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CAPACITY BUILDING TRAINING PACKAGE

EU4 ENERGY TRANSITION: COVENANT OF MAYORS IN THE WESTERN BALKANS AND TÜRKIYE

2023

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CENTRAL PROJECT MANAGEMENT AGENCY

CAPACITY BUILDING TRAININGS FOR SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN (SECAP) DEVELOPMENT

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LONG-TERM PROJECT EXPERT

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CENTRAL PROJECT MANAGEMENT AGENCY

CONTENTS

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1. INTRODUCTION

The EU for Energy Transition project aims "Sustainable energy and climate plans, SECAPs, are developed." Within the scope of the output, a capacity building training series that continues throughout 2023 is planned for 20 observer municipalities selected from Türkiye.

With this training series, it is aimed to share the information that municipalities may need regarding the SECAP preparation and implementation processes, to prepare various studies with questions specific to the subjects, and thus to contribute to the preparation of the action plan.

Observer municipalities are encouraged to have their SECAPs ready by the end of the year. Another important issue in the trainings is to ensure that the important issues in the implementation and monitoring of climate actions are taken into account during the preparation of the action plan.

2. CAPACITY BUILDING TRAINING PROGRAM

The training program has been planned in such a way that each month will be dedicated to a topic related to SECAP and will be discussed with the municipalities after the trainings to be given by the experts of the subject.

In order to increase the effectiveness of the trainings and awareness of municipalities and also contribute to their energy transition plans 2 workshops and 1 site visit are also planned.

The training topics specific to each month are planned as shown in Table 1.

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Table 1: Capacity Building Training Subjects

No	Month	Training Subject
1	March	Introduction to SECAP (SECAP structure and content)
2	April	Preparation of Baseline Emissions Inventory
3	May	Preparation of Risk and Vulnerability Assessment (Adaptation Actions)
4	June	Financial Planning and Financial Attraction Models (Budget Planning)
5	July	Mitigation Actions (Energy efficiency and renewable energy)
6	September	Energy Poverty
7	October	Targets and Scenarios
8	November	Monitoring and Reporting Actions

CAPACITY BUILDING ACTION PLAN for OBSERVER MUNICIPALITIES 2023																
ACTIONS	EVENT TYPE	KEY COORDINATOR	RESPONSIBLE KEY TOPIC EXPERT	DURATION	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23
Opening Meeting of Observer Municipality Strategy Implementation	Online	Gizem Mataraci	Project Team	2 hours		20th										
SECAP Introduction month (contents, studies, structure etc)	Online	Gizem Mataraci	İpek Taşgın	2 hours			8th 21th									
BEI preparation	Online	Gizem Mataraci	Prof. Dr. Sıddık Cindoruk	3 sessions				5th 12th 26th								
RVA preparation: Adaptation actions for Floods **RVA preparation: Adaptation actions for Biodiversity & Heat Islands**	Online	Gizem Mataraci	Prof. Dr. Tuncer Demir	3 sessions					3th 17th 31th							
WORKSHOP: SECAP Reporting & Monitoring Actions	Physical	Gizem Mataraci	JRC, ICLEI, CDP	1 day						13th						
Finance plan and finance atraction models (Budget planning)	Online	Gizem Mataraci	Arūnas Gražulis	3 sessions						16th 23th 10th Jul						
Mitigation Actions: Energy Efficiency **Mitigation Actions: Renewable Energy**	Online	Gizem Mataraci	Prof. Dr. Tanay Sıdkı Uyar	3 sessions							18th 25th 10th Aug					
Site visit to IMM Biomethanization Plant	Physical	Gizem Mataraci	N/A	1 day												
Energy Poverty	Online	Gizem Mataraci	Arif Künar	2 sessions									6th 27th			
Targets and Scenarios	Online	Gizem Mataraci	Mindaugas Stonkus	2 sessions										18th 27th		
Climate Action Sessions- Marmara Urban Forum (MARUF)	Physical	Gizem Mataraci	N/A	2 hours										4-5th		
SECAP Reporting & Monitoring Actions	Online	Gizem Mataraci	Giulia Melica	2 sessions											8th 22nd	
Ceremony for delivery of Certificate / Award	Physical	Gizem Mataraci	Project Team	Half day												

Figure 1: Capacity Building Training Program for 2023

Training periods are determined specifically for the subject, and the issues needed for SECAP preparation are taken into account while preparing the content. Each training is given by an expert who has experience in the relevant subject.

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3. USE OF GOOGLE DRIVE

As part of the training program, Google Drive is used to share files with observer municipalities. Access to the files is granted by the project authorities to the relevant representatives from the municipalities.

Users can access all the details about the trainings through this platform.

The Google Drive folder tree is shown in Figure 2.

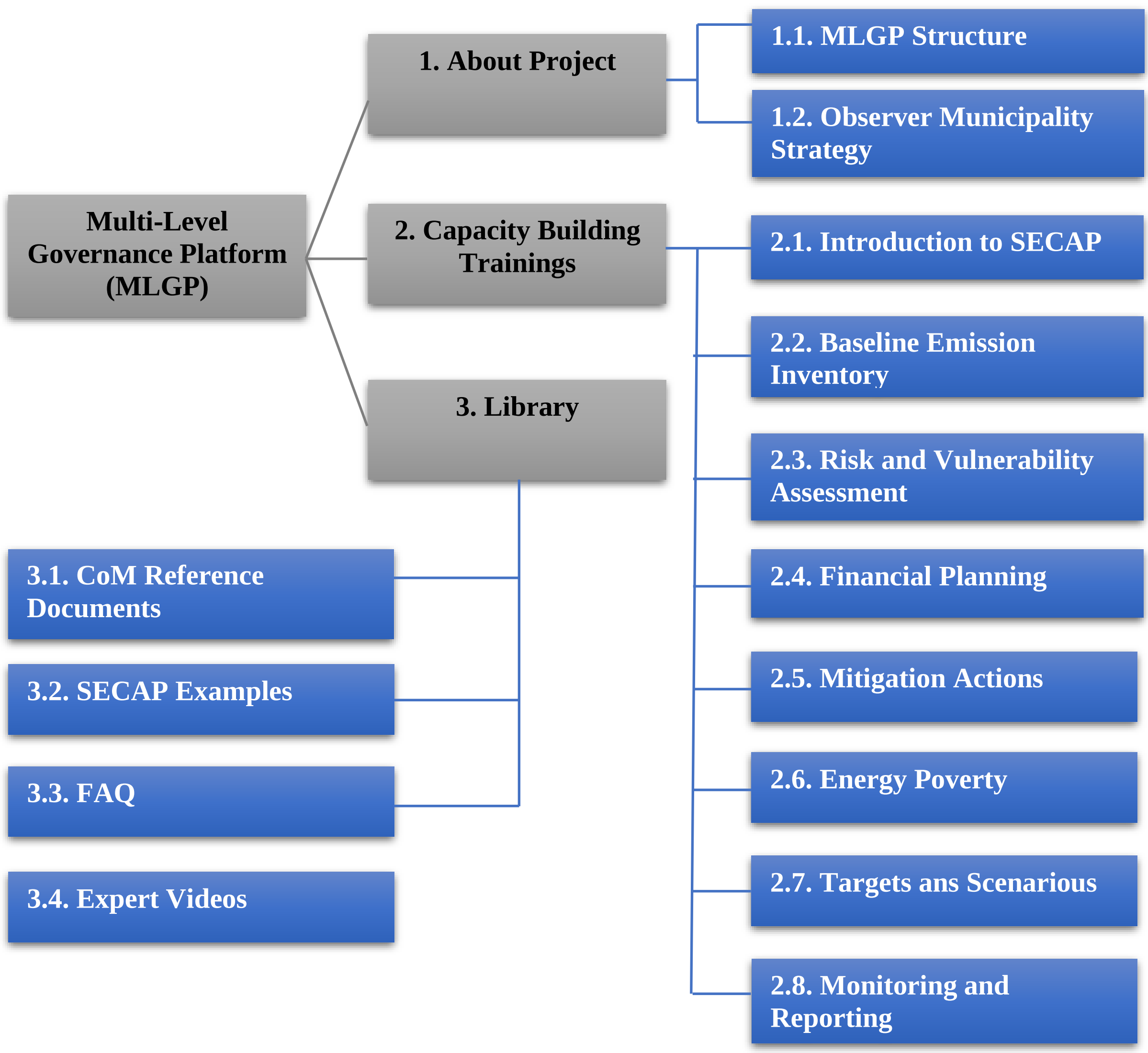

Figure 2: Google Drive Folder Tree

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Capacity building trainings are planned as part of the Multi-Level Governance Platform (MLGP) created within the scope of the project. That's why the main folder name in Google Drive is "Multi-Level Governance Platform". The number 1 folder shared under this folder is the “About Project” folder. In the About the project folder, information is given about both the MLGP and the observer municipality strategy.

