STEAM 3D ACADEMY

STEAM 3D GUIDE

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Contents

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The STEAM3D Academy project

The STEAM3D project aims to increase the interest of secondary school students and teachers in VET education, as they will be in demand on the labour market. The project's specific goal is to increase interest in STE(A)M careers and encourage students to pursue professional and transversal skills, as well as non-trivial competencies that will set them apart from other job applicants.

There are various careers that can be pursued within STE(A)M and this project focuses mainly on the field of engineering.

Aim of the Guidebook

The related term *sustainable design* is very commonly used. While there have been some rather varied and complex definitions put forth, we prefer that Sustainability is “providing for the needs of the present without detracting from the ability to fulfill the needs of the future.”

While this is a simple and good general definition when applied to ecological topics, it is difficult to apply it in a meaningful way, without being arbitrary, to engineering topics (building, automobile, urban design, oil field, industrial plants etc).

This Guidebook is a means of inducing learners, engineering VET students, teachers and educator as well as designers of the built environment to strategies that can be utilized in developing a “green/sustainable design” and set forth some practical techniques to help the future practitioners achieve the goal of green design and, thus, make a significant contribution to urban sites sustainability.

The environmental planning process is international in application. Each site, however, is different; the use people need to make of it is also different and the resources available can vary. For these reasons you should always expect the locally appropriate and sustainable solution to be different on each site, achieved after thorough consideration of local conditions and the people involved.

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Introduction

As more and more Europeans choose to live and work in cities, towns, and suburbs, Europe is becoming a more urbanized continent. The quality of the surrounding environment has a significant impact on the quality of life in metropolitan settings. For instance, it depends on the standard of the air and water, accessibility to nature and biodiversity, the amount of noise pollution, and increasingly, the capacity to maintain a cool environment as temperatures rise.

The majority of resource use occurs in urban areas, which also provide many environmental issues. As people live and work closer together, manage and share resources effectively utilizing the concepts of the circular economy, reduce their reliance on private motorized transportation, and live in more energy-efficient structures, cities also present opportunities to address environmental challenges.

The European Union is aware that cities are essential to fulfilling the goals of the European Green Deal, which include creating a society that is low-carbon, resource-efficient, sustainable, and resilient. The Commission supports a wide range of activities and projects with a focus on air, water, noise, protecting and restoring green spaces, boosting the circular economy, and managing waste better. Cities in the EU and their local governments are crucial collaborators in putting pollution laws, policies, and programs into action.

What are the advantages of a green approach?

The advantages of a green approach to urban design are being recognized by cities all over the world since it has the potential to reduce urban temperatures, reduce air pollution, and increase environmental resilience. Among the top ten urban planning priorities, the Global Agenda Council on the Future of Cities of the World Economic Forum listed expanding green canopy cover.

"Planting greenery, first and foremost, is one way for us to reduce the outdoor ambient temperature from rising to a high level." But it is not just that. "A green city that is close to nature also offers greater livability." *Kok Yam Tan, Deputy Secretary of Smart Nation and Digital Government Office, Singapore*

Why are green public spaces relevant for cities and their populations?

1. **Enhanced quality of living:** According to C40, air pollution affects children who have diseases like asthma in particular and results in about 4.5 million premature deaths annually. Metropolitan forest areas have the potential to improve air quality when they are correctly planned, highlighting the need to disperse trees in urban areas without contributing to existing health disparities.
2. **Enriched physical and mental health:** According to WHO recommendations, green areas may aid in enhancing mental health. According to a London study, there were 1.18 fewer depression prescriptions per 1,000 residents for every unit with higher tree density per kilometre of the street. In terms of physical health, a WHO study found that managing green cover could prevent between 23 and 25% of global sickness. According to several studies, living near green space lowers the risk of dying young.
3. **Improved resilience and equality as part of an adaptation strategy:** Some regions are now far more at risk from the effects of climate change as a result of deforestation. Planting trees increases a city's resilience by helping to protect it against landslides and frequent flooding. Eliminating disparities in the number of trees and green space in different parts of a city lessens inequality because it promotes everyone's health and well-being. A lack of green spaces, usually in low-income regions of a city, makes neighbourhoods hotter and more vulnerable to climate risk.

