including insects, birds, and owls. In the same way, branches in rivers are an important part of the river ecosystem. Likewise, rivers should not be intensely managed but allowed to thrive on their own. Woody debris (often dragged there by beavers) helps to stabilize the riverbanks, providing shelter for insects and animals. If these are cleared from rivers, it causes faster water flow, which increases the chances of flooding, while also disrupting the natural habitats.

Bees are particularly beneficial, even essential, for a healthy ecosystem and their protection is urgently needed. They pollinate 90% of crops.³¹ Abundant areas with wildflowers and meadows, containing rich ecosystems, are needed to provide habitat. In the Netherlands a project was launched that set up 6 km stretch of berms along a highway with wildflowers for bees. It is known as the ‘honey highway’.

Within urban areas, to support the habitat of bees and many other species, a part of the solution involves setting up wide stretches of land (ecological corridors) that contain meadows and rich biodiversity. These can be added along streets and roads, and in particular they should provide connections between parks. In some cases, an ecological corridor will be specifically geared towards wildlife, and can be placed alongside a path or street. The city parks department and urban planners should give special attention to creating these important ecological corridor connections between park areas, but also provide direct green corridors that lead from the urban centre to the periphery or countryside, and thus directly to larger wooded areas or recreational spots. These corridors will be a boon for wildlife and for active mobility and exercise. In some cases fences may be needed to prevent overgrazing of vegetation, if ruminant animals are plentiful in the area.

Similarly, rows of trees can be placed alongside roads that approach urban areas or are within cities. These should contain at least three or four rows of trees and include undergrowth containing indigenous grass and flowering shrubs (best if they require little water or maintenance). This environment is a haven for birds and insects, providing feeding, refuge, and nesting.³²

In the case of long stretches of highway or rail lines, this severs the connection between animal habitats, but this can be addressed by providing ecoducts. An ecoduct is a wildlife crossing (either bridge or tunnel) that connects habitats on both sides of a highway or railway. They are usually

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- 30Mell, I., Green Infrastructure Planning (2019)
 - 31Naren, S., Ecological Corridors and Ecoducts, from: Streets For All – 50 Ideas for Shaping Resilient Cities, ed. Bharne, V. and Khandekar S. (2022)
 - 32Naren, S., Ecological Corridors and Ecoducts, from: Streets For All – 50 Ideas for Shaping Resilient Cities, ed. Bharne, V. and Khandekar S. (2022)

covered in grass and flowers, and serve a link for animals to pass unhindered. This is a great boon for animal life, which is otherwise curtailed by a fragmentation of their habitat due to human transportation infrastructure.

Even street lighting can be organized in way that respects biodiversity better. Intense luminosity can negatively affect trees and tree growth. A type of ecological street lighting can be used instead, with less intense lights.

Finally, it should be kept in mind that having needed expertise integrated with the planning process is of utmost importance. When designing and developing urban and ecological projects, it is highly advantageous for the planning team to consult with experts in soil conservation, beekeeping, forestry, horticulture, and others – and engage in fruitful dialogue with the architects, planners, and council members.

3.7 Questions for trainers

1. What are 3-5 areas that could be selected immediately for starting the decarbonisation process in your town? What are 3-5 areas that could be decided on by the city council, but will first require political agreements and consensus, yet could still be realistic?
2. If you are planning a blue-green corridor with a high level of biodiversity in your city, what would it look like, and what would some of the key features be?
3. Why is it important for an eco-city's mobility network to be based on active mobility? What would the ideal transportation scenario be for an eco-city?
4. What is biophilia, and why does living in closer contact to nature provide direct benefits to humans?
5. What can rewilding do for biodiversity, and how could this benefit your city and region? What are some plant or animal species that could be re-introduced?
6. What are some practical steps that you could take to support biodiversity and create more ecological areas in your region, both in urban and peri-urban areas?



Illustration 10: Planning and Visualising

Module 4 – Smart Eco-city Planning, Design, and Development

The city is an interconnected system, with its own metabolism of complex flows, inputs and outputs. The design task is to integrate these various systems at the neighbourhood scale and to maximise the ecological and social benefits from them – Paul Chatterton

4.1. Purpose of this module

The basic concepts, objectives and a transition trajectory of a smart eco-city have been covered in the previous chapters. The next step is to integrate these concepts into the planning process. An integrated planning process is key, and this involves a high level of participation from the citizenry, as well as launching test runs and experiments. There are several planning principles and conceptual models as well as value systems that can guide planning at every level. This includes Nature-based solutions (NbS) and ecological principles, values based on localism, a blue-green infrastructure planning guide, and finally the regenerative process model and permaculture design.

4.2 Key Learning Points

1. An integrated planning process should combine a number of steps and be structured with reference to a leading conceptual design framework. A wide range of stakeholder participation should be provided for, as well as experimental phases and testing grounds.
2. A participatory approach should tap into the intelligence and knowledge of the widest range of citizenry. A diversity of opinions, perspectives and insights will shape a robust structure to inform a project. When dealing with areas of complexity (like ecology) multiple steps of expert review will help to avoid design flaws.
3. Conservation principles and Nature-based Solutions (NbS) can serve as aids in orienting a development project in a way that is intrinsically connected to nature and adheres to a philosophy and ethics of sustainability and human flourishing.
4. Food, agriculture, health, and local consumption patterns are all a part of the greater picture of health and sustainability in a community and economy. Promoting sustainable lifestyles and consumption habits can go a long way towards creating sustainable communities.
5. The built environment of an eco-city should integrate best practices in sustainable urban planning, which includes active travel modes (walking and cycling) and inducements for reducing travel times (and overall traffic volumes). Car-free street design may add to the attractiveness and quality of living in an ecological landscape.
6. Permaculture and the regenerative culture framework are two further closely linked approaches that are able to ground an eco-city project in a sound and well organised operating system.

4.3. Background

This section attempts to provide some guidelines in planning for eco-cities. It should be noted that the process (or game plan) adopted for an eco-city project or any development project will be greatly aided by incorporating a holistic, integrated approach that embraces the complexity of the variables at work, and provides ample time to consider and choose the best solutions. It is through careful exploration and experimentation – aided by asking the right questions and allowing for a variety of different conclusions – that the best way forward can be discovered, sometimes by the route of surprising turns and deviations along the way. In choosing a transformational path, and one that gently prods positive social and cultural change, it will become possible to create shared benefits across all of society, as the project reaches maturity.

4.4 Planning Guidelines for an Eco-city Project

4.4.1 Planning Phases

While project phases might not always be straight-forward and can indeed become very messy, it is always important to start off with a defined operational strategy and project plan. The following chart illustrates emerging best practices, which are grouped in a simplified process flow sequence:

Table 4: Planning Phases

(by author, with input from Florian Lorenz, LAUT Studio)

PHASE A – PLAN
1. Initiate a dialogue on the eco-city topic with relevant stakeholders or associated allies and colleagues. Begin to sketch a rough vision for your city.
2. As the vision is taking shape, start to assemble a diverse group of allies and experts, who may be involved in various stages throughout the project. Having a list of key allies will be essential to carrying out the project.
3. Link your project early on to a conceptual framework that is most suitable to the project. A starting point could be resilience planning, regenerative design process, or others. Multiple concepts can be integrated, yet the overall project structure and rationale should be clearly defined.
4. Conduct an in-depth review of the subject matter, based on leading questions (questions that serve as a starting point for a deep exploration of the fundamental issues). If a central theme has been identified, devote extra resources to its study; create files on best practices. Initiate a feasibility study.
PHASE B – VISUALISE
5. Examine best practice literature or, if possible, conduct study tours of real-world examples of key eco-city components. A third option is to conduct virtual interviews with competent representatives in different case study areas.
PHASE C – CREATE
6. Create an adaptable plan for your city, including both essential and flexible components. Do extensive preliminary studies of the target area and population, including long-form interviews, stakeholder analysis, and buy-in from local actors. This phase has multiple components and should not be hurried.
7. Define the conditions and scope for a pilot project, or the first section of the larger project that can be rolled out with the specific objective of observation and analysis.
PHASE D – IMPLEMENT
8. Run a pilot project. This can be done using cheap and temporary materials. Do observation and gather extensive feedback. Compare results of observations and interviews from all stages (before, during, after pilot).
9. Update the full project plan, yet keep it adaptable. Determine the sequence of next project phases, or if further pilots or experimentation will take place. Build on the initial pilot project's success, by maintaining a linked sequence of events and roll-out. If necessary, go back to Phase A and reconfigure any planning or guidance structures.

The more complex or ambitious the eco-city project is, the more you will need to develop a bigger project team containing multiple experts in a multi-disciplinary setup.

4.4.2. The Integrated Planning Process

In order to advance an eco-city project you need to have a starting point that is anchored in one or several foundational themes. Adapting an existing area, with the objective of transforming an existing city into a smart eco-city is the more common agenda. The other option is to plan an entire new eco-city or eco-neighbourhood as a single, comprehensive project.

For practical purposes, a project should be centred around the chosen set of pillars. For example, a project's aim may be to convert a specific neighbourhood into an eco-mobility neighbourhood, where walkability is a central theme, coupled with a greening project, that includes several parklets, a green corridor, and a larger park. The theme can be further extended to fitness, health and well-being for the local community, with added project elements being the facilitation of active travel, sports programmes, recreational possibilities, and access to recreational and leisure time in nature. If occasional flooding or hot weather is a recurring issue, then a further project element could be the retrofitting of the streets to better manage water accumulation and dispersion (including permeable surfacing) or shading, either with street trees or other shading solutions.

From the planning perspective, having an integrated master plan will be helpful, but so are sectional plans. Any integrated master plan should be based on prior work that includes a Sustainable Urban Mobility Plan (SUMP), a Water Management Plan, Land Use Plan, etc. Plans are also based on the extensive research and visioning process that should take place with the active participation of the community and all local stakeholders. The best plans are also adaptable and can be adjusted and evolve over time.

In essence, the most successful and enduring projects will be based on extensive citizen participation at the planning stage. Not only do local residents have useful local knowledge and insights that will be essential for avoiding mistakes and pitfalls, but the local population is also the best informed as to their needs and requirements. And it should never be underestimated that the resident population contains meaningful (and sometimes hidden) expertise which include many good ideas that can be incorporated into the project.

For an extensive participatory approach, consider the Pattern Language method. This was developed by the late US architect and planner Christopher Alexander. It is based on establishing a vocabulary and narrative surrounding key principles and the underlying philosophy that guides the project. This approach was used in a school re-design project at the Eichin campus, near Tokyo, Japan (see case study in Module 8). The unusually long and thorough consultation period and gradual process of construction prepared the foundation for a highly successful final outcome, with far greater benefits for the end users of the project, than would have been had a standard, expedited building process been followed.

4.4.3 Pilot Projects and Experimentation

It should also be remembered that the most effective way to run a project of any size is to start with a trial, such as a pilot project, where possible. If we go back to the eco-mobility neighbourhood project example from the previous section, then this would involve taking one street or corridor (including several side streets) and implementing a trial that makes use of tactical urbanism methods, in order to allow for experimentation and observation of the results and the effects within the community.

The two main arguments for running an initial trial are:

- 1) The possibilities for experimenting with different elements are greater. The feedback and responses from the local population will be priceless and greatly support the implementation of the permanent project.
- 2) The execution of a pilot project is far cheaper compared to a permanent project. A lot of money can be saved by noticing mistakes and design flaws before the final designs are rolled out.

There are many further good reasons for experimenting with novel ideas. The use of tactical urbanism approaches (or similarly, acupuncture urbanism) is that it allows for quick results to be studied, while responses from the target population can be measured readily. Directly trying out new options and innovative ideas will be an easier sell to the local population, when they realise that it is not yet a finalised plan, and they will have the opportunity to provide their feedback and opinions. It may be that a trial measure gains a high level of acceptance, which then allows for the long-term plan to gain sufficient support for its realisation.

4.4.4. Inclusive Planning and Diversity of Perspectives

Concerning the selection of experts and consultants who will inform the project development: it is highly advised to plan redundancy into the knowledge base and planning process. Redundancy in this case means that expertise is integrated from multiple sources, in order to reduce the likelihood of system or design errors. Fields and knowledge areas connected to ecology, biodiversity, resilience, or regenerative cultures, for example, are all highly complex, in such a way that any given intervention may unleash unpredictable, and sometimes undesirable results. A panel of diverse experts tasked with a thorough review process will help to mitigate design errors.

