Greenvolve

GREEN CITIES WITH SMART CITIZENS

HANDBOOK ON GREEN CITY ELEMENTS

GREENVOLVE Green Cities with Smart Citizens

2021-1-HU01-K220-ADU-000033719

Version 2.0

Co-funded by the European Union

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www.greenvolve-project.eu

Project Acronym:	**Greenvolve**
Project full title:	Greenvolve - Green Cities with Smart Citizens
Project No:	2021-1-HU01-KA220-ADU-000033719
Funding Scheme:	KA220-ADU - Cooperation partnerships in adult education
Coordinator:	CAM Consulting
Project website	https://greenvolve-project.eu/

Document Information

Author:	Project partners
Reviewer:	Kuldīga Municipality
Status:	V2
Dissemination Level:	Public

Statement of originality

This output contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Introduction to the Greenvolve Handbook on Green City Elements

In the ever-evolving landscape of urban development, the role of innovative solutions and processes is paramount. The Greenvolve Handbook stands at the forefront of this change, focusing on the Green City Elements (GCEs) that address the pressing challenges of climate change.

Our aim is to foster smarter, greener, and healthier cities with smarter citizens.

This handbook simplifies complex topics for citizens, highlighting key areas of GCEs:

- CLIMATE CHANGE MITIGATION
- CLIMATE CHANGE ADAPTATION
- CIRCULAR ECONOMY
- DIGITALISATION
- ENERGY TRANSITION

A unique feature of this handbook is its adaptability. While it presents a holistic view, its structure allows for individual GCEs to be accessed separately, catering to specific needs. Whether you're a citizen eager to understand urban sustainability or a municipality aiming to involve residents in green initiatives, this handbook serves as a bridge.

Our resources draw inspiration from established frameworks, projects, and good practices on urban sustainability across Europe. These can be explored further through the provided references.

Who is this Handbook for?

Greenvolve targets a broad audience, from everyday citizens to municipality staff overseeing urban development.

Our tools and resources are designed to:

- Empower citizens in urban design and participatory decision-making.
- Raise awareness about Green Cities and climate adaptability.
- Support municipalities in green urban initiatives.

Join us in this journey towards a sustainable urban future. Dive into the pages ahead and discover how you can play a pivotal role in shaping the cities of tomorrow.

Greenvolve
GREEN CITIES WITH SMART CITIZENS

Table of content

HUMAN-POWERED MOBILITY

SUSTAINABLE MOBILITY

Image source: es.vecteezy.com

Introduction

Human powered mobility refers to moving around the city on foot or by bicycle. These means of transport are ideal for meeting the transport demand within our cities. Nowadays, these modes can be "enhanced" in order to achieve longer distances with personal mobility vehicles running on electricity, consuming very low energy quantities, not emitting local pollution and being silent.

Description

Active mobility covers walking and cycling as well as other single human transport modes (scooters, skateboards, etc.) as modes of urban – or in some cases even inter-urban – transportation. These forms of mobility should be considered on the same level as motorised modes of transport for their ability to move people around and their contribution to last mile services in our cities.

Around half of the trips we make with our cars are shorter than 5 km and a third of our car trips are less than 3 km. Many of these trips could be done by walking and cycling.

Active mobility is the cleanest type of transportation, being as well the cheapest one. It improves the air quality in our cities, reduces the level of noise, saves energy resources, and it is a good way to improve our health and well-being.

Considering all their advantages, it is important, thus, to recognise walking and cycling in urban development planning and policies, and to prioritise these transport modes by providing adequate urban spaces and infrastructures adapted to these kinds of mobility.

As a rule of thumb, walking is competitive (against other transport means in the city) for distances of up to 1 km or 15 minutes; and cycling for distances of up to 5 km or 20 minutes. The average car speed in cities is under 40 km/hour.

Main Features

- Healthy
- Cheap
- Clean transport mean
- Better air quality
- Less environmental impacts
- Competitive in a 15-minute city

Image by DPG as partner in OPTITRANS EU project bike-bus integration experience

Advantages and challenges

- ✓ Human-powered mobility is a boost to human health.
- ✓ Cycling and walking are the cleanest ways of transport and the cheapest as well.
- ✓ It improves air quality in urban areas as no pollution is emitted.
- ✓ Human-powered mobility can also reduce traffic accidents and congestion in our cities as well as noise and air pollution.
- ✓ It is a competitive transport mode if we speak about time in distances of less than 5 km.
- ✓ These transport modes are silent and improve the liveability in our cities.
- ✓ Personal mobility vehicles such as scooters, electric bikes, and others have a higher environmental impact than walking and cycling but are much better than regular transport modes for higher distances.
- × Depending on the urban fabric, these modes of transport sometimes can be dangerous when no proper urban spaces and infrastructures are created.
- × In dispersed cities, the distances are too long for these transport modes.

References

- Mobility Academy: Active Mobility
- Muscle-Powered Mobility

Further Information

- REPower EU
- OPTITRANS Project
- TRAM Project

PUBLIC TRANSPORT

SUSTAINABLE MOBILITY

Source Teatro Magro

Introduction

Globally, over 50% of the population lives in urban areas today. By 2045, the world's urban population will increase by 1.5 times to 6 billion. Public transport is a good way to reduce congestion, save environment and people from health-harming emissions in urban areas, especially when they run on alternative, cleaner fuels. The European Commission strongly encourages the use of public transport as part of the mix of modes which each person living or working in a city can use.

Description

Public transport services are mobility systems (via land, sea, lagoon, river, etc.) with pre-established routes, timetables, frequencies and fares in a regional or even inter-regional territory. Means such as train, bus, metro play a strategic role in boosting the adoption of new mobility habits: it is possible to **maximise resources and time** by combining the different means available, **contributing to the reduction of CO_2 emissions and traffic**, with all its problems.

In fact, a single person who switches from a 30-km commuting alone by car to existing public transportation, can reduce his/her annual CO_2 emissions by around 9 kg per day, or more than 21 tons in a year. That is equal to 10% reduction in all greenhouse gases produced by a typical two-adult, two-car household.

Further Information

- European Commission, Climate tips
- Training Paths for Adults on Sustainable Mobility project
- European Mobility Week
- Green buses for European cities - video

References

- European Urban Mobility – Policy context
- Action Plan on Urban Mobility
- Cittadinanza attiva “Quattro passi verso una mobilità più sostenibile”
- KCATA: Environmental Benefits of Public Transit

ALTERNATIVE & E-MOBILITY

SUSTAINABLE MOBILITY

Introduction

Electric and alternative means of transport are characterised by a cleaner, greener, more sustainable, and last, but not least, an easier urban mobility. Although greenhouse gas emissions from transport decreased significantly in 2020 as a result of reduced transportation activity during the COVID-19, the transport sector is among the main causes of air pollution representing about 25% of GHG emissions in the EU.

Description

Transport is among the biggest air polluting sectors in the EU, and its impact on air quality and our climate is considerable. The largest share of transport related emissions stems from road transportation. Consequently, the EU has devised a set of tools, measures and incentives to reduce its impact substantially. The goal is a shift to low-emission mobility to which electric and alternative mobility can contribute.

Biofuels, including biodiesel, bioethanol, biomethanol, etc., are liquid or gaseous fuels made from biomass. Although they are considered renewable energy sources and hence seen as more environmentally friendly compared to fossil fuels, large areas of cropland are used to grow plants for producing these biofuels. Ethical, agricultural, economic, and also environmental issues can arise from the production of biofuels.

Electric vehicles (EVs) on the other hand can help us reduce greenhouse gas emission and noise pollution particularly in urban areas. The widespread uptake of electric vehicles depends on several factors, such as the availability of financial incentives like tax deductions and subsidies, status of the charging network, range of electric vehicles, etc. In 2021, one sold car out of ten was an EV, and the sales of electric cars is rising globally. Electric mobility is hence relevant for citizens, public administrations and fright transportation as well.

Further Information

- New transport proposals target greater efficiency and more sustainable travel
- Global EV Outlook 2022
- C-evil

References

- Transport emissions
- Greenhouse gas emissions from domestic transportation in the European Union from 1990 to 2020
- Biofuels

SHARED MOBILITY AND MAAS

SUSTAINABLE MOBILITY

Image source: Freepik

Introduction

Shared mobility means sharing the use of any type of vehicles. Mobility as a service (MaaS) is a type of service that, through a digital channel, enables users to plan, book, and pay for different types of mobility services. These solutions encourage a shift away from owning vehicles and using them solely, and turning mobility into a real society service.

Description

In most cases, shared mobility defines a group of vehicles (cars, scooters, electrical bikes, etc.), usually electrical, owned by a company or other organisation, that can be rented for single trips by the citizens at a competitive price. This is essential as cities and companies look for alternatives to reduce the number of vehicles they use.

There are also different alternative solutions regarding shared mobility. Car-sharing or pooling is offering spare seats in our vehicles with those who are going the same way, either for a single ride or on a regular basis. Besides informal arrangements, there are several local or national platforms providing services to help matching “supply and demand”. The agreement can be based on a fee, sharing driving or free of charge depending on the offer of the car owner.

Mobility as a service scheme is closely related to energy efficiency, emissions reduction, resource-optimization, business sales increasing, better experience of visitors and quality of life of citizens. This profound transformation requires a cultural shift in the industry to share data of different transport modes to be able to integrate all possible transport modes of the city in one platform.

A citizen should be able to get informed about the transport mode options to go from one point to another, see the time needed for the travel, check general conditions, and pay all different transport modes in one application.

Main Features

- Digital payment systems
- Social networks for connecting users
- Different types of sustainable vehicles
- Integration of data of different transport modes
- Timetable, information and ticket integration

Image source: Freepik

Advantages and challenges

- ✓ Fast and easy planning.
- ✓ Cheaper travel due to integrated MaaS schemes, or shared vehicles.
- ✓ Better ecological footprint related to travel, and less pollution leading to the improvement of air quality.
- ✓ Shift of possession of private vehicle to use of common services.
- ✓ More efficient use of vehicles and public transport.
- ✓ Reducing transit waiting times and documentation, as well as lower costs.
- ✓ Reducing congestion in cities.
- ✓ Reducing energy use and greenhouse gas emissions.
- × There are not so many companies that work in this field.
- × Better regulation about data sharing of different operators is needed to be able to integrate different transport modes.
- × The spread of shared mobility services might require development of the infrastructure and introducing new regulations (e.g., new road traffic roads related to electric scooters)

References

- What is shared mobility?
- Shared transport
- Carsharing, carpooling, ridesharing… what's the difference?

Further Information

- Characteristics, impacts, and improvements of Shared Mobility
- Shared Mobility 101: The Impact of Shared Mobility

MULTIMODAL MOBILITY

SUSTAINABLE MOBILITY

Photo under liscence CC BY-SA

Introduction

In our cities, the use of the private vehicles causes air pollution, traffic jams, reduced public space for citizens, or even accidents. This model is obsolete, and in our urban areas, we need to find other ways to move, which usually mean using different ways of transport depending on the people needs. Thus, multimodal mobility helps citizens to find the best transport modes in the city.

Description

This new type of mobility is understood as the possibility of making journeys between two points within the same city, using various means of transport that are environmentally friendly and compatible with human health.

Indeed, personal multimodal mobility (PMM) can be related to the green and smart city concept. PMM can connect citizens, vehicles, all types of transport systems and infrastructure through mobile devices. The data and information that are produced and used during the interconnection of the different users, tools and service providers can provide smarter and personalised mobility services.

As an example, for Multimodal Mobility, a citizen can walk to a bus stop, take the bus, rent a bike at the bus station and arrive to its final destination without having its own vehicle. This is closely related to energy-efficiency, emissions reduction, resources optimization, increasing business sales, better visitor experience and quality of life of citizens.

Cities should adapt local polices to enable the use of bikes or personal mobility vehicles in public transport, have infrastructures and parking facilities for those means of transport, coordinate information-sharing among transport operators, or promote sharing vehicle schemes in the city.

Main Features

- Multimodal exchange platforms.
- Integration of different transport modes infrastructures and services.
- Next step to implement Mobility as a Service (MaaS) schemes.

Image source: Image by storyset on Freepik

Advantages and challenges

- ✓ Cheaper travel as it is integrated.
- ✓ Lower ecological footprint on travel - less pollution.
- ✓ Shift of possession of private vehicles to use of common services.
- ✓ More efficient use of vehicles and public transport.
- ✓ Reducing congestion in cities.
- ✓ Reducing energy use and greenhouse gas emissions.
- × There are still different frictions among different transport modes as private operators are not open for collaboration or to invest in needed adaptations.
- × Better regulation on transport infrastructures and services are needed to promote the possibility to use different transport modes in the same trip.
- × MaaS schemes (explained in its own GCE) and shared mobility should be increased in our cities to improve the multimodal mobility experience.

References

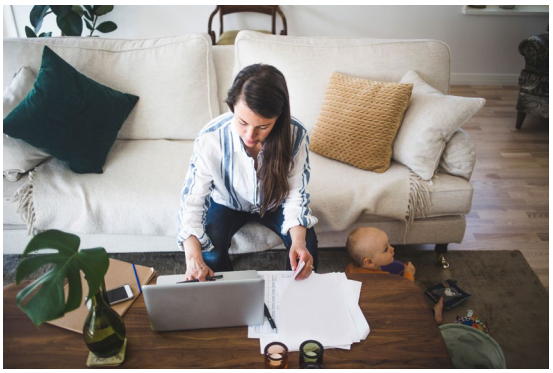
- Multimodal mobility is a transportation revolution. Automotive World
- Multimodal Mobility Solutions developed by Startups
- Multimodal Mobility: ESMARTCITY Project

Further Information

- Moovit world platform
- Multimodal Mobility: tomorrow's solution today

WORKING FROM HOME

SUSTAINABLE MOBILITY



Introduction

The global pandemic situation caused by COVID-19 has led to a sharp increase of employees working from home around the world. As a significant amount of CO_2 emissions stems from commuting to the workplace, home office arrangements can contribute directly to reducing greenhouse gas emission.

Description

In response to the spread of the COVID-19 pandemic, more and more people started to work from home which created a new situation for companies, families, and citizens in general. Remote work is a sustainable solution which has potential to mitigate certain aspects of climate change by reducing the environmental impact of commuting to work in cities and rural areas.

Working from home has numerous benefits for employees and employers alike. It can increase productivity, save time and travel costs, provide flexibility for families, and reduce environmental impacts such as less emission from commuting to work and using less office stationery. Therefore, the carbon footprint of home office work is much lower than working from high-capacity offices. Beyond regular daily working activities, people often have to travel to business meetings. Replacing these physical events with virtual meetings, our greenhouse gas emissions can be decreased more drastically.

These changes have direct effect on cities' fuel and energy consumption, air quality, level of noise pollution, traffic jams, and even on the status of infrastructure. Booming suburbanisation trends caused by the pandemic can also lead to similar benefits together with less daily commutes due to home office.

An average 12% of employed people (20-64 years old) worked from home in the EU in 2020. It's an approximately 7% increase compared to the past decade. This rate was higher in some regions (e.g., Vienna, Lisbon or Luxemburg) reaching up to 23%-25%. In some eastern and southern regions of the EU, the share of people working from home stood at only around 5%.

Main Features

Apart from restructured time management, there are other factors of remote working to consider such as:

- Energy footprint
- Transport footprint
- Technology footprint
- Waste footprint

Advantages and challenges

✓ If we can reduce the use of petrol cars, CO_2 emissions can decrease dramatically. The impact is more significant in those countries where people use older or bigger vehicles, or where road congestion due to traffic jams is more frequent.

✓ If people work four days per week from home, we can achieve roughly a 10% reduction in nitrogen dioxide emissions which is one of the main transport related pollutants.

✓ Although digital devices and solutions also require a considerable amount of energy as a result of their production and use, the net environmental impact is still positive and far below the carbon emission generated by commuting.

✓ As a result of remote work and sprawling suburbanisation, densely populated urban areas can reduce local greenhouse gas emissions.

× People who move to suburban areas usually buy bigger homes which results in higher energy consumption compared to smaller apartments in the city.

× In some regions and companies culture varies, home office arrangements are less popular which hinder the spread of remote work. Although hybrid work is not considered an ideal solution, it is more beneficial than commuting to work daily.

References

- Working from home across EU regions in 2020
- How Eco-Friendly Is Remote Working?
- Is Remote Work Actually Better for the Environment?

Further Information

- How usual is it to work from home?
- 6 Surprising Environmental Impacts of Remotely Working from Home

GREEN URBANISM

GREEN URBANISM RELATED TO ENERGY CONSUMPTION

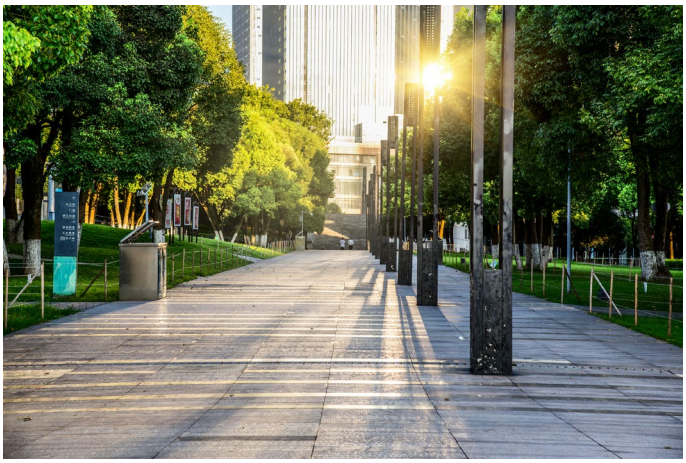


Image by onlyyouqj on Freepik

Introduction

Green urbanism can be defined as an approach to make communities beneficial to humans and environment creating sustainable and liveable urban areas.

It is an interdisciplinary model of a city relying on the collaboration of different professional profiles and pursuing energy-efficient, emission - free and zero - waste urban design.

Description

Green urbanism can be described as a sustainable urban design creating eco-friendly and resource-efficient cities. It also aims at reducing energy, materials, waste and greenhouse gas emissions. Cities should be designed to work with nature which can help clean the city's air and water. Green city leaders must take into account that cities should have plenty of sunlight, and greenspaces, and buildings must be designed well-oriented.

Some of the aspects to take into account:

- Climate and context, renewable energy for zero CO_2 emissions, zero-waste city;
- Water saving, gardens and urban biodiversity, sustainable transport;
- Density and refurbishment of existing districts (green buildings and districts) using local and sustainable materials with less embodied energy;
- Organize healthy communities and mixed-use programmes to consume local food and have in this way short supply chains.

Cities cannot be seen only urban areas anymore, but indeed, each city must be considered as an alive ecosystem with different resources coming in and waste streams coming out.

Main Features

- City as an ecosystem.
- Reduction of resource demand.
- Waste reduction.
- Friendly public spaces.
- Mix use of transport.
- 15-minute city.
- Densification and intensification.

Image by Freepik

Advantages and challenges

- ✓ Compact city with mixed resources allows a 15 - minute city, in which citizens can reach all basic services just walking in their neighbourhood.
- ✓ Connectivity, an interconnected street network improves public space for citizens, disperses traffic and encourages walking.
- ✓ Buildings provide beauty, aesthetics, and comfort, mixing architecture technician principles with ecology and environment care, with more comfort for citizens.
- ✓ The city evolves with more respect for natural systems and eco-friendly technologies like energy-efficiency to minimize effects on the environment.
- ✓ The city is connected with surrounding farmland, encouraging land preservation and local food consumption.
- ✓ Economy is improved due to the use of less resources and generation of less waste, with fewer costs in buying resources and in managing waste.
- × Lack of interdisciplinary project teams and knowledge to apply it.
- × Need of change of different city streams that are not easy to achieve.

References

- Green Urbanism Wikipedia
- What is Green Urbanism and why is it important?

Further Information

- What is Green Urbanism
- New Urbanism

POSITIVE ENERGY NEIGHBOURHOODS

GREEN URBANISM RELATED TO ENERGY CONSUMPTION

Photo under license CC BY

Introduction

Positive Energy Neighbourhoods are energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy.

Description

Cities consume two thirds of energy supply, and 70% of CO_2 emissions come from urban environments, thus a new urban concept has been introduced. Positive Energy Districts/Neighbourhoods (PED/PEN) are urban areas or groups of connected buildings which can produce more local renewable energy than its own consumption, and can manage, store, and distribute it to deliver neighbourhood services in a proper way.

In order to make them real, the first step is ensuring high efficiency in the building, industry and transportation sectors. After achieving it, less energy is needed and the energy demand can be met by using renewable energy sources. In order to deliver the necessary amount of energy to each point in the PED, the integration of different systems and infrastructures as well as interaction between buildings, users, and the regional energy, mobility and ICT systems are required. Securing the energy supply this way is in line with social, economic and environmental sustainability, while it also contributes to the well-being of the local citizens.

To achieve PEN/PEDs, energy efficiency is essential; the energy system transformation incorporates socio-economic, technological, environmental, political and institutional challenges that need to be tackled simultaneously.

Main Features

- High efficiency standards.
- Production of more energy from renewables than the needed amount.
- High-quality indoor environment.

Source: Owned by DPG in a study visit of ESMARTCITY project

Advantages and challenges

- ✓ A neighbourhood approach enables multiple synergies that can help to decarbonise the building stock in a more cost-effective way while incorporating the collective social potential of energy solutions.
- ✓ Peak energy savings.
- ✓ Less energy dependence and improved stability.
- ✓ Boosting local economy as operation and maintenance of all systems stay local and energy savings/revenues can be achieved.
- ✓ The creation of substantial opportunities for the positioning of novel technologies and smart solutions.
- ✓ Increasing connection between key stakeholders.
- × Lack of interdisciplinary project teams and knowledge to apply it.
- × Need for the change of different city streams that are not easy to achieve.