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4. **Reduced emissions to get closer to the sustainability and climate goals of the Paris agreement:** Moving closer to the environmental aim of decarbonization is made easier by green spaces. For instance, carefully placed trees in metropolitan areas can reduce air temperature by two to eight degrees Celsius, lowering the urban "heat island" effect and obviating the need for air conditioning by 30%.

Reconquering public spaces by interlinking design, inclusion, and sustainability

Living in urban areas is changing; there is a growing need for public green spaces, and the COVID-19 pandemic has made local environmental quality and social inclusion even more important. There are a lot of underutilized and abandoned buildings and open spaces in the EU and elsewhere that could benefit urban and rural populations in a variety of ways on an ecological, economic, and social level. Most underutilized areas and structures have both tangible and intangible cultural and ecological heritage, as well as the considerable potential for recreation, aesthetics, therapy, social contact, and cultural exchange. They consequently have important effects on locals' health, happiness, and access to services, especially for the most vulnerable individuals. In keeping with the principles of the New Leipzig Charter, they also offer spaces for social and cultural interaction, community involvement, and participation in social and cultural events, all of which help "reduce and prevent new forms of social, economic, environmental, and territorial inequalities."

This article reviews a number of initiatives and projects carried out under the relevant Actions of Sustainable Land Use, Circular Economy, and Culture and Cultural Heritage Partnerships of the Urban Agenda for the EU. It does so through the lens of the New Leipzig Charter's Green City Dimension and the New European Bauhaus (NEB) framework (UAEU).

The New Leipzig Charter's Green City Dimension emphasizes the transformative power of cities in combating global warming and enhancing the quality of the air, water, soil, and land usage. To achieve this, cities are urged to use nature-based solutions (NBS) to safeguard and regenerate ecosystems in order to build well-planned, maintained, and interconnected green and blue spaces. This calls for adjustments to modes of production and consumption, a redefinition of and commitment to sustainable resource use, a significant decrease in waste production and carbon emissions, investments in cutting-edge and effective technologies, and the promotion of a circular economy model that encompasses all of these elements.

The European Commission adopted the Communication on the New European Bauhaus on September 15, 2021. The EU's goal is to develop lovely, sustainable, and inclusive places, goods, and ways of living by fusing a place-based approach, citizen involvement, co-creation, integration, and collaboration across several disciplines and sectors. The NEB's holistic approach is at the heart of this goal (e.g., culture, technology, innovation, design, engineering, arts, social sciences, and natural sciences). In addition to other things, the four thematic axes of the NEB transformative route may give a chance for the creation of future partnerships or other types of collaboration under the UAEU. **The need for long-term, life-cycle thinking in the industrial ecosystem is one of them.** Others include reestablishing a connection to nature, reclaiming a sense of belonging, and giving priority to the areas and populations that most need it.

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What is green infrastructure, and why is it important?

Parks, gardens, green spaces, green roofs, green walls, street trees, meadows, wetlands, rivers, canals, and lakes are just a few examples of what is referred to as "green infrastructure."

There is a general understanding that green infrastructure should be viewed as a network rather than a single site, function at a variety of scales, from a rain garden to a floodplain, and be multi-functional, meaning it is created and maintained to offer a number of benefits at once.

Numerous studies have shown that green infrastructure has numerous advantages for the economy, society, and environment. These advantages include: enhancing people's mental and physical health; lowering air pollution and improving water quality; preventing climate change by, for example, reducing flood risk; storing water during dry spells; storing carbon; or preventing soil erosion; creating jobs; boosting economic competitiveness; etc.

High-quality green infrastructure also raises property values and makes locations more appealing to investors. The "natural capital" of the earth, or the resources that nature provides for us and on which our economy and way of life depend, includes green infrastructure as a significant component. Natural resources such as land, minerals, soil, water, air, and all living things are considered natural capital.