Finally, sourced experts and the consulted public should also be consistent with an inclusive approach, thus including women in particular and a wide mix of perspectives, across, race, class, political affiliation, and even generations. The voices of children and young people should also be listened to and brought along as co-creators. It is also highly valuable to listen to and incorporate indigenous voices – thus validating and including non-mainstream cultural presence in our societies. In recent times the ideas and wisdom of indigenous thinkers and writers have become more prominent. This makes a compelling case to listen more carefully to such ideas, while letting ourselves be challenged by a very different cultural background than what we are used to.

4.4.5. Asking the Right Questions

There is one planning error that can be avoided at the beginning of any project. It is the fallacy of having a number of pre-set and ready-made solutions to apply to the project and the future vision, in such a way that little inherent flexibility is allowed for. If an integrated approach seeks to be thorough and to speak to the current conditions with their underlying structural and systemic issues, then it needs to be given the time to evolve; the story of the project should be a journey, with all involved actors having an open mind and a willingness to learn and to be ready to be adaptable and to co-create scenarios with the greatest benefit for all.

In this way, superior results can be achieved when the right questions frame the discussion at the beginning. According to author and biologist Daniel Wahl, it is best to start with the ‘why’ and that will guide towards the ‘what’ and the ‘how’. The following is a compilation of voices and quotes, related to starting with the right questions:

Daniel Wahl: *“Once we start with ‘why’ we can define the values that will guide our behaviour and inform the systems and processes we put into place ... ‘why’ offers purpose, cause, or belief; how expresses the values that guide our actions and how we aim to manifest the higher purpose in action; and what refers to the results of those actions”*

Tim Brown, design guru: *“asking ‘why’ is an opportunity to reframe a problem, redefine the constraints, and open the field to a more innovative answer ... there is nothing more frustrating than coming up with the right answer to the wrong question”*

Warren Berger: *“The art of asking beautiful questions is about 1) challenging assumptions 2) inquiring about things normally taken for granted 3) wondering about new possibilities... asking ‘what if?’ can put you onto a path to breakthrough innovation”³³*

Wahl goes on to suggest a number of questions that can be asked, to help shape a fundamental conversation about purpose and vision, of ‘why’, ‘how’, and ‘what’:

- What are the unmet real needs that are obscured by the perceived needs we are focusing on?
- How can we more effectively work with the people affected and involve them in finding solutions that work for them?
- How can we design flexibility and the capacity to transform and adapt into our proposed solutions?
- What can we learn from nature’s patterns and processes in order to create solutions that strengthen rather than weaken local ecosystems and the planetary life support system?
- Are there related problems that we could include in finding a more systemic way of dealing with multiple interconnected issues at once?
- How does what we are proposing to do affect ourselves, our community and the world?
- What implication might our ‘solution’ have for future generations?
- How do we stay flexible and keep learning from systemic feedback and unexpected side-effects?³⁴

A matching component of asking fundamental, deep-going questions is to engage in real listening and keen concern with the subject matter. All of this takes time. The gradual, evolutionary approach, involving numerous discussions, facilitated meetings, honest evaluations, experiments, periods of observation and evaluation, expert insights, and regular stakeholder meetings – this is a more time-demanding approach as opposed to the conventional Design-Build approach. However,

33 Wahl, D.C., *Designing Regenerative Cultures* (2016)

34 Wahl, D.C., *Designing Regenerative Cultures* (2016)

the efforts are well worth it. The results will be far superior, if the necessary time was taken to ‘live the questions together’.³⁵

The remainder of this module will provide a guide to the planning approaches for different conceptual components of a smart eco-city. Please refer also to Module 2 – Smart City Prerequisites, in the *Training Materials for Implementing Smart Cities in Asia and the Pacific*, [available here for download \(pdf\)](#).

4.5 Ecological Security and Nature-based Solutions (NbS)

Nature is resilient and is well equipped to provide the necessary ingredients for an ecological project. But nature also needs humans to do their part to prevent its degradation and destruction. Thus, it is crucial for the principles and values of nature protection to be present in every project. This involves the strict regulation and enforcement of pollution control, and it means that biodiversity and safe habitats and environments need to be ensured at every level.

It never makes sense to allow for a financial trade-off analysis to dictate policy, with the reasoning that it is too costly to protect nature. When nature is not protected, the long-term financial, economic, and social costs will be much greater.

Long-term planning will be more coherent and sustainable, given a philosophy and ethics of nature protection, which should be held close by decision-makers and the community at large. This is where a shift in values needs to take place and accompany the urban development process: as the emphasis moves away from resource extraction, private profit, and an outdated growth-based model of progress, in its place comes inclusion and equality, the credo of stewardship, and a model of nature-based regeneration and deeper interconnections among humans and between the human and natural world.

A planning model based on nature protection, resilience and regeneration will by default create the greatest level of long-term security and sustainability for the resident populations and natural and built systems.

According to Paul Chatterton:

*A more fundamental rethink of the connections between nature and urban space is required, where social and natural aspects, as well as humans and non-humans find a new basis for mutual coexistence and flourishing. Nature is not just as an aesthetic sideline but is a structural determinant of human flourishing and well-being. The task, then, is to radically reimagine and transcend the false boundary between the natural and the urban world.*³⁶

At the heart of a nature-rooted ethic for planning is the Nature-based Solutions (NbS) movement. The focus is on creating a greater awareness for the important role that nature plays for the well-being of humans, while finding design and development solutions that are nature-led. NbS are

35 Wahl, D.C., *Designing Regenerative Cultures* (2016)

• 36Chatterton P., *Unlocking Sustainable Cities* (2019)

devised to address major challenges, including climate change, human health, disaster risk, water security, and more.

NbS is closely related to many of the adjacent design principles and guidelines, explained in other parts of this module and throughout the training materials. This includes planning for green and blue infrastructure, biophilia, biomimicry, regenerative culture, and rewilding.

These are a few examples of NbS:

- Parks and wide tree canopies, as well as minimal paving help to counter the heat island effect
- Urban woodlands function as a carbon sink
- Trees are effective at capturing air pollution
- Blue-green urban territories filter water, reduce flood risk and improve the river water quality, while also creating aesthetic, physiological, and health benefits associated with urban green spaces
- Housing that overlooks green spaces has a restorative effect and services to counter stress levels and lower the risk to disease

4.6 Public Health, Diet, and Sanitation

If a city or region has already ‘graduated’ from a decarbonisation programme and has largely eliminated harmful emissions, then the first level of public health protection is already present – there are fewer if any air-borne pathogens, which is a boon for protection from respiratory diseases.

One major factor contributing to robust public health is food – yet unsustainable forms of food production, diets, and intensive agriculture leads to poor health and depleted landscapes. To keep a population well-fed and healthy, it is of tantamount importance to ensure the sustainable provision of healthy food. While diet is a personal choice, it is also highly dependent on available food and nourishment trends. For instance, the land mass required to produce meat is significantly greater, and the associated emissions are much higher, compared to other food groups. Meat production is carbon intensive, and often relies on the availability of subsidised or cheap fossil fuels.

Transitioning to a largely plant-based diet is considered to be one of the best measures available to reduce GHG emissions, while also leading to a healthier population. While this may be politically or culturally controversial, it is helpful to realise that even a moderate reduction of meat consumption across the population could have a significant beneficial impact.

Local farmers and food producers need to be supported in their mission to provide nourishment for the population. This can be encouraged by the local government via inducements and promotion of healthy local food. It can also be supported by the presence of markets (open air or covered). Vegetable and produce markets are an important feature of local culture and also make it easy to get products from the surrounding region to the consumers.

Public sanitation is also essential for the population. In recent years there have been a lot of innovative programmes to provide better amenities in terms of public toilets in those countries and regions where supply is sparse. Likewise, clean drinking water should be widely available. This is

currently not the case in many countries, and contaminated water sources have been the cause of sickness and carry disease. There are also innovative programmes that are being rolled out to bring clean water directly to every population centre.

Furthermore, there are distinct ecological choices available to the public works programme associated with maintaining the city clean, as well as handling waste. Municipal recycling programmes and waste treatment should be at the heart of city's waste management. Many materials can be reused or recycled, while composting is a highly useful practice. These topics are covered in more detail in module 6 – Circular Economy Action Framework. For street cleaning or the sanitation of public buildings, ecological cleaning products should be used, as well as a sustainable use of the city's water supplies.

A further measure that pertains to public health concerns disaster planning and risk management. This is closely aligned with resilience planning, which is covered in Module 2. Apart from long-term resilience planning and preventative measures, a disaster management programme is linked to public services such as the Fire Department or the Water Management. For an integrated planning approach, regular communication channels should be established between first responder agencies and the resilience planning departments.

4.7 Mobility Management

Due to the fact that the automobile is still so pervasive in cities around the world, and a popular choice for many people – including those who can't very well afford all the associated costs – it will sometimes take more than just providing decent infrastructure to get people to switch to a more sustainable mode of travel. This is where the carrot and stick approach works best, which translated into urban planning terms implies mobility management, or transport demand management. Incentives are used to persuade citizens to choose a sustainable transport mode. This may involve fiscal incentives, such as charging higher prices (usually more realistic prices) for use of automobile infrastructure or rewarding users of public transport, or those who cycle to work for instance, with rewards, financial or otherwise. Other options involve making driving or parking less convenient. It is not an inherent human right to have parking in front of every building entrance (even if some people think it is). Having convenient and affordable public transport service or high quality and safe walking and cycling infrastructure will go a long way to encourage sustainable mode use.

All of this can be planned for in a Sustainable Urban Mobility Plan (SUMP), Transportation plan, Cycling plan, or other integrated planning mechanisms. Specific modal share targets should be set, with ambitious targets set to ramp up use of active travel modes, or PT modes, in case those are low. The additional benefit of active travel is that it encourages health and fitness in the population, which can have important spillover effects into other areas of life, such as wellbeing and performance on the job.

Cities should also consider providing pedestrian zones where cars are completely removed. While lowering overall automobile use and emission levels, this also creates new public spaces which can provide an important social function or create iconic cultural spaces.

While there is a lot of possibility given in the urban mobility domain, it is an area that will require strong leadership and bold planning by the mayor and city administration. Initial decisions to

commit a city to lower its automobile use will not necessarily boost the popularity of the leadership, although in the long run, once the benefits are better understood, this will gain increasingly more public support.

4.8 Blue-Green Landscapes

Orienting a city development plan to incorporate a high degree of blue-green city elements will ensure that resilience features are well endowed. This will ultimately help to both mitigate climate change impacts as well as prepare the urban area to be well equipped to handle a wide range of weather scenarios, including natural disasters. The savings to a city are enormous. Money that would have been spent on diverse items such as road repair, medical care and hospitals, disaster response, even prisons, can all be minimised and instead converted into funding for education, culture, public transport, or stimulation funds to support the local economy.

An important component of the eco-city and an ecological landscape is proximity. Most everyday destinations should ideally be reachable in under 15 minutes, whether that is by foot, by bicycle, or by public transport. Such a level of close-by destinations and clustered amenities makes planning daily schedules much easier. Families can spend more time together because less time is lost commuting. In Seoul, South Korea, the government is investing in new metro lines for the explicit reason of allowing couples and families to spend more time together, thanks to reduced commute times.

There are many other good arguments for keeping destinations nearby. It helps to avoid unnecessary travel, which ultimately saves energy. It makes urban management issues easier and allows for better coordination of municipal services.

4.9 Regenerative Model for Agriculture and Biodiversity

Food and agriculture are important component of an eco-city made up of compact neighbourhoods. If food can be produced near to its consumers, then it eliminates unnecessary freight transport, while also minimising the risk to supply chain disruptions. Community gardens and local agriculture are welcome in any eco-city. Organic food is certainly the healthiest variety for human consumption (by eliminating pesticides and preservatives).

One of the leading agriculture and gardening design movements is permaculture. This is a whole-system design approach, using natural systems to create regenerative solutions to everything from garden design to planting cycles and best practices in food production.

Permaculture designers and practitioners (such as Toby Hemenway) have shown how permaculture design can be applied to the city scale. Here, permaculture as a system treats cities as complex adaptive systems where mutually beneficial relationships form the connecting bonds between different dimensions and layers, from households and communities to whole neighbourhoods and the city level.