References

- Positive Energy Districts (PED) - JPI Urban Europe
- Economic, social, and environmental aspects of Positive Energy Districts
- Positive Energy Districts European Network
- POCIFY EU Project

Further Information

- Positive energy districts: Mainstreaming energy transition in urban areas
- Positive energy neighbourhoods. drivers of transformational change

INTEGRATED PHOTOVOLTAICS

GREEN URBANISM RELATED TO ENERGY CONSUMPTION

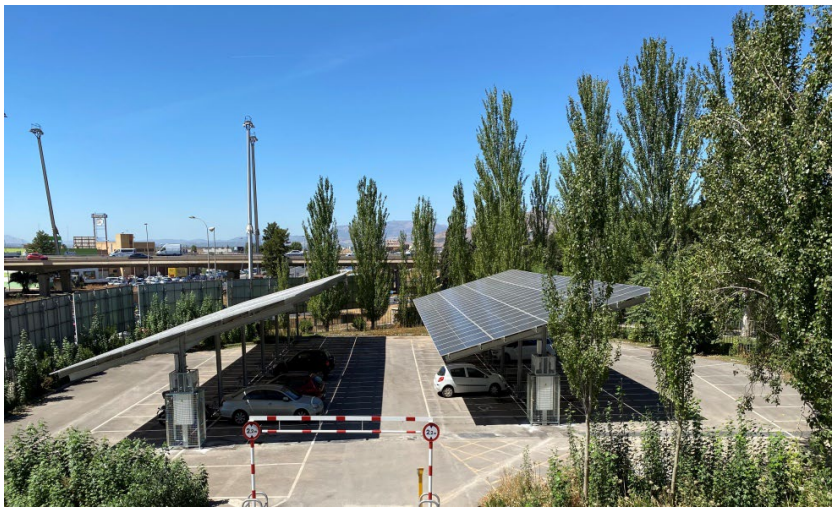


Image source: Owned by DPG partner. PV facilities in its parking lot.

Introduction

Building integrated PVs (BIPV) is defined by the use of different PV technologies to integrate the production of electricity in our buildings, facilities and cities in a way their visual and economic impact is diminished. This way, BIPV makes it possible to produce electricity inside the city from solar energy, even in protected and/or touristic areas.

Description

Integrated photovoltaic solar energy in buildings consists of the use of photovoltaic (PV) modules as part of the structure of a building to replace conventional construction materials such as roof coverings, skylights or facades. Photovoltaic modules are better to be incorporated in the phases of design and construction of new buildings, although existing buildings can also be retrofitted with installing PV panels.

An advantage of integrating photovoltaic systems initially is that the final cost can be compensated by the reduction in spending on conventional construction materials that would have been used. These advantages are making the photovoltaic industry grow in the cities.

Some of the possible technologies to achieve BIPV are transparent PV, PV glazing, PV tiles, opaque passable PV materials, flexible PV, hidden PV, or sun shading PV facilities.

Most of the main cities in Europe have protected cultural heritage areas, or touristic neighbourhoods, and regular PV is not allowed even if most of the citizens live in those areas. BIPV can be the perfect solution in these areas.

Main Features

- Possible to be installed in touristic and cultural heritage protected areas.
- Saving in construction materials.
- Low visual impact.
- Integration of solar energy in cities.
- Multiple possibilities and materials.

Image source: Owned by DPG partner. PV facilities in Malta JST of GREENVOLVE.

Advantages and challenges

- ✓ It has been proved and recognized that building integrated photovoltaics have the potential to become a major source of renewable energy in the urban environment. Buildings and all citizens' energy installations have an enormous impact on environment.
- ✓ Visual impact caused by conventional electrical network is greatly avoided.
- ✓ Replacement of conventional building materials by solar panels is amortized considering the cost of building with classic materials added to the energy savings thanks to photovoltaic panels.
- ✓ Citizen acceptance of BIPV in touristic and protected areas.
- × Generally speaking, BIPV is more expensive than regular PV.
- × There are not so many companies that work in this field.
- × More knowledge about this possibility is required at cultural heritage and tourist management boards to be able to allow it.

References

- Effect of urban climate on building integrated photovoltaics performance
- Building-Integrated Photovoltaics and Urban Environment from the Perspective of Sustainable Architecture
- POCITYF EU Project

Further Information

- Photovoltaics fused with the urban environment
- Solar Urban: Integration of solar energy in the urban environment

EFFICIENCY IN URBAN PLANING

GREEN URBANISM RELATED TO ENERGY CONSUMPTION

Source: frontiersin.org

Introduction

Urban design is vital to achieve energy efficiency objectives in our cities. As a compact city with mixed uses can lower our mobility needs, green spaces can protect us from extreme temperatures. The orientation of streets and buildings can reduce drastically their energy demand, or well-organized public services can promote cleaner ways of transport. This is efficient urban palnning.

Description

Urban sustainability or sustainable urbanism is a model of cities development in which buildings and urban areas are designed, planned and built meeting different criteria that ensure long-term quality results with regards to energy consumption, air quality, natural resources consumption, transportation, etc.

The main strategies for city leaders to shape their cities for greater energy efficiency include:

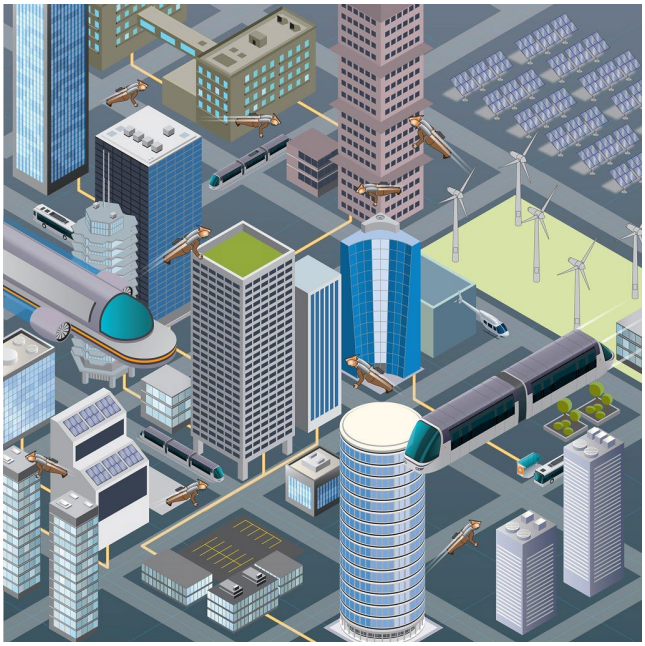
1. Build compact and well-connected urban areas with dense network of streets and paths.
2. Prioritize walking, cycling, and public transportation for access to jobs, social services, and environmental amenities.
3. Foster transit-oriented developments and mixed-use neighbourhood.
4. Optimize designs of buildings and neighbourhood to suit local climatic conditions.

Ecological view of the city: They should emulate nature to maximize the benefit of natural systems and preserve and restore the natural environment, including land use optimization.

To make cities more resource-efficient, different but inter-dependent components of the urban system, such as energy, housing, transport, waste management, public spaces, and green areas need to be changed simultaneously.

Main Features

- Compact, well-connected
- Mixed-uses
- Green areas
- Integration of renewables
- Quality urban space
- Green services/ infrastructures
- Integrated in surrounding conditions



Advantages and challenges

- ✓ Impacts on the environment are minimised.
- ✓ Citizen quality of live is improved, among others it helps to promote healthy habits such as pedestrian transport and cycling.
- ✓ Compact city with mixed resources allows a 15 minutes city, in which citizenship can reach all basic services just walking in their neighbourhood.
- ✓ Less dependency from imported energy sources, improved stability.
- ✓ Local economy is boosted as energy efficiency means less energy expenses.
- × Lack of interdisciplinary project teams and knowledge to apply it.
- × Need of change of different city streams that are not easy to achieve.

References

- Evaluation of Cities in the Context of Energy Efficient Urban Planning Approach
- Energy Efficiency in Buildings for Urban Sustainability - DEXMA
- POCITYF project

Further Information

- Sustainable urban energy planning: a strategic approach to meeting climate and energy goals
- Planning Energy Efficient and Livable Cities
- Resource-efficient cities: vital step towards urban sustainability in Europe

ENERGY COMMUNITIES

GREEN URBANISM RELATED TO ENERGY CONSUMPTION

Introduction

For clean energy transition, benefits of local communities are encouraged to be exploited by promoting citizens as “Prosumers”. Instead of being just consumers of energy, local shareholders can associate themselves to produce, distribute, store, and manage energy in the greenest way possible, in order to generate carbon-free energy services to the local community, and be less dependent from external actors.

Description

The main functions of the energy community are energy production, storage, consumption and management. As renewables are the main energy sources, ensuring flexibility is an important challenge which can be addressed by storage facility and demand-responsive energy management systems. Further services like energy efficiency services or charging of electric vehicle might also be offered in the energy community. The collaboration can provide further community-based initiatives like awareness-raising and educational programmes, environmental conversation actions, development of public spaces or supporting vulnerable local residents.

Citizens, municipalities, authorities or small enterprises can cooperate with each other in the energy community on a voluntary basis to provide environmental, economic or social benefits to its members and the local area. Making financial profits cannot be their main intention. Members of the energy communities can take any type of legal form, such as association, NGO or SME. It is important to be able to act as one entity, so all type of members can represent their interests, necessary permits can be required, and sale of electricity can happen. Cities can accelerate the spread of such communities by local initiatives - offering technical and financial support or defining local policies with a target for community-based ownership of renewable energy capacity.

Further Information

- DIRECTIVE (EU) 2019/944
- Energy communities
- Energy Communities - video
- What is an energy community?

References

- How can local energy communities promote sustainable development in European cities?
- How cities can back renewable energy communities
- Image by wirestock on Freepik

SOLAR ENERGY - PHOTOVOLTAICS

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Solar panels can generate electricity from solar energy. The delivered power depends on the size and type of panels, the intensity of solar radiation, wavelength and angle of incidence. Photovoltaics (PV) can substitute traditional energy sources.

Description

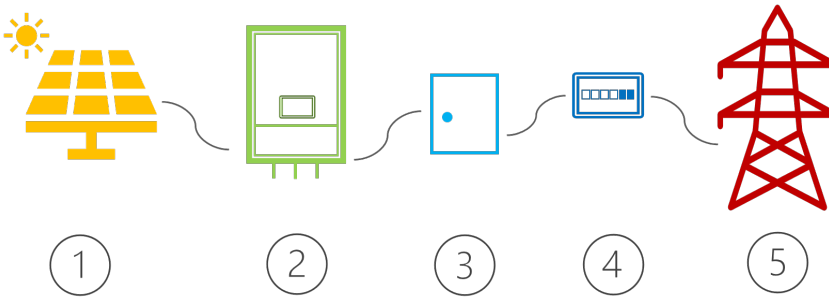
Based on the amount of feed-in power in the photovoltaic system, there can be domestic small-scale solar power plants and larger solar power plants. The two main components that are required for PV systems are solar modules and inverters.

In households, solar modules are connected in series or parallel on the house roofs in general. In the urban environment, you can find them on roofs over parking areas or on the ground in enclosed areas. From a technological aspect, there are different types of solar panels: thin-film technologies, multicrystalline or monocrystalline silicon panels; with average lifespans of 25-30 years.

Inverters are necessary for transforming direct current (DC) into alternating current (AC) and regulating voltage and frequency. There are two main types of inverters, single- and three-phase inverters, which are used based on the amount of power delivered by the PV system.

In May 2022, the European Commission adopted the EU solar energy strategy alongside the REPowerEU plan to boost the use of solar energy in buildings. This plan intends to gradually introduce an obligation to install solar energy in different types of buildings over the next years.

Solar panels have lower maintenance cost compared to fossil fuels, and their investment costs can be covered in the medium term. If the cost of fossil fuels is increasing, the recovery period of PV panels is reducing. Before installing solar panels, do not forget to collect information about the regulations of your service provider and national tax legislation.



Main Features

1 – Solar Panel;
2 – Inverter;
3 – Switch Box;
4 – Meter;
5 – Electrical Grid.

Advantages and challenges

- ✓ PV systems can reduce the energy bills of both households and public buildings.
- ✓ Although the generated electricity decreases slightly over time, solar panels still have 80-90% of their original output after 25 years.
- ✓ PV systems installed in the city can reduce greenhouse gas emission in urban areas significantly.
- ✓ A standard 25-year warranty usually covers weather damages to PV panels.
- × Power generation is affected by weather conditions, and, without energy storage, PV systems cannot be the sole energy source of a building.
- × The whole life cycle of PV panels cannot be considered clean, and there are still uncertainties related to environmental impacts.
- × Before installation, the major challenges are related to the extraction, manufacturing and transportation of the raw materials, and the amount of used energy.
- × In case of PV systems installed on the ground, the used area can suffer from degradation of the soil and reduction of biodiversity.
- × Disposal of the used solar panels is another challenge. Waste management and recycle are essential as PV panels contain toxic materials.

References

- Handbook on Renewables for Households of Mezőfalva
- Integrating Environmental Considerations into Energy Systems Development
- How long do solar panels actually last?
- European Commission: Solar Energy

Further Information

- CLEAN-kWAT project
- How do solar panels work? – Richard Komp – video
- Fundamentals of Solar Photovoltaic Systems – video

SOLAR THERMAL COLLECTORS

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Solar thermal collectors can generate heating energy and hot water from solar energy. However, the delivered power strongly depends on the weather conditions. Therefore, with flat plate collectors and evacuated tube collectors, we cannot supply the total heating energy demand of a building. The efficiency of this technology is between 30-70% (or worse in case of flat plate collectors), thus, it is used as additional facilities run by solar power.

Description

Nowadays, solar thermal collectors are not amongst the state-of the-art technologies, but they still have obvious benefits compared to fossil fuels. The average lifetime of these collectors is around 25-30 years with warranties for 10-15 years in general. The installed systems have almost zero maintenance cost, however, it is required to check the systems after 1-3-10 years.

Solar thermal collectors are installed on the roof of the buildings, the planned capacity depends on the purpose of energy production and the average consumption of the building.

The collectors can be installed easily within a few weeks after the on-the-spot assessment noting that the planning phase can take longer time compared to solar panels, and unexpected challenges can also occur.

Solar thermal collectors installed in the city can reduce greenhouse gas emission in urban areas significantly, but the old collectors must be collected separately and re-used taking into account appropriate waste management which is a challenge for the near future.

Further Information

- Solar Heat Europe
- European Commission: Solar energy

References

- Handbook on Renewables for Households of Mezőfalva
- Napkollektor, mint hulladék?

BIOMASS

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Biomass can be an alternative solution if other renewable energy sources are not available or exploitable economically. We can generate heat or electricity via combustion from plants primarily (agricultural waste), as well as use secondary or tertiary sources (e.g., animals, urban waste, biological waste of industry). Although biomass is not the greenest energy source, with careful planning and logistics it has low risks which makes biomass competitive.

Description

Biomass utilization can be applied by households as well as bigger public-private buildings in urban areas. Depending on the capacity of the installed system, it can even supply energy for district heating systems reducing energy dependency and energy costs significantly. However, it is always important to check if the biomass was produced in a sustainable way.

Boilers usually use processed organic materials which are chopped, sliced, or pressed. Biomass should be stored in dry, protected spaces. In addition, we also have to take into account the physical location of the biomass as shipping wood/pellet from great distances can have big ecological footprint and greenhouse gas emission depending on the mode of transport.

The investment cost of a boiler/heating system depends on its capacity. The recovery time, which is relatively short, is approximately 5-10 years in case of independent buildings. The installation is simple, the boilers can be operated and moved easily. The technology is recommended if big amount of green waste is available locally, e.g., from urban green areas. The share of biomass in the EU's energy mix is significant but has started to become a less preferred solution which can result in limiting the use of primary biomass.

Further Information

- The European Commission's Knowledge Centre for Bioeconomy
- URESA project – Biomass training
- Biomass carbon cycle – video
- SolarReviews: Biomass energy pros and cons

References

- Handbook on Renewables for Households of Mezőfalva
- European Commission: Biomass
- Potential revisions to EU biomass rules remain a work in progress

AEROTHERMAL ENERGY

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Aerothermal energy is energy stored in the form of heat in ambient air. This is done through very efficient heat pumps. Heat pumps can produce energy from the heat of the ground, water sources or using air. We can use them for heating, cooling and hot water production, too. It is a low-investment renewable energy source with quick installation.

Description

Based on the type of source, we can differentiate geothermal (ground-source), water source and air source heat pumps. The EU defines aerothermal energy as those regular heat pumps based on air that have an efficiency over 2.5 (meaning that they produce 2.5 times more energy in the building than the electricity consumed).

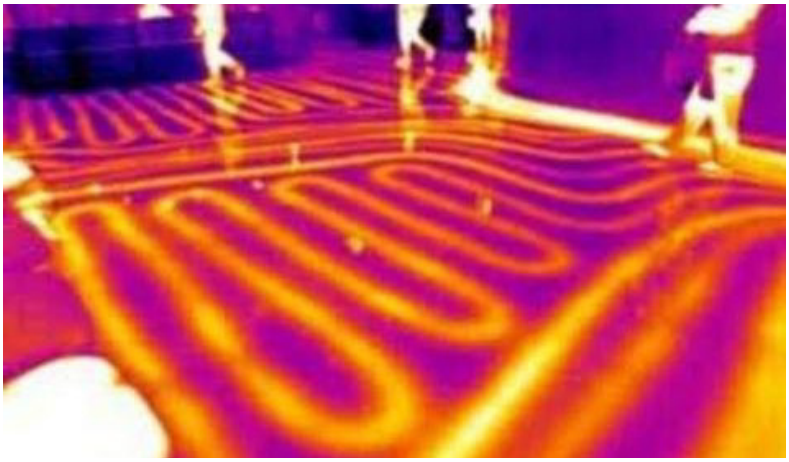
Air source heat pumps use the ambient energy in outside-air or exhaust-air for heating, cooling and production of hot water. They can be installed as compact units entirely inside or outside the house (so called mono-bloc). Split systems consist of one unit inside the building and one outside of it. Heat is commonly distributed inside the house by a hydronic distribution system or by air using fan coils or a ducted ventilation system.

Aerothermal heat pumps have relatively low investment costs, in addition, the system's maintenance costs are low but contain the cost of electricity which is needed for the operation.

About 2.5 kW thermal energy is generated per 1 kW of electricity used by the heat pump. It means about 250% efficiency. Conventional gas boilers have around 70-80%, direct electric heating has 35-45% efficiency.

Main Features

Compressor
Condenser
Expansion valve
Evaporator



Advantages and challenges

- ✓ Installation can be finalized in days.
- ✓ It is a low-investment renewable energy source.
- ✓ It produces both heat and cooling, making them perfect for Mediterranean regions with hot summers and cold winters.
- ✓ If the country electricity is produced based on a good percentage of renewables it is much cleaner than other conventional technologies.
- ✓ Heat pumps can also be a great solution in case of supermarkets, shopping centres, schools, etc. in urban areas to reduce greenhouse gas emission significantly.
- × Efficiency of heat pumps using sources from air depends on the temperatures of the air, and may vary during the seasons in the year.
- × During summer, these machines expel heat from houses, making it worse in urban areas with heatwaves.
- × Heat pumps need electricity to deliver the produced energy which can cause greenhouse gas emission depending on the electricity's source.

References

- Renewable Energy Statistics
- EU Heat Pumps: warnings against "one size fits all" policies
- European Heat Pump Association

Further Information

- REPower EU
- Heat Pumps - How they work and their benefits – video
- What are heat pumps? (with subtitles) – video

GEOTHERMAL ENERGY

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Photo by Viktor Hava

Introduction

Geothermal energy provides the opportunity to produce large amounts of clean, secure and sustainable electricity and heat for residential and industrial buildings as well as for district heating systems 24/7. By using geothermal systems, we can reduce greenhouse gas emission not only in urban areas but also globally.

Description

Basically, geothermal energy is heat that is generated within the Earth. This type of renewable energy source is available only in certain location, but usually in abundance. In order to be able to use this heat, we need a transfer medium which is usually water. Depending on the temperature of this medium, we can produce energy for heating buildings, electricity or use it in thermal baths.

Cities with appropriate underground reservoirs of steam or hot water can exploit this special renewable energy source efficiently and reduce their energy dependency. Geographical conditions, the existing databases and know-how can guarantee a high level of utilisation of this alternative energy source.

Geothermal energy has a great potential in reducing greenhouse gas emissions while contributing to the realisation of the energy objectives set at EU-level. Therefore, higher utilisation of geothermal energy is promoted by different strategic policies such as the European Green Deal or the new REPowerEU Plan. The role of geothermal energy in energy diversification and green transition of district heating systems to replace fossil fuels in urban areas is crucial.

The value of geothermal gradient which is the rate at which temperature increases with depth in the Earth's crust, helps us to make a decision on the suitability of a geothermal system. The potential capacity of the system also depends on the expected water temperature and water flow.

Main Features

- Geothermal wells
- Pipelines
- Heat exchanger

Photo by Viktor Hava

Advantages and challenges

- ✓ Properly planned and operated geothermal systems have negligible environmental impacts.
- ✓ Geothermal systems are very reliable and can deliver energy independently from changing weather conditions.
- ✓ With geothermal energy, we can replace a great amount of natural gas, contribute to energy price stability and energy security.
- ✓ As geothermal energy is amongst the greenest alternatives, cities and energy companies might require grants to finance investment costs.
- × Geothermal energy is not available or exploitable economically everywhere.
- × Geothermal investments have high drilling risks and costs which hinder the spread of this alternative energy.
- × Installing a geothermal system requires a long planning phase and has high investment costs.

References

- European Commission: Geothermal energy
- Geothermal a key element of REPowerEU plan

Further Information

- National Geographic: Geothermal Energy
- Geothermal Basics

GROUND SOURCE HEAT PUMPS

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Heat pumps can produce energy from the heat of the ground, water sources or using air. We can use them for heating, cooling and producing hot water too. Heat pumps can utilise solar indirectly all year, which makes this alternative solution effective and reliable for independent buildings and block of flats as well in the city. Low temperature sources can also be exploited by heat pumps.