According to the European Union (EU), green infrastructure should be incorporated into the majority of EU policies and is crucial for the more effective use of tools for spatial planning. Additionally, it ought to be taken into account throughout environmental impact assessments (EIAs) and strategic environmental assessments (SEA). Green infrastructure is acknowledged for helping to enable intelligent and sustainable growth.

Sustainable Design Standards

As of 2015, over 55% of the world's population lives in urban areas according to UN declarations, with an expected increase to 66% by 2050. The response to global climate change is even more relevant in urban areas with the highest demands on resources (to stimulate production and the associated environmental impacts elsewhere) and in which the health of citizens and urban infrastructure are becoming increasingly vulnerable.

An integrated and sustainable approach to the design of urban sites and buildings will be critical to mitigate the negative impacts of unplanned urbanization, and their implications for resource use, biodiversity, and climate.

And "sustainable cities and communities" start with sustainable designed urban sites.

By emphasizing the importance of local context, design, education and integration, this guide aims to inspire all stakeholders involved in planning and service provision to think differently, and to provide them with the necessary tools to take action. [1]

Sustainable design principles consist of the ability to [2]:

- optimize site potential.
- minimize non-renewable energy use.

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- use products of environmental preference.
- protect and preserve water.
- improve the quality of the indoor environment.
- Optimize operations & maintenance practices.

The use of a sustainable design philosophy promotes decisions in each phase of the design process. that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line. It's an integrated, holistic approach to trade-offs. Such an integrated approach has a positive impact on all stages of an urban site's life cycle, including design, construction, operation and decommissioning.

But this requires a holistic shift in the educational process, especially in technical and vocational education. Curricula and skills acquired by students should be directed toward sustainable development.

Sustainability in architecture

Sustainability was not the goal of yesterday year's master builders. Yet some of the resulting structures appear to have achieved an admirable combination of great longevity and sustainability in construction, operation, and maintenance. It would be interesting to compare the ecological footprint (a concept discussed later in this book) of, say, Roman structures from two millennia ago heated by radiant floors to a 20th century structure of comparable size, site, and use.

Through the passing of time, more complicated technologies and the scientific method developed, the discipline of engineering emerged separate from architecture. This change was not arbitrary or willful but was due to the increasing complexity of design tools and construction technologies and a burgeoning range of available materials and techniques. This complexity continued to grow throughout the 20th century and continues today. With the architect transformed from master builder to lead design consultant, most engineering practices performed work predominantly as a subconsultant to the architect, whose firm, in turn, was retained by the client. Hand-in-hand with these trends emerged the 20th century doctrine of "buildings-over-nature," an approach still widely demanded by clients and supplied by architectural and engineering firms.

Under this approach—buildings designed under the architect as prime consultant following the "buildings-over-nature" paradigm—the architect conceives the shell and interior design concepts first. Only then does the architect turn to structural engineers, then HVAC&R engineers, then electrical engineers, etc.

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Embodied Energy and Life-Cycle Assessment

Building materials used in the construction and operation of buildings have energy embodied in them due to the manufacturing, transportation, and installation processes of converting raw materials to final products. The material selection process should also consider the environmental impact of demolition and disposal after the service life of the products. Life-cycle assessment (LCA) databases and tools are used to calculate and compare the embodied energy of common building materials and products. Designers should give preference to resource-efficient materials and reduce waste by recycling and reusing whenever possible.

The International Organization for Standardization (ISO) 14000 series of standards on environmental management serves as a method to govern development of these tools. LCA tools are available from both private commercial as well as governmental or public domain sources. The BEES (Building for Environmental and Economic Sustainability) tool was developed by the National Institute for Standards and Technology (NIST) in the United States with support from the US Environmental Protection Agency (EPA). The TRACI (Tools for the Reduction and Assessment of Chemical and Other Environmental Impacts) from the EPA focuses primarily on chemical releases and raw materials usage in products.