Further eco-city related attributes include embedding regenerative cultures and rewilding. These are both similar aspects that support the re-introduction of nature in places where it has been previously eroded, while helping to regenerate and heal depleted ecosystems. This is very important for those

cities and metropolises that have experienced significant environmental degradation and are in urgent need of allowing the natural landscape to return, and for the intrusion of harmful human activities to be rolled back.

These approaches will help urban areas regenerate through greater biodiversity: specifically this entails the flourishing of plant and animals species where that has been deficient. A regenerative culture and rewilding process will establish protected habitats and the proper conditions for biodiversity to flourish. It also means that the current trends of urbanisation in many parts of the world need to be halted, and replaced with a slow growth, holistic and ecologically inspired paradigm.

4.10 Questions for trainers

1. What are some of the most important elements (and planning aids) that should be prepared before an Eco-city masterplan is developed? Why is having a robust conceptual framework important, while basing a development programme on a particular planning philosophy?
2. What are the meaningful contributions that a wide diversity of perspectives and an extensive consultation process can bring to a project? How can tension among stakeholders or ideologies be resolved and lead to a stronger outcome?
3. What are the benefits of running pilot projects and urban experiments before implementing a large-scale project?
4. How can Nature-based Solutions (NbS) and other approaches rooted in ecological frameworks and values support a planning programme and design implementation? How can this lead to better outcomes than a conventional approach?
5. How can the mobility needs of a city and neighbourhood best be addressed and integrated in a smart eco-city? Is there a scope for a reduction, not only of automobiles, but mobility in general? Can car-free streets or car-free zones provide the basis for social life and transportation in an eco-city?
6. What are the benefits of a rewilding programme? What types of projects could rewilding be included in as an important component?



Illustration 12: Galleria Vittorio Emanuele II, Milan, Italy

Module 5 – Eco-city and the Circular Economy

5.1 Purpose of this module

The main aim of this module is to highlight the circular economy idea, concept, and principles for establishing a smart eco-city. It is important to understand how the circular economy of eco-cities enhances its social, economic, and environmental sustainability. This module further discusses the importance of circular economy principles which deliver benefits to cities and communities. The principles of the circular economy underscore the resource efficiency, renewable resources, circular design principles, circularity business models, green infrastructure development, innovative technologies, and human capacity development and awareness raising. It also helps to mitigate climate change impacts.

5.2 Key learning points

1. There are essentially three types of city-based economies: a) Linear economy: This system revolves around buying, using, and discarding products. The linear model focuses on abundant, inexpensive materials and mass production and profit generation without considering

- long-term environmental sustainability. b) Recycling economy: It is based on using waste materials to recycle or refurbish them, creating new materials and products. c) Circular economy: This economy maintains products and materials in circulation through maintenance, re-use, refurbishment, remanufacture, recycling, composting, and restoration.
2. In the industrial context, the circular economy is restorative and regenerative by design. It aims to maintain products, components, and materials at their highest utility and reduce waste. It replaces the 'end-of-life' concept with restoration; promotes the use of renewable energy; eliminates toxic chemicals; and aims to eradicate waste through superior material, product, and system design.
 3. The principles of the circular economy provide a foundational framework for its concept and implementation. They advocate for practices such as sharing, repairing, refurbishing, recycling, remanufacturing, and reusing to extend the life cycle of products and materials.
 4. The main objective of the circular economy is to facilitate effective flows of materials, energy, labour, and information to rebuild natural and social capital. It offers an alternative to the traditional linear economy (make, use, dispose) by keeping resources in use for as long as possible, maximizing their value through recovery.

5.3 Background

Before diving deeply into the circular economy, it is important to understand the fundamentals of the linear economy and how it operates to foster economic prosperity. According to the European Investment Bank, “*the linear economy is a system in which people buy a product, use it, and then throw it away*³⁷.” The linear economy advocates for mass production and profit generation above the long-term environmental considerations and sustainability. It typically revolves around maximising the use of earth's finite resources to fuel economic growth, often without allowing adequate time for nature to recover. The linear model relies on abundant, inexpensive materials and energy, contributing to resource depletion and environmental degradation. Rapid population growth has surged along with a high demand for material consumption, resulting in severe impacts of resource depletion, which are major concerns in the face of the climate crisis. This unbalanced and unsustainable approach of economic prosperity has led to ecological imbalance, loss of biodiversity, and the escalation of environmental degradation. As the modern industrial revolution and economic growth has been based on the linear economy, new economic thinking and scholarship has come to understand that the existing linear economy is not viable option for a sustainable future.

Compared to the conventional linear economy model of ‘take-make-consume-dispose’, the circular economy model approach of ‘made-to-be-made-again’ presents significant opportunities. The circular economy model not only aims to significantly decrease the need for natural resources but also prompts a re-evaluation of resource and waste management processes. It encourages product redesign, regeneration and reuse for cost-efficiency and fosters eco-friendly-nature based practices. The idea of the circular economy traces its roots to the 19th century and is intertwined with the activities of a British textile company – along with the Luddites. As recycling was not a common practice during that era, materials were either consumed or disposed of. As a first in human history,

37 <https://www.eib.org/en/stories/linear-economy-recycling#:~:text=Linear%20economy%20is%20a%20system,line%20regarding%20recycling%20or%20reuse.>

the Luddites emphasized the importance of recycling the existing materials using new machinery, and advocating for efficiency over continuous production of new materials.

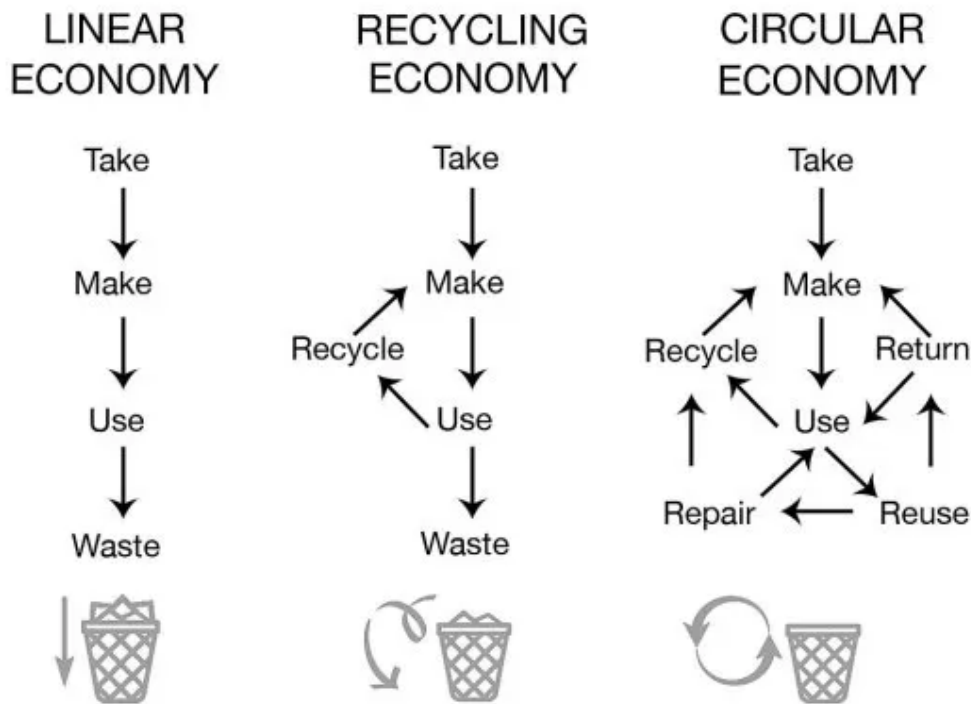


Figure: Difference among the linear economy, recycling economy and the circular economy adopted³⁸- <https://rfittingroom.com/circular-vs-linear-economy/>

The circular economy idea began to take shape after the inception of the modern environmental movement in the 1960s. The circular economy involves the management of material flows within an economy, and the consideration of economic frameworks conducive to fostering such flows³⁹. According to the Ellen MacArthur Foundation, the circular economy is a system where materials never become wasted and nature is regenerated⁴⁰. This approach addresses climate change and other global challenges, such as biodiversity loss, waste, and pollution, by disassociating economic activity from the consumption of finite resources. A circular economy minimises material consumption, redesigns materials and products to be less resource-intensive, and reuses 'waste' as a resource to manufacture new materials and products⁴¹. In a circular economy, materials and products are kept in circulation for as long as possible, reducing waste and promoting sustainability. In this manner, the circular economy provides a substantial improvement as an economic model, promoting and integrating sustainable practices in production, consumption, and waste management.

38 <https://rfittingroom.com/circular-vs-linear-economy/>

39 <https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf>

40 <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

41 <https://www.epa.gov/circulareconomy/what-circular-economy#:~:text=A%20circular%20economy%20reduces%20material,manufacture%20new%20materials%20and%20products.>

5.4 The Circular Economy Concept

The concept of a circular economy emerged from various schools of thought over time. In 1966, Kenneth Boulding introduced the concept of the "spaceship economy," conceptualising earth as a closed system with minimal exchanges of matter with the external environment. In his economic model, the circular economic relationship exists between the economy and the environment, where all components interact with each other⁴². It is believed that the circular economy system was primarily introduced by environmental economists Pearce and Turner, who developed their theoretical framework based on previous studies by ecological economist Kenneth Boulding⁴³. Pearce and Turner (1990) elaborated on the shift from the traditional linear or open-ended economic model to the circular economic system, which is based on the extensive interdependence between the economy and the environment⁴⁴. A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value, while reducing waste streams⁴⁵.

A concept that distinguishes between technical and biological cycles, the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimizes system risks by managing finite stocks and renewable flows, while reducing waste⁴⁶. It refers to the 'production and consumption of goods through closed loop material flows that internalise environmental externalities linked to virgin resource extraction and the generation of waste (including pollution)⁴⁷. This approach transforms the function of resources in the economy, and the waste from factories henceforth become a valuable input that can be repaired, re-used or upgraded instead of thrown away⁴⁸.

42 Boulding, K. E. 1966. The Economics of the Coming Spaceship Earth', in Jarrett, H. (ed) Environmental quality in a growing economy: Essays from the sixth RFF forum, New York, RFF Press, pp. 3–14.

43 Thibaut Wautelet, 2018. The Concept of Circular Economy its Origins and its Evolution

44 Pearce, D. W. and Turner, R. K. (1990) *Economics of natural resources and the environment*, New York, London, Harvester Wheatsheaf.

45 <https://www.sustainability.com/thinking/creating-a-circular-economy-for-plastics/#:~:text=A%20circular%20economy%20is%20restorative,used%20once%20and%20then%20discarded.>

46 Recommendation ITU-T L.1020: 'Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks'.

47 Sauvé, S., S. Bernard and P. Sloan (2016), 'Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research', *Environmental Development*, Vol. 17, pp. 48-56.

48 Preston, F. (2012), 'A Global Redesign? Shaping the Circular Economy', Briefing Paper, London: Chatham House.



Figure 2: Circular economy model proposed by the European Parliament Research Service.

In the context of the industry, the circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, and aims for the elimination of waste through the superior design of materials, products, and systems. The overall objective of the circular economy is to ‘enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt⁴⁹. The value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised⁵⁰. Therefore, the circular economy is an alternative approach to a traditional linear economy (make, use, dispose) in which the resources stay in use for as long as possible, extracting the maximum value through recovering and re-using products and materials⁵¹.

49 <https://tinyurl.com/zt8fhxw>.

50 European Commission (2015a)

51 Mitchell, P. (2015), ‘Employment and the circular economy – Job Creation through resource

5.5. Circular Economy Principles

The circular economy principles serve as foundational guidelines for the concept and implementation of a circular economy. The principles of the circular economy advocate for the economic practice of sharing, repairing, refurbishing, recycling, remanufacturing, and reusing as extensively as possible, thereby extending their life cycle⁵² while reducing waste and the extraction and creation of virgin materials⁵³. These principles offer a framework for businesses, governments, cities, and communities to shift towards a more sustainable future. The following table summarizes the widely supported principles of the circular economy. While implementing every element simultaneously would be difficult, it is often possible to weave elements of these principles into ongoing and planned projects. The table below provides a suite of potential avenues for integrating circular economy principles into projects.