Description

Based on the type of source, we can differentiate geothermal (ground-source), water source and air source heat pumps.

It is possible to install the heat pumps to supply energy for an existing building, but it is more rentable if it is planned and installed for a new building.

Heat pumps can produce energy for floor and wall heating while the use of radiators is rather uneconomical.

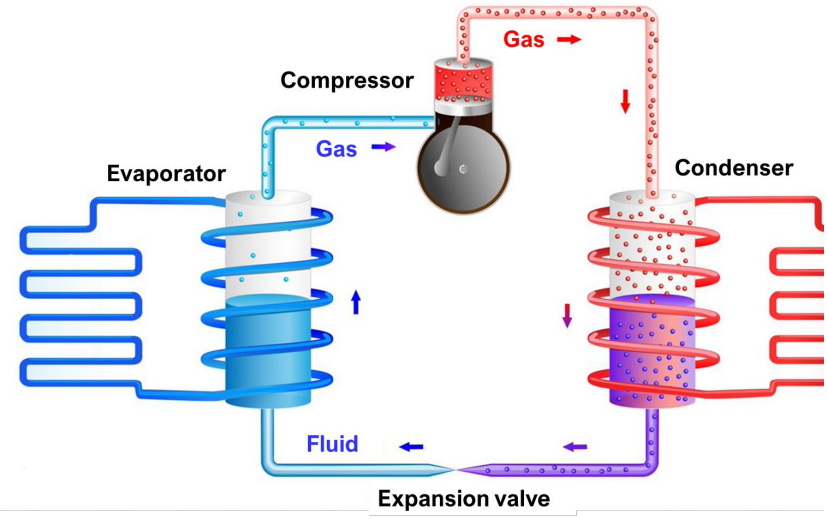
Heat pumps have relatively high investment costs which can only return in long-term. In addition, the system's maintenance costs contain the cost of electricity which is needed for the operation. The installation of heat pumps requires experts and engineers which also increases the investment costs.

Before installing heat pumps, preliminary pilot drilling might be necessary. In addition, licences might be required by the authorities for drilling which can prolong the construction time. The investment costs depend on the type of heat pump and setup needed.

About 4 kW thermal energy is generated per 1 kW of electricity used by the heat pump. It means about 300% efficiency. Conventional gas boilers have around 70-80%, direct electric heating has 35-45% efficiency.

Main Features

- Compressor
- Condenser
- Expansion valve
- Evaporator



Advantages and challenges

- ✓ Installation can be finalized in a few months.
- ✓ Low temperature sources can also be exploited by heat pumps.
- ✓ Independent from the current strength of solar radiation.
- ✓ Cheaper and cleaner solution than natural gas-based heat generation.
- ✓ Heat pumps can be a great solution in case of supermarkets, shopping centres, schools, etc. in urban areas to reduce greenhouse gas emission significantly.
- × Heat pumps using sources from ground have better performance but need more maintenance and can cause environmental damages.
- × In some cases, only registered contractors can do the installation.
- × Heat pumps need electricity to deliver the produced energy which can cause greenhouse gas emission depending on the electricity's source.
- × Heat pumps use fluorinated gases which, similarly to CO_2, remain in the atmosphere for a long time contributing to global warming.

References

- Handbook on Renewables for Households of Mezőfalva
- EU Heat Pumps: warnings against "one size fits all" policies
- European Heat Pump Association

Further Information

- REPower EU Plan
- Heat Pumps - How they work and their benefits – video
- What are heat pumps? (with subtitles) – video

MICRO-HYDRO POWER

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Micro-hydro power systems generate electricity up to 100 kilowatts generally from flowing water, thus, it can be an ideal alternative solution for homeowners, small businesses, and farmers.

Micro-hydro power is clean energy which can be used to provide power for several entities in the city if the circumstances allow the system's installation.

Description

Hydro power plays a crucial role in supplying electricity from renewable energy sources and fight against climate change. Based on the capacity of the plant, we can differentiate home-scale, pico, micro-hydro power systems and power plants with bigger rated power. The utilization of the water's kinetic energy has a great tradition, people have used waterwheels for centuries.

In the modern age, a micro-hydro power system produces electricity from the energy of flowing water by transferring it usually with a turbine or a pump. We can differentiate grid-connected and stand-alone systems.

Nowadays, micro-hydro power systems are easy to install, have low maintenance cost, but environmental aspects must be taken into account not to harm the local ecosystem (e.g., it should be fish-friendly).

We also have to consider different factors before planning the installation of a micro-hydropower system, i.e., the vertical distance available and water flow.

Regarding the future, innovation has a key role in developing new solutions to increase the efficiency of these small systems, thus, energy can be produced from small differences in the water level as well, and to reduce the environmental impacts of such systems.

Further Information

- Small and micro-hydro: A development everywhere in Europe, an alarming boom in France!

References

- Microhydropower Systems
- Planning a Microhydropower System
- European Commission: Hydropower

HYDROELECTRIC POWER PLANTS

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

The biggest hydroelectric power plants can generate more than 100 TWh electricity yearly, but the smaller ones are also capable to produce hundreds of GWh electricity and can supply clean energy for a whole city. Beyond run-of-river power plants, which channel flowing water from a river through a canal or penstock to spin a turbine, we also find reservoir-dam power plants as well as wave and tidal power plants.

Description

Hydroelectric power plants are built nearby bigger rivers, streams, lakes, high sea level artificial water reservoirs and on sites ideal for dams. Due to the traditional use of water's kinetic energy, hydroelectric-technologies are deemed as a renewable solution.

Similar to micro-hydro power systems, power plants produce electricity from the kinetic energy of flowing water with a turbine which is connected to a generator.

Among the advantages of hydroelectric plants, we can mention the very low maintenance cost or CO_2 emission reduction. The time and performance of electricity generation can be set and change quickly by dams, and hydroelectric power can supply electricity continuously. In contrast, the investment costs can be extremely high, and it is not easy to find appropriate site for a hydroelectric plant. During the hydroelectric project, natural and residential areas can be flooded and damaged. Suitable sites are often situated among the mountains, far from the city and losses due to energy transport can occur. A large amount of alluvial is deposited in the reservoirs, which must be removed constantly, but it has direct effect on the ecosystem.

The EU supports innovation activities to reduce the environmental impact of such power plants, increase the sustainability and efficiency of hydro power also focusing on efficient retrofitting of the existing older plants.

Further Information

- Vízenergia és vízerőmű kisokos
- Vízenergia: a klímaharcban hasznos, de elmélyíti a kihalási válságot

References

- Vízenergia
- European Commission: Hydropower

WIND ENERGY

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Middelgrunden wind farm

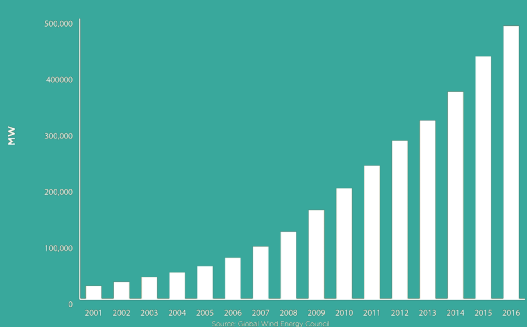
Introduction

Turbines are windmill-like structures that use wind to drive a three-bladed rotor. The rotor is attached to a generator that converts the energy to electricity. Wind energy is currently one of the cleanest and sustainable forms of electricity generation available. Wind power is harvested in windy regions, by the shore or in sea.

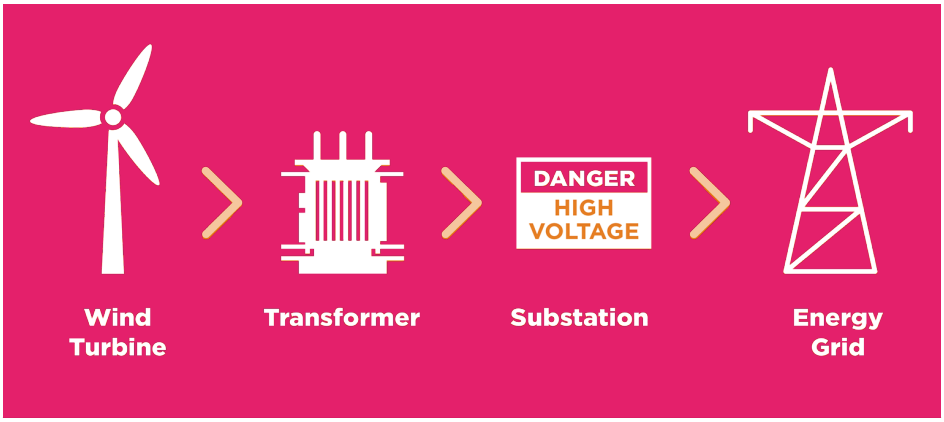
Description

Wind energy is generated by converting wind currents into other forms of energy like electricity, using wind turbines. Turbines extract kinetic energy from the blowing air and converts the rotational movement via a rotor into electricity, which is then passed onto the utility grid for consumption. Today wind turbine blades are made from fiber-reinforced epoxy, or unsaturated polyester. In recent times, turbines have also been developed to float out at sea, rather than just land based, thus reducing the visual impact of such installations.

Wind energy projects produce 95% less CO_2 than electricity from gas, and 98% less CO_2 than electricity from coal. The modern wind turbine converts 45-50% of its input into electricity. Coal-fired power stations generally convert around 29-37% of their input. The CO_2 footprint is negligible and turbines hardly consume any water.



A wind turbine pays off its lifecycle emissions in 6-9 months of operation; and 85%-90% of a turbine is recyclable.



Main Features

1 - Wind turbine
2 - Transformer
3 - Substation
4 - Energy grid

Advantages and challenges

- ✓ Wind energy is a clean fuel source.
- ✓ Wind power is cost-effective and sustainable.
- ✓ Wind creates jobs and a domestic source of energy.
- × Wind power must still compete with conventional generation sources on a cost basis.
- × Good land-based wind sites are often located in remote locations.
- × Wind energy is an intermittent source.
- × Wind resource development might not be the most profitable use of the land.
- × Turbines can cause noise and aesthetic pollution.
- × Wind plants can impact local wildlife.

References

- Why People Are Turning To Wind Power
- Advantages and Challenges of Wind Energy

Further Information

- IRENA (2016). Renewable Energy in Cities.
- DW (2021). How sustainable is wind power?

ALTERNATIVE ENERGY SOURCES

RENEWABLE & ALTERNATIVE ENERGY SOURCES

Introduction

Alternative energy sources refer to all kinds of energy beyond the conventional ones (fossil fuels and nuclear) which are capable of replacing the non-renewable energy sources.

Regarding their characteristics, alternative energy sources are infinite or renewable, and cleaner than the previously known and used energy sources.

Description

These “new” energy sources were widely used by our ancestors (wind ships, solar heating, hydropower), but were forgotten when the fossil fuels appeared mainly in the last century. Nowadays, we know the environmental effects of conventional energy sources both at global and local level, as well as their finite character.

At the moment, all these alternative energy sources can be used in our cities in both ways, directly with installed facilities (solar PV or thermal, wind integrated, micro hydropower in pipes, geothermal, biomass in its different forms), or indirectly via an “energy vector” such as electricity, green hydrogen, or green ammonia. An energy vector is not an energy source itself but a way to transform, store, distribute and manage energy that can fit perfectly our needs we have in our cities. This way, electricity, green hydrogen or ammonia can be produced via renewables and easily integrated in our cities.

Alternative energy sources can be a solution for the future fossil fuel depletion in our cities, and via direct application or energy vector, these sources are already part of our cities and should be introduced in a deeper way to achieve even energy positive districts that produce more energy than they consume.

In 2020, renewable energy sources made already up to 37% of gross electricity consumption in the EU. Furthermore, in 2020, renewable energy represented 22.1% of TOTAL ENERGY consumed in the EU.

Main Features

- Infinite/renewable resources;
- Greener than fossil fuels;
- Less geopolitical constrains;
- Local resources.

Advantages and challenges

- ✓ Infinite and renewable resources are not going to be depleted.
- ✓ Less impact than fossil fuels on the environment, reduced or eliminated greenhouse gas emission, carbon footprint and generated waste, cleaner air and water in our cities.
- ✓ Use of local resources and thus, promotion of local economic activity.
- ✓ Less dependency from imported energy resources, improved stability.
- × Some renewable energy sources are still difficult to integrate in our cities. More research and development, and investments are needed.
- × The integration of renewable energy sources in our main “energy vectors” is slow.
- × Green hydrogen is still too expensive for main usages in a city; however, fossil fuel feedstock costs are increasing so alternative energy sources may become more economical in the future.

References

- EU Renewable energy statistics
- Renewable energy on the rise: 37% of EU’s electricity
- POCITYF project

Further Information

- Developing alternative energy sources
- In focus: Renewable energy in Europe

WATER REUSE

WATER AS NATURAL RESOURCE

Introduction

Water reuse is efficiently practiced around Europe, however, this varies across EU member states and is underutilised. Safe reuse of urban wastewater in agricultural irrigation is just one of the minimum requirements of water reuse. As urbanisation is increasing, water management must explore further solutions for the citizens.

Description

Approximately 11% of the European population and 17% of the EU territory are affected by water scarcity. The situation is worse in Mediterranean areas where water stress can be extreme. Thus, efficient water resource management focusing on wastewater treatment is required. As only a tiny proportion of water is suitable for drinking and irrigation, water reuse is the key element of circular economy. It not only has remarkable environmental benefits, but also social and economic ones.

Nowadays, treated wastewater reuse is a real alternative source of water supply. In addition, water reuse might have lower investment costs and energy demand compared to other alternative solutions like desalination or water transfer.

The EU promotes the use of safe and efficient water reuse technologies, provides guidance and financial support, and sets the minimum requirements to increase cost effectiveness, create jobs, develop innovative technologies to exploit the highest potential for water reuse.

Water reuse sometimes requires minimal or no treatment. It contributes to the security of water supply and fight against water shortages, droughts and water stress for farms, companies and cities as well. Therefore, integrating water reuse in our daily lives and operations can help facilitate circular water management and the independency on freshwater while increases our resilience of climate change. Awareness-raising is essential to inform the general public and stakeholders on the benefits of water reuse as well as irrigation and sustainable drainage systems.

Further Information

- Water – the basis for effective climate adaptation
- Water reuse for irrigation in Murcia (Spain)

References

- Water is too precious to waste
- Water reuse

WATER STORAGE

WATER AS NATURAL RESOURCE

Introduction

Worsening problems related to the accessibility of freshwater are forcing people to face the negative effects of climate change. Freshwater shortage, water pollution, increasing number of drought days, as well as flash floods, have direct impacts on people's daily lives. In addition, freshwater shortage is an emerging issue for all sectors at global level.

Description

Water is among the most essential and irreplaceable natural resources for humanity - we can only live a few days without water. As more and more people live in the world, our water demand and pollution are also increasing. Therefore, it is crucial to change our mindset and start to treat water as valuable resource. We should reduce our water footprint and preserve good water quality.

The water crisis is real and includes, inter alia, extreme weather conditions, water scarcity, and restricted accessibility to clean water. Although we have to fight against water pollution, the reduction of water use is also required. Water storage is a simple way to use rainwater more efficiently by collecting and using it later instead of ensuring its drainage. Therefore, circular water management is relevant both in rural and urban areas as well as at companies.

The water storage potential of soil and aquifers can be supported by different retention measures which includes natural processes and the restoration of natural characteristics of water courses. Climate change adaptation in water management systems can be implemented in several ways including urban areas too. Beyond rainwater harvesting, green roofs, rain gardens, permeable paving, sustainable drainage systems, e.g., retention ponds, can help us manage water efficiently.

Further Information

- EU policy document on Natural Water Retention Measures

References

- Water – the basis for effective climate adaptation
- Natural water retention measures

SUSTAINABLE DRAINAGE SYSTEMS

WATER AS NATURAL RESOURCE

Image source: flickr.com

Introduction

Sustainable drainage systems (SUDS) are drainage solutions for the urban environment, which provide an alternative to remove urban surface waters via pipe networks and sewers to nearby watercourses or dedicated catchments. With appropriate SUDS, authorities can manage heavy rains efficiently.

Description

Sustainable urban drainage systems have been developed to reduce the volume of surface runoff and improve drainage of urban areas. SUDS allow water to be controlled using trees and vegetation, green roofs, ponds and wetlands. Alongside a reduction in the risk of flooding, SUDS in the urban landscape can also provide other environmental and ecological benefits. The benefits of implementing SUDS are typically improved water quantity, quality, amenity and biodiversity. SUDS can also contribute to noise reduction, air filtering, support biodiversity and provide an aesthetically pleasing communal green space.

An example of SUDS are green roofs which can increase storm water interception and storage, evaporation in highly urbanised areas, especially when space to introduce green infrastructure is restricted. SUDS are expected to grow as a green city solution in view of climate change and the extreme weather being experienced across most EU Member States.

SUDS are unique to each situation and take account of environmental issues, policy context, physical location, relevant organisations, individuals involved and how they are brought together to discuss SUDS at a particular point in time.

Image source: thames21.org.uk

Main Features

The four general structures for flood and pollution control are:

- Basins and ponds
- Filter strips and swales
- Permeable surfaces and filter drains
- Infiltration devices

Advantages and challenges

✓ Reduce runoff, thereby reducing the risk of flooding.
✓ Improve water quality and protect from point or diffuse pollution.
✓ Safeguard the environment and needs of the local community.
✓ Provide a habitat for wildlife.
✓ Allow new development in highly urbanised areas.

× Skill shortages.
× Lack of legislative backing.
× Poor planning process.
× Severe lack of resources in local authorities.
× Difficult terrain and limited storage capacity.

References

- Sustainable drainage systems (SuDS)
- Understanding the challenges of managing SUDS to maintain or improve their performance over time

Further Information

- Overcoming common SuDS challenges – Busting some design myths
- Assessing the Effectiveness of Sustainable Drainage Systems (SuDS): Interventions, Impacts and Challenges.

IRRIGATION

WATER AS NATURAL RESOURCE

Introduction

Climate change will escalate current hazards, particularly in areas with existing water scarcity concerns, especially in regions where water scarcity is already a concern. Knowledge of previous adaptation strategies and related risks can aid in creating effective water management systems aimed at both urban and agricultural sectors.

Description

Water stress is a situation where there is not enough water of sufficient quality to meet the demands of people and the environment (reality in many parts of Europe). The EEA report says: “Droughts and water scarcity are no longer rare or extreme events in Europe, and about 20% of its territory and 30% of the Europeans are affected by water stress during an average year.” Climate change is expected to make the problem worse. In those areas, agriculture, public water supply and tourism put the main pressures on water availability with significant seasonal peak in summer. Overall, European cities need to strengthen the resilience of their ecosystems and use water more efficiently to minimise the impacts of water stress on people and the environment. Policies and regulations at European level are in place and cities are more and more implementing adaptation plans, but their effectiveness need to be improved.

One way of managing the issue is applying smart irrigation practices by citizens:

- Mulch the garden - mulch can keep up to 70% more water in the soil.
- Use drip irrigation systems instead of sprinklers.
- Beware of using green lawn clippings. Better to put them into the compost pile and let them break down.
- Do not overuse sprinklers in hot weather. Your lawn only really needs watering once a week and it is better to water in the morning when evaporation is less.
- Collect rainwater.

Further Information

- National Geographic: Irrigation
- Livesley, S. J., Marchionni, V., Cheung, P. K., Daly, E., & Pataki, D. E. (2021). Water smart cities increase irrigation to provide cool Refuge in a climate crisis. Earth's Future, 9, e2020EF001806

References

- M. Danielsson: Reduce water consumption at home
- CDC: Types of Agricultural Water Use
- EEA Report: Water resources across Europe

RIVERBANKS AND SEASHORE AREAS

WATER AS NATURAL RESOURCE

Image source:whowhatwhy.org

Introduction

River flooding is the costliest natural disaster in Europe. Global warming and continued development in flood prone areas will progressively increase river flood risk. Direct damages from flooding could become six times present losses by the end of the century in case of no climate mitigation and adaptation. Keeping global warming well below 2°C would halve these impacts. Adequate adaptation strategies can further substantially reduce future flood impacts.

Description

Around one third of the EU population lives within 50 km of the coast. Extreme sea levels in Europe could rise by as much as one meter or more by the end of this century. Without mitigation and adaptation measures, annual damages from coastal flooding in the European Union could increase sharply from 1.4 € billion nowadays to almost 240 € billion by 2100. Around 95% of these impacts could be avoided through moderate mitigation and by raising dykes where human settlements and economically important areas exist along the coastline.

Around 100 000 people in the EU are exposed to coastal flooding every year. Restoring natural wetlands and floodplains to retain excess water also improves the state of water and ecosystems.

Further Information

- Increasing flood risk under climate change: a pan-European assessment of the benefits of four adaptation strategies. Climatic Change 136, 507–521 (2016).
- Cradle of Transformation: The Mediterranean and Climate Change.

References

- Adapting to rising river flood risk in the EU under climate change. JRC Technical Report.
- Floods: Climate Change And Adaptation Strategies For Human Health

BUILDINGS AND CLIMATE CHANGE

BUILDINGS & ENVIRONMENT

Image source: flickr.com

Introduction

Available research suggests that buildings across the world are responsible for a considerable share of energy use and greenhouse gas (GHG) emissions. However, there is also major potential for energy savings in buildings of between 50–90%.

Description

According to the Intergovernmental Panel on Climate Change, buildings across the world were responsible for 30% of global final energy use and 27% of all GHG emissions in 2021. If this trend is not reversed, the use of energy in buildings could be twice or three times as high by the year 2050.

Despite serious regional variations in climate change impacts and intensity, buildings are likely to face increasing risks of damage due to extreme weather events such as increased rainfall, forest fires, severe storms and floods.