Green Building Rating Systems/ Environmental Performance Improvement Programs

There are two general types of programs that exist to encourage green building design. One type might be termed a rating system and the other a guide or program to encourage and assist designers in achieving green building design.

Green Building Rating Systems: here are various rating systems developed by reputable organizations. They all provide useful tools to identify and prioritize key environmental issues. These tools incorporate a coordinated method for accomplishing, validating, and benchmarking sustainably designed projects.

The leading rating method in the United States is the LEED program, created by the US Green Building Council (USGBC). LEED stands for leadership in energy and environmental design. It evaluates environmental performance from a “whole building” perspective over a building’s life cycle, providing a numerical standard for what constitutes a “green building.” Their goal is to raise awareness of the benefits of building green, which is transforming the marketplace. LEED has been applied to numerous projects over a range of project certification levels, and its use has grown rapidly over the past several years. Rating systems are now in place for new construction (LEED-NC), existing buildings (LEED-EB), core and shell construction (LEED-CS), and commercial interiors (LEED-CI). For residential projects, LEED programs are also in development for new homes (LEED-H) and neighborhood developments (LEED-ND). LEED also qualifies individuals as LEED consultants, although it does not require such consultants on projects seeking LEED ratings.

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Another rating method that was originally developed in the UK is "The Building Research Establishment Environmental Assessment Method (BREEAM)" This is a voluntary, consensus-based, market-oriented assessment program. With one mandatory and two optional assessment areas, BREEAM encourages and benchmarks sustainably designed office buildings. The mandatory assessment area is the potential environmental impact of the building; the two optional areas are design process and operation/maintenance. Several other countries and regions have developed or are developing related spin-offs inspired by BREEAM.

The European Commission presented its proposal on a Corporate Sustainability Reporting Directive in April 2021. Back in 2018, Parliament called for a revision of the NFRD and in 2020 set out its recommendations on sustainable corporate governance. The CSRD is one of the cornerstones of the European Green Deal and the Sustainable Finance Agenda and part of a wider EU policy to commit companies to respect human rights and reduce their impact on the planet.

The Corporate Sustainability Reporting Directive (CSRD), will make businesses more publicly accountable by obliging them to regularly disclose information on their societal and environmental impact. This would end greenwashing, strengthen the EU's social market economy and lay the groundwork for sustainability reporting standards at global level.

These rules address shortcomings in existing legislation on the disclosure of non-financial information (NFRD), perceived as largely insufficient and unreliable. The CSRD introduces more detailed reporting requirements on companies' impact on the environment, human rights and social standards, based on common criteria in line with EU's climate goals. The Commission will adopt the first set of standards by June 2023.

The rules will start applying between 2024 and 2028:

- From 1 January 2024 for large public-interest companies (with over 500 employees) already subject to the non-financial reporting directive, with reports due in 2025;
- From 1 January 2025 for large companies that are not presently subject to the non-financial reporting directive (with more than 250 employees and/or €40 million in turnover and/or €20 million in total assets), with reports due in 2026;
- From 1 January 2026 for listed SMEs and other undertakings, with reports due in 2027. SMEs can opt-out until 2028.

Fundamentals of related engineering topics

Understanding the basic tenets that define the engineer's profession is imperative for thoughtful design. While this Guide is not intended to serve as an engineering textbook, it is helpful to review key fundamentals of engineering that influence the design of sustainable buildings and urban sites from the perspective of the engineer profession and study. These include the first and second laws of thermodynamics, heat transfer, and fluid systems. This will provide the reader with insights into the opportunities available for energy conservation as well as other green-building design opportunities

Thermodynamic Laws

The laws of thermodynamics are at the core of the analysis and design of energy systems. This section briefly summarizes the first and second laws and their implications in green design.