Table 5 Basic Overview of Circular Economy Principles

5.5.1 Resource Efficiency	
Eliminate waste and pollution	The circular economy focuses on designing products and systems that minimise waste by applying all necessary measures during and after the production, consumption, and disposal. Material products and processes should be designed in such a way that minimise waste products, pollution, and emissions throughout their life cycle
Reduce the consumption of raw materials	Reducing the consumption of materials is a fundamental strategy in the circular economy which is aimed at minimising resource extraction. It is important to create products that have a longer lifespan by using high-quality, durable materials and robust construction and design methods. A regulatory framework is needed for reducing the extraction and consumption of materials (in particular rare minerals), while fostering the refurbishment and recycling of outdated models. Industry needs to be kept to high standards, with stricter guidelines covering the mining and extraction process. In the long-term, the extraction of raw materials and minerals from the ground should be kept to a bare minimum, and where possible, discontinued altogether.
Keep product and materials in-use	Instead of disposing of products after use, they should be reused, repaired, refurbished, or recycled to maintain their circulation as long as possible. Waste from one process is used as a resource in another. This concept, known as industrial symbiosis, helps in reducing the extraction of virgin materials and lessens the

efficiency in London'. Report produced by WRAP for the London Sustainable Development Commission, the London Waste and Recycling Board and the Greater London Authority.

52 <https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits>

53 <https://www.lombardodier.com/contents/corporate-news/responsible-capital/2020/september/the-10-steps-to-a-circular-econo.html>

	environmental impact.
5.5.2. Use of Renewable Resources	
Sustainable Sourcing	Prioritising the use of renewable and sustainable resources over non-renewable ones. This ensures that natural systems are not over-exploited and have time to regenerate.
Regenerate Natural Systems	By learning from the nature and utilising natural concepts and processes it becomes possible to create more sustainable designs and products. This approach can lead to innovations that are inherently sustainable and regenerative.
Renewable Energy Use	Transitioning to renewable energy sources is essential for reducing the environmental impacts of material production and consumption. It is equally important to discourage the use of non-renewable energy and resources.
5.5.3 Regenerative Practices	
Ecological and biodiversity practices	Implementing regenerative practices that restore natural soil, ecosystem, and biodiversity through agricultural crop rotation, permaculture, and agroforestry.
Natural forestry and ecosystem restoration	Adopting sustainable forestry practices that ensure plants can support reforestation while avoiding desertification through restoring degraded habitats, such as wetlands, forests, and coral reefs.
5.5.4 Circular Design Principles	
Circular Design Principles	Products and designs can be easily assembled and disassembled, with materials that allow for an efficient reuse, repair, or recycling. This reduces the need for raw material extraction
Material Innovation	Developing and using materials that are safe, recyclable, and regenerative such as use of biodegradable materials that can decompose without harming the natural environment.
Eco-design Practices	Integrating environmental considerations into the planning, design and development of products, services, and systems that aim to minimise environmental impacts throughout the entire production, consumption and life cycle, including the end-of-life disposal or recycling.
5.5.5. Systemic and Innovative Thinking	
Product Life Cycle	Adopting a holistic approach that considers the entire life cycle of products and materials to maximise economic, social, and environmental benefits.
5.5.6. Circularity Business Model	

Circularity and Resource Efficiency	Businesses, industry and enterprises should explore novel models that prioritise circularity and resource efficiency.
5.5.7 Restrict Plastic Products	
Reduce the use of plastic	Implement the necessary policy measures and strategies to limit the production, use, and disposal of plastic items. Promote alternatives to plastic packaging and improving recycling and waste management systems for plastic materials.
5.5.8. Green Infrastructure Development	
Enhance Green Infrastructure	Invest in green infrastructure solutions such as green roofs, permeable pavements, and urban forests to enhance the resilience of cities to climate change while also providing ecosystem services like stormwater management and air purification
5.5.9. Education, Awareness, and Capacity Development	
Raise Awareness	Raise public awareness about the importance of adopting circular economy principles and provide education and training to policymakers, planners, and the private sectors to implement sustainable practices in their daily lives and businesses.
Mitigate Climate Change Impacts	This involves taking proactive measures to mitigate and adapt to the climate change impacts on both human and natural systems.
Collaboration and Partnerships	Encourage cooperation among different stakeholders including government entities, businesses, academic institutions, and civil society to develop innovative programs and solutions that support circular economic practices and sustainable development goals.

5.6. Benefits of Circular Economy Principles

- **Foster the local economy:** Promotes and supports local economic activities by prioritising local businesses, industries, and production to meet the needs of the local population to strengthen existing industry or create new economic opportunities.
- **Preserve and optimise natural resources:** Conserve existing limited natural resources and ensure their efficient and optimal utilisation.
- **Minimise environmental hazards:** Taking necessary measures to reduce the negative effects of human actions on the environment and human health. This involves promoting sustainable practices in different areas and sectors to mitigate pollution and resource depletion.
- **Regenerate and restore natural systems:** Natural resources should be managed efficiently and sustainably, with efforts focused to preserve and restore urban ecosystems and biodiversity for long-term environmental protection.

Other benefits include the following:

- Reduces the use of non-renewable resources
- Lowers carbon emissions
- Increases affordability by lowering consumer prices
- Opens new opportunities to industries and companies
- Enhances technological innovations
- Better use of natural resources
- Protects urban ecosystem and biodiversity
- Creates new jobs and promotes skill development
- Builds resilient communities
- Bolsters biodiversity conservation and environmental sustainability
- Improves resource and food security
- Leads to a zero-waste society
- Improves health and social well-being

5.7. Questions for trainers

1. Why is the circular economy important for eco-city development?
2. How can the circular economy enhance livability and sustainability in eco-cities?
3. What are the major circular economy principles? How can these principles contribute to the social, economic and environmental improvement in cities?
4. How can the circular economy contribute toward building self-sustainable, socio-economic, and climate-resilient communities?
5. What are the major benefits of implementing circular economy principles at different stages of the eco-city development?



Illustration 14: Hundertwasser Haus in Vienna, Austria

Module 6 – The Circular Economy Action Framework

6.1 Purpose of this Module

This module highlights the circular economy action frameworks including the material recovery and recycling, industrial symbiosis, collaborative consumption, biomimicry, product-life extension, and circular city actions. It further explains how smart eco-cities can achieve city-based circular economy and green growth development. This module discusses the industrial symbiosis framework which promotes collaboration among different industries to exchange resources, energy, and by-products for reducing waste and optimising resource efficiency. The circular city action framework uses the 12R strategies: Refuse, Rethink, Regenerate, Reduce, Reuse, Repair, Refurbish, Remanufacture, Restore, Repurpose, Recycle, Recover.

6.2 Key Learning Points

1. The Circular Economy Action Framework (CEF) is a strategic initiative designed to shift economic systems from linear, resource-intensive models to circular and regenerative ones. It

focuses on redesigning processes, products, and systems to reduce waste, enhance resource efficiency, and foster sustainability.

2. The material recovery and recycling framework is a strategic component of the circular economy that concentrates on extracting and recycling materials from products at the end of their life cycle. The objective of this framework is to establish a closed-loop system in which materials are perpetually reused and recycled, thereby minimising waste and conserving resources.
3. The industrial symbiosis framework encourages collaboration among various industries to share resources, energy, and by-products, thereby reducing waste and enhancing resource efficiency. The collaborative consumption framework emphasises the sharing, renting, and borrowing of goods and services, moving away from ownership.
4. Biomimicry framework draws inspiration from nature to design products, processes, and systems that mimic natural cycles and ecosystems. The product-life extension framework focuses on extending the lifespan of products through strategies such as repair, refurbishment, and remanufacturing as well as designing products for durability and ease of maintenance.
5. The Circular City Actions Framework for Cities serves as a valuable tool for local governments and practitioners of city-based circular economies, regardless of the city's current stage of transition. It facilitates the advancement of systemic approaches toward a more sustainable and circular economy. A circular city advocates for a fair transition from a linear to a circular economy throughout the urban landscape, involving various city functions and departments, in collaboration with residents, businesses, and the research community.
6. Smart eco-city development can be realised in conjunction with city-based circular economy practices and green growth strategies by integrating sustainability principles into urban policy, planning, infrastructure development, resource management, and community engagement.

6.3 Background

The Circular Economy Action Framework – or also just the Circular Economy Framework (CEF) is a strategic approach that aims to transform economic systems from linear and resource-intensive models to circular and regenerative by redesigning processes, products, and systems to minimise waste, maximize resource efficiency, and promote sustainability. The CEF was developed by a number of scholars, organisations, and institutions. These frameworks can be implemented in various ways depending on the specific context, goals, and stakeholders involved. Some of the important CEFs are discussed below.

6.4 Material Recovery and Recycling Framework

The material recovery and recycling framework is a strategic approach within the circular economy that focuses on recovering and recycling materials from products at the end of their life cycle. This framework aims to create a closed-loop system where materials are continuously reused and recycled to minimise waste and resource depletion. The Ellen MacArthur Foundation's Circular

Fibres Initiative is one of the examples of this framework which aims to create a circular economy for textiles by promoting recycling and reuse⁵⁴.

6.5 Industrial Symbiosis Framework

The industrial symbiosis framework promotes collaboration among different industries to exchange resources, energy, and by-products for reducing waste and optimizing resource efficiency. This framework is widely used in the industrial sector. Kalundborg Industrial Symbiosis in Denmark⁵⁵, and Kitakushu Industrial Area of Japan⁵⁶ are prime example where multiple industries share resources such as water, steam, and by-products to minimise waste and costs.

6.6 Collaborative Consumption Framework

This framework emphasizes the sharing, renting, and borrowing of goods and services to maximise their utilisation and minimise ownership. Some of the best examples of this framework are online platforms that enable residents within a local community to exchange goods and services directly with one another, facilitating buying, selling, or lending of items which also boost the local economy. For example, Airbnb platform that enables individuals to rent out their homes or spare rooms, promoting shared access for accommodations can also help to generate jobs and boost the local economy⁵⁷.

6.7 Biomimicry Framework

This framework draws inspiration from nature to design products, processes, and systems that mimic natural cycles and ecosystems. Urban planning and design that mimics natural ecosystems to enhance environmental quality and resilience, such as green roofs, urban wetlands, and tree-lined streets are a few examples of it. Another example could be closed-loop water management system that mimics natural hydrological cycles, such as rainwater harvesting, grey water recycling, and wetland filtration systems.

6.8 Product-Life Extension Framework

This framework focuses on extending the lifespan of products through strategies such as repair, refurbishment, and remanufacturing as well as designing products for durability and ease of maintenance. For instance, converting older buildings into new uses rather than demolishing them, preserving architectural heritage, and reducing construction waste. Retrofitting infrastructure such as roads, bridges, and utilities, to extend their lifespan and improve performance, rather than building new infrastructure.

54 Ellen MacArthur Foundation, "Circular Fibres Initiative"

55 Chertow, M. R. (2000). "Industrial symbiosis: Literature and taxonomy"

56

<https://encyclopedia.pub/entry/16848#:~:text=Later%2C%20the%20Kitakyushu%20City%20developed,became%20a%20unified%20functional%20region.>

57 Botsman, R., and Rogers, R. (2010). "What's Mine Is Yours: The Rise of Collaborative Consumption"

6.9 Circular City Actions Framework

The Circular City Actions Framework for cities serves as a valuable tool for local governments and practitioners of city-based circular economies, regardless of their city's current stage of transition. It facilitates the advancement of systemic approaches toward a more sustainable and circular economy. The Ellen MacArthur Foundation recommended Circular City Actions Framework with 10R strategies which emphasizes ten key principles aimed at maximising resource efficiency and minimising waste generation as discussed below⁵⁸. Two more strategies were added with the total of 12R for the comprehensive circular city actions framework.

Table 6 12R Strategies for Maximising Resource Efficiency

1. Refuse	Refusing unnecessary and unsustainable materials and products to minimize waste generation.
2. Rethink	Rethink conventional consumption habits and embrace more sustainable approaches. Each product and system should undergo reassessment with the aim of minimising its environmental footprint
3. Regenerate	Align with nature by promoting infrastructure, production systems, and sourcing methods that support the thriving of natural ecosystems.
4. Reduce	Optimise resource utilisation by utilising and endorsing infrastructure, processes, and products designed to minimise material, water, and energy consumption, as well as waste generation, throughout the production and usage lifecycle.
5. Reuse	Promote the reuse of products and materials to extend their lifespan and minimise the need for new resources.
6. Repair	Support repair services and initiatives to extend the lifespan of products and lower disposal rates and minimise waste.
7. Refurbish	Renovate and refurbish products to restore functionality by preventing premature disposal

58 Ellen MacArthur Foundation. "Towards the Circular Economy: Accelerating the Scale-up Across Global Supply Chains." 2014.

	and extending their useful lifespan.
8. Remanufacture	Encourage remanufacturing of products to reclaim materials and components for reuse in new products.
9. Restore	Restore products to their original or near-original condition, thereby extending their lifespan and optimising their utility
10. Repurpose	Explore alternative uses for products or materials that would otherwise be discarded, maximising their value through repurposing.
11. Recycle	Establish efficient recycling systems to recover valuable materials from waste streams and reintroduce them into the production cycle. This process helps conserve resources, reduces the need for raw materials, and minimises environmental impacts by diverting waste from landfills.
12. Recover	Minimise waste by maximizing resource recovery at the end of the usage phase, enabling their reintroduction into production processes. For example, utilise waste-to-energy technologies or other methods to recover energy or resources from waste materials that cannot be recycled.