Capacity building trainings were established in line with the observer municipality strategy.

The folder number 2 is the "Capacity Building Trainings" folder, under which there are folders for all training topics.

Under each training topic in the capacity building training folder, there are folders named Training Presentations, Training Video Records, End of Training Studies and Training Material. The sample folder tree is shown in Figure 3.

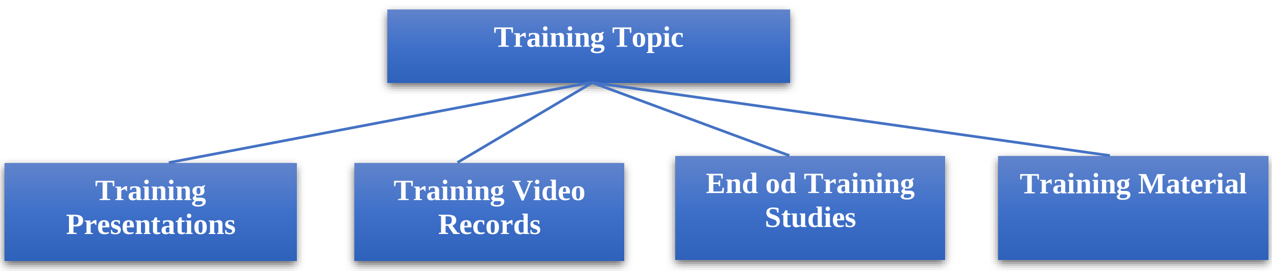

Figure 3: Training Topic-Specific Folder Tree

Presentations prepared by experts are shared in the "Training Presentations" folder after the training. Video recordings related to the training are added to the "Training Video Recordings" folder.

After the trainings, specific questions are shared, and the municipalities are given time to work on the subject. In the final training held approximately 1 week later, municipalities present their studies specific to the question, and the studies are evaluated in the presence of subject-specific experts and the expert's recommendations are taken.

The folder related to this process is the "End of Training Studies" folder, and the shared studies can be taken as an example between municipalities.

After the completion of the training, the relevant expert prepares training material that gathers all the knowledge, experience and sample applications on the subject. This material is added to the "Training Material" folder.

The 3rd folder is “Library”. Under this folder are “CoM Reference Documents”, “SECAP Examples”, “Frequently Asked Questions” and “Expert Videos”.

ANNEXES

Annex-1: Greenhouse Gas Emission Inventory (Baseline Emission Inventory) Training Material

Annex-2: Risk and Vulnerability Assessment Training Material

Annex-3: Financial Plan and Financial Attraction Models Training Material

Annex-4: SECAP Mitigation Actions Training Material

Annex-5: Energy Poverty Training Material

Annex-6: Targets & Scenarios Training Material

Annex 7: SECAP Reporting & Monitoring Training Material

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1

BASELINE EMISSION INVENTORY (BEI)

TRAINING MATERIAL

Prepared by:
Prof. Dr. S. Sıddık Cindoruk

PREPARATION OF BASIC EMISSIONS INVENTORY

EDUCATION NOTES

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CONTENTS

INDEX OF ICONS and ABBREVIATIONS

icons	Explanation
CFC	chlorofluorocarbon
CH_4	Methane
CO	carbon monoxide
CO_2	Carbon dioxide
CO_2e	carbon dioxide equivalent
d	Intensity
HFCs	Hydrofluorocarbons
gg	gigagram
kg	Kilogram
km	Kilometer
kVA	Kilovolt Amperes
	Kilowatt
kWh	Kilowatt hour
lt	Liter
m	Metre
m^3	cubic meters
MW	Megawatt
N_2O	nitrous oxide
O_2	Oxygen
PFCs	Perfluorocarbons
SF_6	Sulfur Hexafluoride
TJ	terajoule
°C	degrees Celsius

Abbreviations	Description
EU	European Union
UNFCCC	United Nations Framework Convention on Climate Change
CDM	Clean Development Mechanism
CE	Conformité Européenne
CER	Certification Emissions Reduction
RUBBISH	Conference of Parties
EF	Emission Factor
ERU	Emissions Reduction Units
MEAT	Emission Trading
PV	Activity Data
GHG	Greenhouse Gas
GWP	Global Warming Potential
IEA	International Energy Agency
ILO	International Labor Organization
IMO	International Maritime Organization
INDC	Intended Nationally Determined Contribution Determined Contribution)

INCH	Intergovernmental Negotiating Committee Negotiation Committee)
ISO	International Organization for Standardization Standards Organization)
IPCC	Intergovernmental Panel on Climate Change Change Panel)
THAT	Carbon Content
MODE	Global Warming Potential
KP	Kyoto Protocol
LPG	Liquid Petroleum Gas
NIR	National Inventory Report
NKD	Net Calorific Value
OECD	Organization for Economic Co-operation and Development (Organization for Economic Cooperation and Development)
UGH	Oxidation Factor
OTIM	Substance that Depletes the Ozone Layer
TSE	Turkish Standards Institute
TUIK	Turkish Statistical Institute
TÜRKAK	Turkish Accreditation Agency
UNDP	United Nations Development Program Development Program)
UNEP	United Nations Environment Program program)
UNFCCC	United Nations Framework Convention on Climate Change
GIVE	Voluntary Emission Reduction
WMO	World Meteorological Organization
DBEIS	Department for Business, Energy & Industrial Strategy
ICLEI	Sustainable Cities Association

1.INTRODUCTION

The history of humanity, which started about 2.5 million years ago, started fire about 750 thousand years ago.
used it consciously and started to live in colder regions in Asia and Europe by leaving Africa (Akın 2007). Man is a person on the environment he lives in.
On the one hand, while struggling for life, on the other hand, he struggled to know himself and to exist. The weakness of man against nature has manifested itself as both an obligation and harm in the use of natural resources. energy in human history.
agricultural and industrial revolutions. The steam that entered our lives with the industrial revolution
The rapidly increasing energy need of machines has increased the use of fossil fuels. This
environment with the release of greenhouse gas emissions into the atmosphere, which is a natural consequence of the situation. The seeds of carrying the pollution to the level of climate crisis have been planted. To get energy
The fuels used are wood, oil, coal, natural gas. produced by the combustion of these fuels.
Carbon dioxide, methane and nitrous oxides are defined as greenhouse gases and
are involved in warming.

The most important energy source of our world is the radiation emitted by the sun. To the world with my glow
The incoming energy is reflected back by the earth's surface. Natural in atmosphere during glow
This energy, which is absorbed to some extent by the gases found as
it warms up. This effect has a significant positive effect on the lives of living things.
The annual average surface temperature, which is the most important feature of our world, is vegetative.
and the guarantee of animal life (Happy 2014). However, the use of fossil fuels
The increase in greenhouse gas emissions due to the increase in greenhouse gases has caused the planet to warm up.
For this problem, the Paris Agreement under the Framework Convention on Climate Change
regulated and Türkiye as a scope 1 country, by signing the Kyoto protocol, greenhouse
He promised to reduce the gas to the level that was in the industrial revolution period. all this
These situations have brought new responsibilities to countries and the greenhouse gas inventory of local governments addressing the climate crisis on a regional basis by preparing climate change action plans.
Specifically, the step of seeking a solution within the scientific framework has been taken.

The aim of this study is to analyze the temperature increase, hurricane, tornado, which is expected to be related to the climate crisis. Adaptation to adverse effects such as sudden and severe weather events and water stress.
formulation of strategies. In the socioeconomic dimension, energy use is also

Greenhouse Gas in the ÿnegöl district of Bursa province in the geography of Turkey, where it varies

By doing inventory work, fixed resources, transportation, industry,

The amount of emissions originating from waste, agriculture and livestock has been determined. According to the resulting table

Greenhouse gas reduction strategies can be developed.

2. THEORETICAL FOUNDATIONS

2.1. Evaluation of Climate Change in Türkiye's Perspective

United Nations Framework Convention on Climate Change, adopted in 1992.
Climate change in the first article of the UNFCCC; "comparable time
In addition to the natural climate change observed in the
a condition that occurs in the climate as a result of human activities that disrupt the composition of the global atmosphere.
change" (Haksevenler et al. 2020).

Our country, which is an OECD member, became developed countries when the UNFCCC was adopted in 1992.
was included in the Annex-I and Annex-II lists of the Convention. in Marrakech in 2001
With resolution 26/CP.7 taken at the 7th Conference of the Parties (COP7) held in
different position of our country from other Annex-I Parties has been recognized. Thus, Turkey was removed from the Annex-II list of the UNFCCC, but remained on the Annex-I list. Our country joined the UNFCCC as the 189th Party on May 24, 2004 (Anonymous 2021).