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The first law in its basic form is

$$Q - (W flow + W shaft) = \Delta U + \Delta Epotential + \Delta Ekinetic.$$

For a system in steady state and substituting in for the internal, potential, and kinetic energy terms leads to the following:

$$\dot{Q} - \dot{W} = \dot{m}\left[(u_2 - u_1) + (p_2 v_2 - p_1 v_1) + \left(V_2^2 - V_1^2\right)/2 + g(z_2 - z_1)\right]$$

Where:

$\dot{Q}$	=> heat transferred to or from the system; the dotted symbol refers to the rate of heat being transferred
E	=> energy contained in the system (potential or kinetic)
$\dot{W}$	=> work produced or required by the system; the dotted symbol refers to the rate of work being done
u	=> internal energy of the fluid (i.e., water, steam, air, refrigerant) per unit mass
m	=> mass of fluid
pv	=> product of the pressure and specific volume of the fluid
V	=> velocity of the fluid in the system
h	=> enthalpy of the fluid per unit mass, expressed as (u + pv)
z	=> height or potential energy of the fluid 1 and 2 = subscripts denoting before and after states of the parameter

(Note: A dot over a symbol means "the rate of transfer of.")

The internal energy (u) and flow energy (pv) terms can be combined into the fluid enthalpy, given by
$h = u + pv$

The second law is represented by several equations involving the change in entropy of the fluid, but for the purposes of making decisions on energy and green design, studying the Carnot cycle, as represented on temperature-entropy coordinates, is particularly useful.
One common application of the first-law equation to an energy system is the combustion processes generating heat to raise the temperature of a fluid for providing heat to a building. When looking at the heating means, be it a boiler, hot water generator, or warm air furnace, the terms for work (W), changes in kinetic energy $\left(V_2^2 - V_1^2\right)/2$, and potential energy $(z_2 - z_1)$ are small in comparison to enthalpy difference, so the first law becomes:

$$\dot{Q} \cong \dot{m}(h_2 - h_1)$$

Green Design Implications of Thermodynamic Laws

There are two types of energy: stored (potential) energy and the energy of motion, called kinetic energy. Regardless of its form, however, the first law of thermodynamics always applies. For a closed system, in essence, it says:

Energy cannot be created or destroyed.

A closed system is one in which energy and materials do not flow across the system boundary. The first law is why energy efficiency and green design are a necessity. If we could create

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energy, there would be no reason to conserve it. We must be aware that we are largely dependent on sources of energy that are in finite supply.

Therefore, it is logical to use less energy of this type as a rule and to move toward renewable, more efficient energy sources in general.

If energy is the ability to do work, then what happens when we tap that potential? The result is threefold: work, heat, and entropy. Work is the transfer of energy by mechanical means, such as a fan or pump. Heat refers to a transfer of energy from one object to another because of a temperature difference. And entropy, simply stated, is an indicator of the state of disorder of a system.

The second law of thermodynamics helps us to appreciate the relevance of sustainable design even more:

All processes irreversibly increase the entropy of a system and its environment.

If you understand that the Earth is our system, then you realize that the limited amount of usable energy we have been granted (first law) will eventually and irreversibly be converted into unusable energy (second law), which brings us full circle. Of course, the earth is not a completely closed system in that energy is entering (via solar radiation) and leaving (such as earth radiating energy out into space). Regardless, our dependence on energy in a useful form, and the immutable laws of nature, set the tone for proper (green) design: use energy judiciously and effectively.

Fundamentals of Heat Transfer

Heat travels in three ways: conduction, convection, and radiation. Note following general correlations:

Conduction	≈>	Heat transfer by molecular motion within a material or between materials in direct contact
Convection	≈>	Energy exchange via contact between a fluid in motion and a solid
Radiation	≈>	No contact required; heat transfer by electromagnetic waves

In real-world situations, heat transfer occurs via all three modes at the same time. Depending on the problem type, one or two of these modes will generally dominate the rate of heat transfer at any given moment. But to keep things simple, we will discuss each mode of heat transfer separately.

Conduction. Consider heat transfer through a portion of the building shell (wall, window, door, floor, or roof). The process can be expressed as follows:

$$Q = UA\Delta T$$

where Q is the amount of heat transferred, A is the exposed surface area, and temperature delta (ΔT) is the difference between the two boundaries of the (outdoor air and indoor air).