6.10 Concept of Circular City

Given the unsustainable nature of the existing economic models, the emerging paradigm of the circular economy is adapted to tackle the complex socio-economic challenges faced by cities. Rapid population growth and urbanization have led to a substantial increase in material consumption, the overexploitation of natural resources, and the continuous accumulation of waste materials in urban areas. This persistent demand for materials and resources exceeds the earth's finite resource capacity. Therefore, there is an urgent need for cities to shift towards more sustainable practices.

There is no single definition of the circular city. However, a circular city can be defined as a city that practices circular economy principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realise its vision of a future-proof city.⁵⁹ A circular city integrates the principles of the circular economy into urban

⁵⁹ Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular cities: Mapping six cities in transition. *Environmental Innovation and Societal Transitions*, 26, 171–194.

policy, planning and development. The city aims to operate in a self-sustainable and regenerative manner, where resources are used efficiently and effectively so that waste is minimised, recycled, and reused to protect the urban eco-system and the environment. Circular cities promote resource efficiency, waste reduction, resource recovery, renewable energy use, sustainable transportation, green infrastructure, and the adoption of circular business models.

According to ICLEI – Local Governments for Sustainability, a circular city advocates for a fair transition from a linear to a circular economy throughout the urban landscape, involving various city functions and departments, in collaboration with residents, businesses, and the research community⁶⁰. In a circular city, material loops are closed, ensuring continuous recycling of materials rather than their disposal as waste, thereby also decreasing the necessity for resource extraction. During this transition, cities aim to enhance resource accessibility, reduce emissions, safeguard, and enrich biodiversity, and mitigate social inequalities in accordance with the Sustainable Development Goals (SDGs)⁶¹. In this way, the main objective of the circular city is to create a city which supports not only economic prosperity but also encourages social equity, cohesion, and equality. Thus, a circular city is a pathway that focuses on enhancing the urban ecosystem and benefitting the urban population by means of environmental conservation and pro-social policies. Smart eco-cities should adopt the principle of the circular city to enhance the circularity and sustainability in urban development.

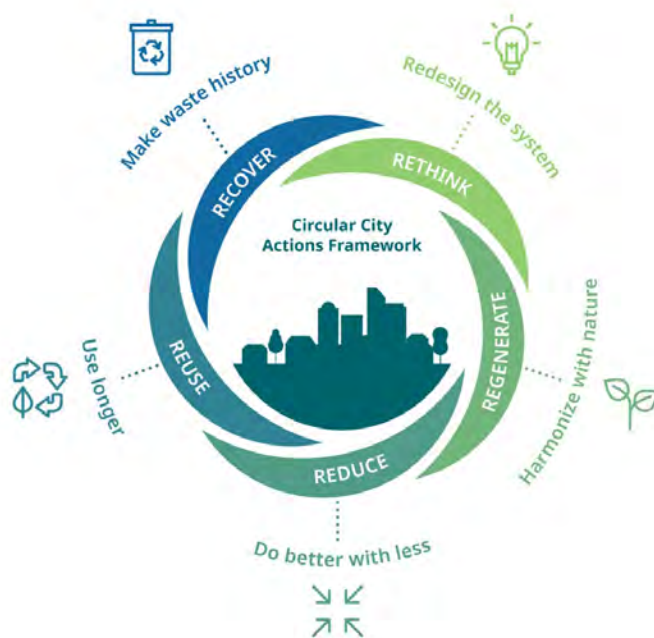


Figure: The Circular City Actions Framework developed by ICLEI, Circle Economy, Metabolic and the Ellen MacArthur Foundation to introduce cities to the range of strategies and actions⁶²

60 <https://circulars.iclei.org/action-framework/>

61 https://circulars.iclei.org/wp-content/uploads/2021/10/Circular-City-Action-Framework_V2.pdf

62 <https://circulars.iclei.org/action-framework/>

6.11 Circular Economy and Green Growth Practices

Smart eco-city development can be realised in conjunction with city-based circular economy practices and green growth strategies by integrating sustainability principles into urban policy, planning, infrastructure development, resource management, and community engagement. Some of the important stages of urban development process are discussed below.

6.11.1 Policy Development

It is crucial for policy makers, planners, and city leaders to implement innovative policies, strategies, and measures to foster a circular economy and green growth development. It is important to establish sustainability goals such as key objectives related to carbon neutrality, resource efficiency, waste reduction, and green growth in the policy development stage. This requires a comprehensive approach that encompasses urban planning and design, resource availability and management, industry and waste reduction management strategies, sustainable production and consumption practices, urban transportation, energy, and community engagement.

6.11.2 Initial Planning and Design

In the initial stage of the smart eco-city planning and design, urban planners and designers need to incorporate circular economy principles by prioritizing factors like resource efficiency, waste minimisation, and the establishment of circular economy practices. Smart eco-cities should place a high priority on designing for resilience to both disasters and the impacts of climate change. This involves integrating green infrastructure, sustainable building practices, measures for disaster risk reduction, and climate mitigation into urban design plans.

6.11.3 Funding and Financing Mechanisms

Allocate funding for robust green infrastructure projects that enhance resource efficiency, elevate environmental quality, and foster sustainable urban development. These projects may include initiatives like renewable energy, resilient and robust urban infrastructure, green spaces, and low-carbon sustainable urban transportation, among others.

To achieve these objectives, smart eco-cities can implement financial mechanisms such as green bonds, tax incentives, subsidies, and public-private partnerships. These mechanisms should be designed to attract private investment in green infrastructure projects and facilitate the transition to a circular economy. At the same time, subsidies to fossil-fuel intensive projects and programmes should be discontinued. Only those projects and programmes should be financed that pass a rigorous environmental audit and are deemed compatible with Eco-city accreditation.

6.11.4 Urban Infrastructure Development

During the infrastructure development phase, smart eco-cities should give utmost priority to constructing robust, resilient, and sustainable urban infrastructure. This includes the development of green technology such as installation of renewable energy sources, implementation of low-carbon green transportation, energy-efficient buildings, and the adoption of water conservation measures. It

is equally important to adopt circular economy practices to ensure resource efficiency, reduce environmental impacts, and promote green economic activity.

6.11.5 Resource Management and Operations

Smart eco-cities deploy resource management strategies to maximize the utilization of water, energy, and materials through efficient resource allocation, demand-side management, and resource conservation measures. The city should institute waste reduction programs, comprising recycling, composting, and waste-to-energy initiatives, to diminish landfill usage and advocate for a circular economy in waste management. Furthermore, smart eco-cities must foster innovation and entrepreneurship that bolster green growth and economic resilience.

6.11.6 Community Engagement and Participation

Smart eco-cities should actively involve residents and businesses in sustainability initiatives by promoting sustainable lifestyles. It is important to encourage citizens and business to adopt sustainable production and consumption practices that align with circular economy principles and green growth objectives. Furthermore, cities should provide educational programs, outreach activities, and community engagement events to increase awareness of environmental issues, promote understanding of circular economy, and highlight opportunities for green growth development. By empowering and educating individuals and communities, smart eco-cities can drive meaningful change.

6.11.7 Foster Collaboration and Partnerships

Smart eco-cities should facilitate multi-stakeholder partnerships to share knowledge, resources, and expertise, fostering joint strategies to address common urban challenges. Public-private partnerships are vital for mobilising private sector resources and expertise in infrastructure development and technology innovation. By integrating stakeholders from various sectors, groups and businesses, smart eco-cities harness synergies, explore integrated solutions, and increase the impact of sustainability efforts. Involvement of governments, civil society, organizations, and local communities ensures responsiveness to community needs, promotes social equity, builds community ownership, and fosters support for sustainable development.

6.11.8 Facilitate Knowledge Sharing and Capacity Building

Smart eco-cities can facilitate knowledge exchange and capacity enhancement through workshops, seminars, training sessions, initiatives, and peer learning opportunities. These efforts aim to support the skills, capabilities, and networks of stakeholders engaged in sustainable urban development. By supporting a culture of learning, knowledge dissemination, technology adoption and cooperation, smart eco-cities empower citizens to collectively act, innovate and move towards social and ecological transformation.

6.12 Questions for trainers

1. What is the Circular City Action Framework, and how can smart eco-cities utilise this framework to achieve a city-based circular economy and green growth development?
2. List an advantage of each of the circular city action frameworks: material recovery and recycling, industrial symbiosis, collaborative consumption, biomimicry, product-life extension, and circular city actions.
3. How can the 12R strategies of the Circular City Action Framework maximize resource efficiency and minimise waste generation?
4. What is the concept of a circular city, and how can circularity in cities contribute to reducing greenhouse gas (GHG) emissions and achieving zero-waste communities?
5. Why are resource efficiency and the material recovery and recycling framework important for eco-cities? How can these frameworks, along with circular economy and green growth practices, benefit eco-cities?



Illustration 16: Sora-sagano-meguro-river-matsuno-Japan

Module 7 – The Energy, Infrastructure, and Climate Benefits of a Smart Eco-city

7.1 Purpose of this Module

This module covers the energy and infrastructure – in essence, the backbone – of a smart eco-city, as well as the numerous benefits this brings in the context of climate mitigation and adaptation. By the time a city has advanced to a mature stage of its eco-city development, it has likely already adapted many of the technologies and infrastructure elements needed to power a smart eco-city that is also carbon-neutral and climate-positive. The renewable energy systems, transportation, green infrastructure, and green buildings all point to a healthy environment and resilient urban fabric. The benefits this brings to biodiversity, human health, and the climate are enormous.

7.2 Key Learning Points

1. In order to create or live in an eco-city, there are a number of infrastructure issues that need to be thought of. First and foremost: energy. Powering an eco-city by renewable energy is a natural starting point for any eco-city project.
2. Blue-green infrastructure is the term used to describe all natural elements that relate either to water or green cover. Focussing on blue-green infrastructure is a way to ensure that eco-city conditions can exist.
3. Green buildings will feature as a major part of the transition to eco-cities. Net-zero buildings contain numerous innovations that help to create largely self-sustaining systems.
4. Urban mobility is another area that plays a major role in reconfiguring our cities to embrace sustainability and decarbonisation.
5. Consumer choice and sustainable consumption are important areas that related to how we make use of the given infrastructure of a city. This might involve local values or the sharing economy.
6. Nature conservation should be a high priority for citizens of any town. One of the prime areas that needs to be focused on for better conservation is water, and good water stewardship.

7.3 Background

There can be no such thing as an eco-city if there is not the commensurate infrastructure to serve as the backbone, and function as the basis for service provision, for amenities, and for a quality experience that focuses on safety, climate, and ecological values.

The world has come a long way in the field of renewable and green technology. It has become clear that renewables have a firm place in the future of urban systems, if for no other reason than that they are gradually becoming more affordable for the end user than fossil fuels are.

Modern ingenuity has fine-tuned the management of green infrastructure, realising that the selective management approach of eco-systems brings more benefits than an over-managed or excessively engineered systems does.

Multiple types of technology and infrastructure define the features and texture of a city. Coupled with energy, these are the building blocks for a smart eco-city. Without sustainable infrastructure and renewable energy, there is no 'eco' in the eco-city.

7.4 Renewable Energy and the Eco-city

Smart eco-cities prioritise the integration of renewable energy sources such as solar, wind, and hydroelectric power. By harnessing these clean energy sources, cities can reduce their dependence on fossil fuels, thereby lowering greenhouse gas emissions and mitigating climate change.

7.4.1 Solar Energy

Perhaps the most basic and central of all renewable energy technologies is solar. The sun shines every day and provides a steady and reliable source of free energy. Solar panel technology has been getting cheaper and cheaper, and is perfectly situated to replace coal plants. Therefore, solar energy is predicted to see continuous growth.