Concrete reduction targets were set for Annex-I countries in the Kyoto Protocol for the UNFCCC, which was accepted in 1997 (Anonymous 2021). United Nations Climate Change
Turkey's accession to the Kyoto Protocol to the Framework Convention is appropriate.
The law on the existence of the law entered into force in 2009 (Anonymous 2009). acceptance of the protocol
Since we are not a party yet as of the date of its decision, in the period between 2008-2012,
No concrete reduction obligation has been mentioned for our country.

With the Paris Agreement adopted in 2015, the states for the period after 2020
obligations have been determined (Anonymous 2015). Türkiye signed the Paris Agreement in 2016.
signed and passed by the Turkish Grand National Assembly on 07.10.2021.

Türkiye, presenting the national contribution intent statement within the scope of the Paris Agreement,
Commit to reduce greenhouse gas emissions by 21%, effective between
has done. According to this ratio, which is defined as the increase-to-decrease ratio, Turkey's target is normal
21% of the greenhouse gas expected to be emitted by 2030 under these conditions.
(Anonymous 2015 a). Türkiye, in order to realize this goal; industry, energy,

plans and policies in the field of transport, buildings and urban transformation, agriculture, waste and forestry determined.

2.2. Greenhouse Gas Reduction Need

The global climate crisis has affected the most underdeveloped countries and the underdeveloped countries with high vulnerability.

will affect societies. In this context, as a person's environment in living conditions

The vulnerabilities in the ecosystem, which we can characterize, bring along high risks in societies that

develop living conditions depending on nature. For example, to agriculture

If we consider the section of society that lives with earnings based on

parameters such as yield, water stress, increased precipitation and frequency of drug use depending on its severity.

It creates loss grounds that cannot be covered by technology. Climate is an average temperature value

and this is a process that has been formed for thousands of years.

With the balance, the ecosystem can be lived with the diversity it creates within itself.

ensured balance. However, we are still looking at the direction of growth.

on the importance of restoring the balance that nature offers unconditionally.

According to climate scientists, a temperature increase of 2 °C will restore normal conditions in the climate system.

It is emphasized that there is a threshold value that will cause irreversible deterioration. This

No measures should be taken to ensure that the global emissions volume is not exceeded by 2050.

It is necessary to reduce 50% according to the situation that is foreseen to occur without

(Kumbaroÿlu et al. 2017). IPCC 1.5 °C report, latest in emissions

international trends and determined by national contributions under the Paris Agreement.

indicates a deviation from the ongoing path as a result of limiting the level of targets to warming below 2 °C. Increasing and urgent reduction efforts in the coming years will cause a sharp decrease in

greenhouse gas emissions by 2030. the next ten

Global warming will exceed 1.5 °C per year, which will return the most fragile ecosystems.

loss and recurrent crisis of the most vulnerable people and communities.

means exposure (Delmotte et al. 2019).

There is substantial evidence that global warming has major effects.

Melting of large glaciers and rising seas in parts of Antarctica

It affects some coastal areas and islands. The slaughter of nature and in some cases extinction of animals and loss of some plant species, serious epidemic The spread of diseases (scarlet fever, malaria) occur in high places and low places. extraordinary climate changes (droughts, floods and storms) originates (Majumdar et al. 2013).

Emission reduction in line with the Paris Agreement global fight against climate change, compliance, loss and damage, financing, technology transfer, capacity building, monitoring-review It has set out the basic rules about pass-transparency and compliance mechanisms. This method, called 'bottom-up', is the "Nationally Determined Contribution" It has been added to the Paris Agreement with the name of "Intentions" (INDCs) (Yeldan et al. 2016). Turkey Within the scope of INDC, 1.175 million tons of CO2 predicted in the base scenario in 2030 equivalent to 929 million tons of CO2 equivalent , with a 21% reduction in greenhouse gas emissions declared that it aims to download (Figure 1).

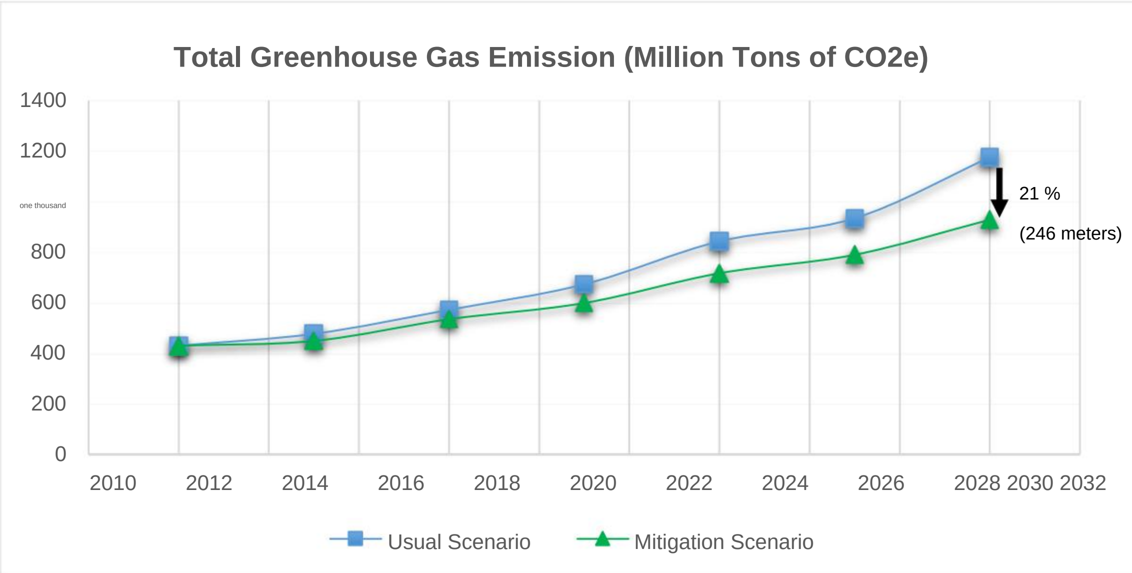


Figure 1. Nationally determined total greenhouse gas reduction contribution (Anonymous, 2015 a. Modified from Republic of Turkey Intended Nationally Determined Contribution.)

CO2 emissions from the residential and tertiary sectors have steadily increased over the past decade. increasing. While this is a cause for concern, emissions in national action plans This is an area that needs to be targeted for mitigation measures. Within the framework of the Kyoto Protocol According to the agreed targets, in the first commitment period (2008-2012) in developed countries

total emissions of six greenhouse gases (GHG) at least 5% below 1990 levels
should be reduced (Georgopoulou et al. 2005).

Greenhouse gas reduction is in question for residences and tertiary sectors (school, hospital, hotel..)
In this case, it can be achieved by producing solutions based on heating potential with a rate of 50%.
It is important in measures that save electricity. Residential and tertiary sectors
renewal of used boilers and replacement of diesel boilers with natural gas
It offers an effective solution to reduce the rate of exterior wall insulation, roof insulation, openings
sealing, the use of double-glazed windows, the use of low-energy light bulbs,
To list solutions such as the use of solar collectors for hot water, cogeneration
possible (Georgopoulou et al. 2005).

2.3 Energy Efficiency

Energy Efficiency, renewable energy sources and Greenhouse Gas Emissions Reducing are important strategic activities to achieve sustainability goals.
Energy efficiency for local governments, making a positive contribution to climate change
point is important.

Energy consumption per unit without causing a decrease in service and production quality.
reduction is called energy efficiency (Akça et al 2019). Population growth, prosperity due to reasons such as the increase in the level of energy consumption, industrialization and the use of technological devices.

Energy demand and energy consumption are increasing day by day. Urbanization and environmental problems the policies and practices followed, the sustainability of the ecosystem, the people today and are the most important determinants affecting their future environmental satisfaction (Atanur et al. arc. 2020).

Classification of energy is as primary and secondary energy sources. in nature
The original energy state found is called primary energy sources. These are coal, oil,
biomass consisting of natural gas, nuclear, water, solar energy, geothermal, wood and straw,
wind etc. In order to use primary energy sources, they must be converted to secondary energy sources (Uzun et al. 2018). Secondary energy sources are electrical energy, petroleum product fuels consist of steam, heat and compressed air (Akça et al. 2019).

Ensuring energy efficiency, energy supply security, preventing energy losses and waste,
to use effectively and efficiently, to reduce costs, to reduce energy imports, to reduce greenhouse gases
contribute to low carbon emission targets and protect the environment.
understood (Meral et al. 2009). Energy efficiency, from production to consumption
using the energy in the highest efficiency at the stages and without reducing the production
It is also defined as measures for energy use (Uzun et al. 2018).