The rate at which heat is transferred by conduction is controlled by the overall heat transfer coefficient U:

$$U = 1/\Sigma R$$

where ΣR is the overall thermal resistance for the material layers of the system in question.
The overall thermal resistance will typically include terms for convective heat transfer resistances in effect on both the inside and outside surfaces.

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Convection. There are numerous formulas describing energy transfer through convection. The ASHRAE Handbook—Fundamentals gives at least 12 factors used in determining convective heat transfer coefficients, and it lists no fewer than 25 equations for calculating heat transfer through forced convection. We will limit this discussion to the comparison of natural versus forced convection.

Natural convection is often called free convection and is primarily due to differences in density and the action of gravity. To see convection in action, observe a LAVA® lamp. The "lava" gains heat from the lightbulb and rises; as it cools, it falls again. Replace the lightbulb with a hot-water-filled finned tube and swap the "lava" for air, and you get a fair idea of how convection works in a heating application. The lesson from this fairly obvious example is that natural convection is a simple law of nature that can be used to the designer's benefit in a number of ways. Forced convection occurs when the fluid (air, water, etc.) movement is done via an external mover, such as a fan or pump.

Radiation. Heat transfer via radiation presents a unique challenge and opportunity for the designer. We all stood next to a cold window and felt chilled even though the ambient temperature was at a comfortable level. The same holds true for sunny days when one can get too warm even though the thermostat says all is well.

The simplified form of the equation describing radiant heat transfer is:

$$Q = \varepsilon\sigma A\left(T_1^4 - T_2^4\right)$$

where ε is emissivity, σ is the Stefan-Boltzmann constant, A is surface area, and the temperature (T) terms are the absolute temperature difference between the radiant object (subscript 1, with emissivity of ε) and its surroundings (subscript 2, a blackbody).

Emissivity is a property that reflects the ability of that material to emit thermal radiation energy relative to the maximum theoretically possible at the material's temperature. Emissivity is a function of both the material itself and surface conditions. A dull black surface such as charcoal has an emissivity close to 1 (that of a blackbody), while shiny metallic surfaces have lower values, more in the range of 0.1 to 0.4. A related property for thermal radiation is the material absorptivity, which reflects that material's ability to absorb incoming thermal radiation. A material with absorptivity of 0.8 will absorb 80% of the incoming thermal radiation. In general, one can consider the material's absorptivity and emissivity to be the same value.

Surfaces with higher emissivity will absorb and emit more thermal energy. But notice the dramatic difference changing the temperature difference can make; the rate at which an object radiates or absorbs heat is proportional to the difference in the fourth powers of the absolute temperatures involved.

When the designer is faced with the challenge of minimizing the heat transferred by radiant means, the following steps can be taken for situations where cooling loads dominate:

- Explore the possibility of eliminating or drastically reducing the area (A) directly exposed to the radiant source through shading or other means. For most building applications, the radiant source is the sun, which can be treated as an object emitting energy at 5800 K, or 10,000°F.
- Recommend the use of "cool roof" technologies that balance the emissivity and absorptivity of the surface to minimize the net solar heat gain to the roof.
- With glazing, the designer should evaluate the trade-off of using a low-emissivity material with other selective (reflective) coatings.
- Avoid dark colors on the building exterior, which typically have a higher emissivity and absorb more heat.

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- Limit east and west exposures, especially those with a large amount of glass.
- Offset the radiant load. For example, in a large atrium with a large glazing exposure and/or exterior walls, offsetting the radiant gains from the envelope with radiant cooling in the floor will produce a net effect that is significantly more comfortable for the occupant.

Fundamentals of Fluid Flow

The analysis of fluid flow and systems is also a fundamental concept for HVAC designers. For an incompressible, steady-flowing fluid, the Bernoulli equation governs. This equation is based on the conservation of energy principle and states that between Points 1 and 2 within a system, the following relationship holds:

$$0 = \frac{P_2 - P_1}{\rho g} + \frac{V_2^2 - V_1^2}{2g} + (z_2 - z_1)$$

where P is the fluid pressure, V is the fluid velocity, and z is the elevation at Points 1 and 2.