While rooftop solar panels are the most readily known instances of this technology, solar farms have great uptake capacity as well. This involves a large scale array of hundreds, thousands, or even millions of solar panels. They act like conventional power plants, but with radically different emissions. A solar plant amounts to an emissions reduction of 94% compared to that of a carbon plant.⁶³

The use of solar technology draws on solar photovoltaics (PV) and this could meet 20% of global energy needs by 2027. By comparison, in 2017, it was just 2%.

At the same time, rooftop solar is a very important localised technology, as its big advantage is to generate electricity right at the site of consumption as this can be installed in locations where there is lack of access to a power grid. In 2015, in Bangladesh, 3.6 million home solar systems were installed, generated 115,000 direct jobs and 50,000 more downstream. In Australia, 16% of homes feature solar.

The benefits for end users are clear, and amount to important savings, while utility companies can also benefit by feeding unused electricity into the grid, making it more variable and able to meet overall demand.

7.4.2 Geothermal energy

Geothermal energy is literally 'earth heat' as it involves the constant flow of heat that moves from within towards the earth's crust. Heat energy generated by the earth is about 100 billion times more

• 63Hawken, P., ed. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (2018)

than the total current energy consumption worldwide.⁶⁴ Underground reservoirs of steamy hot water act as hydrothermal reservoirs that can be piped to the surface and drive turbines to produce electricity. Iconic examples of this are the geysers of Yellowstone National Park (USA) or Iceland's hot thermal lagoons.

Prime geothermal conditions are found on less than 10% of the planet, but new technologies can expand their access. Enhanced Geothermal Systems (EGS) targets deep underground cavities.

To demonstrate the potential of this technology, in El Salvador and Philippines, this is already 25% of domestic electric capacity. In volcanic Iceland, it makes up one third. In Kenya, it is 50%, due to the conditions beneath the Rift valley. According to the Geothermal Energy Association, 39 countries could supply 100% of their electricity with this technology in the near future.

But while geothermal is reliable, efficient, and available around the clock, potential negatives have to be managed – such as carbon dioxide or other gases that need to be filtered out, or any potential concerns for land use change (noise pollution or foul smell). Additionally it comes with up-front costs to install the technology in power plants. Yet managed well, this technology could be successfully harnessed on a large scale.

7.4.3 Biomass

Biomass is considered a 'bridge solution' to a fully mature renewable energy regime, as it is an imperfect technology, yet can produce electricity on demand, and can help to shift away from fossil fuels.

Biomass utilises photosynthesis, which is an energy conversion and storage process. Solar energy is captured and stored as carbohydrates in biomass. Ideally biomass is utilised through a low emission conversion technology, working with gasification or digestion.

Biomass energy generation works with carbon that is already in circulation, as opposed to releasing fossil-fuel carbon that has been stored underground. This technology should be based on waste products or sustainably grown appropriate energy crops. It should not be linked to utilising native forests, for instance. Suitable crops include perennials or short-rotation woody crops.

One positive example of sourcing biomass sources was trialed in the Indian state of Sikkim, where extracting invasive species from forests are gleaned and then converted into 'bio-briquettes' for clean cookstoves.

7.5 Blue-Green Infrastructure

Blue and Green Infrastructure provide the essential landscape features and elements of an eco-city. Blue infrastructure relates to water, and includes naturally occurring waterways, as well as water management and flood protection. Green Infrastructure (GI) covers a wide array of natural elements and green spaces.

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- 64Hawken, P., ed. Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming (2018)

The mixture of blue-green infrastructure provides a whole host of opportunities to deal with and solve problems such as flooding and water management, heating and the urban heat island effect, and also contributes to local bio-diversity.

GI feature components such as bioswales, parks and greenways, and green streets. These can be combined with blue infrastructure, such as canals, small urban ponds, or mini-wetlands. This helps to create a city fabric that has reduced emissions, lower temperatures, and can respond favourably to shocks or natural disasters.

One important feature for water management is the retention and distribution of water. When many cities experience increasingly heavy rains, the capacity to adequately deal with water volumes is often missing. Features such as bioswales and parks that double as water storage will go a long way to prepare for many weather events. Green filtration (like permeable road surface) is an additional way to soak up precipitation. There is also a managed technique for allowing the gradual release of water to existing waterways, without causing swells.

There are further examples of the features and benefits of blue and green infrastructure:

Carbon sinks: These are the green spaces such as parks, forests, and green belts that act as carbon sinks, absorbing carbon dioxide from the atmosphere and mitigating climate change.

Heat island cooling: Green spaces play a crucial role in reducing the urban heat island effect by providing shade, evaporative cooling, and reducing surface temperatures. Installing green roofs, green walls, and tree canopies in urban areas helps mitigate heat buildup, improving local micro-climates and enhancing residents' comfort.

Biodiversity Conservation: Abundant green spaces support diverse ecosystems and biodiversity, which is essential for ecosystem resilience and adaptation to climate change impacts.

Sustainable Urban Drainage System (SUDS): This is a water management practice that makes use of natural water processes and thus aligns with green infrastructure. The approach involves using localised investments in water-sensitive designs, such as rain gardens, bioswales, or retention ponds, and can connect to blue networks, while capturing, holding and releasing water during peak flow periods. This can help mitigate the impacts of seasonal flooding and reduce surface water flooding. Bio-filtration and soil percolation are also key to this approach.

7.6 Buildings and the Built Environment

7.6.1 The Built Environment in the Eco-city

Buildings need to be fully integrated with the green environment and not only be built of sustainable materials, but also connected to natural areas. This will often involve green rooftops – which may contain vegetable gardens – as well as green facades, with plants and creepers that can comfortably reside on the building. The allocation and function of spaces between buildings need to include the maximum proportion of green space, without being crammed – as ‘empty’ or unallocated space is often the better choice, compared to an overabundance of utilitarian elements. For new town developments, it will be crucial to allow for sufficient space between buildings to include parks, forests, meadows, and gardens. If residential or office buildings are too densely grouped, insufficient space is available for nature to thrive.

All streets and transport corridors should be connected to blue and green infrastructure. This might include canals, and will involve grassy surfaces or hedges, as well as trees, flowers, and fruit orchards. In hot climates large trees and green canopies should be installed on streets with a high amount of footfall. Playgrounds in particular need to be shaded

An innovative design option was put forward by J.H. Crawford, who created a blueprint for car-free cities⁶⁵. In the neighbourhood reference design, residential buildings (up to four stories) front the street (with access to local transit nodes) on one side, while on the back side there is access to a communal green space, a direct community amenity for all those who live on that block, or in that neighbourhood. This design option allows for a sufficient level of density, while also providing abundant green space for everyone. There are certainly variations of this design that can be used in a wide variety of cities and landscapes.

7.6.2 Green Buildings

Buildings make up for the lion's share of the built environment in cities. Buildings consume very large amounts of energy, while their construction and use generally have low scores in their environmental analysis. At the same time, technology exists for the creation of green buildings, of which there are more and more examples. Buildings and construction therefore have a huge transformative capacity and could potentially be the driving force behind eco-city movements.

The goal of any building construction project should be to attain a net zero status. A net zero building has net zero energy consumption when looked at over the course of a year. In some months it may require additional electricity inputs, while in other months it generates excess electricity. This is thanks to a complex set of design features and included technologies. Lighting can be engineered to maximise natural daylight. Windows, ceilings, and walls can be built with insulation that retains heat in the winter and maintains cool temperatures in the summer. There are further passive house features that minimise energy use, in particular related to the building orientation, natural ventilation, as well as electrochromic glass panes that are adjustable.⁶⁶

Green buildings are the object of increasing attention and investment, worldwide. This includes standards and norms, as well as targets. The US Green Building Council was the first trade organisation to call for higher than government standards, in 1993. The International Living Future Institute promotes the idea of Living Buildings, while notable architects have advanced their versions of net zero buildings. Examples include ZEBs, or Zero Energy Buildings (Jason McLennan), and the 2030 Challenge, intended to target that year for all buildings to become carbon-neutral (Ed Mazria). A number of cities have pledged to achieve carbon-neutrality of their buildings by 2030 or 2040.

There are many further promising areas that connect to green buildings. One of them is green roofs. Green roofs (with tree canopy, bushes, gardens) create real ecosystems on the tops of buildings, which can immediately bring numerous benefits, such as cooling the temperature inside the building, filtering rainwater, creating recreational areas with parks and gardens, and even providing

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- 65Crawford, J.H., *Carfree Design Manual* (2009)
 - 66Hawken, P., ed. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (2018)

food-growing opportunities. Since conventional buildings are major contributors to the heat island effect, green roofs have the capacity to counter this trend in a significant way. Additionally, biophilia – the close experience of nature – comes into play as a tremendously important benefit for those who live or work in a building with an accessible green roof. It should be noted that such buildings require carefully designed layers to protect the roof and ensure its capacity to sustain a living rooftop with biodiversity, and rainwater filtering.

A further technology that is expected to keep growing in the future is LED lighting. While still more expensive than the far more inefficient incandescent lights, they already start to generate savings after one year. LED lighting also has a beneficial impact on economic livelihoods and can help even those households without electricity, when connected to small solar cells. LED lighting can thus help to fight light poverty as well as climate change.

There are a whole number of additional technologies that hold promise for the future and support net zero buildings as well as renewable and clean energy provision, which however go beyond the scope of this manual, but are worth mentioning. **Heat Pumps** provide both heating and cooling and are almost emission-free if powered by renewable energy. **Smart Glass** is another feature in buildings, based on photochromic technologies, and can adjust lighting as well as provide cooling. **District Heating and Cooling (DHC)** involves underground pipes of hot or cool water connected to a centralised system, and can be powered by conventional energy or geothermal, solar water, or biomass.

Green buildings will have a major role to play in steering cities towards sustainability, and embracing the smart eco-city approach. It should be stressed that beyond considerations for new buildings, retrofitting existing buildings with green technology is just as important. Retrofitting buildings can curb emissions as well as generate jobs and business opportunities.

7.7. Sustainable Urban Mobility

Next to buildings, transportation is the other urban infrastructure category that is both responsible for considerable emissions (up to 1/3 or ¼ of global emissions) and is in urgent need of decarbonisation, while also being an area with the potential to completely redesign and redefine the structure and fabric of cities.

From the point of view of equity as well as efficiency, Public Transportation (PT) should feature at the centre of planning any mobility system. Buses, railways, trams, metros can all be included in an integrated, multi-modal transportation system.

Public transportation has evolved in the modern era, including innovative systems like Bus Rapid Transit (BRT) which uses dedicated bus lanes and metro style boarding, and comes at great cost savings compared to an underground system.

Next to public transportation, active travel is a sustainable and healthy way to travel. This usually involves walking and cycling. Contemporary developments include bicycle-share systems, electric bicycle, scooters, and more.

Together, public transportation and active travel can play a great role in decongesting cities from private automobile and motorbike use, while reducing emissions and providing for cleaner air.

7.8 Sustainable Consumption and Environmental Protection

Closely connected to the infrastructure provision and the policies that concern the availability and use of resources is the culture and mindset of ‘going green’. This implies raising consciousness among people as consumers as well as members of society. It will be of great benefit to the wider citizenry to adopt an approach of environmental protection, resource conservation, as well as a shared responsibility towards living in a sustainable society.

It is for that reason that communication, cooperation, and co-creation should enjoy wide support within the population as well as between citizens and government. There are whole guidebooks written on green lifestyles and consumer choices. There is also a lot of literature supporting networks of cooperation and mutual benefit, such as win-win solutions, and the sharing economy.

While this manual can’t cover every area, a few noteworthy items are included.

7.8.1 The Sharing Economy

According to recent environmental trends, not every item needs to be owned, especially if it is not needed on a frequent basis. There has been a dynamic growth trajectory of items for rent on a one-time basis or for a specific period of time. This may include: cars, bicycles, tuxedos or other clothing items, sports equipment, technical machines, studio space, and much more. There are also many opportunities for selling unwanted items, like used clothing. Many apps and online marketplaces now exist, and it is a growing economy. Solidarity shops contain items for free or for cheap, and provide another way for people to get rid of dispensable items.