For example, the import of incandescent lamps is prohibited in Lebanon. Akça et al. By 2019, energy
priority topics within the scope of efficiency; private sector to solar and wind energy
encouraging investment, installing solar water heaters in buildings,
implementation of effective and economical strategies in lighting the roads, wind
electricity generation from solar energy, electricity generation from sun, electricity generation from water, geothermal
and energy production from biomass, issuing energy efficiency certificates to buildings, financial
establishment of mechanisms, determination of insufficiency and overcapacity rates, energy
control is to encourage the use of energy-efficient equipment.

80% of carbon dioxide emissions and energy consumption are from activities in cities
originates. In 2008, the European Commission established what are known as the 20-20-20 targets.
He approved a plan titled "Energy for a Changing World". This plan has three purposes; EU
greenhouse gas emissions will decrease by 20%. Energy from EU renewable energy sources
will increase its production by 20% in the share of energy consumption. EU to increase energy efficiency by 20%
(Akça et al. 2019).

Considering the sectoral distribution of energy demand in Turkey; 30% of energy consumption
conversion facilities, 24% in the housing and service sectors, 23% in industry and 19%
It is used in transportation (Karakaya 2017).

To the National Energy Efficiency Action Plan being implemented from 2017 to 2023
according to; buildings and services, transport, energy, industry and technology, agriculture and horizontal subjects
As of 2023, with 55 actions defined in 6 categories, including
It is aimed to reduce energy consumption by 14% (Anonymous 2017).

Although our energy consumption per capita is lower than in developed countries,
Our energy intensity is still high. There is a significant amount of energy in Turkey.
shows potential for savings.

2.3.1. Building Structures and Services

According to the data obtained from the Turkish Statistical Institute, as of 2017 in Turkey
There are 9.1 million buildings. Approximately 87% of these buildings are residential.
nature. According to the statistics prepared for the building occupancy permit
Turkey's building stock is increasing, with more than 100,000 new buildings added annually. This
According to the results, new buildings being built should be more efficient and existing buildings should be
Significant energy savings can be achieved by improving Also building and
services sector, use of renewable energy sources and on-site production
also has an important potential in the fields of (Anonymous 2017).

In the Energy Efficiency Strategy Document, 'Energy demands of buildings and carbon
reduce their emissions; sustainable environment using renewable energy sources
under the strategic objective of 'disseminating friendly buildings'; 'Maximum to buildings
energy and maximum emission limitation' and 'carbon dioxide emission amount related
Administrative sanctions are imposed on those who exceed the minimum values defined in the legislation.
actions towards it are defined (Anonymous 2012).

2.3.2. Industry and Technology

The industry sector, which has a share of 26% in our Gross Domestic Product in 2015,
continues its trend, and as in many countries, growth is at the forefront in our country.
coming sector. Türkiye's economy is 'energy intensive' compared to developed countries
one of the economies. What can be done in the field of energy efficiency in the industrial sector
improvements as well as reduction of energy consumption, process efficiency, technological
It is also important for raising the level of development and reducing greenhouse gas emissions.
offers opportunities (Anonymous 2017).

With the Energy Efficiency Strategy Document, energy intensities in each industrial sub-sector Reduction of not less than 10% at the rates to be determined by industry collaborations targeted (Anonymous 2012).

2.3.3. Energy

The first power plant in our country was established in Tarsus on 15.09.1902 with a power of 2 kW. Electricity production started with a dynamo. The first large-scale generation of electrical energy was established in Istanbul on February 14, 1914, with Silahtaraÿa Thermal, our first large power plant. It was realized with the commissioning of the power plant (Anonymous 2019).

In recent years, with the increase in living standards and the increase in population in Turkey, The demand for electrical energy has increased significantly. Gross electrical energy demand 2016 increased by 3.3% compared to the previous year and reached 278.3 billion kWh in 2023. to 367.9 billion kWh or high demand according to the expected low demand scenario for According to the scenario, it is expected to reach up to 407.9 billion kWh (Anonymous 2017).

Different studies have been carried out for the targets set to increase the efficiency of the energy sector in Turkey. Accordingly, Climate Change Action
Total loss rates in the transmission and distribution network in the plan are above the OECD average. As of 2023, electricity distribution losses across the country in our country, which is above By reducing it to 8%, energy efficiency and electricity generation in all sectors There are different targets for increasing the share of renewable energy (Anonymous 2017).

2.3.4. Transportation

According to Turkey's 2015 data, approximately 25% of total energy consumption is transportation. occurred in the industry. 91.6% of this consumption belongs to road transportation. Highway Almost all of the energy consumption in transportation consists of petroleum products.

In order to create a sustainable transportation system in our country, the transportation infrastructure planning and operating in an integrated way, interconnection of modes of transport

integration, reducing the unit fuel consumption of vehicles and environmental
It is extremely important to develop policies and strategies that minimize the damage. This
In this context, it is one of the main documents dealing with the energy efficiency in transportation of our country.
With the Energy Efficiency Strategy Document, which is one of the
reducing consumption, using railways in freight and passenger transport and in urban
Increasing the share of public transportation and reducing unnecessary fuel consumption in urban transportation
It is aimed to prevent and reduce harmful emissions to the environment (Anonymous 2017).

Transportation in freight and passenger transportation with the Climate Change Action Plan 2011-2023
balanced use of urban transport modes, in line with the sustainable transport principles of urban transport.
restructuring, the use of alternative fuel and clean vehicle technologies
dissemination and increasing efficiency in energy consumption of the sector
is intended. In addition, by the Ministry of Transport, Maritime Affairs and Communications
Aiming to adapt information and communication technologies to the transportation sector, the National
Transportation in the Smart Transportation Systems Strategy Document (2014-2023) and Action Plan
There are measures for the sector (Anonymous 2017).

2.3.5. Agriculture

In order to create a competitive agricultural sector in Turkey, our physical potential,
Although effective use of our energy and resources is of great importance, land
regulation and consolidation, for raising the level of agricultural mechanization
dissemination of energy efficiency activities and renewable energy in agricultural applications.
the use of energy sources comes to the fore.
In order to increase energy efficiency in the agricultural sector, the use of tractors and combines
ensuring their renewal with their energy efficiency, using energy efficiently
switching to irrigation techniques, energy efficiency projects in the agricultural sector
supporting the use of renewable energy sources in agricultural production
biomass that can be obtained from agricultural by-products and wastes.
actions to reveal its potential and promote its use.
determined (Anonymous 2017).

2.3.6. Waste Management

As a result of various strategies applied to reduce solid waste, greenhouse gasses in the environment amount is increasing. Waste accounts for 3.5% of greenhouse gas emissions and anthropogenic sources account for 1/5 of all emissions worldwide is being considered. All greenhouse gas emissions from landfills It is said to account for 15% of gas emissions. Garbage due to increasing global population production is increasing, and the greenhouse gases produced also have low compliance rates with other sources. although it is increasing. As a result, one of the sources that needs to be reduced is the greenhouse. are gases. The contribution of waste-sourced greenhouse gases to global warming is becoming increasingly challenging. therefore, simultaneous greenhouse gas emissions from various sources and unique greenhouse gas emissions due to disposal, among other sources as a whole It must be taken into attention. CO_2, CH_4 and N_2O are major contributors to global warming. are the three most important greenhouse gases, and these three greenhouse gases are at many stages of waste storage processes. may occur (Demirarslan 2020).

Urban waste includes organic materials, especially food, paper, wood and garden waste. When these wastes are transported to landfills, bacteria begin to consume the carbon of the waste. starts. In addition, bacteria producing methane due to anaerobic conditions in landfills develops. These bacteria collect organic materials mainly methane (approx. 50%), CO_2 (approx. 50%) and small amounts of other gases (1% hydrogen, water vapor, H_2S, NH_3 aromatics, chlorinated organic compounds and VOC) into the landfill gas. Carbon-free greenhouse N_2O, one of the gases, is also a landfill gas formed during the processing of wastes. However It is stated that this gas is mostly caused by waste transportation and the amount depends on the load and appears to vary with distance. In addition, the work used in waste management greenhouse gas emissions occur from the machines and it has been mentioned in the literature that a diesel-fueled engine It is seen that it causes approximately 2.7 kg of CO_2/L emissions (Demirarslan 2020).