Without investment and upgrade in improved resilience, the vulnerability of buildings is likely set to increase significantly in the near future. Still today, several barriers exist towards the greater uptake of energy-saving technologies and practices including but not limited to poor market transparency for building components and homeowners' limited access to capital to invest. However, there is an increasingly accessible pool of knowledge on retrofitting of buildings with energy-efficient materials and components, and how to build very low and zero-energy buildings. Also, regulators in many countries today have a wide portfolio of policy instruments at their disposal to help citizens in energy-efficient building and retrofitting of their homes such as feed-in tariffs, carbon taxes and soft loans for small-scale renewables.

There are a good number of mitigation interventions available for buildings today such as wall and roof insulation, investing in energy-efficient appliances, including lighting, heating, ventilation and air-conditioning, investing in renewables such as photovoltaics and solar thermal solutions. Furthermore, one can make use of smart meters and focus on behavioural and lifestyle changes to reduce service demand.

Image source: energy-cities.eu

Main Features

1. Reduce greenhouse gas emissions.
2. Reduce exposure to climate change events.
3. Improve thermal comfort.
4. Meet the growing energy demand.
5. Save money.

Advantages and challenges

- ✓ Long-term energy and cost savings: energy-efficient buildings consume less energy, water and result in lower maintenance costs.
- ✓ Reduced emissions and environmental impact: energy-efficient buildings produce less greenhouse gas emissions due to their reduced reliance on fossil fuels.
- ✓ Increased thermal comfort in summer and winter leads to improved health: building components for heating and ventilation are adjusted to create comfortable indoor temperatures which in turn leads to better well-being of the occupants.
- ✓ Higher value: energy-efficient buildings can be sold and leased at a premium as the building components are more expensive than in homes built conventionally.
- × High Initial Investment: Building components of energy-efficient buildings are generally more expensive than traditional inefficient building styles.
- × Availability of the right materials and workers with expertise can be difficult in times of high demand and unavailability of raw materials on the market.

References

- Climate change: implications for buildings. Key findings from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) on Buildings
- A Practical Guide to Climate-resilient Buildings & Communities
- Technology Roadmap Energy-efficient Buildings: Heating and Cooling Equipment

Further Information

- Energy efficiency in buildings

GREEN ROOFS & WALLS

BUILDINGS & ENVIRONMENT

Introduction

Green roofs and walls are among the most widely used water management practices in urban areas. Green spaces clean the air, facilitate water retention, provide natural habitats for a variety of species, cool the temperature, serve as shadowing facilities, etc. Green roofs and walls make the cities more liveable places for the citizens while also contribute to climate change adaptation.

Description

As densely populated cities often have fewer green areas, bigger cities have to seek creative solutions to make their environment greener. Increasing the territory of green areas in the city can be very difficult or limited. However, building stock has a great potential via their exposed surfaces - we can cover the roofs or walls of residential, public and industrial buildings with vegetation after paying attention to the necessary waterproof membranes and roof loading.

Green roofs and walls contribute to retain precipitation while providing insulation for the buildings. They not only cool the building and the urban environment, limiting urban heat island effect and facilitating biodiversity, but they also reduce the effects of extreme temperatures and flash floods since storm water can be kept by the vegetation of the green roofs.

Better air and water quality are also amongst the potential benefits of investing in green roofs and walls. Green roofs can be installed on small and large structures, typically including drainage and irrigation systems. Although green roofs are recommended to be applied in urban areas, it is not a suitable solution where wind can be strong. Vertical green walls have similar benefits as green roofs while they can also help protect the building stock.

Further Information

- Natural water retention measures
- Exploring nature-based solutions
- European Federation Green Roofs & Walls
- Advantages and disadvantages of green roofs

References

- EU policy document on Natural Water Retention Measures
- Final Report - Costs, benefits and climate proofing of natural water retention measures

SHADING FACILITIES

BUILDINGS & ENVIRONMENT

Image source: Life Adaptate project in Lorca (SPAIN)

Introduction

Natural based solutions are the best elements we can include in our cities to promote shadowing in our public spaces. Nevertheless, when this is not possible or difficult, a city can choose to install awnings. Awnings can be installed by means of anchors on the building facades to shade complete streets. Shading elements have demonstrated to reduce urban spaces temperatures by several degrees.

Description

The climate change risks that some EU regions are experiencing are heat waves and urban heat islands. These risks can be tackled via shading elements, for example installing shadow corridors in the public spaces to counteract the urban heat islands. This action involves the installation of awnings in various crowded streets or key routes of the city creating shaded areas and corridors that improve the thermal comfort of pedestrians, reducing the temperature in the building facades and pavements, as well as reactivating trade in the months of extreme heat.

As well, other options are horizontal blades attached to the facades of buildings to offer “effective solar shading without impairing the view. These sunshades protect the users against an excessive level of heat due to solar radiation, the possibility of glare when the solar altitude is at its highest or when the levels of radiation are very high. Together with a proper orientation of the building, the sunshades enable optimal use of the incoming light in times of low solar altitude” as a case study says on Climate ADAPT.

Natural based solutions, white reflection areas in roof areas, green roofs, or PV shading facilities are other possibilities that help us minimise extreme temperatures.

Further Information

- EU Climate Adapt official site

References

- Life Adaptate EU project pilot actions in Lorca
- White roof, innovative solar shadings and bioclimatic design in Madrid
- Climate proofing of buildings against excessive heat

HEAT ISLAND EFFECT

BUILDINGS & ENVIRONMENT

Introduction

Temperature is higher in cities than in surrounding landscapes or in rural areas due to the densely built environment. The surfaces of buildings, paved streets and squares can be heated up extremely on summer days and radiate at night. We call this global warming issue as urban heat island (UHI) effect.

Description

Cities can be overheating easily due to the increasing number of heatwaves.

Primarily, the building environment and materials used can cause a temperature difference between urban and rural areas. Secondly, the lack of green areas in the cities can strengthen the UHI effect. Nevertheless, we also have to mention water drainage among the reasons for UHIs.

It is essential to take actions against UHIs at the city level, otherwise, people will continue to use intensively air conditioning which most likely uses electricity produced from fossil fuels, and increases the temperature outside of the flat. In addition, UHIs are harmful for human health, especially for senior citizens and little children.

Naturally, rain cool the temperature efficiently, but due to the quick drainage of rainwater in urban areas, this beneficial effect cannot be exploited.

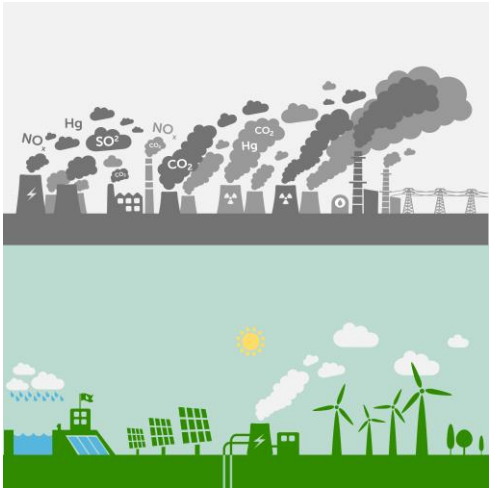
The best solution for UHI mitigation is developing urban green infrastructure.

Urban climate and heat waves can cause several fatal and non-fatal health issues including heat strokes or dehydration, and they can also decrease labour and learning productivity. Urban green infrastructure can contribute to water retention and help in cooling the city.

Main Features

We can mitigate UHI effect by/with:

- Planting and taking care of trees
- Shading
- Green roofs and corridors
- Water retention
- Natural waters



Advantages and challenges

- ✓ If streets are shaded, they can be prevented from overheating.
- ✓ By planting trees and taking care of the existing vegetation, we can fight against UHIs efficiently and cool the temperature. Increasing the surface of green areas in public places and on buildings (e.g., green roofs and facades) is not only recommended, but rather becoming inevitable.
- ✓ Water retention is a priority. Cities and citizens should collect and store rainwater instead of draining it away, and use this natural resource during the dry periods for irrigation or make it possible for plants to absorb it.
- ✓ Natural waters like rivers also cool the surroundings. Creating relaxing zones along them, making hot days easier for the citizens.
- × UHI has adverse effects on citizens' health and well-being.
- × Although common actions are needed, individuals are also responsible for UHIs. Therefore, awareness-raising, participatory decision-making is required.
- × In order to fight against the UHI effect efficiently, cities need climate adaptation action plans as well as commitment and financial sources to implement them.

References

- LIFE TreeCheck: Green Infrastructure Minimising the Urban Heat Island Effect
- LIFE TreeCheck
- Why are cities overheating

Further Information

- Let's give people access to rivers
- Innovative pavement solution for the mitigation of the urban heat island effect

BEE-FRIENDLY GARDENS

BUILDINGS & ENVIRONMENT

Image source: flickr.com

Introduction

The global decline in pollinator populations poses a distinct threat to a wide variety of flora important to human well-being and livelihoods. In today's cities, urban gardens play an increasingly important role in pollinator conservation due to rich and widely available floral resources.

Description

The rapid decline of pollinators including bees and bumble bees has become a global environmental concern in recent years.

Habitat loss due to human activity including urbanization as well as intensive farming practices, pesticide use, competition with invasive pollinator species and higher temperatures associated with climate change are considered to be major causes of pollinator decline. This has sparked a world-wide movement for pollinator friendly gardens.

In todays' cities, urban as well as private gardens play an increasingly important role in pollinator conservation due to their rich and widely available floral resources. Furthermore, urban green spaces with their associated benefits can potentially address a number of challenges prevalent in cities around the world, namely temperature regulation, air purification, noise reduction, recreation as well as health and well-being. The effectiveness of urban gardens in pollinator conservation is closely related to the design and composition of the garden. More specifically, the selection of particular plant species (flowers and trees) can account for much of the activity of insect pollinators such as bumblebees. Conservation programs in your area can provide information on how to create a "pollinator friendly" garden. These programs also often encourage the cultivation of native plant species rather than non-native ornamental flowers and invasive species.

Bees have some basic but fundamental needs. By providing for example an insect hotel, a fresh water source, a wind protected sunny spot and various flowers in your garden or balcony, you can increase the chances of attracting bees and other pollinators.

Main Features

- Choose plants that are best suited for attracting bees in your region.
- Limit the use of pesticides and insecticides.
- Provide shelter for pollinators from elements such as wind, rain, or cold weather.
- Create a habitat for the nest with an insect hotel.

Advantages and challenges

✓ Growing a mixture of annuals, perennials and flowering trees and shrubs will help bees and other beneficial insects.

✓ Attracting pollinators and insects can provide natural control of plant pests.

× Honeybee and wasp colonies in gardens or close to areas of human activity may cause a nuisance, and even a health hazard.

References

- Small gardens as vital as big ones for conserving bees, says study (The Guardian)
- Urban gardens create a buffet for bees (Science News Explores)
- From large to small, every urban garden is important for pollinators (ZME Science)
- Urban Gardens A Haven For Pollinators (Science Connected Magazine)

Further Information

- Bee-friendly community gardens: Impact of environmental variables on the richness and abundance of exotic and native bees. Urban Ecosyst 20, 463–476
- Increased pollinator activity in urban gardens with more native flora. Applied Ecology and Environmental Research. 14. 297-310.

CHANGING TOURISM

TOURISM ADAPTED TO CLIMATE CHANGE

Introduction

Climate change has a direct impact on tourism. The main season starts earlier and ends later due to the increasing average temperature. People like having rest nearby the water on extremely hot and sunny summer days. Nevertheless, periods of drought can cause low water level and bad quality, or even temporary drying up of lakes and rivers. In addition, we also feel the effects of global warming in winter.

Description

Tourism is the third largest sector in the EU and has a huge impact on greenhouse gas emissions, arising from the transport of tourists. Climate change has an impact not only on when to go for a holiday, but also on the destination choice. Mediterranean areas have started to become so hot and/or humid that tourists consider travelling at the beginning or at the end of the main season in order to avoid the warmest periods. But if they would like to go for summer holiday, they might choose another destination where the temperature is not above the comfort level.

Due to the heat island effects, sightseeing tours in metropolises can become less popular in summer. Cities could help tourists by providing dedicated mobile apps to find shaded or cooled areas, fresh water, sending warning messages on heat wave days, and recommending climate adaptive and weather-independent tourism programmes. Digital solutions can also support sustainable tourism management. Nature lovers might have to find new destinations or dates as climate change has negative impact on the ecological landscape of tourist destinations, too. However, as some destinations become less attractive for the tourist due the effects of climate change, other places might become more preferred than earlier, e.g., the United Kingdom. Furthermore, global warming increases the sea level and causes erosion which can have negative effect on coastal areas and the available recreation activities.

In winter, ski lovers have to face a shorter season, while low lying ski resorts suffer from decreasing snow cover. This can also result in the selection of another destinations.

Further Information

- Sustainability Travel International
- Why clothes are so hard to recycle

References

- Climate Change and Its Impact on Tourism
- European Parliament: Sustainable tourism

TOURIST FACILITIES

TOURISM ADAPTED TO CLIMATE CHANGE

Introduction

Climate change and global warming require the adaptation of existing and future tourist facilities. Resorts must be prepared for extreme weather conditions such as extreme warm and cold, flash floods, or drought. Tourism sector has to be equipped for these challenges but only focusing on facility upgrades are not sufficient; the offered programmes should also be climate adapted. New solutions and approaches are needed to make the sector more environmentally friendly.

Description

Climate change impacts our holidays directly and indirectly changing our travelling patterns and choices. Nevertheless, we can benefit from the higher average temperature and facility adaptation via extending the main season and saving energy. Besides upgrading tourist facilities, preservation of cultural heritage, e.g., monuments, is also essential. Modern materials and technologies can help fight against acid rain, thermal expansion and fires which cause chemical and mechanical damages.

Nowadays, conditioned air (AC) is inevitable if a resort wants to provide thermal comfort for their guests. In addition, these devices can be used for heating on cooler days out of heating season which ensures better exploitation of the existing facilities. Nevertheless, AC's have high energy consumption which should be supplied from renewable energy sources. An adequate, climate adaptive solution could be, for example, if we install photovoltaics to create shaded parking areas for the guests. Also, facility's insulation is important to reduce the operation time of ACs.

Meeting sustainable tourism criteria can also help hotels to change their facilities in a climate adaptive way. Eco tourism are more and more popular as the consciousness of the tourists are increasing. By taking into account environmental and marketing aspects, sustainable tourism offers with adapted touristic facilities can be the future of the sector which should be prioritize by the city leaders. Green cities with adapted tourist facilities can provide a liveable environment for local people while contribute to sustainable tourism and development.

Further Information

- Europe backs sustainable tourism with public funds

References

- Climate Change and Its Impact on Tourism
- European Parliament: Sustainable tourism

HEATWAVES

BEHAVIOURAL ADAPTATION TO EXTREME WEATHER

Introduction

Extended periods of high temperatures are becoming more frequent and intense all over the world. This process is fast forwarded with the climate change. Heat stress affects the vulnerable population the most. Heatwave intensity is a major public health issue in high urban areas. More expanded green areas can help mitigate the negative health impacts of heatwaves.

Description

A heatwave refers to a period of extreme and unusual warmth which can lead to heat stress and serious implications for human health. Heat-related mortality occurs when the body's ability to cool itself through increased perspiration and blood circulation cannot keep up with a rapid rise in ambient temperature. Heat stress affects the vulnerable like the elderly, the young, and persons with mental diseases or chronic illnesses the most.

Heatwaves are not only affected by the climate but also urban land uses. Urban areas are places where a large number of people and property are concentrated, and can be quite sensitive to heat waves due to the urban "heat island effect". At 1.5°C of warming, 2.3 billion people could be vulnerable to heatwaves, with negative impacts on their health and productivity. Green city elements like trees, green roofs, and vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

"Redesigning urban landscapes with more vegetation and water and implementing passive cooling strategies to improve thermal performance and reduce energy consumption in buildings are key to making cities more resilient to heatwaves."
Jonathan Duwyn, head of the Cities Unit at UNEP.

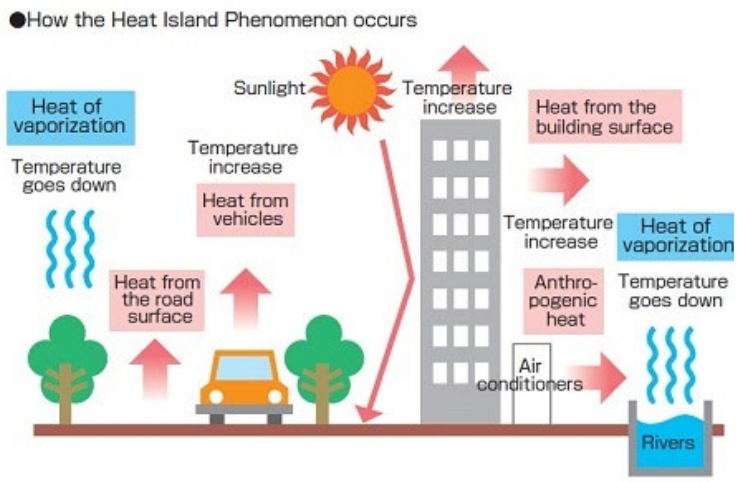


Image source: gardinergreenribbon.com

Main Features

Types of heatwaves based on intensity:

- Low-intensity heatwaves – most people can cope.
- Severe heatwaves – challenging for vulnerable people.
- Extreme heatwaves – dangerous for people who do not take precautions to keep cool and work outdoors.

Advantages and challenges

Green City Elements can help reduce heatwaves which can be mitigated by:

- ✓ Undertaking urban planning and green infrastructure improvements into regular street upgrades and capital improvement projects.
- ✓ Undertaking tree canopy assessments to use trees to address urban heat, stormwater management, and other concerns.
- ✓ Painting buildings with light colours that absorb less heat.
- ✓ Planning urban forestry and vegetation initiatives in busy urban areas.
- ✓ Building of green roofs to decrease the thermal load.
- × The rate of climatic change is generally occurring too quickly for many species to adapt.
- × Hard to change city design, urban and emergency planning from the grassroots.
- × Poor understanding of community-related factors.
- × Cash flow and resource issues that stall ambitious projects.
- × Older adults may face more challenges than most in reaching consultation efforts.
- × Competing issues for public space, and indifference from public and private entities.

References

- Living in a heatwave: How cities are being futureproofed against climate change
- Reduce Urban Heat Island Effect.
- As heatwaves blanket Europe

Further Information

- EEA: Heat waves — both a low share of green and blue urban areas and high population densities can contribute to the urban heat island effect in cities
- What Is the Heat Island Effect?

EXTREME COLD

BEHAVIOURAL ADAPTATION TO EXTREME WEATHER

Introduction

Climate change causes extreme weather conditions. Warming of the Arctic in wintertime can affect Europe's climate via weakened jet stream and wind stream. Cold waves have direct effects on human health and can result in higher mortality. Cities should be prepared for extreme cold and take it into account during urban planning.

Description

Due to increased global warming, the number of people exposed to extreme cold events will decrease significantly in all European countries in the next decades according to the latest studies. These projections suggest that southern and northern European countries will experience the highest decrease in extreme cold events. Consequently, older people and those who suffer from energy poverty are more vulnerable to extreme cold weather.

Extreme cold winter can be explained by Arctic Oscillation. If high-pressure air over the Arctic pushes the cold air to the south, it results in a very cold and snowy winter season. This phenomenon will happen from time to time in the future despite global warming. Scientists claim that the accelerated warming of the Artic is linked to extreme cold winter in the U.S.A. This type of change at the Arctic can boost the chances of extreme events such as powerful snowfalls in and beyond the U.S., e.g., in Canada or Asia.

Cities still need to be prepared for cold winters and ensure the necessary energy supply for citizens. Energy security is among the highest-priority safety questions, thus, a complex energy mix based on locally available renewable energy sources and energy-efficient retrofitting of the buildings is required to decrease our energy dependency from fossil fuels and changing extreme weather.

Further Information

- Cold weather and climate change explained
- Linking Arctic variability and change with extreme winter weather in the United States

References

- Global warming and human impacts of heat and cold extremes in the EU
- Climate change: Arctic warming linked to colder winters

FLASH FLOOD

BEHAVIOURAL ADAPTATION TO EXTREME WEATHER

Introduction

Climate change has increased the frequency and intensity of floods. Floods are sudden onset events where normally dry land is inundated with an overflow of accumulated water that it is unable to absorb. There are several types of floods such as flash floods caused by heavy rain, river floods which are seasonal, and coastal floods associated with cyclones and tsunamis.

Description

What can cause flooding? The frequency and intensity of floods depend on several factors: degradation of soils and the ecosystem due to unsustainable development makes it increasingly difficult for lands to absorb waters from heavy rains.

How is climate change connected to flooding? Climate change warms up the atmosphere and the air can hold 7% more water vapour for every one-degree Celsius rise in temperature. When this air rapidly cools, water vapour turns into droplets which join together to form heavy rainfall.

What can flood cause? Impacts of flash floods might be death or serious injury, immediate property damage, long-term property damage, loss of critical infrastructure, deposited sediment & silt, economic and biodiversity losses.

What cities and citizens could do? Cities can, inter alia, map the location of past floods; map areas that are susceptible to flooding based on their geography; prepare comprehensive flood risk assessment which combines data on flood-prone areas with information on vulnerable people to identify the most at-risk areas; develop flood emergency protocols and early warning systems, etc.

Rapid urbanization often entails informal settlements in areas with high flood risk, such as floodplains and riverbanks, exposing the urban poor to higher risk of floods. Nature-based solutions (NBS) can help increase onsite stormwater absorption. They can be applied from building level to landscape scale. Using multiple NBA solutions in combination with grey infrastructure components will provide the most comprehensive and effective urban development plan.