7.8.2 Localism

Localism and a local way of life plays an important role in numerous social movements. The rationale is that needed items or solutions for something can almost always be found at the local level. This encourages participation in the local community and helping to reduce long-distance travel of people and goods. The environment is protected and the local economy boosted. This is good for artisans and makers, small-scale farmers, artists, and anyone who can benefit from having a market for providing their goods and services, in a neighbourly way. There are even local currencies that were thought of to support local industry. The Local Energy Transfer System (LETS) is one of the early examples of that. Time-banking, or a time-based currency is a similar approach: it allows for service exchanges or an exchange of goods for a service. These all have in common the value of keeping wealth (goods, skills, spending) in the local area, thus creating a more resilient and robust community.

7.8.3 Conservation – Water

While there are many areas of conservation that are worthy of incorporating into daily habits, water conservation is a vital part of protecting natural resources, and is thus treated here as a distinct item. Water needs to be better managed and treated as a scarce resource. In many countries, water is

already a scarce resource, and there are prolonged periods of draught and depletion of reserves. A for energy, hot water is responsible for 25% of residential energy use worldwide.⁶⁷

There are multiple actions that can be taken inside homes (and in gardens), and normally these are one-time upgrades. Others relate to behaviour change. Options include:

- low flush toilets
- water efficient appliances, including washing machines
- solar heated water
- outdoor irrigation reduced or eliminated by using captured rainwater
- flushing less, shorter shower times, washing only full loads of laundry

Furthermore, conservation can be aided by local policies requiring efficient plumbing, or providing incentives (such as rebates) for more efficient appliances.

7.9 Questions for Trainers

1. What could be a sensible energy mix that would responsibly handle the main energy needs of one neighbourhood in a south Asian or east Asian city?
2. What are 5 innovative features of a net zero building that could be added to a sales brochure that would help sell real estate to a conscientious customer?
3. What kind of mobility management approach (stick and carrot) could work in your city, and help transform the city's transportation infrastructure?
4. What are some ideas that could be implemented to help foster values related to environmental protection? Why should water conservation be an important part of environmental protection?
5. What are 5 ways that a localism approach can reduce emissions?

Module 8 – Eco-city Best Practices

8.1 Singapore, and the Evolution of Grand Projects

• ⁶⁷Hawken, P., ed. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (2018)



Illustration 17: A projection of the Jurong Lake District

Singapore is a small island in the Asia-Pacific region, bordering Malaysia. It is a city-state of just 750 square km, with population of 5.5 million. But it is also a global business centre and major tourist destination. Major developments were launched in the 1960s, including large infrastructure projects. As a part of the original, comprehensive planning regime, Singapore was dubbed ‘a City in a Garden’.

Since the 1960s there has been a steady progression of grand projects in Singapore. As each of these projects reflected its time period, it is worth noting the progression to more advanced forms of sustainability and inclusiveness in the more recent projects.

One of the first large projects involved Marina Bay. Its was developed along the lines of a classic CBD design, including skyscrapers and a high saturation of roads and car travel.

A next iteration of project type was the Marina Bay Sands Complex, which is listed as an ‘integrated urban resort’ with a mixed-use standalone architecture design. This features a degree of permeability and openness to the waterfront and gardens by the bay. It also serves as a strong tourist magnet.

This phase was followed by Marina South. It was already updated to stand in for the ‘liveable city’ approach, and efforts were taken to learn from previous experience. It was specifically given sustainable design elements as well as iconic architecture designs. Thus, expansive green roofs are present as well as eye-candy items like the giant super trees, which are composed of living plants stitched into a steel base.

Finally, the latest and greenest grand project in Singapore is still under development. It is the Jurong Lake District, and billed as an ‘ultra-dense mixed-use district with ultra generous blue-green public spaces’⁶⁸. This is a further evolutionary extension of the ‘city in a garden’ concept. In this case, major mobility infrastructure has been placed underground, while the area can be described as car-

2. 68Christiaan, K., Gasco, A., Hanakata, N., Understanding the grand project, from: *Shaping Cities in an Urban Age*, ed. Burdett, R, and Rode, P. (2018)

lite. A key feature is the special urban block typology: a porous podium with high-rise towers above, as well as green roof gardens. It should also be noted that this project is strategically linked to high speed rail lines.

The approach of Singapore may not be scalable everywhere – with its grand projects, involving major coordination efforts by the government, as well as its emphasis on business districts and exclusive housing. But it is important to note that the ecological landscape (with high levels of biodiversity and ample public space) is the preferred route and the chosen masterplan designs follow ecological principles and ample blue-green infrastructure elements.

8.2 Rotterdam, City on the Water



Figure 4: Schepenstraat in Rotterdam

Rotterdam deserves recognition as a best practice case study for the sake of its high degree of liveability and its provisions of climate resilience. This relates in particular to how the city incorporates water planning. The second largest Dutch city is situated on a major river (Maas, an extension of the Rhine) as well as having an opening to the sea, which includes a delta and Europe's largest port.

As for Rotterdam's sustainability credentials, it has pledged to become climate-neutral with zero-emission transportation by 2050. Concerning urban mobility, it has a bicycle modal share of over 30%, which is high on the global scale, yet behind a number of other Dutch cities, like Groningen, Utrecht, and Amsterdam.

Rotterdam puts forward a 'city lounge' feeling in the centre of the city, made possible by its open areas for strolling, shopping, cafés, as well as inviting public space. Rotterdam is the first European city in the post-war period to have undertaken a pedestrianisation program, called the Lijnbaan, which still functions as such to this day.

As in many Dutch cities, Rotterdam has an extensive network of canals. This is a type of street typology which lends itself to combining water management functions with green infrastructure, thus creating blue-green corridors. The canals almost always include a grassy river bank, with places for strolling or sitting.

One of the features of Rotterdam's water management programme is the use of public space as locations where water can be stored temporarily during heavy rains, and then allowed to run off safely (and with staggered release) into the neighbouring waterways.

This type of dual function of public space and water storage facility has been established in several locations. But what has brought the city additional accolades is its public engagement programme. The city initiated a 'Right to Challenge' programme, which allows residents to petition the city to create a new design for a project, provided there is local support for it and it is not too costly.

Through this mechanism, a design process co-created with the neighbourhood was submitted to the city for the Schepenstraat street. The project works took place in 2019, and added green space to the street, planting new trees from the city's tree orphanage, and saving some of the mature trees. The project also raised pedestrian crossings and added bicycle parking, in addition to improving drainage. The results are considered to be a successful example of resilient street planning, since they addressed the water (and potential flooding) dimension, as well as traffic-calming the street.⁶⁹

This project was also featured in the Yearbook Landscape Architecture and Urban Design in The Netherlands.

It should come as no surprise that Rotterdam has done extensive planning work around water, creating a number of planning documents, as a culmination of careful work and time invested into the process. Thus the city created its second water plan in 2007, and then went on to create the Rotterdam Climate Proof Programme in 2008, and then the Rotterdam Adaptation Strategy in 2013.

Beginning in 2015, the city launched Water Sensitive Rotterdam (WSR), which was intended to function more as a civic movement than just a government strategy. WSR focusses on adequate drainage that can prevent flooding occurrences, while also looking to rainwater as an important public resource, and building ecological processes to increase the attractiveness of the city, as well as play an important role in water management.

• 69Fields B., Renne, J.L., *Adaptation Urbanism and Resilient Communities* (2021)



Illustration 19: Reduce Reuse Recycle Poster

8.3 Gamagori City – Circular City Concept and Public-Private Partnership (Japan)

Gamagori City in Aichi Prefecture, Japan, has gone to great lengths to implement the Circular City concept. The city has partnered with some private sector companies to achieve the development of a “well-being city” through circular economy. As an example of its initiatives, Gamagori City has signed an agreement with Mercari, Inc., which is an e-commerce company that allows people to buy and sell easily. The goal is to reduce waste by reusing materials and products.

Through the company’s market activities in Japan and the U.S., Mercari was reportedly able to reduce CO2 emissions by 420,000 tons in the clothing sector alone, by reducing the level of waste. In Japan, the company reduced garment waste by 43,000 tons, which amounts to almost 9% of that country’s clothing waste.

The company has been partnering with Gamagori City, by helping with its waste reduction programme. For instance, large items that would have gone to waste (such as refrigerators) can be resold via the app and locally participating stores. The cooperation between the city and the company was recently recognised by Japan’s Cabinet Office as an outstanding example of public-private partnership in connection to local development and SDGs.

The approach of the company as well as the efforts of Gamagori City were presented at the 11th Regional 3R and Circular Economy Forum in Asia and the Pacific on 8-10 February 2023 in Siem Reap, Cambodia, which was set up to promote the 3Rs – Reduce, Reuse, Recycle in Asia. This is a Japanese initiative, including partnership with the United Nations Centre for Regional Development (UNCRD).



Illustration 20: The Seine Riverbank in Paris

8.4 ‘Reinventing Paris’ Strategy and the Urban Commons (France)

The city of Paris, France has dedicated itself to promoting the urban commons, and including social and environmental dimensions in projects with private sector involvement. This is a part of its effort to make the city more attractive in terms of making public spaces more pedestrian-friendly, building social housing in all parts of the city, supporting startups, and co-designing public policies with its citizens.

This has involved strong municipal involvement and a flexible approach to how the city governs. The current city government already presented its ideals and programme when it converted the riverbanks of the Seine to become a stroller’s paradise, giving back to pedestrians a space that had previously been used by cars.

The idea of the ‘Reinventing Paris’ programme was to go a step further to advance pro-social policies and celebrate the idea of the commons. Under this banner, calls were issued in public competitions to redevelop land. While this mainly involved the private sector, a wide range of stakeholders were included, so also NGOs and CSOs. The calls have been for innovative projects to transform certain areas, with key concepts being: innovation, quality of architecture, green spaces, and social housing. In essence, private companies (and consortia) have been tasked with creating

value for the public. A major difference compared to how competitions are usually staged, is that the city would not sell to the highest bidder, but to the best project.

One of the noteworthy projects is called Mille Arbres (a Thousand Trees), designed by Sou Fujimoto and OXO, which connects central Paris to the suburbs, by means of an inhabited bridge over a ring road. This includes housing, offices and social services, as well as an urban forest.

Numerous other projects have come to life through this process, and the idea behind 'Reinventing Paris' has spread to other parts of France and even the world. It has also been picked up as a global initiative with C40 Cities.



Illustration 21: Hong Kong Public Transport

8.5 Environmentally-friendly Transportation Network (SAR Hong Kong)

Any city that wants to attain eco-city level status, or even improve its environmental credentials should build an environmentally-friendly transportation network. This is a case study from Hong Kong Special Administrative Region of China.

Hong Kong is one of the most densely populated cities in the world, with over 7 million inhabitants. It also has a very dense business district and shopping district. It is only natural that efficient and high quality public transportation system would be required as a backbone to the city's urban mobility infrastructure.

This is also the case. Certain transport features are so popular and iconic that they have become tourist attractions in of themselves. The bulk of the public transport infrastructure is made up of trams, trains, and metro. Roughly 90% of the population use public transport, which makes it the highest modal share of any major city in the world.

Another innovative feature is the Central-Mid-Levels escalator, which provides pedestrian access up the steep slopes of the island. This is considered the longest covered outdoor escalator system in the world, including 20 escalators and 3 moving walkways, and 36 access points. Parallel to the escalators is retail and shopping.

The entire system has become a tourist hot spot, and there are considerations of constructing another escalator in the historic area, although there is resistance to this idea by residents, as it is feared that it will have gentrifying effects.

Nonetheless, Hong Kong shows what is possible in the realm of public transportation; in particular it is a proven fact that a mega city can provide an efficient public transport system, if built to high standards and providing variability in the network. In a dense city like Hong Kong, a greater modal share of driving would neither be very feasible, nor would it be desirable.



Illustration 22: Chhatrapati Shivaji Maharaj Terminus, Mumbai, India

8.6 Data Observatory and Audit For Better Streets in India

If the aim is to target the streetscape with a view to improving the liveability and upgrading the urban morphology, and gradually move the dial in the direction of eco-city streets, then the right tools will be needed in order to catalyse the process.

Matching a safety audit based on new data of streets and public spaces with recent policy guidelines was the approach taken in India by the organisation Safetipin, which performed audits in Mumbai and other Indian cities using mobile applications.

The safety audit queried citizen responses along numerous corridors, using ‘audit pins’ to pinpoint the conditions and responses in regular intervals throughout the corridor. Data was gathered on security, lighting, crowd size, and walkability. Each audited city then received a map with a safety score and highlighted areas with the variation in results (and thus conditions).