3. METHODOLOGY

3.1. Greenhouse Gas Calculation Methods

Greenhouse gas calculations are based on emission factors from IPCC 2006 documents. utilizing,

The expression of the global warming potential of greenhouse gases in terms of carbon dioxide gas called carbon dioxide equivalent (CO2e). As given in Equation 1, the greenhouse in question It is obtained by multiplying the mass of the gas with the global warming coefficient (GWP). greenhouse gas emissions, activity data (FV) (Fuel Consumption, Electricity Consumption, Amount of Fertilizer Used for Agricultural Fields, etc.) and Emission Factors (kilogram CO2e/activity) calculated by multiplying. Emission factors used in the calculations are given in Table 1. summarized. Greenhouse gas emissions as a result of wastewater activity, as stated by ICLEI calculated with formulations (ICLEI 2009).

$$CO_2 = Mass_{GHG} \times Global\ Warming\ Potential_{GHG} \quad (1)$$

$$GHG\ Emission_{(CO2)} = Activity\ Data\ (AD)\ x\ Emission\ Factor\ (EF) \quad (2)$$

$$LFG_{total}\ x\ CH_4\%\ x\ \{(1\text{-}DE) + [((1\text{-}CE)/CE)\ x\ (1\text{-}OX)]\}xConversion\ Factor\ x\ GWP \quad (3)$$

Here,

LFG collected : The amount of gas collected by the LFG system annually (m3),

CH4 %: The ratio of CH4 in LFG,

CE: LFG collection efficiency,

$\rho(CH_4)$: Methane density [g/m3],

DE: CH4 destruction efficiency,

OX: oxidation factor, 10-6 : g

= ton conversion coefficient,

GWP: Global Warming Coefficient (CH_4).

$$((P x Find\text{-}com) \times BOD_{5\ load}\ (1-F_p) x\ B_o x MCF_{anaerobic} 365.25 x 10^{-3}) x GWP \quad (4)$$

Here,

P: The total population served by the Wastewater Treatment Plant,

Find-com: In case of industrial and commercial waste discharge into the wastewater channel.

$BOD_{5\ load}$: The amount of BOD5 produced per person[kg BOD5 / person/day],

F_p: The ratio of BOD5 removed by pretreatment,

B_o: Maximum amount of CH4 production in wastewater[kg CH4/kg BOD5 removed],

$MCF_{anaerobic}$: CH4 correction factor for the anaerobic system.

365.25 Coefficient [day/year],

10^{-3} : ton conversion coefficient [metric ton/kg],

GWP : Global Warming Coefficient (CH_4) .

$$P_{tot} \times F_{ind\text{-}com} \times EF_{nit/denit} \times 10^{-6} \times GWP\ (N_2O\ Emissions) \quad (5)$$

Nitrification Denitrification

Here,

Ptot: Total population served by the Wastewater Treatment Plant,

Find-com: The case of industrial and commercial waste discharge into the wastewater channel,

EFnit/denit: Wastewater treatment plant emission factor with nitrification/denitrification [gN2O/person/year],

10-6 : Tone conversion coefficient

GWP: Expresses the Global Warming Coefficient (N2O) .

Table 1. Emission factors that can be used in calculations

Emission Factors (Kg CO2e/unit)					Reference
Fuel Emission Factors					
Fixed Resources	**Unit CO2**		**CH4**	**N2O Total kg CO2e**	(DBEIS, GHG emission factors 2020)
Liquid fuel	liter 3.17 0.01 3.19		0.01		
Diesel	liter 2.58 0.04 2.62 m3 0.003 0.002 2.030 kg 2.54				
Natural gas	0.002 2,544 kg 2.94 0.002 2.94				
LNG/CNG			0.004		
LPG			0.003		
Coal (Lignite)	T 2632.00 214.60 36.66 2883.26 2750.00 0.00 0.00				(DBEIS, Methane emission factor combustion
Methane	T	2750.00			equation 2020)
Hardboard	m3			113	(GHG Protocol)
Indirect Energy Sources					(National grid emission factor 2021)
Electric	kWh 0.571		0.001	0.002 0.574	
Mobile Resources					(IPCC, 2014)
Gasoline	Liter	2.22	0.026	0.07 2.31	
Diesel	liter	2.63	0.004	0.04 2.67 2.95	
LPG	kg	2.88	0.071 0		
Agricultural Activities Emission Factors (kg CO2e/unit)					
Agriculture Unit CO2 Total kg CO2e (IPCC, 2006 Vol 4, Ch,11 Table 11.1) 0.01 0.01					
Chemical fertilizers	ton				
farming	**Unit Enteric Fermentation Fertilizer Management**				(IPCC, 2006, TurkStat official communication, 2011)
cattle	Head	1712.50		400	
Horse	Head	450		40	
Mule	Head	250		22.5	
Donkey	Head	250		22.5	
Sheep	Head	125		4	
Goat	Head	125		4.25	
Chicken	qty n/a			0.45	
Turkey	qty n/a			0.45	
Duck	qty n/a			22.5	
Camel	Head	11150		47.5	
Pig	Head	11150		50	
Water Buffalo	Head	1375		50	

Emission factors used in inventory calculations are given in Table 2. Sources used in emission factors; IPCC: Intergovernmental Panel on Climate Change 2006, 2014 tables, DBEIS: Department of Business, Energy and Industrial Strategy

The 2020 tables refer to the GHG Protocol: GHG Protocol tables.

In the thesis study, the global warming potential values are shown in Table 3 of the IPCC 5. Calculated using evaluation report data. Global warming potential

value refers to the heat absorbed by the greenhouse gas in the atmosphere.

Table 2. Global warming potential values according to CO2 (modified from the IPCC 5th assessment report).

Greenhouse Gases		IPCC ASSESSMENT REPORT		
Formula	**Name**	Fifth Evaluation Report (AR5)	Fourth Evaluation Report (AR4)	Second Evaluation Report (EVIL)
CO2	Carbon dioxide	-	-	-
CH4	Methane	28	25	21
N2O	nitrousoxide	265	298	310
SF6	Sulfurhexafluoride	23,500	22,800	23,900
CF4	carbontetrafluoride	6.630	7,390	6,500
C2F6	hexaflorethane	11.100	12,200	9,200
CHF3	HFC-23	12,400	14,800	11,700
CH2F2	HFC-32	677	675	650
CH3F	HFC-41	116	92	150
C2HF5	HFC-125	3.170	3,500	2,800
C2H2F4	HFC-134	1.120	1,100	1,000
CH2FCF3	HFC-134a	1,300	1,430	1,300
C2H3F3	HFC-143	328	353	300
C2H4F3	HFC-143a	4,800	4,470	3,800
C2H4F2	HFC-152a	138	124	140
C3HF7	HFC-227ea	3,350	3,220	2,900
C3H2F6	HFC-236fa	8,060	9,810	6,300
C3H3F5	HFC-245ca	716	1,030	560
NF3	Nitrogentrifluoride	16,100	17,200	

Greenhouse gases are as seen in the table above, and each greenhouse gas contributes to global warming. potential value is different. Global warming value is calculated in CO2 equivalent. In the calculations, the effects of methane and nitrousoxide are expressed in CO2.

3.4. Greenhouse Gas Calculations

The tCO2e calculations made are classified under different headings of emission sources. evaluated. Groupings in international greenhouse gas classification standards as follows.

Scope 1 – direct greenhouse gas emissions: Organization owned or directly controlled Emissions from all fixed and mobile emission sources. owned, leased or finance leased assets are included in these resources. Scope The limit is all controllable emission sources.

Scope 2 – indirect energy greenhouse gas emissions: purchased for the organization's operations are emissions from energy. In this chapter, the mains electricity or heating/ other types of energy used for cooling should be included.

Scope 3 – other indirect greenhouse gas emissions: caused by the activities of the institution and GHG releases under its control, excluding indirect releases. These activities ahead or behind the core activities of the organization travel or sub-contractor activities (WRI 2014).

3.5. Carbon footprint

• An organization, event , greenhouse gas emissions caused by the product or person

is the name given to all.

• Greenhouse gas emissions include fuel and electricity use, production, transportation, transportation, service

due to reasons such as land acquisition and land use change.

a) Identifying emission sources and reducing emissions. b) To identify the risks arising from climate change and to take precautions.

c) To identify sustainable products and services.

1. Environmental Risks
2. Financial Risks
3. Regulatory Risks

d) Playing a leading role in the sector and increasing profitability with "Green Image", meet their demands.

e) To take measures for the future.

Greenhouse Gas emission reporting using internationally valid standards. calculation should be preferred.