Further Information

- European Commission, Floods

References

- EC, Environment and Flood Risk management
- How to reduce flood risk in your city
- Impacts of a Flash Flood

CIRCULAR DESIGN

WASTE MANAGEMENT

Image by Freepik

Introduction

Circular Economy is the model in which we do not use and dispatch resources, but instead we use our resources more reasonably and in a more efficient way, reducing our waste production.

Circular design is aimed at the beginning of the resource use chain, and thus, a very important part of the whole circular economy concept.

Description

Circular design is proven to be the main challenge to implement circular economy in our cities.

Different strategies can be used towards the general public such as promotion of services via rents (or sharing, leasing, subscription, etc.), instead of buying products that are going to be used only sometimes.

Making products easier to be repaired reduce as well the number of products citizens “need” to buy. Another way is not applying planned obsolescence and extend the products’ life. Another general circular design strategy is preparing products that do not mix different types of materials, which would make products more difficult to be recycled. The use of local products that reduce the transport needs, or the production of platforms that enable citizenship to use second-hand products are other examples of strategies in the design phase of circular economy schemes. Dematerialisation to find solutions to deliver utility using the minimum amount of material possible (for example digitalization), or modularity of products, make it easier to reduce the number of resources needed.

Design is key to the first principle of circular economy, as around 80% of a product’s total environmental impact is determined in the design phase.

Main Features

No mix of materials
Easy to repair
Avoid planned obsolescence
Servilization (offer services instead of products)
Local products
Reuse of materials/products

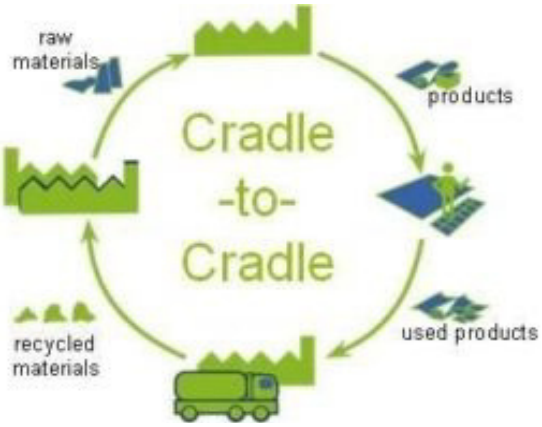


Image by CC BY

Advantages and challenges

- ✓ Asking companies and public institutions to implement circular design helps achieve circular economy objectives in the city.
- ✓ Applying circular design in products for those citizens who are part of local companies, helps their economy (reducing resources needed), simplifies their business, and can get them revenues for selling previously considered waste products.
- ✓ Citizens can better implement circular economy principles in their daily life with circular design products (for example, products in which no mix of material is foreseen, so it is easy to recycle).
- ✓ Avoiding waste is often a mindset of not wanting to throw anything out, but actually, it's an opportunity to re-think and be more efficient.
- × Lack of professionals who have the relevant knowledge and experience to include these rules both in private and public sectors. General public is not really aware of circular design and how to ask for it either.
- × We need to be more conscious about the materials that we use, how they're impacting the planet and how they're impacting us. They may not directly be affecting us right now but they will affect the generations to come.

References

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- Circular Design - Design for Circular Economy. (2017). ResearchGate

Further Information

- Circular design
- Circular by design: the 5 principles to make it happen

3RS/7R RULE

WASTE MANAGEMENT

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Introduction

Circular Economy is the model in which we do not use and dispatch resources, but instead we use our resources more reasonably and in a more efficient way, reducing our production of waste. The **3Rs** rule (Reduce, Reuse, Recycle) or a more extent version, **7Rs** (Reduce, Reuse, Repair, Renovate, Recover, Rethink, Recycle) help citizens to take steps towards circular economy.

Description

Circular economy is a production and consumption model that consists of sharing, renting, reusing, repairing, renewing and recycling existing materials and products as many times as possible, giving them added value. This way, the lifecycle of the products is extended, and the production of waste is reduced to a minimum, getting economic and environmental benefits.

The 3Rs/7Rs rule aims to remind local actors in a simple way about straightforward actions to change our consumption habits (reduce your consumption, reuse things, recycle more), making citizens and local shareholders responsible for the use of resources and generation of waste. This rule is based on different main steps that take into account that nearly 80% of the impact of the products used in a city can be reduced in the design phase done mainly by private companies, but as well promoted by public regulations. As well, the change in the management of waste resources in the city and the change of behaviour of citizens and private local actors can achieve to reduce drastically our waste production and reuse of products.

Any local actor, i.e., private, public organizations, regular citizens, can apply in their daily life these rules of 3Rs/7Rs to use resources in a better and more economical way.

By implementing zero waste lifestyle, we protect the environment as we reduce our carbon footprint and the need for new materials. For this, it is essential putting “Circular Economy” into practice by following the simple rule of 3Rs/7Rs.

Main Features

Easy to remember
Aimed at all local shareholders
Applicable in our daily life
Reduction of used resources
Reduction of generated waste

Adobe Stock Photo #395198038

Advantages and challenges

- ✓ 3Rs or 7Rs rule are an easy way to remember simple actions that all local shareholders can implement to improve the use of resources.
- ✓ Applying these rules improves the reduction of using the limited resources, promotes the use of local resources over overseas resources, and reduces drastically the quantity of waste produced by each one of us.
- ✓ If applied well, it usually means better local economy as we tend to reduce the purchase of resources, and savings can be made by reusing resources and reducing waste (that implies the payment of waste management costs).
- × Only with this rule, we do not solve the whole problem, thus, more actions are needed (even though it is a good start).
- × There is a lack of professionals who have the relevant knowledge and experience to include these rules on a professional basis. In addition, there is also a lack of knowledge sometimes on how to apply these rules in different sectors of the city.

References

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Further Information

- From the 3Rs to the Zero Waste hierarchy
- The 3Rs Erasmus Project

PAPER WASTE

WASTE MANAGEMENT

Introduction

Paper is made of cellulose fibres, a renewable biopolymer derived from wood or waste paper. Paper consumption has vastly increased due to consumer demands, thus increasing paper production and the natural resources necessary to produce it. Unfortunately, paper needs a lot of natural resources to be made, and more often than not, it and its by-products end up in landfills in huge piles. A circular economy on paper can resolve that issue so that there is no waste and the material is used, again and again, saving up natural resources.

Description

The most important part of paper circular economy is “use and reuse”, which means that consumers should use paper in households and offices in a way that it can be reused easily, like avoiding getting paper dirty or crumpling and shredding it. They should maximize the use of the paper they already have and minimize that of the new paper. For cardboard or packaging paper especially, there are creative ways to reuse them like re-packaging or making decorations. While using paper, citizens should be conscious of three questions: Do I need that many paper? Have I used the other side of the paper? Can my work be done without paper? Citizens should also be aware that keeping paper clean of spills, glue and staples, makes it easier to recycle. Paper can easily be recycled through a pulping, de-inking and drying process and turned back into new paper products. It can also be turned into bio-based chemicals like monochloroacetic acid. Through incineration, paper can turn into energy or heat as well as produce by-products like ashes that can be used otherwise. Municipalities should put paper recycling boxes next to all printers and photocopiers as well as set up paper collection stations to facilitate the process of recycling. Paper that can be recycled, e.g.: cardboard, boxes, newspapers/magazines, office paper. Cannot be recycled: greasy containers, dirty napkins, dirty cartons, paper cups and paper towels.

One ton of paper is estimated to need 24 trees, 300 million litres of water and 32 million BTUs of energy. The EU had as a target for 2020 to reach a 74% of paper waste recycling, following the 72.3% of 2017. However, a higher goal might be difficult due to packaging paper also containing plastic and aluminium, meaning that not all highly used papers can be recycled.

Steps of paper recycling:

- Waste Collection
- Transportation
- Sorting & Baling
- Pulping
- De-Inking
- Drying
- Reorganization
- New Product

Advantages and challenges

- ✓ Paper waste is easily recyclable as well as degradable in nature.
- ✓ Recycling of paper waste saves a lot of natural resources such as trees (wood), water, oil and electricity, having high environmental benefits. The process also reduces the emissions of CO_2, NO_2 and SO_2 and diminishes water pollution.
- ✓ Paper doesn't have to be recycled only back to paper as it can be used in the production of biochemicals.
- ✓ Most packaging papers and cardboards are made of recycled fibers. Newspapers, napkins and printing paper can also be produced from recycled paper.
- ✓ Recycling paper waste has high economic value due to profit made out of the development of new products.
- × Paper can only be recycled a maximum of 7 times due to the fibers getting lost in the process or wearing out.
- × There is difficulty in recycling coloured paper during the bleaching process. Ink and glue added by consumers are also difficult to separate from the material, making recycling of paper more challenging.
- × There is not always enough pulp from used paper which means that manufacturers are not able to produce enough paper to cover the markets demands and end up adding additional raw materials.
- × Paper such as sanitary napkins and coffee filters cannot be recycled.

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- Recell - Markten | Infra | Compose | Chem
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GLASS WASTE

WASTE MANAGEMENT

Introduction

Glass is a material made out of sand, soda ash and limestone and it is 100% recyclable. Circular economy processes help in capturing the lost value from the recycling glass. This makes up more favourable circumstances for reusing and saving raw glass materials and eliminating carbon emissions. Glass is also a vital material for circular economy policies as it can be recycled again and again without losing its elemental properties.

Description

In the EU, it is estimated that 73% of post-consumer glass packaging is collected and recycled. The types of glass that can be recycled, inert alia, are bottles, jars, cosmetic and perfume containers, pharmaceutical packages and vials. In order to properly recycle those, it is necessary to separate the lids and corks of the jars and have them thoroughly cleaned up. The process of recycling glass is as follows: it is collected and sent to recycling facilities where it is crushed and remelted in oversized furnaces to turn into a cullet and then back into useful glass again.
Some types of glass cannot be recycled because they will not melt properly or are coated with special substances. For these, households can resort to reusing their glass containers, in order to reduce glass waste in landfills. Reuse of glass containers can be easily achievable as glass is a long-lasting material that does not gather toxics and has an almost zero amount of chemical interaction. Containers such as glass jars and bottles can be reused through crafts, decorations, storage, planters, or even drinking glasses, after a sanitization process.

So far in Europe, most building end-of-life glass ends up on landfills or is crushed and aggregated to the construction of roads. However, if building glass were adequately sorted from other building debris and collected separately it could be easily recycled into other glass products.

Circular Economy for Glass process elements:

- Mining materials
- Glass manufacturing
- Glazing units
- Reuse ← Use
- Collection → Recycling/ Refurbish/ Remanufacture
- Energy recovery
- Landfill

Advantages and challenges

- ✓ A big number of raw materials can be replaced by cullet (the material resulting from glass recycling) and can be used in manufacture, thus, conserving natural resources.
- ✓ Cullet melts at lower temperatures than raw materials used for glass making, thus saving energy and reducing energy costs.
- ✓ CO_2 emissions, air and water pollution are reduced.
- ✓ Through reuse of containers, materials sent to the landfills as waste are lessened.
- ✓ Glass waste management reserves sustainability because it is 100% recyclable and can be recycled endlessly without losing quality or purity.
- × Not all types of glass can be recycled. However, there are many ways to reuse glass containers in households, from refilling them to turning them into decorations.
- × High cost in the recycling glass process.
- × Difficulty in sorting broken glass or sorting through the various colours and types of glass.

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- VDMA: Recycling Glass – Circular Economy with Potential (glassmachine.com)
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- European container glass industry at last welcomes circular economy package | GlassOnline.com - The World's Leading Glass Industry Website
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COMPOST

WASTE MANAGEMENT

Introduction

In circular economy there is a mechanism action that eases the decomposing of organic material in an oxygenated environment and consequently, it constitutes a nutrient rich fertilizer, and a soil amendment. That mechanism/process is called composting. A plethora of material can be composted, including fruits and vegetables, eggshells, coffee grounds and filters, nut shells, tea bags, shredded newspapers, cardboards, etc.

Description

Everyone can compost, weather municipality professionals or households, as long as they have browns- dead leaves, branches and twigs, greens- vegetable and fruit scraps, coffee grounds, grass clipping, and water, all in equal amounts. The browns release carbon, the greens release nitrogen and the water provides the necessary moisture in order to break the organic material with composting. For indoor composting, it is possible to buy a composting bin from a hardware store or a gardening supplies store and afterwards be careful of the materials they through inside so that no pests or rodents are attracted to the pile and the pile has no bad odour. Indoor composting takes up to 2 and 5 weeks. Backyard composting includes finding a place in the garden that has plenty of shade and is dry to set up the composting pile. Then greens and browns are added to the mix, are moisturized if dry, and cut to smaller pieces if big. The compost pile is complete once grass clippings and vegetables have been added. Backyard composting can take between 2 months to 2 years. Four different types of composting: Vermicomposting which is the process of composting in a confined container with the aid of worms that disintegrate the compost. Aerated (turned) windrow composting: the process of composting in windrows, which are huddled rows periodically aerated either manually or by mechanical pile turning. Aerated static pile composting: a big stack is aerated with ventilation ducting and/or materials of organic bulking for the composting process. In-vessel composting: the procedure of composting in a big, confined vessel that oversees the five criteria necessary for composting.

It has been estimated that less than 40% of organic waste is composted in OECD countries, which proves that at least 58 million tonnes of materials that could be recovered are lost annually.

Main Features

When composting there are five criteria to take into account:

- Nutrient balance
- Particle size
- Moisture
- Oxygen
- Temperature

Advantages and challenges

- ✓ Minimal environmental effects. Composting of organic matters halts the production of methane and leachate formulation in landfills and reduces greenhouse gas emissions.
- ✓ Regenerates poor soils by producing bacteria and fungi, which are useful microorganisms that decompose organic materials to create humus. The biodiversity of the soil is also augmented.
- ✓ Provides water retention, halting the clogging of waterways with waste products.
- ✓ A natural organic fertilizer, meaning no need for chemicals in planting.
- ✓ Supresses plant diseases and pests.
- ✓ Anyone can compost in urban areas by using indoor composting bins.
- × The release of gases that are harmful for the environment, especially methane which traps heat and affects the global warming in the case of anaerobic composting.
- × Reports of low nutrient and agronomic value. There is a need to add nutrient-rich substrates.
- × Collecting and attending to the waste piles is a time-consuming process.

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- The Compost Story
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- Home page - Green Recess (green-recess.com)

PLASTIC WASTE

WASTE MANAGEMENT

Introduction

The use of plastic has increased considerably in the past years, also increasing the amount of plastic waste that ends up in landfills or in the environment. Plastic waste has a negative impact on the environment and human health as it causes ground and water pollution if it remains unmanaged, can cause air pollution and respiratory problems. It is therefore necessary to find solutions to manage plastic waste better or lessen its use.

Description

To better manage plastic waste, cities should adopt a circular economy approach by investing in sustainable disposal infrastructure and advancing their waste collection systems, encourage recycling and the use of recycled plastic in manufacturing. Meanwhile, as plastic waste management often starts in the households, there are many ways to reduce plastics, such as reducing cellophane wrapped products, switch soap bottles for bars and plastic sponges for natural ones, and most importantly, reuse and repurpose plastic containers. Packaging that is reusable can be used multiple times once it is washed and returned to its original form. Reuse of plastic identifies 4 models: **Refill at home** (refilling plastic containers at home), **Refill on the go** (refilling out of home, at an in-store), **Return from home** (picking up packaging from home by pick up services), **Return on the go** (picking it up at stores). Special attention should also be paid on the use of biodegradable plastics, a kind of plastic that comes from natural and not artificial materials. Biodegradable plastics have the same end results in products as simple plastic but for its breakdown only needs a few months, while simple plastic can live for centuries. They can be absorbed in the soil or turn into compost, which means that plastic waste is decreased significantly.

The European Strategy for Plastics in the circular economy targets specific actions to eliminate the use of plastic. The recyclability of plastic packaging is a priority area. The goal is that by 2030 all plastic packaging in the EU will be either reusable or recycled. The next step is boosting the demand for recycled plastics and improving the collection and sorting process.

Main Features:

- Design of recyclable packaging
- Uplift of demand for recycled plastics
- Improvement of collection and separation of waste
- Reuse of plastic containers

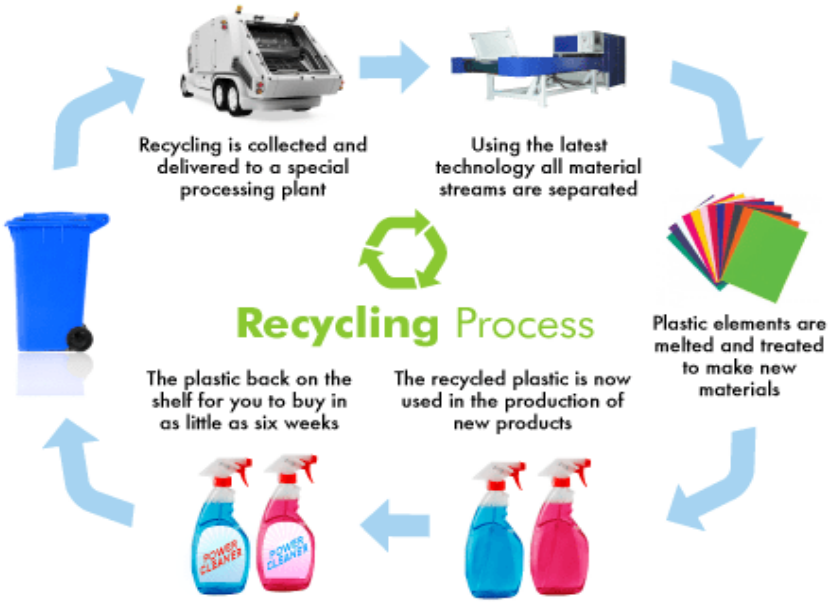

Image source: *Different Methods to Recycle Plastic*

Advantages and challenges

- ✓ Environmental damage can be decreased by the reduction of plastic litter in landfills or plastic leaked to the environment if recycling plastic, reuse and refill methods are adopted by the citizens.
- ✓ It is cost effective to follow reuse models instead of using single use plastic packages. Households spend less when they reuse their previous containers.
- ✓ By switching to bioplastics, greenhouse gas emissions from plastic manufacturing can be reduced.
- ✓ Conservation of natural resources and energy, as manufacturing of raw plastic requires more energy compared to producing from recycled plastic.
- × Recycling is tightly tied with individual behaviour and there is not enough incentives for the consumers.
- × It is difficult to collect and sort plastic waste if it has not been separated from the rest of the waste correctly and effectively. That is the reason why municipalities need to update their waste collection methods.

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RECYCLING OF CLOTHES

WASTE MANAGEMENT

Introduction

Environmental impact of textile and clothing industry is approximately between 2% and 10% of the EU's consumption which means a giant share. The sector has a very high energy and water demand, and uses chemicals including pesticides. In addition, the consumers are also responsible for this large environmental footprint, but with consciousness and recycling we can do a lot for the environment.

Description

Textile industry with its yearly 1.2 billion tonnes greenhouse gas emission is among the most pollutant sectors which affects people living in third countries primarily. Production not only consumes large amount of energy and water, but also creates 20% waste from fabric residue. On one hand, the greening of textile and clothing industry is inevitable. On the other hand, citizens have direct effect on the industry actors via their demands, requirements and choices.

Regarding individuals' habits, we buy more and more clothes due to the influence of fast fashion and low prices and tend to forget about the environmental aspects. Cities should support the collection of textile waste, for example, via waste collector facilities or designates areas.

In fact, the industry uses high volumes of non-renewable materials. Thus, the rate of recycling in the industry is extremely low, only 1% of the used clothes are used for new products due to technological burdens and deficiencies. Therefore, awareness-raising has a key role in decreasing the sector's ecological footprint by promoting slow and circular fashion, re-use of clothes, collecting and recycling, also taking into account sustainability. Detergent used for washing, high temperature washing, and ironing are also accounted for the environmental impact. Quality products, cleaner processes and consciousness are required from manufacturers and consumers as well besides the necessity of appropriate waste management.

Further Information

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- The European Apparel and Textile Confederation
- Why clothes are so hard to recycle

References

- European Parliament: Environmental impact of the textile and clothing industry
- Refashioning clothing's environmental impact

SERVITISATION

CIRCULAR ECONOMY

Image source: www.goodsign.com

Introduction

Servitisation refers to the potential of reducing material needs by changing a product's ownership or its offer as a one-off sale alone, in favour of providing a more comprehensive service or solution. The opportunity lies in delivering a package of services, goods, support, and knowledge that together offer a better solution to the customer.

Description

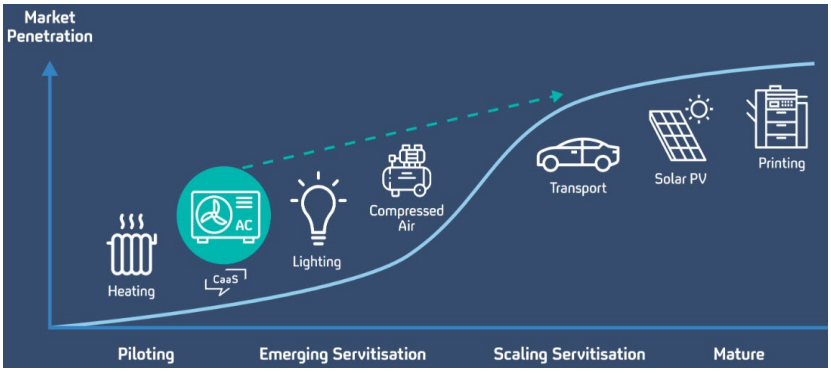
The servitisation model offers solutions around typical barriers that impede the uptake of greener city ambitions, despite their clear economic benefits, including high up-front costs, performance uncertainties, and more tangible or easier investment priorities. Servitisation is generally defined as adding services or solutions to cities, citizens and business; and which deliver greener environments or outcomes on an ongoing basis. Servitisation also offers a lot of potential for a more circular economy in terms of greener solutions that disrupt current systems.