When a fluid passes through a fan or pump, additional energy is input to the system in the form of an increase in pressure and perhaps fluid velocity. The power required to move a fluid involves, in essence, a modification of the Bernoulli equation with the left-hand side not being zero but reflecting the additional energy input to the fluid.

Sustainable Design in Open Spaces

For both people and the environment, green urban spaces—from parks and gardens to green roofs and urban farms—offer a variety of advantages. They offer essential space for both physical and mental health, as well as an essential home for wildlife, including birds and pollinators. In addition to many other benefits, green space protects against heat waves, droughts, and air, water, and noise pollution.

Although some urban green spaces are now better protected, as more people choose to live in cities, green spaces frequently lose out in the race for available property. These tendencies are intended to be reversed, and our priceless urban ecosystems are protected and restored under the Biodiversity Strategy for 2030.

The Green Space Factor

The Green Space Factor (GSF) is a method for calculating the amount of green infrastructure needed for new construction. It is utilized in many municipalities' policies to impose conditions on developers before granting planning clearance for a location. The goal is to guarantee that green infrastructure is designed from the very beginning when places are being built. Various modifications to the GSF have been made throughout Europe. Its versatility, which allows it to be modified to fit varied political, planning, and cultural settings, has been one of the reasons it has been effectively transported between cities.

The GSF operates by laying out in a municipality's planning policy the standards for how environmentally friendly a new development should be in order to receive planning clearance, with a focus on both the quality and quantity of the offered green components. The GSF policy assigns "factors" (between 0 and 1) for different forms of surface cover; hard, sealed surfaces receive a score of 0, while the greenest and most natural surfaces receive a score of 1. The area of the surface cover type is multiplied by the factor that is associated with it to determine the

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GSF score for a specific location. An overall GSF score between 0 and 1 is produced by adding the scores for each type of surface cover and dividing the result by the size of the entire site.

Different expectation thresholds can be set by municipalities. The GSF approach's fundamental tenet is to play the role of an enabler by fostering discussions between developers and municipalities about how to hit a target score and create fantastic communities where people can thrive.

One advantage of the GSF is that it promotes cooperative working between the public and commercial sectors by providing a flexible and user-friendly planning tool for implementing green infrastructure in new developments. All stakeholders involved in the development process can benefit from the method. Within a defined policy framework, developers can modify master plans and designs to meet shifting needs and conditions. To achieve their place-making goals, municipalities can proactively interact with developers and the community. Communities, both new and old, profit from construction projects that make use of green infrastructure's many uses.

The GSF is particularly important for towns and cities that must densify to handle growth. The GSF can ensure that green infrastructure is incorporated into the built environment, thereby countering some of the negative effects of growing density in areas where there is pressure on the use of land and where space for traditional parks and green spaces is in the shortest supply. The GSF can also assist legislators and policymakers in other policy areas in understanding the potential advantages of green infrastructure for their jurisdictions, which will motivate them to support the argument for increased urban greenery.

Urban Greening Plan Guidance and Toolkit

The Commission urged European towns and cities with at least 20,000 residents to *"develop ambitious urban greening plans" that include "measures to create biodiverse and accessible urban forests, parks, and gardens; urban farms; green roofs and walls; tree-lined streets; urban meadows; and urban hedges"* as part of the Biodiversity Strategy, which aims to restore nature to cities and reward community action.

This advice intends to assist local governments in reaching this goal. It was created in partnership with Eurocities and ICLEI and is the result of discussions with numerous local governments that have already designed and put into effect successful urban greening programs.

It emphasizes the significance of the cooperative process of creating an urban greening plan, including the necessity of collaborating with residents and other stakeholders, as well as the necessity of cross-departmental collaboration and integration of the greening plan with other aspects of urban development, from mobility and health to air and water quality to energy and climate adaptation.