Most used standards and reference documents:

1. ISO 14064 series
2. IPCC National GHG Inventory Guidelines
3. Sectoral studies with international validity
4. National/International Legislation and Implementation Guidelines

3.6. ISO 14064 Standards

TS EN ISO 14064 1 Greenhouse gases Part 1 of greenhouse gas emissions and their removal

Guidance and specifications for accounting and reporting at the enterprise level

TS EN ISO 14064 2 Greenhouse gases Part 2 Greenhouse gas emission reductions or

for the activities of calculating, monitoring and reporting removal improvements.
guide and features

TS EN ISO 14064 3: Greenhouse gases Part 3: Approval of greenhouse gas statements and

Guidance and specifications for verification

TS EN ISO 14065 Greenhouse gases in Accreditation or other mutual recognition forms

Requirements for organizations performing greenhouse gas validation and verification to use

TS ISO 140 6 6 Greenhouse gases Greenhouse gas validation kits and verification

Competency requirements for teams

3.7. ISO 14064-1 and Basic Terms

Design and development of greenhouse gas inventories at the enterprise or company level,

Provides detailed information on the principles and requirements for managing and reporting

The standard sets out greenhouse gas emission limits to improve greenhouse gas management.

determination of an organization's greenhouse gas emissions and removals

for calculation and identification of the company's specific measures or activities.

includes requirements. The standard also provides inventory quality management for verification activities,

includes requirements and guidance on reporting, internal auditing, and the organization's responsibilities

Greenhouse gas: In the spectrum range of infrared radiation by the earth, atmosphere and clouds

absorbed and emitted at certain wavelengths of the atmosphere, both natural and anthropogenic

gas component

Greenhouse gas source: A physical unit or process that releases greenhouse gases into the atmosphere

Greenhouse gas sink: Physical activity that removes any of the greenhouse gases from the atmosphere.

unit or process

Greenhouse gas reservoir: A greenhouse gas removed from the atmosphere by a greenhouse gas sink.

or a greenhouse gas captured from a greenhouse gas source into the biosphere, geosphere or

physical unit or component for the storage or deposition capacity of the hydrosphere

Greenhouse gas emission: The total amount of one of the greenhouse gases released into the atmosphere in a certain period of time.

mass

Greenhouse gas removal: The greenhouse gases that are removed from the atmosphere in a certain period of time.

one's total mass

Greenhouse gas emission or removal factor: Emissions of greenhouse gases or

factor related to activity data for removals

Direct greenhouse gas emission: greenhouse gas owned or controlled by an organization

greenhouse gas emissions from sources

Energy indirect greenhouse gas emission: Outsourced by an organization

greenhouse gas emission during the production of consumed electricity, heat or steam

Other indirect GHG emissions: Other than energy indirect GHG emissions, a

owned or controlled by other entities as a result of the entity's activities

greenhouse gas emissions from greenhouse gas sources

Greenhouse gas activity data: resulting in an emission or removal of a greenhouse gas

quantitative measure of activity

GHG statement: Statement made by the responsible party or a realistic or objective statement

GHG information system: To generate, manage and maintain GHG information

required policies, processes and procedures

Greenhouse gas inventory: Greenhouse gas sources, greenhouse gas sinks, greenhouse gas belonging to an organization

information on emissions and greenhouse gas removals

GHG project: GHG emission reductions or GHG removal

activity or activity that changes the conditions specified in the baseline scenario for improvements; or

activities

Greenhouse gas program: greenhouse gas emissions outside the organization or greenhouse gas project,

recording their removals, emission reductions or removal improvements,

voluntary or mandatory international, national or regional

system or plan

Greenhouse gas report: Information about an organization's or project's greenhouse gas independent document prepared to communicate to its users (Article 2 24)

Global warming potential (KIP): A specific greenhouse in a specific time period.

Define the mass-based radiant force effect of a gas in terms of equivalent carbon dioxide factor

Carbon dioxide equivalent: The radiant power of a greenhouse gas compared to carbon dioxide. unit used to compare

Base year: GHG emissions or removals or GHG related

a period in the past determined for future comparison of other information

Facility: Within a single geographic boundary, organizational unit, or production process

a single identifiable facility, set of facilities, or production processes (fixed or mobile)

Organization: Own business and management, partnered or not, public or

private company, firm, entrepreneur, institution or institution, or all or part of them

Responsible party: Responsible for filing the GHG declaration and providing GHG information

person or persons

Target user: defined by those reporting GHG-related information and

person or organization that relies on this information to provide

Customer: Person or organization requesting approval or verification.

Guided action: Directly or indirectly not organized as a greenhouse gas project

reduce or prevent greenhouse gas emissions or increase greenhouse gas removals

specific activity or enterprise practiced by an organization for

Trust level: Required by the target user for validation or verification

degree of confidence

Materiality/Materiality: One of errors, omissions and misunderstandings, or

which may affect the greenhouse gas statement and the decisions of the target users due to the concept

Fatal Error: In the greenhouse gas statement that may affect the decisions of the target users

(clause 2.12) one or all of the actual errors, omissions and misunderstandings Monitoring:

Monitoring of GHG emissions and removals or other GHG data

continuous or periodic evaluation.

Validation: Greenhouse in a GHG project plan according to accepted validation criteria

systematic, independent and documented process for the assessment of the gas claim

Confirmation criteria/Confirmation criteria: Reference for comparison of obtained evidence

policy, procedure, or condition used as

Validator: Responsible for preparing and reporting the results for approval,

authorized and independent person or persons (can also be used for organization)

Verification: GHG statement according to accepted verification criteria

systematic, independent and documented process for evaluation

Verifier: Responsible for the execution and reporting of the verification process,

(can also be used for enterprise)

Uncertainty: attributable to the assigned quantity and showing the distribution of values

parameter related to the result of the calculation.

Relevance: GHG sources, GHG sources suitable for the target user's needs

sinks, greenhouse gas reservoirs, data and methodologies are selected

Completeness: Includes all relevant greenhouse gas emissions and removals

Consistency: Allows meaningful comparison of GHG related information

Accuracy: Systematic errors and uncertainties are reduced as much as possible

Transparency: Allowing target users to make decisions with confidence

For this purpose, sufficient and appropriate information on greenhouse gases is disclosed.

The organization is responsible for the direct greenhouse gas emissions originating from the facilities within its borders.

and calculate their removal. produced, exported, or

direct greenhouse gas emissions from distributed electricity, heat and steam

may be reported separately, but they are derived from the organization's total direct greenhouse gas emissions.

should not fall. CO_2 emissions from the combustion of biomass are also

must be calculated.

Energy Indirect Greenhouse Gas Emissions

An organization is responsible for the electricity, heat or steam imported and consumed by it.

Calculate the greenhouse gas emissions generated in the production.

Other Indirect greenhouse gas emissions

The organization may address the applicable GHG program, internal reporting needs, or GHG

Calculate other indirect greenhouse gas emissions based on target use for inventory

Examples of Other Indirect GHG emissions

- Fugitive Emissions

ÿ Employees' commutes and business trips,

ÿ an organization's products, materials, employees, or waste

transport by the organization,

ÿ Income generating activities, manufacturing contracts and leasing,

ÿ Greenhouse resulting from waste produced by the organization but managed by another organization

gas emissions,

ÿ From the use and end of life of the organization's products and services

greenhouse gas emissions from the stages,

ÿ Energy products other than electricity, steam and heat consumed by the organization

greenhouse gas emissions from production and distribution,

ÿ Greenhouse resulting from the production of purchased raw materials or primary materials

gas emissions.

Hesaplama faktörleri için kademelerin tanımı:

Kademe	Açıklaması	Belirsizlik (Örnek)
Kademe 1	Referans belgelerdeki değerlerin kullanılması	%8-10
Kademe 2	Kullanılan yakıt/hammadde/ürüne özel referans verilerin kullanılması	%3-5
Kademe 3	Tesise özel verilerin kullanılması	%1-3

For activity data, the tiers are defined as uncertainty intervals.

Fuel Emission Factors and Fuel Mass Associated with Net Calorific Value (NCV)

Per NCV (IR Communiqué)

Yakıt Tipi	**Emisyon Faktörü ($t\ CO_2/TJ$)**	**Net Kalorifik Değer (TJ/Gg)**	**Kaynak**
Ham Petrol	73.3	42.3	IPCC 2006 Kılavuzu
Orimulsiyon	77.0	27.5	IPCC 2006 Kılavuzu
LNG	64.2	44.2	IPCC 2006 Kılavuzu
Benzin	69.3	44.3	IPCC 2006 Kılavuzu
Gazyağı	71.9	43.8	IPCC 2006 Kılavuzu
Şist Yağı	73.3	38.1	IPCC 2006 Kılavuzu
Motorin	74.1	43.0	IPCC 2006 Kılavuzu
Fuel Oil	77.4	40.4	IPCC 2006 Kılavuzu
Sıvılaştırılmış Petrol Gazları	63.1	47.3	IPCC 2006 Kılavuzu
Etan	61.6	46.4	IPCC 2006 Kılavuzu

Stoichiometric Emission for Process Emissions from Carbonate Decomposition

Factors (IR Communiqué)

Baking soda	Emission Factor [t *CO2 /* t Carbonate]
$CaCO_3$	0 .440
$MgCO_3$	0.522
Na_2CO_3	0.415
$BaCO_3$	0_ _23
Li 2C, Q 3,	0.596
K_2CO_3	0.318
$SrCO_3$	0.298
$NaHCO_3$	0.524
$FeCO_3$	0.380

3.8. ISO 14064 1: SAMPLE CALCULATION It

requires you to calculate the carbon footprint for a University:
1.Electricity use

2.Natural gas use (for heating and kitchens)
3. Voltage converters in the electrical control room 4.
Central air conditioning and cooling system 5. Air
conditioner, refrigerator and water dispensers in the facility
6. Fire protection system 7.
Emergency generators and water pumps 8.
Vehicles

ELECTRICITY USE Electricity

usage in 2013: 14,564,744 kWh Transmission and
Distribution Losses: Losses: 14.24% Average Emission
Factor 0,4603 kg CO2/ kWh
Emissions [t CO2] = FV
x EF FV : Activity Data (EF: Emission
Factor (kg) CO2 /kWh)

ELECTRICITY USE How to

Calculate Electricity Usage Emission Factor?