An example of this model can be found in the switch undertaken by the photocopier industry which started leasing multifunctional products to foster a pay-per-printed or scanned page model rather than just printers and cartridges, thus reducing customers capital outlay, while securing long-term relationships and improving profit margins. More recent models can be found in renewable energy projects where the customer pays a fixed fee per unit of service consumed, while the ownership of the system remains with the technology provider, who remains responsible for all operation and maintenance costs.

Servitisation offers some interesting opportunities for ecological innovation, sustainable product-service systems and resource efficiency.

The figure illustrates some sectors where servitisation solutions have already been applied and of relevance to greener cities.

Source: Basel Agency for Sustainable Energy.



Advantages and challenges

- ✓ Transformation from up-front payment to pay-per-period or per use.
- ✓ More efficient supply chains which are less intrusive on cities.
- ✓ Better alignment with citizen or customer needs and expectations.
- ✓ No product obsolescence and increased sustainability.
- ✓ More flexible offers to citizens or customers.
- ✓ Improved repairability and modularity.
- ✓ Service becomes a value offer rather than a just a cost but a value.
- ✓ Initial capital investment is typically reduced.
- × Sometimes only large implementations can achieve the necessary critical mass.
- × Requires a substantial change in mindset.
- × High volatility in intensity of services provided and cash flow support needs to be proactive instead of reactive in order to minimise service downtime and maintenance costs.

References

- Servitization in Support of Sustainable Cities: What Are Steel's Contributions and Challenges?
- What is servitization, and how can it help save the planet?
- The advantages and challenges of servitization.

Further Information

- Study on the potential of servitisation and other forms of product-service provision for EU SMEs

WASTE-RESOURCE MARKETPLACES

WASTE MANAGEMENT

Introduction

Although, it is important to reduce the amount of generated waste in order to decrease the related environmental impacts like soil and water contamination, air pollution, appropriate waste management, recycling, reuse of waste also have remarkable role in this fight. Waste can be exported and imported, thus, they can be considered as goods which is traded across borders and represents value. We can use waste, for example, to produce heat or electricity.

Description

In total, we generated 5.2 billion tonnes of waste in the EU in 2018 from food, construction, industry, mining, electric devices, batteries, old vehicles furniture, clothes, etc. While construction and quarrying had a significant share (35.9% and 26.6%), households were responsible for 8.2% of the total amount. As the number of one-person households are growing, the amount of generated waste by households is also increasing. Recycling, backfilling and energy recovery are among the most common recovery operations in waste treatment.

We should change our perspective and see unused waste as a potential loss. Waste can be a valuable resource which is simply not in the right place. Nowadays, we can find organizations who are specialised in matching recyclers and secondary material users to companies. They have the relevant knowledge on circular waste management and use AI supported IT infrastructure. The so-called “waste to resource marketplaces” help resources be treated correctly and facilitate the expansion of markets for circular products. Urban waste collection and management should also offer such services. Initiations related to waste-resource marketplaces can bring together all the actors supporting co-creation, reuse, repair, recycling, thus, save energy and water, and reduce the amount of raw materials used for production of new goods. By reducing the amount of waste ending up in landfills, we can reduce methane and CO_2 emissions, too.

Further Information

- European Waste Management Association

References

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- Waste2Resource Marketplace Cyrkl

CONSCIOUS CONSUMPTION

WASTE MANAGEMENT

Introduction

Conscious consumption covers several topics, i.e., food waste and packaging, energy consumption, transport as well as buying new clothes, furniture, household appliances, etc. The key elements of conscious consumption are to avoid unnecessary purchases, prefer reuse, repair, quality products and reliable producers supporting circular economy, sustainability, and recycling.

Description

Conscious consumption has environmental and ethical aspects, too. Thus, awareness-raising and protecting consumers to be able to get correct information on products before purchasing is strongly required. In 2022, the European Commission adopted a proposal for a directive on Empowering Consumers for the Green Transition. Greenwashing and false environmental claims can mislead the consumers, but this directive can help eliminate these issues as well.

Buying second-hand products, choosing to repair instead of buying new products are in line with the principles of circular economy. A recent study highlighted that EU citizens have a low engagement in circular economy which can be explained by the lack of information on products' durability and reparability. However, there are also identified market barriers. By organizing local flea markets or farmer's markets, and opening recycling centres, cities can provide opportunities for their residents to consume consciously.

Energy consciousness is about improving our energy efficiency and becoming more conscious consumers. It can cover labelling, smart home solutions and environmentally friendly mobility.

We have to fight against consumer society, unfair prices, food, packaging and energy waste together. We should reduce our raw material, water and energy demand as well as the amount of produced waste to mitigate our society's ecological impact.

Further Information

- The pandemic has increased "conscious consumption" habits
- Sustainable consumption – Helping consumers make eco-friendly choices

References

- What is conscious consumption, and who is a conscious consumer?
- Sustainable consumption

SHORT SUPPLY CHAIN

WASTE MANAGEMENT

Introduction

Short supply chains (SSCs) are relevant especially in case of food chains and serve sustainability at global level. Short transport distances and direct purchase from producers can reduce negative environmental effects of shipping.

Conscious consumer behaviour can contribute to reduce waste and the related environmental impacts (e.g., packaging waste) while supports local economy.

Description

A considerable amount of food is produced and wasted, resulting in significant unnecessary greenhouse gas (GHG) emissions. According to the estimations, 8%-10% of GHG emission derives from food waste at global level. One of the main reasons of this 1.3 billion tonnes food waste and loss is unaddressed supply chains. The goal is to improve the efficiency of supply chains.

The problems of food waste and short supply chains are relevant for citizens, retailers, farmers, hypermarkets, etc. Thus, awareness-raising and innovative solutions are important equally. Cities can provide physical and virtual space and infrastructure for supporting local supply chain.

In order to promote environmentally and socially sustainable production and consumption, it is recommended to prefer local producers. In addition, small-scale trade and better logistics can be the key elements of development, as shorter transport distances also mean lower GHG emission. Beyond the environmental aspects, short supply chains build trust between the producers and the consumers, represent a higher added value, support local communities and more beneficial for small farms and producers from financial point of view, too. To change our mindset and behaviour, we should focus on healthy eating and lifestyle, preferring local and seasonal products.

Further Information

- Short Food Supply Chains
- SMARTCHAIN Smart Solutions in Short Food Supply Chains - video

References

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CRADLE-TO-CRADLE

CIRCULAR ECONOMY IN BUILDINGS

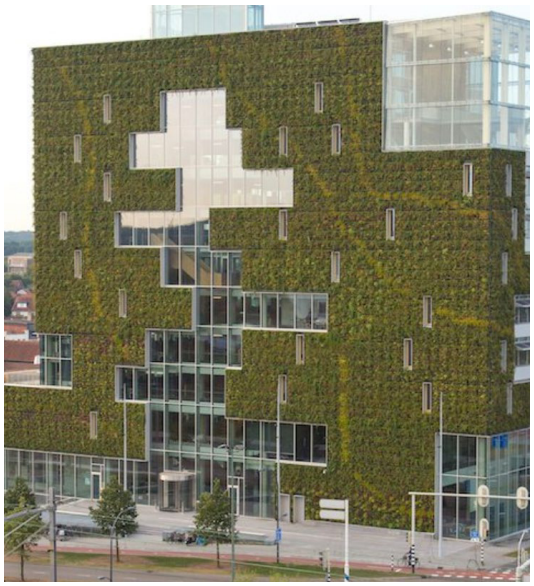


Image source: City Hall Venlo

Introduction

Energy efficiency is crucial to achieve the EU's climate goals, but it is also important to improve the efficiency of our waste management at home and in buildings. The so-called cradle-to-cradle (C2C) concept is an innovative approach in this topic focusing on zero waste. Only a few buildings have been built with C2C approach due to its relatively high investment costs, however, this type of buildings have numerous benefits.

Description

The principle of C2C concept is that all materials can be recycled, reused or composted, thus, life cycle of products is in the centre of this innovative approach. The goal of C2C is to build such buildings which use environmentally friendly materials, and thus, produce zero waste.

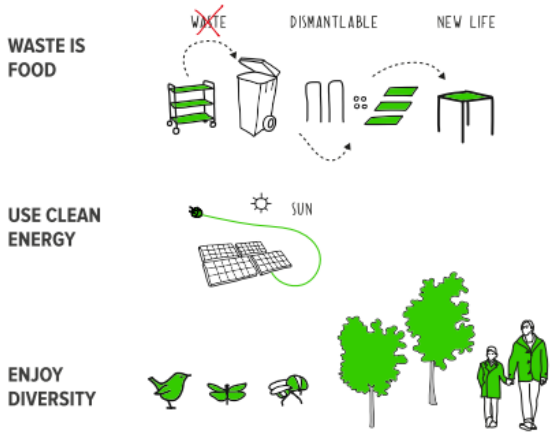
The Dutch city, Venlo was committed to build a C2C municipal building which embodies the city's vision in 2007, but the implementation took almost a decade. The building is used by the municipality, businesses, and citizens as well providing them a pleasant and healthy environment. In addition, the return on investment is favourable according to the calculations.

The City Hall Venlo exploits water by collecting and using rainwater, makes energy by solar panels collectors, and a solar chimney, while they also use geothermal energy for heating. It purifies the air via a greenhouse which also generates heat, etc. Green facade produces oxygen, cleans indoor and outdoor air, has a good insulation quality, and provides habitat for smaller animals like birds.

With a special sort of reed bed, we can reach several benefits. In the City Hall Venlo, it not only creates a green environment for people and animals, and cleans the air, but it also purifies rainwater and wastewater of the building, and reduces the effects of heat stress locally.

Main Features

Sustainability
Closed loop life cycle
Energy independency
Biological and technology cycle
Consumer awareness
Eco-friendliness



Advantages and challenges

- ✓ C2C technology results lower operation cost.
- ✓ C2C buildings can contribute to increased biodiversity in the urban areas.
- ✓ Independent from fossil energy sources. In addition, it produces more energy than needed.
- ✓ By providing a healthier working environment, we can expect less sick leave.
- ✓ It improves the quality of water and air.
- ✓ Only C2C certified materials and products are used.
- ✓ C2C buildings form the city's image.
- ✓ We can monitor the building's performance continuously.
- ✓ C2C buildings have positive effects for the people, the planet, and the economy.
- × High investments costs while the maintenance costs can also be higher.
- × Lack of professionals who have the relevant knowledge and experience to plan such buildings.
- × As of today, we cannot build a 100% C2C building, thus, stakeholders have to set the main objectives in advance.
- × Difficult to find reliable suppliers due to the high standards.

References

- City Hall Venlo
- Venlo City Hall - video

Further Information

- What is Cradle to Cradle Certified®?
- Cradle to Cradle: A Clear Way to Source More Sustainable Build Materials

SMART ECONOMY

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES

Image by Dragana_Gordic on Freepik

Introduction

For smart economy, as one of the many areas of a smart city, information communication technologies and their newest applications are key to enabling the transformation of traditional economies into more dynamic and interconnected ones linking local and global economies. Smart economy solutions can be applied across all sectors of the economy, including production, services, commerce, finance, and tourism, to unlock new efficiencies and create value for customers.

Description

The concept of a smart economy refers to the integration of digital technologies and innovative applications in different areas of economic activity. One of the main benefits of smart economy solutions is their ability to improve the performance and profitability of businesses by enhancing their e-commerce services, logistics, and product offerings. This can lead to growth and prosperity for both established businesses and start-ups. In today's interconnected world, smart economy solutions can enable businesses to reach new markets and connect with customers from around the globe, leading to increased competitiveness and profitability.

Smart economy can also have a significant impact on citizens who benefit from the convenience of digital banking applications, a wider selection of online shopping options, and shipping choices that are better suited to their needs. In addition, smart economy solutions have the potential to improve the sustainability and efficiency of cities by promoting circular economy practices, reducing freight traffic, and attracting new businesses using online tools.

However, the adoption of smart economy solutions also presents challenges, including the need for reliable and secure internet coverage, potential job insecurities due to automation and changing labour markets, and concerns related to online privacy and security. Despite these challenges, the possible benefits of smart economy applications are significant and have the potential to create a better future for businesses and citizens alike.

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SMART PEOPLE

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES

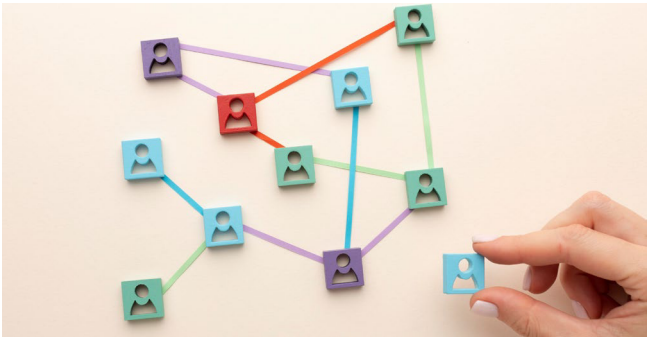

Image by freepik.com

Introduction

The "smart people" aspect of a smart city pertains to the principles of 21st-century education, inclusivity, and creativity. It emphasizes the need for digital literacy to effectively navigate in the online environment and access training opportunities. With the rapid adoption of digital technologies, our daily habits and cultural norms are also evolving, and people increasingly rely on the internet and online applications for communication and information.

Description

Smart people solutions play a critical role in improving the well-being of citizens in smart cities and have the potential to transform urban environments into vibrant and inclusive communities. Education is crucial for smart people, not only encompassing online learning but also adaptive and lifelong learning, and personalized education solutions. These opportunities can enhance labour market opportunities, lead to the development of professional and personal skills, and provide better access to cultural heritage and information using digital tools in the cultural sector, resulting in improved tourism experiences and virtual tours.

Although citizens today rely heavily on online platforms for information and socialising, the digital divide may exacerbate social tensions if vulnerable groups are excluded from these opportunities. Nonetheless, smart people ideas can contribute to community-building. Smart people solutions can help address the digital gap by fostering community-building and citizen engagement and revitalising underused spaces with innovative urban solutions. It is crucial to ensure that vulnerable groups are not left behind in the digital divide. Utilising their skills and knowledge, smart people can create innovative solutions for urban challenges, such as transportation, energy efficiency, waste management, and affordable housing, ultimately leading to the development of a sustainable and inclusive society. Working together, smart people can create a bright future for smart cities where everyone has access to the benefits of digital technology and inclusive community development.

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- I-ACCESS project
- Digital Literacy – What is digital literacy? – video

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SMART GOVERNANCE

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES

Image by rawpixel.com on Freepik

Introduction

Smart governance is an essential aspect of a smart city, as it allows for seamless collaboration and coordination among various organisations and institutions within a city, as well as, between cities on a global scale. Smart governance refers to the use of digital technologies and data analytics to improve the efficiency, transparency, and responsiveness of public services and government decision-making.

Description

Effective smart governance can facilitate collaboration across all levels of urban governance, from identifying social problems and analysing local issues to planning and implementing comprehensive solutions. To establish and maintain high quality information and communication infrastructure in a city is not only crucial for providing local services but also for attracting and retaining new businesses, in alignment with the objectives of a smart economy.

Utilising smart tools such as big data, artificial intelligence, and virtual reality can support the analysis of collected data and enable predictions based on the results. Encouraging citizen involvement in urban planning and decision making can have significant benefits for both the citizens and the local governance. Citizen science, whereby residents provide data about their environment, can be an invaluable resource for cities. It is also an effective means for citizens to notify the municipality about any ongoing local issues.

Smart governance is a particularly sensitive area in smart cities, as it relies on the collection and utilisation of data and information from citizens. Consequently, appropriate privacy policies, reliable ICT technologies, and other security guarantees from the authorities are necessary to ensure the protection of citizens personal information.

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SMART MOBILITY

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES

Image by rawpixel.com on freepik.com

Introduction

As urbanisation and globalisation continue to increase mobility and traffic in cities, their impact on our environment has become a growing concern. Smart mobility solutions offer a promising path forward, providing a means to create cleaner and more sustainable cities while also facilitating our daily lives. Smart mobility encompasses mixed models, clean and non-motorised forms of transportation, and integrated, technology-driven systems. With innovative applications, smart mobility can lead to more effective traffic management and improved safety on the roads.

Description

Smart mobility solutions have the potential to transform both individual and public transportation. For those who choose to drive, smart solutions can help with navigation, parking, and provide real-time traffic information. With the development of sensors and other smart applications, self-driving cars are becoming a reality. These advances also mean that cities can have access to more and better data about traffic patterns and their effects on the environment, enabling them to prioritise the most sustainable mobility options and lead to more efficient traffic management.

Regarding public transportation, smart solutions can improve the journey experience through real-time information and citizen communication to develop demand-oriented services. Additionally, smart mobility can enable private car use for community purposes in line with sharing economy principles. In Stockholm, for example, an electric car-sharing system was implemented to reduce the number of parking spaces in residential areas and promote sustainable transportation options. In Thessaloniki, the C-MobILE app has been developed to promote eco-friendly driving while improving road safety and traffic efficiency through features such as road works and hazard warnings, green light optimal speed advisory, and emergency vehicle warnings. Overall, smart mobility solutions have the potential to significantly improve urban mobility and create more liveable and sustainable cities.

Further Information

- C-MobILE project
- GrowSmarter

References

- Mapping smart cities in the EU
- Deloitte: Smart Cities

SMART ENVIRONMENT

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES

Image by rawpixels.com on freepik.com

Introduction

A smart environment refers to an intelligent and interconnected system of physical objects, devices, and technologies that work together to enhance the sustainability and efficiency of a system, such as a city or a building. The goal of smart environment is to optimize the use of resources, reduce waste, and improve the quality of life for its inhabitants, while also mitigating the impact of human activities on the natural environment.

Description

Smart environment approaches involve the use of technologies to monitor, evaluate, and ultimately reduce our negative impact on the environment. By incorporating smart technologies into urban systems such as water, energy, and waste management, we can effectively monitor, predict, and control these systems. For instance, greenhouse gases and air pollutants are responsible for accelerating the effects of climate change and contributing to bad air quality in cities. Energy consumption is one of the most relevant sectors in cities in terms of greenhouse gas emissions, and we can address this issue through the integration of renewable energy sources, dynamic energy management solutions, and the optimal operation of energy storage through ICT solutions. We can monitor CO_2 emission and air quality through the installation of mixed and mobile air quality and meteorologic sensors that track pollution levels in real time.

As another example, in Stockholm an automated waste collection system based on colour codes was introduced to facilitate sorting and promote recycling. Similarly, sustainable and inclusive urban development can be achieved through smart solutions such as the AvaLinn application developed by Tallinn where citizens can share their views and ideas about planned brown site developments in the city. Copenhagen also developed a software application that supports the decision making of local municipalities by describing the local buildings and the expected impact of their energy-efficiency renovation based on urban data. Overall, smart solutions can significantly contribute to a more sustainable and environmentally friendly urban lifestyle.

Further Information

- iSCAPE project
- SMARTER TOGETHER project
- ReSPONSE project

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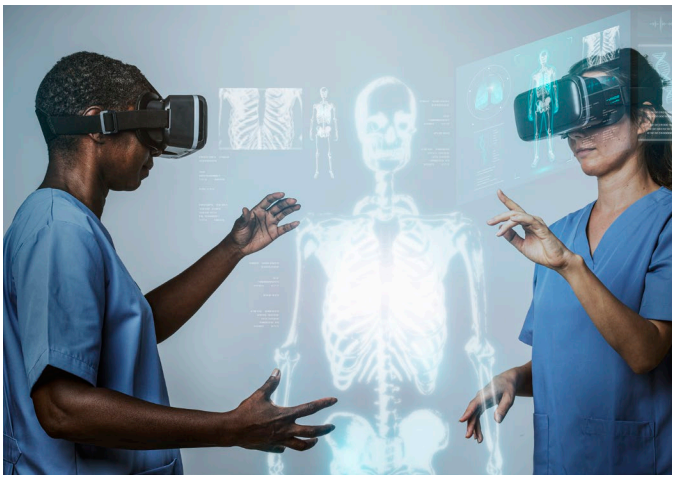
SMART LIVING

SMART CITY DOMAINS FOR THE CITIZENS IN GREEN CITIES



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Introduction

In addition to the other smart city domains, there are many further areas where smart solutions can enhance citizens lives, leading to a concept often referred to as "smart living". From improving the quality of public safety to enhancing health and wellness, providing access to cultural and leisure activities, and promoting happiness and a high quality of life, smart living addresses a broad range of expectations from the citizens. Cities are taking notice of these needs and actively working to develop smart homes, smart healthcare, and smart public safety services.

Description

Smart homes are key component of smart living, offering energy-efficient, controllable, and monitorable systems that integrate household appliances. By using technology to meter and control heating, cooling, room temperature, lighting, shading, air ventilation, and renewable energy sources, homeowners can effectively manage and reduce energy consumption while enhancing the overall sustainability of their living space.

The health sector is also experiencing exciting innovations that can improve and facilitate care, such as better access to patient history, artificial intelligence for finding the most effective treatments, and care solutions for seniors with reduced abilities. For example, the niCE-life project in Warsaw developed a smart monitoring platform using sensors, ICT, and data analysis solutions to support the independent living of local elderly residents with decreased cognitive abilities.

Smart cities also prioritise safety in public spaces, using dynamic and adaptive LED outdoor street lighting with functions for sensing and counting pedestrians and bikers, as well as mobile applications for emergency calls and dynamic risk assessment to improve security at mass events. For instance, the City.Risks project in Rome introduced a mobile application that accelerates information sharing between citizens and authorities in case of crimes like stolen items, enhancing the overall feeling of safety in the community.