An urban greening plan is a long-term framework and strategy to make sure that towns and cities continue to become greener. It is not a standalone document.

You can find the draft Urban Greening Plan Guidance [here.]

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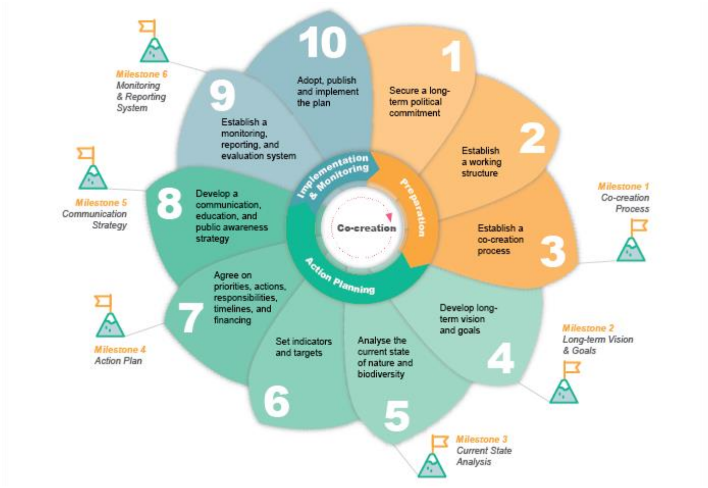

Image source: https://environment.ec.europa.eu/sites/default/files/styles/embed_large_2x/public/2022-10/Urban-Greening-Plans-graphic-10-steps-no-title_0.png?itok=_HGmnlMQ

Urban greening plan cycle steps [2]:

1. Political commitment
2. Working structure
3. Co-creation process
4. Long-term vision and goals
5. The current state of nature and biodiversity
6. Indicators and targets
7. Priorities, actions, responsibilities, timelines, and financing
8. Communication, education, and public awareness strategy
9. Monitoring, reporting, and evaluation system
10. Adopt, publish and implement the plan

How to ensure successful implementation

Recognize societal objectives and sustainability drivers: Green spaces should be planned with an understanding of both the current ecological state and the ultimate objective for attainment in order to help meet environmental targets. In order to plan the route from the starting point to the destination while taking into account the cultural and social dynamics of the city, this "impact assessment" is essential. This procedure should include assessing the hazards, as some cities lack knowledge about which areas are more vulnerable to flooding.

In comparison to city centres, suburbs are sometimes overlooked when it comes to the creation of walking trails and green spaces. For instance, a study in Melbourne found that the amount of tree cover decreased by more than 2% for every ten kilometers away from the city centre. Suburban regions may be more susceptible to the effects of warming air due to a lack of urban tree cover. Furthermore, it's crucial that the construction of new streets and parks take place without displacing a community's long-term low-income residents. An integrated viewpoint is required due to the fact that updated mobility strategies with the right incentives for lowering private car usage must be implemented in conjunction with walking and cycling corridors.

Do not undervalue the influence of community participation; it is essential to get support from the populace for green and livable urban development. Under the auspices of its Urbinact initiative, which is supported by community involvement efforts, the City of Porto is establishing healthy corridors in Campanh. To guarantee local participation in renovation and maintenance projects, active community engagement is also crucial.

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Ensure funding and financing: Budgetary constraints may make it difficult to give green cover priority. Therefore, cities may take into account creative funding strategies for green spaces. Leverage could be used with other conventional financial instruments as well.

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Other:

- Examples of public spaces - https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1062-10-sustainable-and-innovative-public-spaces-around-the-world/
- Article: "Public Space Design and Eco-Friendly Development" https://indvstrvs.org/public-space-design-and-eco-friendly-development/
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- ASHRAE GreenGuide The Design, Construction, and Operation of Sustainable Buildings; ISBN 1-933742-07-0, ISBN 978-1-933742-07-6; 2006 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1791 Tullie Circle, NE Atlanta, GA 30329; www.ashrae.org; pp 17-20.

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