Energy Sources	Consumption (ton/1000 m3)	Emissions (GgCO2)
Coal	12.105.930	25,775
Lignite	47.120.306	31,084
Fuel Oil	573,534	1,774
Diesel	129,359	550
Natural gas	22,909,746	46,206
	Total	105,414.775

Electricity generation: 228,977 GWh (fossil renewable)
Average EF = 105.414,775 Gg CO 2 / 228.977 GWh = 0.4603
Gg CO2/GWh = 0.4603 kg CO2/kWh

NATURAL GAS CONSUMPTION

Months	Consumption (m3)	K factor	Final Total (m3)

Fireplace	375,846	0.945	355,340
February	369,874	0.953	352,359
March	310,548	0.954	296,258
April	55,698	0.944	52,604
May	20.109	0.934	18,778
June	19,854	0.919	18,239
July	15,879	0.903	14,344
August	13,547	0.892	12,085
September	19,896	0.889	17,684
October	25,002	0.898	22,441
November	225,369	0.913	205.673
December	390,698	0.932	364,188
		Total	1,729.993

K factor: To determine the actual amount of natural gas used at different pressures is the calculated coefficient.

Natural gas use in 2013: 1,729,933 m3

Natural Gas Average density: 0.78 kg / m 3

Natural Gas Oxidation factor: 1

Emissions [t CO2] = FV x EF x OF

FV : Activity Data (TJ, t or Nm3)

EF: Emission Factor (t CO 2 /TJ, t CO2 /t or tCO2 /Nm3)

OF: Oxidation Factor

ELECTRIC CONTROL ROOM

2013 SF6 charge amount: 1.5 kg

Emission amount = amount charged to the system

Emissions [t CO2] = FV x KIP

CENTRAL AIR CONDITIONING AND COOLING SYSTEM, AIR CONDITIONING, REFRIGERATOR AND WATER DISPENSERS

• Charge amount to chiller system: 3,5 kg (

• Emission amount = amount charged to the system

• There is no service information for air conditioners, refrigerators and water dispensers.

• Total charge of all devices (except chiller) = 100 kg (

• Assume that the annual emission amount of the cylinders is 1% of the total charge.

• R410a = 50% R 32 / 50% R125 mixture.

Emissions [t CO_2] = FV x KIP

FIRE PROTECTION SYSTEM

• There is no service information for the Fire Protection System. Total amount of charge = 515 kg (FM200)

• Assume that the annual emission amount of the cylinders is 1% of the total charge

• FM200 : Trade name of HFC 227ea gas.

Emissions [t CO_2] = FV x KIP

EMERGENCY GENERATORS AND WATER PUMPS

Diesel use in 2013: 4,500 liters

Diesel Average density: 0.85 kg / liter

Diesel Oxidation factor: 1

Emissions [t CO_2] = FV x EF x OF

FV : Activity Data (TJ, t or Nm^3

EF: Emission Factor (t CO_2 /TJ, t CO_2 /t or t CO_2 /Nm^3)

OF: Oxidation Factor

VEHICLES

Vehicles	diesel (Liter)	Gasoline (Liter)
Passenger Cars	150,225	14.145
Construction Machinery	32,698	-

Other	150	-
Total	183.073	14.145

Diesel Average density: 0.85 kg liter

Gasoline Average density: 0.78 kg liter

Oxidation factor: 1

Emissions [t CO2] = FV x EF x OF

FV : Activity Data (TJ, t or Nm 3

EF: Emission Factor (t CO2 /TJ, t CO2 /t or t CO2 /Nm3)

OF: Oxidation Factor

3.9. Greenhouse Gas Inventory Components Greenhouse gas emissions and removals

The establishment shall ensure that the following calculated points are at the facility and establishment level.

should be documented separately to:

- Direct greenhouse gas emissions for each greenhouse gas,
- Greenhouse gas removals,
- Energy indirect greenhouse gas emissions,
- Other indirect greenhouse gas emissions,
- Direct CO 2 emissions from the combustion of biomass.

The organization is responsible for other GHG emissions and removals, as appropriate.

should document their classes separately at the facility and establishment level.

The organization should use tonnes as the unit of measurement and determine the amount of each type of greenhouse gas appropriately.

It should convert to CO2 equivalent tons using (KIP)'s.

3.10. Selection and Determination of the Base Year

For comparison purposes or to meet GHG program requirements or to meet GHG program requirements, the organization

for other uses of the gas inventory, greenhouse gas emissions and

should set a baseline year in the past for their suspension. Adequate greenhouse gases from the past

If sufficient information is not available on emissions or removals, the organization

can use the first greenhouse gas inventory period as the year.

Emissions = Activity Data (FV) x Emission factor (EF)

ELECTRIC		scope 2	scope 3	
PV	14564744 kWh	emissions	loss/leakage	10.8
EF	0.00049223 t CO2 / kWh	7,169.17	774.27	

304801.9 total electrical energy produced in a year (GWh)
150032 Total emission amount of electricity generation for 2018 (1000 tons)
0.4922279 1000 tons of CO2 /. GWh
0.00049223 t CO2 / kWh
0.4922279 kg CO2 /kwh

NATURAL GAS

PV	1729993 Sm3		
EF			
CO2	56100 kg CO2 / TJ 3633649.617 kg CO2 1 kg CH4 / TJ		3,633.65 tons CO2
CH4	64.77093792 kg CH4 0.1 kg N2O / TJ 6.477093792		1,3601897 tons CO2-equivalent
N2O	kg N2O		1.93017395 tons CO2-equivalent
NKD	48 TJ/Gg	TJ / 1000 Tons	
intensity	0.78 kg / Sm3	total emissions 3,636.94	

E = FV x EF
1349394.54 kg natural gas
1.34939454 Gg = 1000 Tons

ELECTRICAL CONTROL ROOM

FV = E	1.5 kg SF6	35.85 tons of CO2-equivalent
MODE	23900	

AIR CONDITIONING COOLING
chiller

R134a	3.5 kg	4.55 tons of CO2-equivalent
MODE	1300	

Other

R410a	50% R32 + 50% R125		1,725 tons of CO2-equivalent	
	1 kg			
	R32	650	total	6,275
	R125	2800		
		1725		

FIRE

HFC-227ea	5.15 kg	14,935 tons of CO2-equivalent
MODE	2900	

DIESEL GENERATOR

diesel	4500 LT	
EF	74100 kg CO2 / TJ	
NKD	43 TJ/Gg	TJ / 1000 Tons
PV	0.003825 Gg	

Emissions 12,1875975 tons of CO2

VEHICLES

Diesel		
PV	183073	
EF	74100 kg CO_2 / TJ 43	
NKD	TJ /Gg	TJ / 1000 Tons
emissions	495.83 tons CO_2	
Gasoline		
PV	14145	
EF	69300 kg CO_2 / TJ	
NKD	44.3 TJ /Gg	TJ / 1000 Tons

Emissions 33.8715067 tons of CO_2

Total	529.70

carbon footprint chart		percent weight coverage
Electric	7169,17339	58.86 coverage 2
Electricity KK	774.270727	6.36 coverage 3
Natural gas	3636.93998	29.86 coverage 1
Electrical control room	35.85	0.29 coverage 3
Air conditioning cooling	6,275	0.05 coverage 3
fire Gen	14,935	0.12 coverage 3
+ Fire Pumps 12.1875975 Vehicles		0.10 coverage 1
529.698182		4.35 coverage 1
Total	12,179.33	

distribution of emissions by scopes percent		
		by weight
Scope 1	4178.82576	34.31
Scope 2	7169,17339	58.86
Scope 3	831.330727	6.83

The organization should consider the following when determining the base year:

a) the activity of the organization, a general single-year data, a multi-year average, or using representative data of the rounded average of the organization's base year greenhouse calculation of gas emissions and removals,

b) Availability of verifiable GHG emissions and removal data selection of a base year,

c) Announcement of the selection of the base year,

d) A greenhouse gas for the base year in accordance with the provisions of this standard. development of inventory.

The organization may change its base year, but the data for the year it re-determines should indicate the changes.