Further Information

- LETS-CROWD project
- MONICA project
- City.Risks project

References

- Mapping smart cities in the EU
- Deloitte: Smart Cities
- mySMARTLife

CITIZEN ENGAGEMENT

SMART CITY SOLUTIONS AND TOOLS

Image by peoplecreations on freepik.com

Introduction

In the rapidly growing field of smart cities, citizen engagement has emerged as a critical aspect of urban development. By involving citizens in decision making processes, smart cities can more effectively address the needs and concerns of their communities. This can lead to more responsive and accountable governance, as well as more effective delivery of public services, offering greater transparency, accountability, and trust between citizens and their local governments.

Description

Smart cities are designed to leverage technology and data to improve the quality of life for citizens, increase efficiency, and reduce negative impacts on the environment. Citizen engagement in smart city development can be seen to ensure that technology is developed and implemented with the needs and perspectives of the community in mind. There are several guiding principles that underpin effective citizen engagement processes. Firstly, to strengthen representative democracy, it is essential to have active and meaningful citizen participation in governance. Secondly, addressing complex societal challenges requires continuous collaboration and partnership between city governments, citizens, civil society, and other local actors to co-create and implement effective policies. Thirdly, citizens are key stakeholders in identifying issues, proposing solutions, and shaping decisions that impact their lives, and their meaningful involvement can lead to better outcomes. Fourthly, building and maintaining trust between city governments and citizens is essential for successful citizen engagement processes. Finally, as citizen engagement processes continue to evolve, public administrations must be flexible, innovative, and adaptive in responding to changing needs and expectations to ensure that citizen engagement remains effective and relevant. Overall, citizen engagement is an essential aspect of smart city development, as it helps to ensure that the technology and infrastructure that are being created are truly serving the needs of the community.

Further Information

- Five principles for citizen engagement
- Smart Cities and Citizen Participation - video
- How Smart Cities Are Boosting Citizen Engagement

References

- Eurocities: There is no Europe without citizens
- Participatory Methods: Citizen Engagement

SENSORIZATION

SMART CITY SOLUTIONS AND TOOLS

Introduction

Today, the design of cities must take into account rapidly changing needs of the citizens. Thanks to the Internet of Things (IoT), the digital and technological world of information and communication is closely linked to the real world of things: objects capable of interacting with each other by transmitting data and receiving instructions. The fundamental elements of this ecosystem are sensors allowing the digitalization of infrastructures, collection and analysis of data.

Description

Major uses of sensors in Green Cities:

- Smart Lighting: intelligent management of public lighting for energy saving by controlling the switching on and off of installations according to the amount of light detected or sensitive areas.
- Smart Air Quality Monitoring: pollution, temperature and humidity to control/prevent pollution and improve the health of the environment.
- Smart Parking: management of parking spaces to decongest traffic by directing users to available parking spaces in order to reduce air pollution.
- Smart Waste: sensors placed in bins to detect fill levels and plan collection.
- Smart Governance of public green spaces: sensors to regulate watering based on weather conditions or the state of the soil and plants.

An example of citizen participation in public policy thanks to sensorization technologies is citizen sensing: a new way of working that puts communities at the heart of innovation, ensuring that new technologies are developed to meet people's needs and tackle the issues they care about, rather than being imposed on them by "big tech" companies in a "top-down" process. The approach enables the development of a "city commons" where resources, tools, expertise and technologies are shared and used for the common good.

Further Information

- To know more about smart cities in Europe, visit the European Commission's website.
- To know more about Smart Cities Marketplace
- To know more about energy and smart cities

References

- Milano Smart City alliance
- Invisible farm: smart city I mille usi della sensoristica iot
- Citizen sensing - where people act as sensors

SMART METERING

SMART CITY SOLUTIONS AND TOOLS

Image source: commons.wikipedia.org

Introduction

Smart meters are a digital solution to old energy meter systems, improving energy efficiency - recording, storing, and transmitting real-time energy consumption data by a residence or commercial building back to the utility via secure wi-fi enabled communications networks.

Description

Smart meters monitor energy quality, quantity, and time of electricity, gas, and water consumption in real-time. Smart meters also send digital data provided by utilities directly back to energy customers for real-time monitoring; besides sending data to the utility for better resource management and load balancing. By providing a better understanding of individual usage, smart meters can help customers make sustainable choices based on their actual household needs. However, having a smart meter cannot reduce households' electricity use on itself. By being aware of their usage and spend, they are more inclined to reduce their usage, especially if they don't pay attention to it.

Smart and green cities today are ensuring that smart metering technologies are incorporated in to their core urban infrastructural systems, ranging from transport, energy, water, and sewage systems, schools, enterprises, public spaces and services to improve cost efficiency and performance.

The smart grid refers to "informed" energy distribution grids that optimise transmission of electricity, so that it becomes decentralised in relation to the power plants where it is produced. This enables green cities to predict energy requirements and optimise production.

How do smart meters work

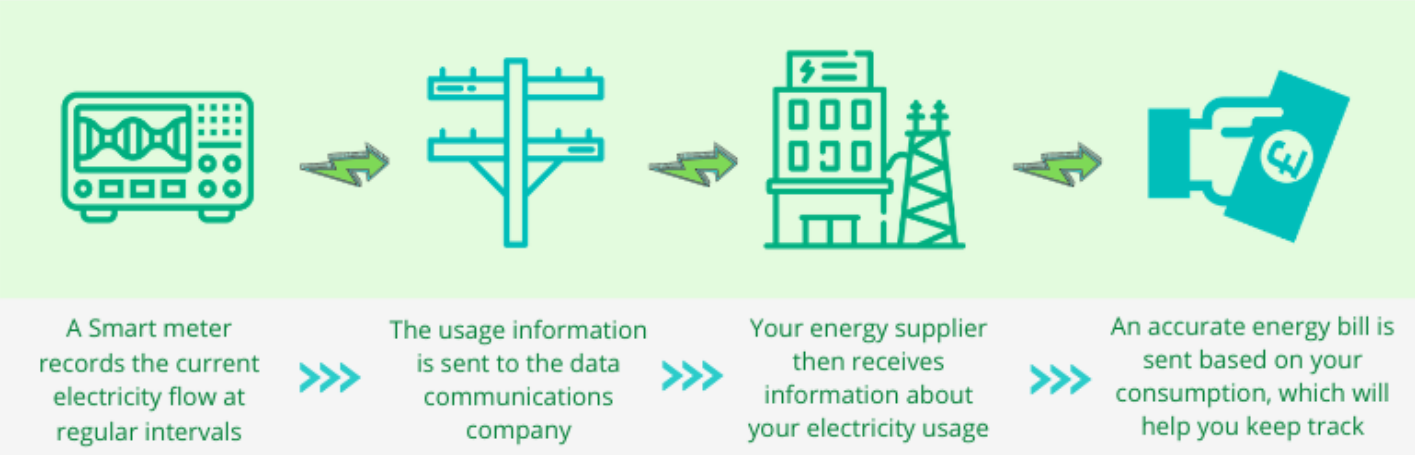

Image source: greenmatch.co.uk

Advantages of and challenges

- ✓ No need to submit meter readings and accurate electricity bills.
- ✓ Households can track their usage and spend in real time, and identify how they use electricity.
- ✓ Remote troubleshooting or notification, restoring of power outages and service disconnect if necessary.
- ✓ Easier to prevent meter tampering and energy theft.
- ✓ Easy to change utility provider, and implement new pricing and load management efforts.
- ✓ Improved power quality throughout the grid by reducing distribution losses and energy costs.
- × Transitioning to new technology and processes is costly.
- × Managing public reaction and customer acceptance of the new meters.
- × Making a long-term commitment to the new metering technology and related software can also be challenging.
- × Requires IT competence and digital literacy.
- × No guarantee households will save energy or money.

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- Economic and Social Research Council (2018). Smart cities and sustainability.
- European Commission (2022). In focus: Energy and smart cities.
- Electrical Academia (2022). What is a Smart Grid. Components.
- European Commission (2019). Smart grids and meters.

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- SMART-UP, funded by the Horizon 2020 programme.
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DYNAMIC LIGHTING

SMART CITY SOLUTIONS AND TOOLS

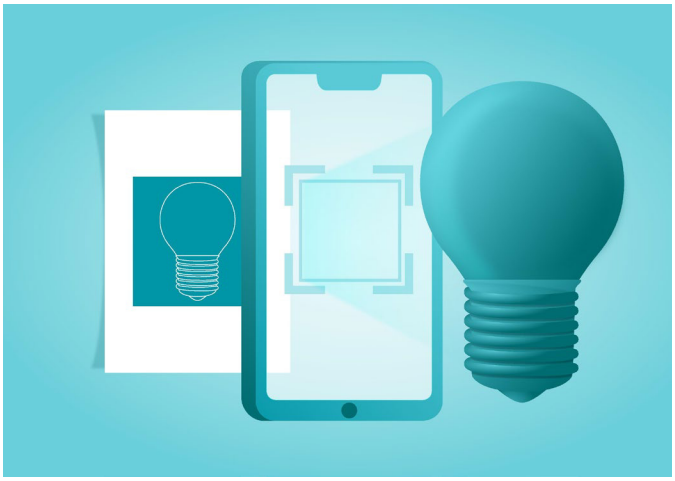

Image by pikisuperstar on freepik.com

Introduction

Dynamic lighting is a technology that has the potential to transform the way we experience and interact with our urban environments. In the context of smart cities, dynamic lighting refers to a system of intelligent lighting that can be controlled and programmed to adapt to different conditions and situations in real-time making our urban environments safer, more efficient, and more aesthetically pleasing. Dynamic lighting is a valuable technology that can help to improve safety, functionality, and sustainability in smart cities.

Description

At its core, dynamic lighting is an intelligent lighting system that can be controlled and programmed to adapt to different conditions and situations in real-time. The systems consist of several key components, including lighting fixtures, sensors, control systems, communication networks, power supply, and user interface. They work together to adjust lighting levels and colour temperature based on environmental changes, user preferences, or automated settings. This versatility allows it to be used in a wide range of applications, including public spaces, streets, and buildings. Unlike traditional lighting, which typically consists of static, uniform lighting fixtures, dynamic lighting can be adjusted to respond to changes in traffic flow, weather conditions, and other variables. This allows cities to improve safety and security on their streets, as well as enhance the aesthetic appeal and functionality of public spaces. In addition to its practical benefits, dynamic lighting can also contribute to more sustainable and energy-efficient cities. By using sensors and other smart technologies to monitor and adjust lighting levels, cities can reduce energy consumption and carbon emissions, while still providing safe and effective lighting for their citizens. The use of dynamic lighting can also help to reduce maintenance costs by minimizing the need for manual intervention and reducing wear and tear on lighting fixtures. As cities continue to invest in sustainable and energy-efficient technologies, dynamic lighting can help cities achieve their goals.

Further Information

- Intelligent street lighting for Smart City - SIIUR 22@ Barcelona - Multilamp System

References

- Smart Street Lights
- Why Smart Street Lighting Should be the First Step in Your Smart City Project
- Dynamic Light—Towards Dynamic, Intelligent and Energy Efficient Urban Lighting

CO-CREATION IN URBAN PLANNING

SMART CITY SOLUTIONS AND TOOLS

Image by vectorjuice on freepik.com

Introduction

Co-creation has become an increasingly popular concept in urban planning and in the development of smart cities. It involves a collaborative approach to problem solving that brings together diverse stakeholders including local government, businesses, universities, citizens, and other relevant actors. By involving everyone in the process, it can help to build trust, foster a sense of ownership, and create more sustainable and resilient communities. As cities continue to grow and evolve, co-creation will also play an important role in shaping the physical and social infrastructure of smart cities.

Description

The approach of co-creating fosters a multi-directional approach to problem-solving, breaking down traditional hierarchical structures and enabling the sharing of knowledge, ideas, and resources across different sectors of society. By engaging in co-creation, citizens can participate more meaningfully in the urban planning processes, working with local authorities and other stakeholders to co-create solutions that are tailored to their needs and preferences. Co-creation also promotes innovation and fosters a sense of ownership among stakeholders which can lead to better outcomes and increased support for smart city initiatives.

Through co-creation, cities can become more inclusive, sustainable, and resilient, as they consider the unique perspectives and experiences of all members of the community. Co-creation can also help to build trust and promote more effective communication and collaboration between local authorities and their citizens which can lead to more successful implementation of smart city initiatives. Overall, co-creation is an important tool for creating smart cities that are truly responsive to the needs of their citizens and that promote greater collaboration, innovation and sustainability in urban planning.

Further Information

- Can “co-creation” help cities find a new way to solve their problems?
- Co-creation Days 2020 | Smart Cities
- Co-creating sustainable urban planning and mobility interventions in the city of Trikala

References

- What can co-creation do for the citizens? Applying co-creation for the promotion of participation in cities
- Co-creation—the key to creating value for a city’s future
- Co-creating sustainable urban planning and mobility interventions in the city of Trikala

ARTIFICIAL INTELLIGENCE

SMART CITY SOLUTIONS AND TOOLS

Image by rawpixel.com on Freepik

Introduction

Artificial intelligence (AI) refers to the use of advanced algorithms and machine learning techniques to analyse vast amounts of data generated by various sensors and connected devices, to optimize and automate urban systems and services. From infrastructure and transportation to public safety and environment, AI has the potential to enable a wide range of innovative and efficient solutions for the cities of the future.

Description

The integration of AI in smart cities offers a range of advantages - more effective management of energy and water resources, better waste disposal, reduced levels of pollution, noise and traffic congestion. It can play a crucial role in urban planning and management, offering advanced security systems, traffic monitoring and waste management, all contributing to enhancing community security and greater control over residential areas. According to estimates, AI will power more than 30% of smart city applications by 2025, delivering smart urban solutions that boost resilience, sustainability, social welfare, and vitality of urban life. In its briefing, the European Parliament has identified **seven dimensions of AI applications** in smart cities: **governance,** including urban planning, disaster prevention and management, and tailored subsidy provision; **living and liveability**, safety and security, with applications such as smart policing, personalised healthcare, and noise and nuisance management; **education and citizen participation** offering locally accurate, validated and actionable knowledge to support decision making; **economy**, enabling resource efficiency, improved competitiveness and tailored solutions for customers through efficient supply chains and sharing services; **mobility and logistics**, delivering autonomous and sustainable mobility, smart routing and parking, supply chain resiliency and traffic management; **infrastructure**, optimising infrastructure deployment, use and maintenance covering areas such as waste and water management, transportation, energy grids and urban lighting; **environment**, supporting biodiversity preservation, urban farming and air quality management.

Further Information

- On big data, artificial intelligence and smart cities
- Artificial intelligence and smart cities

References

- Artificial Intelligence in smart cities and urban mobility
- Urban Artificial Intelligence: From Automation to Autonomy in the Smart City

ENERGY MANAGEMENT SYSTEMS

SMART CITY SOLUTIONS AND TOOLS

Image source: Telegraph

Introduction

The potential of energy management systems (EMS) goes beyond accurate metering technology and better system control. Green cities can integrate EMSs into a smart grid which can match energy demand with supply and decrease GHG emissions thanks to resource optimisation. This creates great opportunities to improve services, bolster businesses, energise green growth, and improve our communities with sustainable solutions.

Description

Smart Metering is an energy management system (EMS) technology which can give consumers clear and comprehensive information about their energy consumption and help them become more energy efficient. Smart meters typically record customer consumption and other parameters with the utility provider and its clients, supporting the management of contracts and control of the power demand. Smart Metering provides better information to customers in order to optimise power demand and consumption. Smart Metering is a technology which adds value to the tenants energy use by encouraging behavioural changes towards energy efficiency.

Utilities are replacing analog meters with digital smart meters that automatically capture information about electricity consumption and transmit it back to electric companies. Smart meters provide accurate measurements of electricity use, thus, citizens can save money if they monitor their consumption and make a positive decision to cut back.

The smart grid refers to “informed” energy distribution grids that optimise transmission of electricity, so that it becomes decentralised in relation to the power plants where it is produced. The figure illustrates how smart meters record, store and transmit, via secure wi-fi networks, real-time energy data on the quality, quantity, and time of electricity consumption by buildings back to the energy provider. This ensures accurate billing and outage notifications, while providing the building blocks for matching energy demand with energy supply in green cities today.

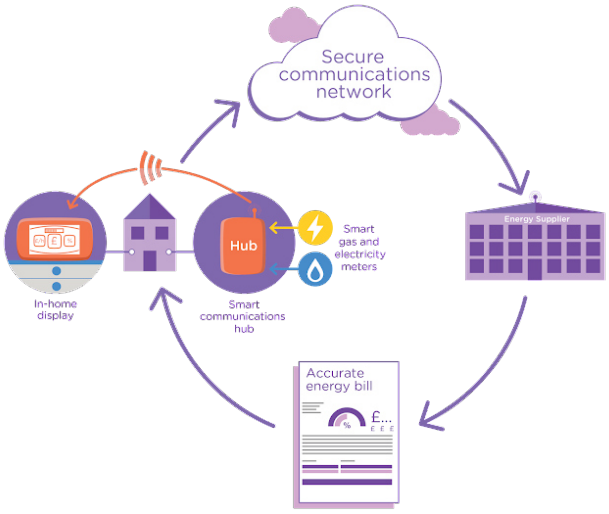

Image source: greencityimes.com

Advantages and challenges

- ✓ No need to submit meter readings since it tracks your usage and spend accurately.
- ✓ Encourages better energy habits.
- ✓ Enables dynamic pricing and income optimization.
- ✓ Provides real-time data useful for balancing electric loads and reducing outages.
- ✓ Help reduce your carbon footprint.
- ✗ Sometimes only large implementations can achieve the necessary critical mass.
- ✗ Transitioning to new technology and processes is costly and risky.
- ✗ Managing public reaction and customer acceptance.
- ✗ Making a long-term financial commitment to the new metering technology and related software.
- ✗ Managing and storing securely vast quantities of metering data.

References

- European Commission (2021). Smart Metering deployment in the European Union.

Further Information

- European Commission (2021). Smart grids and meters.

CYBERSECURITY

SMART CITY SOLUTIONS AND TOOLS

Image source: pixabay

Introduction

Cybersecurity in the context of a smart city refers to any data leakages originated from attacks or bad actions leading to malfunctioning of digital systems and violence of data protection of citizen's relation to governmental bodies.

Description

Smart cities promote the city's collective intelligence by connecting physical infrastructure with IT services towards establishing an ecosystem of urban services. Smart City improves citizens lives by automating municipal duties, improving communication between governmental bodies and citizens, decreasing consumption of resources or removing financial burdens.

The backbone of a smart city is the various IoT (Internet of Things) network sensors deployed in the infrastructure and provide raw data for different sectors (health, transportation, governance, grid).

Cybersecurity is about protecting the devices people use, the information stored and processed in these devices, and the identity of people using these devices. Cybersecurity threats can be divided into three main categories: Cyber-Crime targeting systems for monetizing or sabotage, Cyber-attack for gathering information (politically motivated) and Cyber-terrorism aiming to create intimidation. Typical methods against cybersecurity include Malware (viruses, spyware, adware and botnets), DoS attack, SQL injection, social engineering, etc.

- Security alert systems, street video surveillance and smart traffic lights are considered as the most vulnerable to cyberattacks with high impact.
- Real Case: In January 2021, in Florida, the local water supply system was shut down due to chemical concentrations coming from malicious attack.
- Real Case: Atlanta city systems were hacked, and data encrypted by ransomware, authorities were asked to pay a ransom to get data back.

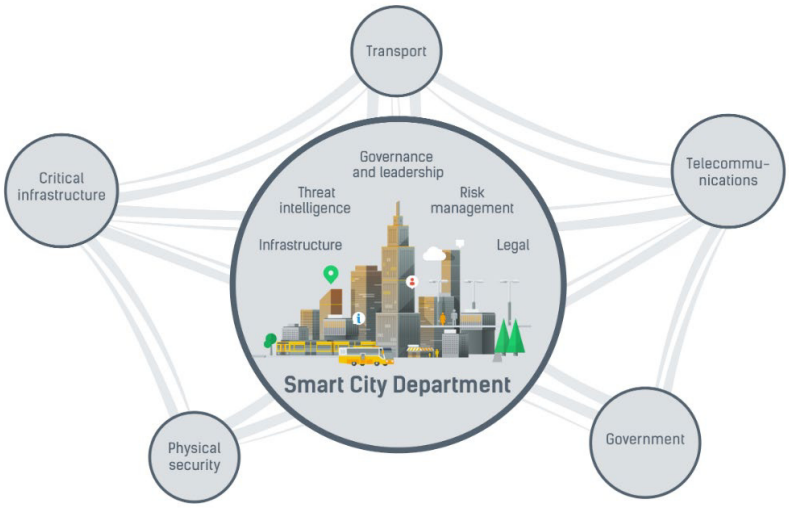

Image source: Securingsmartcities.org

Applications of cybersecurity

Transportation

Critical Infrastructure

Physical security

Telecommunications

Government

Advantages and challenges

- ✓ Secure Smart Government applications reduce crimes by increasing the level situational awareness, efficient response to accidents, improving municipal services.
- ✓ Secure Smart Healthcare solutions can connect people and health facilities. It can improve patient remote monitoring, diagnosis and treatment, hospital management services.
- ✓ Design urban digital systems to establish privacy by restricting the collection of anonymised personal data and deploying stricter data encryption techniques.
- × Smart buildings, as a subsystem of the smart grid, are vulnerable to privacy breaches.
- × Lack of policies or standards allows cities to experiment with new products that create interoperability and integration problems – vulnerable for cyberattacks.
- × Each city is unique and must take its own approach to address cybersecurity issues. However, there are some principles and best practices defined on city level (Model Policy for Cyber Resilience in Local Government).

References

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- Gunes, B. et al., 2021. Cyber security risk assessment for seaports: A case study of a container port
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- Securing Smart Cities
- Case Study: CYBERSECURITY SOLUTIONS IN A SMART CITY
- Cybersecurity Challenge Smart Cities & Infrastructure - Larry O'Brien - ARC Industry Forum 2019
- Smart Cities Cyber Security Worries

URBAN ENERGY CONSUMPTION

BETTER CONSUMPTION AND PRODUCTION

Introduction

Economic activity, transport, geographic factors explain 37% of urban direct energy use and 88% of urban transport energy use.