The policy environment includes the National Urban Policy Framework (NUPF), developed in 2018 by the Ministry of Housing and Urban Affairs (MoHUA). The policy framework promotes public spaces with high social interaction, as well as environmental sustainability and participatory governance. This could be interlinked with the report titled *The Strategy for New India @ 75*, by the government’s policy think-tank NITI Aayog, which calls for sustainable modes of transportation and multi-purpose utilities, in safe, vibrant and equitable streetscapes.⁷⁰

By referencing the policy guidelines with the findings in the safety audit, Safetipin was able to propose a series of useful and needed interventions in order to strategically develop and improve the urban landscape. Thus, reclaiming spaces allocated to automobiles in the public realm and connecting fragmented streets could be posited according to an evidence-based approach.

A second, yet related approach was taken by Mad(e) in Mumbai, which undertook a mapping and spatial analysis of a specific corridor – Maulana Shaukat Ali Road – where an ethnographic study of the community was undertaken, that looked at multi-modality, public amenities (including restrooms) and infrastructure needed by workers, sellers, travellers, and passers-by. This helped to inform strategic planning as well as retrofits.

Such proposals and recommendations are also key to informing the government as to the best allocation of resources in a given situation. Audits of this kind that support urban information systems can provide highly pertinent information to the strategic planning cycle. This in turn opens the door to bring about change and improvements that are felt on the ground, by users, and not only reflected in policy documents and reports.

The redevelopment strategies for streets in India have capitalised on the processes presented above, and have put forward creative solutions, as a part of partnerships between public and private bodies. There are projects to alleviate pedestrian flow in Thane, near Mumbai, involving wider footpaths with planters and trees, bicycle tracks, wayfinding (sign-posting) and other traffic-calming measures. An additional approach is to focus on a multi-purpose zone, or ‘multi-utility zones’ (MUZ) which employs various elements, such as street furniture, green cover, bollards, LED lighting, and a general reclamation of space from vehicular lanes.

• 70Kulkarni C., and Mohanty-Padora, R., Streets as Ingenious Infrastructure, from: Streets For All – 50 Ideas for Shaping Resilient Cities, ed. Bharne, V. and Khandekar S. (2022)

Thus, by harnessing new technologies, and paying attention to the needs of stakeholders, in addition to the employment of best practices and the alignment with progressive policies, allows for real and tangible street upgrades in Indian cities.

8.7. Participatory Design Process at the Eishin school campus, Japan

The story of the Eishin school campus, just outside of Tokyo, is instructive in relation to the participatory process. It is also notable in the way that the use of the Pattern Language methodology, as a part of the participatory process, can lead to quality designs and functions that are significantly higher than those provided by standard building processes.

The Pattern Language method was developed by the American architect Christopher Alexander, and it involves creating and using a number of key concepts and patterns that are established during a gradual development process in a co-creation fashion. The principal values and hoped-for functions of the project are reflected in a list that was created by means of interviews and discussions with all stakeholders.

In the case of Eishin campus, the stakeholders included students, faculty, and staff. All of them were able to describe their needs and wishes for those aspects of the campus that were important to them; these were then synthesised and included as crucial inputs, and in that way could influence the design process flow. This went well beyond token participation. The stakeholders were consulted in a period lasting a full five months, and a single interview could last up to an hour. This allowed for a deeper exploration of the themes and dreams of all involved.

The campus was completed in 1989 (it was built on a new site to replace the former campus). The building process took place under the guidance of Christopher Alexander and used local materials and local teams. The approach was made possible by the visionary leadership of the school principal in that time, Hisae Hosoi. He requested Christopher Alexander's involvement and use of the Pattern Language approach. The whole project was documented in Alexander's book *The Battle for the Life and Beauty of the Earth*.

What is unique about this process is that it allowed for an end result that provides many functions and designs that are specific to each area (such as classroom, gymnasium, pond, etc.) and well suited for the needs. The details and the designs help to make the campus more beautiful and interesting than they would have otherwise been, yet the outstanding feature of this process is its ability to correspond to the local needs and conditions, cater to the desires of the users, follow an environmentally-friendly construction approach, and create a far superior process to the standard construction standard of entrusting the whole project to a large company, that build on a tight schedule, with minimal inputs, and cost-saving wherever possible, compromising the end result.



8.8 Urban Heritage and Pedestrian Design (Bandipur, Nepal)

Illustration 23: Bandipur, Nepal

A small town in central Nepal shows how cultural and urban heritage, local community organising, and exposure to international best practices can all come together to create the right conditions for a car-free city centre, vibrant with cultural life and a local economy connected to tourism.

Bandipur, sometimes referred to as ‘Queen of the Hills’ is located along the main Kathmandu-Pokhara highway. It is a market town, similar to many traditional Newari settlements. Most such towns ended up in one of two ways: hilly towns without access to the national highway network have few vehicles, but are cut off from the rest of the country and lack economic vibrancy. Or they are connected to the road system, and have allowed an influx of traffic to take place.

Bandipur carved out a unique position for itself. It is connected to the highway system, but vehicle access to the town stops at the entrance to the city. Permanent concrete barriers as well as steps define the entrance areas, ensuring that it remains car-free year round. In this way, Bandipur has managed to get the best of both worlds.

In the modern history of the city, there was a period where locals migrated to other cities, leaving Bandipur not much more than a ghost town. Residents then realised that they could lead a revival of their town, building on a legacy of a vehicle-free design, with a high tourism potential and cultural activities. A part of the catalyst to choosing this route was exposure to best international practices, including models of cities that retained their traditional structures and resisted becoming over-run by vehicles. The revival process began in the early 2000s.

Today, Bandipur residents are proud of their achievement, and see themselves as ambassadors of the car-free urban design model. Other cities have begun to notice. Notably, Dhankuta in eastern Nepal has informed itself and is planning its own pedestrianisation plan. The Nepali NGO Digobikas organises study trips to Bandipur, showcasing the ‘Queen of the Hills’ to interested participants, usually mayors and local government representatives from around the country.

RECOMMENDATIONS

In this final part of the Training Materials for Smart Eco-cities, a number of recommendations are provided for any practitioners or developers of eco-cities. While included in the recommendations section, the list below contains many key principles. It could thus function just as well as an action framework of fundamental principles for developing smart eco-cities. Moreover, these principles can be treated as a set of guidelines or rules that reflect the values and structural requirements to create true eco-cities.

Every city authority, planning agency, consulting firm, or think tank is well advised to take these principles to heart and incorporate them in the planning process or policy elaboration for cities. Even if a given city is still far from being an eco-city, incorporating these principles can significantly help to propel a city in that direction. An auspicious direction in fact – as embracing eco-city values will greatly improve the quality of life of a city’s inhabitants, while it will also play an important part in improving planetary health: slowing down the factors that lead to climate change and ecosystem degradation.

Many of the principles listed below are mutually supportive, yet leaders and practitioners of eco-city projects may well choose a number of them to adopt as their signature style or primary focus.

The main prerequisites for working with these principles are: a) a steadfast commitment to achieving real results and steering change that benefit the most people possible b) the willingness to act boldly to promote and defend ecological and social values.

In the best-case scenario, there are many local actors present who are willing allies in forging a path towards an eco-city scenario, and who are interested in creating a better future for all. The UNCRD as well as a host of other transnational actors and organisations are also ready to support governments, project teams, and any stakeholders working towards these common goals.

Principles for Smart Eco-city Development

1. Institute an accelerated drawdown from fossil fuel use along with the wide-scale adoption of renewable energy. This may involve an Energy Descent Action Plan (EDAP) at community level, or a Zero Carbon Framework at the city level. A decarbonisation plan should be established with GHG emissions set to hit net zero within a reasonable time frame – targets set more than ten years into the future lose any meaningfulness.
2. Introduce and augment the city’s stock of natural green elements at a significant rate, with officially declared targets, every year. This includes, parks, trees, vegetation, and all variety of ecosystem services and biodiversity.
3. Act as an earth steward. Nature is more than eco-system services. Other species, including animals, plants, and all of wildlife, have a right to exist and should not have to make space or suffer at the expense of humans. Nature protection and environmentalism should be at the centre of our philosophy and world view. For many, this will involve forging a new relationship with nature. Likewise, any development project should take a holistic approach, and include biodiversity and ecological regeneration and flourishing at the heart of the design principles.

4. Follow a resilience-based climate change adaptation and mitigation plan. This involves mitigating the contributing externalities that cause climate change as well as preparing all urban systems for adaptation to and protection from climate change hazards.
5. Place equity at the centre of all development plans. This means ensuring that urban projects and development trajectories are tuned to the needs of everyone. Inclusiveness means that all of society (rich and poor alike) as well as every ethnic and religious minority, and diverse social groups and age categories (the elderly as well as children) should all be properly catered to with suitable access to amenities and urban services.
6. Prepare wisely and smartly for transformation. In order to successfully follow an eco-city pathway and to adapt to climate-related urgency, it will be necessary to radically transform the current urban structures and policies, as well as urban management, planning, energy systems, social and economic conditions. With good planning, this can all be prepared for adequately, without causing inexpedient disruption. With the benefits well communicated and understood, the urban population can be cooperative partners. This amounts to an *evolutionary* transition framework. If insufficient action is taken, conditions may precipitate to a situation of social and environmental collapse, at which point a *revolutionary* transition framework kicks in. This would be far messier and lead to massive hardships and chaos.
7. Investments should be geared toward eco-city values and sustainability principles, and lead to decarbonisation and net positive impacts. The UN SDGs provide the definitive roadmap to achieving sustainability goals, while the New Urban Agenda provides a reference point for urban development. Urban financing needs to divest from fossil fuel related projects and investments, and reinvest these funds into projects that foster bio-diversity, climate mitigation, and human flourishing. This should happen at an accelerated pace.
8. The role and the function of the street needs to be reconsidered and redesigned. The large-scale roll-out of streets and roads (the practice hitherto) are huge disruptors. They create disturbances to the natural flows of life, inhibiting the movement of plants, animals, water, and the soil. They create emissions, noise pollution, and destroy any other functions around. Streets can also function as connectors, with a wide variety of activities, like markets, playing, social encounters, rituals, and processions. While streets were originally developed to carry transport, the less of a transport function it embodies, the richer the street actually becomes. Streets can serve as ecological and social corridors. A place to start would be by replacing the transport function, decommissioning highways, and repopulating the space with trees and parks.
9. At the heart of any urban renewal plan or transition to smart eco-cities is an updating of transport policy and practice. The transportation paradigm shift prioritises street space allocation and modes of travel: walking first, then cycling, then public transportation, with automobiles and motorbikes last (if at all). The majority of urban public space should be allocated to pedestrian use. Urban automobile mode share can be reduced by 70-80%. Car-free street design and car-free neighbourhoods hold promise for future urban design. These are emission-free zones where all destinations can be reached in under 15 minutes, and brings enormous savings to government, residents, the health system, and more.

10. Visionary leadership is needed in order to fundamentally transform cities and increase the well-being of citizens. Leaders must be able to prevail in the face of destabilising factors and compromising influences, such as: economic growth obsession, corruption, subservience to the fossil fuel lobby, squandering of resources, facilitating mega-projects at the expense of measures and programmes that support a wider population. Leaders come and go, but truly visionary leaders create ripple effects and a legacy that long outlive their mandate.
11. A pro-social policy and ethical framework should also be at the heart of urban development. An urban society that is based on a social code of kindness, sharing, compassion, co-operation, love, and forgiveness will lead to a benevolent city. A socially just city will have little to no crime, nor problems with addiction.
12. Participation is the key to a successfully operating society, and is much more than a buzzword, and should go beyond tokenism. Citizens should be included in the process of development as equals, and able to help co-create their future city. A diversity of opinions, attitudes, and perspectives is healthy, as this creates more opportunity for reflection and selecting the best course of action. Dissenting opinions (or counter-arguments) should not be suppressed – instead even the most recalcitrant hold-outs should be invited to the table, as it is important that everyone's needs and concerns are listened to.
13. Any decision-maker, project manager, or active stakeholder in an eco-city development project should spend dedicated periods of time in nature, such as a national or natural park, nature reserve, or recreational areas of significance. This exposure to nature, in an unhurried way (and without a busy agenda) will greatly expand the person's perspective of nature, its minute details, and bring additional inspiration and innovative ideas back to the board room or office. If walking or hiking, make sure to allow for periods without conversation, in order to better absorb the surroundings. Otherwise, finding a convenient spot for contemplation or observation alongside lakes, rivers, or in forests and hills, is recommended.

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