Energy is required for daily operational needs of the cities and citizens such as lighting, air conditioning, and cleaning. In addition, urban sprawl increases distances between destinations.

Description

A sustainable urban energy system needs low carbon technologies on the supply side, and efficient distribution infrastructure as well as lowered consumption on the end user side adopting energy saving techniques.

The less energy is used, the less needs to be produced. The major change needs to come from the end users – residents, businesses, industries. Technology can also assist in optimizing energy use. Savings can be made by integrating efficient heating, cooling, insulation, lighting, and water distribution systems in new or rehabilitated buildings.

The use of recycled, reused, or low energy building materials also contributes to a better energy balance. To cut fossil fuel use for transportation needs, cities need to develop attractive public transport systems and must increase the share of non-motorized transport, and optimize delivery of goods. Consumption habits also need to change, residents should be encouraged to use more local products and to take on presumption, the production of one's own food.

In addition, cities need to establish strong policies and standards to develop sustainable urban energy systems and to reduce the use of unsustainable technologies and practices. Governments should not only institute legislation to regulate energy use and consumption, but also set up incentive measures that promote innovation, and, most importantly, the adoption of greener and more efficient technologies.

Further Information

- Renewables in Cities – 2021 Global Status Report

References

- UN- Habitat – Energy topic
- OECD : Energy and Resilient Cities

ENERGY CONTRACTS

BETTER CONSUMPTION AND PRODUCTION

Introduction

Energy contract means any agreement for the purchase or sale of energy. Citizens as clients of energy contracts should receive clear and correct information from the retailer. They should also get notice in advance if any changes are made to the contract, and be able to end the contract if they don't accept the new conditions. They are entitled to have access to their consumption data for free. They have the right to have a competitively priced, accurate individual meter for electricity and gas.

Description

Efficient buildings offer benefits to building owners, and occupants: they are healthier and more comfortable; owners can maximise the profit-earning potential of installed building-scale renewables; net-zero-carbon buildings help to increase resilience to extreme weather events.

Opportunities for reducing emissions and, at the same time, benefitting from energy savings:

Energy Service Companies (ESCOs): a company that offers energy services which may include implementing energy-efficiency projects and in many cases on a turn-key basis. It supports primarily larger facilities, municipal buildings or larger residential buildings/block of flats. ESCOs guarantee energy savings and/or provision of the same level of energy service at lower cost; the remuneration of ESCOs is directly tied to the energy savings achieved; ESCOs can finance or assist in arranging financing for the operation of an energy system.

Energy Service Provider Companies (ESPCs): a category of companies that offer energy services to final energy users, including the supply and installation of energy-efficient equipment, the supply of energy, and/or building refurbishment, maintenance and operation, facility management, and the supply of energy (including heat). ESPCs provide a service for a fixed fee or as added value to the supply of equipment.

Further Information

- Clean energy for all Europeans package
- Energy performance of buildings
- EC: European Construction Sector Observatory
- ENEA

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- How to reduce embodied emissions in private and residential buildings
- Energy Service Companies (ESCOs)
- Energy communities

ENERGY SAVINGS

BETTER CONSUMPTION & PRODUCTION

Introduction

Not only high-cost investments can achieve significant energy savings. We can save money and energy by changing our behaviour, improving our daily activities, or focusing on better logistics. Thus, as a conscious citizen, we can do a lot to reduce greenhouse gas emission in urban areas and thus, mitigate climate change.

Description

Energy saving cover several things from energy efficiency investments to the usage of renewable energy sources. By reducing our energy demand and consumption, we become less dependent on fossil fuels while reducing our carbon footprint too.

By acting more energy conscious and changing our daily activities we can achieve remarkable amount of energy savings at home and outside. For example, we can save energy by changing our travel modes: we can walk or bike instead of driving for short journeys or choose public transport instead of car. We can use less fuel if we put out unnecessary stuff from the car or just reduce the speed on motorways. Electric vehicles can be an environmentally friendly option, especially if the used electricity derives from clean sources. Sharing a car with others is also in line with our goals. In addition, high-speed trains can be a great alternative of plane on certain routes in Europe.

Although working from home does not reduce our energy consumption individually, in total, we use less energy by heating and cooling our homes compared to the energy demand of big office buildings. Moreover, remote work saves time, money and fuel by skipping commuting. If we use modern household appliances, we can save energy, e.g., we can set digital thermostats and air conditioners efficiently taking into account which room we use and when we are at home.

If we turn down the thermostat by 1°C at home, we can save 7% heating energy in average. Similarly, if we set the air conditioner lower by 1°C, we can reduce the used electricity by around 10%. Modifying the default settings of the boiler is also recommended to save heating energy up to 8%.

Main Steps

- If you wear warm clothes, you can turn down heating and save energy.
- Try to use less air-conditioning and do not set it too cool.
- By having shower instead of bathing, you can easily reduce the energy used for producing hot water.
- Select eco mode on electric facilities.
- Use energy efficient lighting.

Advantages and challenges

✓ Energy savings can contribute to lower energy costs, greenhouse gas emission reduction, secure and sustainable energy supply as well as job creation.

✓ Reducing our energy consumption is essential for a low-carbon economy. In addition, saving energy helps reach the EU's renewable energy targets and accelerate the clean energy transition.

✓ By metering our energy consumption, we can also monitor the energy savings.

✓ Almost all EU member states offer some subsidies for its citizens to execute small investments to be able to achieve energy savings at home.

✓ EU citizens' energy savings have a great potential to reduce the European Union's resilience on fossil fuels – especially, on imported natural gas – in a cheap, safe, and clean way.

✓ More and more innovation projects using artificial intelligence and state-of-the-art technologies help cities and citizens to increase their energy savings.

× The EU has ambitious goals in terms of energy savings covering all sectors. Nevertheless, the target numbers can only be achieved with the direct contribution of the citizens. Therefore, their awareness-raising is crucial.

× An optimal mix of policy instruments and incentives is required to boost energy savings in the EU and to exploit its end-use energy saving potential.

References

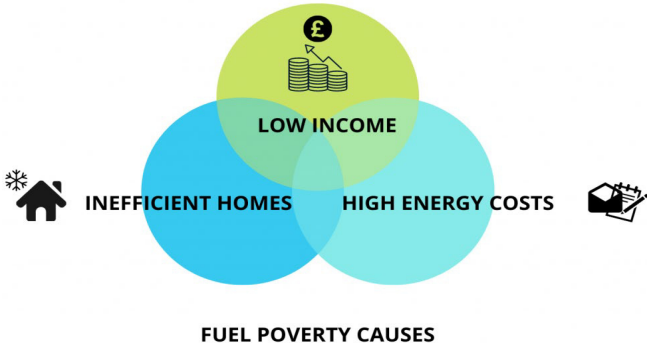
- Energy Savings 2020
- Playing my part

Further Information

- Energy Saver Guide: Tips on Saving Money and Energy at Home

ENERGY POVERTY

BETTER CONSUMPTION AND PRODUCTION



FUEL POVERTY CAUSES

Image source: switchedongosport.co.uk

Introduction

Energy poverty refers to persons or households that have difficulty obtaining the necessary energy in their home to meet their basic needs due to inadequate resources or living conditions. In 2020, about 36 million Europeans were unable to keep their homes adequately warm.

Description

Energy or fuel poverty (ePov) refers to households which are unable to afford to heat or cool their homes to an adequate ambient temperature. This is typically caused by low income, high fuel prices, poor energy efficiency, unaffordable housing prices and poor quality private rental housing.

Cities and their urban form are constantly changing, and the effects of climate change and endless consumption by the effluent can have profoundly negative impacts on social inclusion. These impacts are felt most acutely by disadvantaged groups such as the urban energy poor. Untended, the shift to low-carbon energy districts and urban forms can lead to “green gentrification” and exacerbate inequalities. However, green cities can also be drivers of inclusive cities that become low-carbon and remain socially sustainable, cushioning against the unprecedented energy crisis currently afflicting most of the EU, while offering the community a decent standard of living, better quality of life, more affordable housing, and improved health.

The promising shift towards greener city projects can provide a great opportunity for mitigating energy poverty at the local level. Energy poverty can be assessed and addressed at various levels. At the district scale, ePov needs to be assessed in relation to city low-carbon energy transitions, integrating historical retrofitting and renovation, behavioural change, community scale renewable energies, social housing and energy sector intersections with the vulnerable.

Key drivers that contribute to fuel poverty are:

- The energy efficiency of the property ;
- The cost of energy;
- Household income.

The impact of fuel poverty on households

- Fuel poverty causes more deaths during winter, especially affecting older people and those in ill health.
- Cold households can increase colds and flu, and exacerbate existing conditions like arthritis or rheumatism, and heart and lung diseases.
- Children are particularly vulnerable and can suffer more from coughing, wheezing and respiratory illness.

How to tackle energy poverty in Green Cities

At the household level, typical initiatives include:

- ✓ Train frontline workers dealing with vulnerable cohorts.
- ✓ Improve the energy efficiency of homes, and health and comfort conditions by conducting a home energy audit and offering tailored tips for that household.
- ✓ Deliver training on efficient consumer habits and consumer rights and identify broader intervention needs to favour energy efficiency improvement.
- ✓ Promote community work to combat energy poverty.
- ✓ Promote employment and improve the employability of people with difficulties.
- ✓ Identify causes of heat or cold loss in the home.
- ✓ Help identify and tackle damp or mould problems.
- ✓ Facilitate switching energy providers to save money.
- ✓ Facilitate accessing support, such as emergency heating, government subsidies or grants, advice on energy or water debt.
- ✓ Follow-up on the interventions proposed.

References

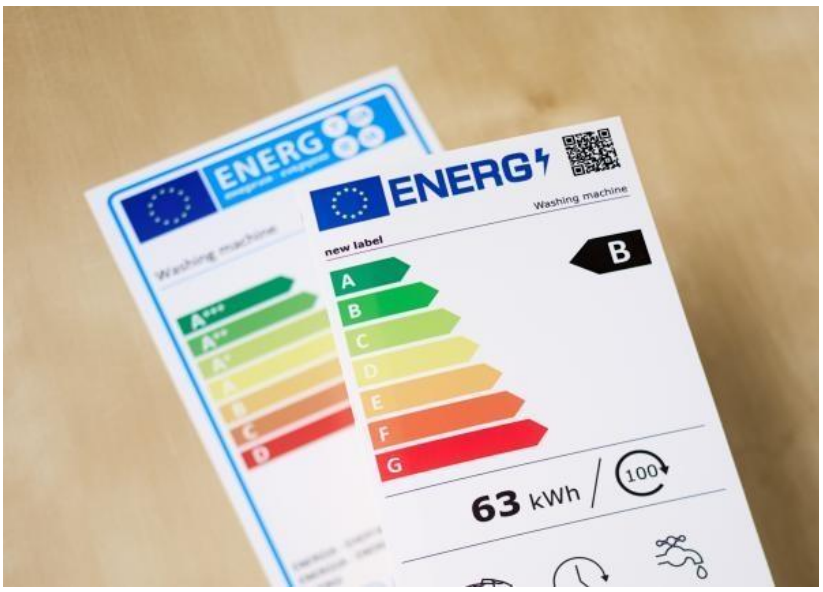
- End Fuel Poverty Coalition.
- European Commission. Energy Poverty.
- Sareen S, Robinson C, Thomson H and Ochoa RG (2022) Editorial: Urban Energy Poverty and Positive Energy Districts. Front. Sustain. Cities 3:775705. doi: 10.3389/frsc.2021.775705
- European Parliament (2022). Energy poverty in the EU.

Further Information

- SMART-UP, funded by the Horizon 2020 programme.
- Turn2Us. Fuel Poverty - What is fuel poverty?

ELECTRIC APPLIANCES

ENERGY EFFICIENCY



Introduction

The EU has energy labels which help citizens to compare the different electric household appliances on the basis of their efficiency in order to make informed choices before purchasing. These labels can be seen on lightbulbs, televisions, refrigerators, air conditioners, washing machines, etc. From March 2021, we use rescaled labels with simpler classification which uses only letters (A-G), but only for a few product categories, i.e., fridges, freezers, dishwashers and television sets also, covering monitors. In 2021, light sources were also rescaled.

Description

EU energy label provides a rating on energy related performance of certain product groups. Besides the energy consumption, it also takes into account the consumed resources per cycle like water depending on the type of the product. The new classification is simple, A indicates the most energy efficient household appliances while the least efficient ones get G. This A-G scale eliminated the former rating (A+ - A+++) in case of certain product categories. According to the plans, by August 2023, the rescaled labels should be applied for each product group which requires an energy label.

Energy labels help consumers to identify energy efficient products, thus, to save energy and in this way money in the household. It also motivates manufacturers to invest in innovation and develop more and more efficient products. Rescaled labels also have a QR code allowing the consumers to get more information on the product. EU ecodesign rules addressing manufacturers sets minimum requirements for products sold on EU market.

Energy labels and ecodesign measures are estimated to save 230 Mtoe energy yearly by 2030 that is equal to the final energy consumption of Spain and Poland together.

Further Information

- The new EU Energy Label
- Energy Labelling - video
- How to Comply with the EU Energy Labelling Requirements in 2022

References

- A new generation of EU energy labels
- New EU energy labels applicable from 1 March 2021
- Questions and Answers about the rescaled EU energy labels and ecodesign measures

HEATING AND COOLING

ENERGY EFFICIENCY

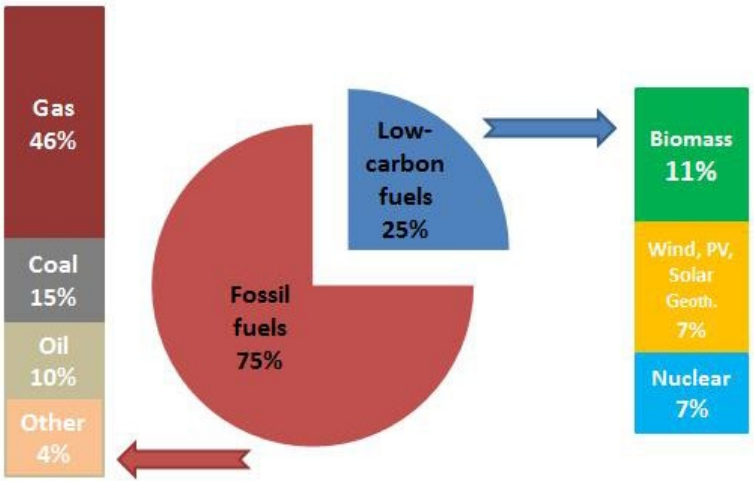


Image source: EC COM (2016) 51 final

Introduction

Space and water heating as well as cooling accounts for roughly 45% of the European final energy consumption. Despite recent efforts to introduce more renewable energy sources in the heating and cooling sector, around 75% of the fuel consumed still stems from non-renewable sources (ca. 50% from gas).

Description

Space heating and cooling makes up a considerable share of the total energy consumption in buildings across the European Union today. Whereas space heating accounts for more than 80% of the total heating and cooling consumption in colder climates, space cooling is the most important factor in warmer climates such as southern Europe. Buildings frequently lose heat or cold due to poor quality. Circa 70% of the EU's building stock was built when energy efficiency requirements were very limited or non-existent, thus, their renovation is essential.

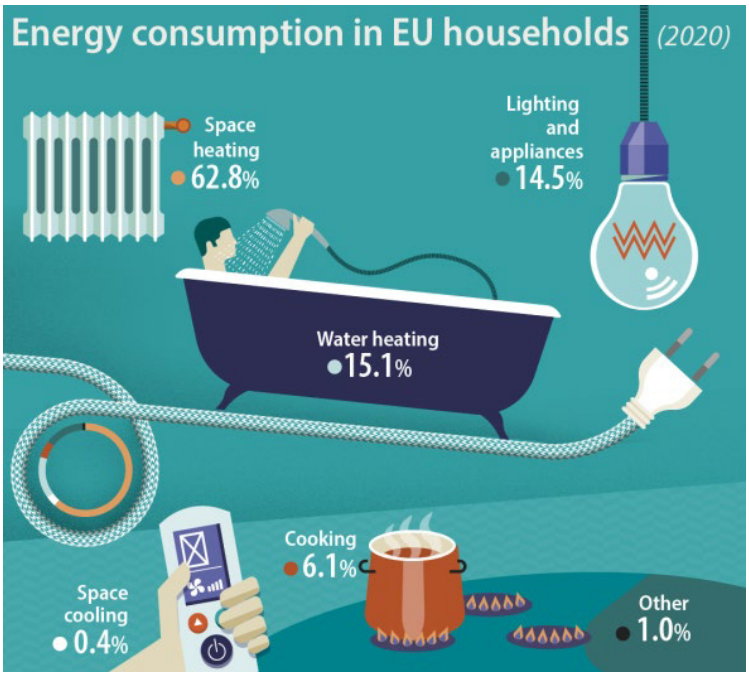
The affordability of heating and cooling can be understood as the ability of households to pay the energy cost necessary to keep their homes adequately warm in winter or cool in summer. As a reference, the cost of space and water heating across the EU represents on average 6.4% of total household expenditure, ranging from only 3% in Malta to a staggering 16% in Slovakia. The cost of heating varies widely across households in Europe as it heavily depends on individual factors such as the energy efficiency of the premises, the fuel type and technology used to heat and cool, the price of energy per unit, and the individual needs and living conditions of the occupants.

Replacing fossil fuels such as oil or gas with renewable energy sources and other zero-carbon solutions in the heating and cooling sector has not gained the same thrust as in the electricity sector where the use of wind or solar for electricity generation is today more widely available. In the heating and cooling sector renewables currently provide only 23% of the total consumption.

Main Features

- A big proportion of the energy bill is dedicated to space heating.
- Energy poor households are at a higher risk of suffering from temperature related mortality, mental health issues and social isolation.
- Adverse impacts on health are also widespread as a result of heat waves during summer.

Image source: Eurostat



Advantages and challenges

- ✓ Energy efficient buildings can result in net zero utility bills.
- ✓ Considerable energy savings can be made through simple renovations such as insulating walls, foundations, attic, installing double/ triple glazing.
- ✓ Nature-based solutions, e.g., trees, green roofs and walls providing insulation and shade to buildings reduce demand for heating and cooling.
- ✓ Building or renovating a home in an energy efficient manner is usually costlier up front, although some costs can be recovered through tax credits, energy savings, and other financial incentives.
- × Lack of awareness of the benefits of energy saving, lack of professional advice on technical aspects and financing are the most prominent constraints for homeowners to renovate/modernise.
- × Energy efficiency investments are less attractive in multi-apartment buildings due to split ownership. They can be also challenging in case of rented buildings due to tenancy rules and the fact that property owners have little incentive to invest if the tenant pays the energy bill.

References

- Climate Change: Implications for Buildings. Key Findings from the
- Intergovernmental Panel on Climate Change Fifth Assessment Report
- In focus: Energy efficiency in buildings

Further Information

- BUILD-UP. The European Portal for Energy Efficiency in Buildings

EFFICIENT BUILDINGS

ENERGY EFFICIENCY

Introduction

Although it is essential to increase the use of renewable energy sources in order to be able to reduce greenhouse gas emission significantly, it is also crucial to improve the energy efficiency in buildings. By reducing the energy demand of buildings, we can also reduce energy dependency and energy bills.

Description

Energy efficiency is relevant in case of the existing building stock as well as the planned ones. The EU set ambitious targets related to energy efficiency in buildings and therefore, to climate change.

It is important to improve energy efficiency of buildings since approximately 35% of buildings is 50+ years old in the EU which also means poor energy performance generally. In addition, around 75% of the existing building stock is energy inefficient. The speed of renovation is very slow (approximately 1% of building stock per yearly), thus, investments are needed to reduce the buildings energy consumption and the related greenhouse gas emission.

Energy efficient renovations are required in public buildings, too. In accordance with the Energy Efficiency Directive, in case of central governmental buildings at least 3% of the total floor area must be renovated each year.

As the role of building sector is important to achieve the EU's energy and climate goals, several EU documents on energy security, climate change, climate neutral economy refers to it. In order to boost renovations and decarbonisation, a revised Energy Performance of Building Directive was proposed in December 2021, targeting, inter alia, zero emission new buildings as of 2030.

Energy performance certificate helps the EU citizens to purchase or rent a house/flat by providing information on its energy performance rating and also on future improvements. Based on the certificate, we can get information on the building's energy demand and consumption.

Main Features

- Thermal insulation of buildings;
- Door and window replacement;
- Replacement of old heating & cooling systems;
- Lighting modernisation;
- Further renovation and modernisation, e.g., thermostats, sensors, smart homes, etc.

Advantages and challenges

- ✓ By increasing energy efficiency of buildings, we can not only save energy and decrease energy-related costs, but also fight against energy poverty and improve citizens' quality of life.
- ✓ Energy efficiency investments have direct effects on GDP, job opportunities, and economic growth as well.
- ✓ By reducing the building stock energy consumption, we can decrease the EU's energy import, and thus, its energy dependency.
- ✓ Awareness-raising can have a key role in informing the citizens on the benefits of building automation and other enhanced functionalities.
- × Our homes and buildings are responsible approximately 36% of energy-related greenhouse gas emission, and 40% of final energy consumption.
- × About 85%-95% of the EU's buildings will still stand in 2050 according to the expectations, thus, their renovation is a great challenge for the economy and the society.
- × Due to different economic and social backgrounds of homeowners, building renovation is not manageable for all citizens without financial incentives.

References

- Energy Performance of Buildings Directive
- Making our homes and buildings fit for a greener future
- Certificates and inspections

Further Information

- Energy Efficiency Directive
- Commission recommendation on building renovation (EU) 2019/786
- Commission recommendation on building modernisation (EU) 2019/1019