3.11. Greenhouse Gas Information Management

The organization should establish greenhouse gas information management procedures for: should continue:

a) Ensuring that it complies with the principles of this standard,

b) Ensuring consistency with the intended use of the greenhouse gas,

c) Continually and appropriately to ensure the accuracy and completeness of the GHG inventory making checks,

d) Identification of errors and omissions and their correction,

e) GHG inventory records, including information management activities documentation and archiving.

STORAGE OF DOCUMENTS AND RECORDS

The organization shall establish procedures for the retention of documents and records; and should continue.

The organization shall design the greenhouse gas inventory to facilitate verification, maintain and maintain documentation that supports the development and maintenance of should continue. Documentation held in written, electronic or other format, greenhouse gas inventory information management of the organization for the preservation of documents and records should be made in accordance with the procedures.

THE FOLLOWING IN THE ORGANIZATION'S GREENHOUSE GAS INFORMATION MANAGEMENT PROCEDURES MATTERS MUST BE CONSIDERED:

a) Authorization and authority of the persons responsible for the development of the greenhouse gas inventory determining and reviewing their responsibilities,

b) Identifying appropriate training for members of the inventory development team, implementation and review

c) Determining and reviewing the boundaries of the establishment,

d) Identification and review of greenhouse gas sources and sinks,

e) GHG activity data consistent with the intended use of the GHG inventory and GHG emission and removal factors. selection and review of methodologies,

f) Calculation to ensure consistency between multiple sites reviewing the application of methodologies,

g) use, maintenance and calibration of measuring equipment, if applicable;

h) Establishment and maintenance of a robust data collection system,

i) Regular accuracy checks,

j) Periodic internal audits and technical reviews,

k) Periodic review of opportunities to improve knowledge management processes. passing.

The organization shall verify the greenhouse gas inventory and participate in the greenhouse gas program. a greenhouse gas report to facilitate or inform external or internal users should prepare. GHG reports must be complete, consistent, accurate, relevant and transparent.

The organization must comply with the applicable GHG program requirements, internal reporting needs and the content of greenhouse gas reports, based on the needs of the target users of the report, It should determine its structure, public accessibility and publicity methods.

The organization submits a public greenhouse gas statement that purports to comply with this International Standard. independent third-party verification of this standard or the greenhouse gas statement It should make the greenhouse gas report prepared in accordance with the statement made available to the public.

If the organization's greenhouse gas statement has been independently verified, the verification statement should be given to target users.

The organization should consider and document the following issues when planning the greenhouse gas report.

should:

a) The organization's greenhouse gas policies, strategies or programs and applicable greenhouse gas

the aim and objectives of the report in the context of gas programs,

b) Intended use and intended users of the report

c) General and specific responsibilities in the preparation and submission of the report

d) Frequency of preparation of the report,

e) The time period for which the report is valid,

f) Format of the report,

g) Data and information to be included in the report,

h) Policy regarding the report's explainability and delivery methods.

3.12 Uncertainty Assessment

'Uncertainty' The random and systematic factors that characterize the distribution of the measured values.

expressed as a percentage, including the effect of

The values obtained by taking into account the asymmetry are 95% correct.

means the parameter that defines the monitored

emissions.

it depends.

Reliability of data ÿProximity to reality

• The results of the measurements may differ even if the same measuring device measures the same amount. This

The difference is due to the sensitivity of the devices, that is, the uncertainty.

Difference in measurement result ÿUNCERTAINTY

• Therefore, for the quality of emission data,

Uncertainty must be kept at a certain level.

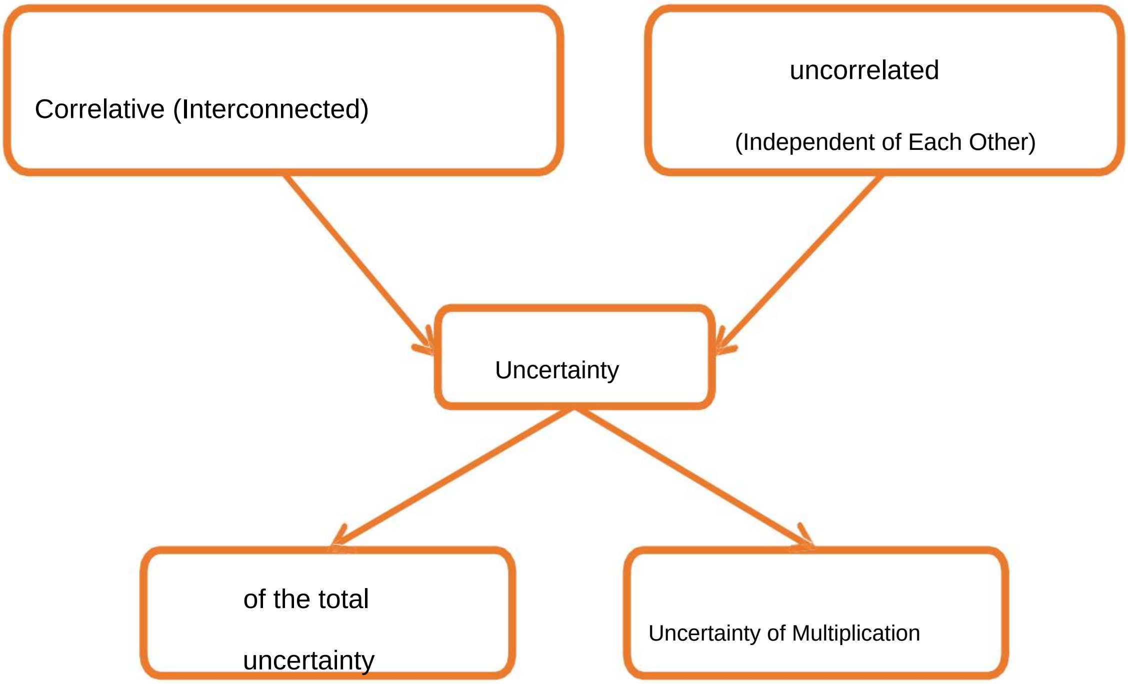
The quality of uncertainty

Activity/Source Stream Type	Uncertainty to be applied Parameter	Level 1	Level 2	Level3	Level4
Combustion of fuels and fuels used as process inputs					

commercial standard fuels	amount of fuel [t] or [Nm3]	± 7.5%	± 5%	±2.5%	±1.5%
Other gas & liquid fuels	amount of fuel [t] or [Nm3]	± 7.5%	± 5%	±2.5%	±1.5%
solid fuels	Fuel quantity [t]	± 7.5%	± 5%	±2.5%	±1.5%

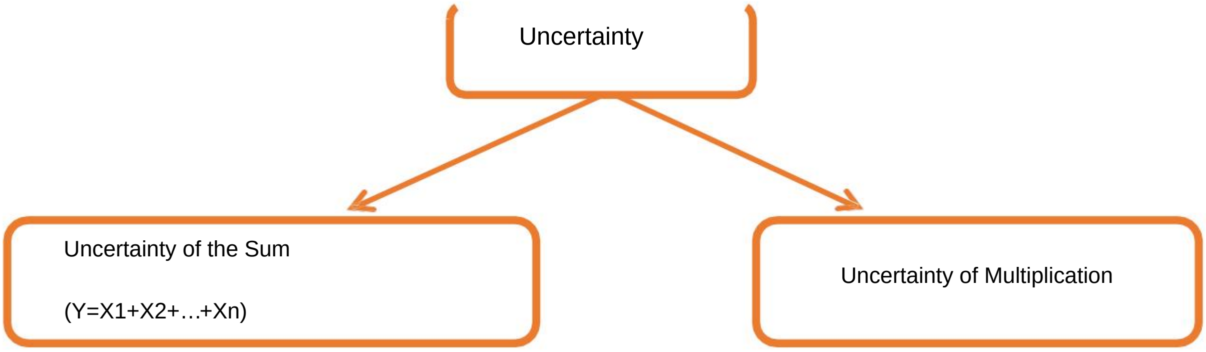
Achieved Uncertainty ÿ Level Required Uncertainty

The uncertainty assessment is summarized in the following diagram:



It is used to arrive at the overall uncertainty in national emissions and the trend in national emissions between the base year and the current year.

It is used to combine emission factor, activity data and other forecast parameter ranges by category and greenhouse gas.



$$U_{toplam} = \frac{\sqrt{(U_1 \cdot x_1)^2 + \cdots + (U_n \cdot x_n)^2}}{|x_1 + \cdots + x_n|} \qquad U_{toplam} = \sqrt{U_1^2 + \ \ldots + U_n^2}$$

Correlated Input Amount

$$U_{toplam} = U_1 + \cdots + U_n$$

Utotal=Percent uncertainty in the sum of the amounts (half the 95 percent confidence interval)

dividing by the sum (ie the mean) and expressed as a percentage). This "uncertainty"

The term is therefore based on a 95 percent confidence interval.

Ui, Xi= uncertain quantities and their associated percentage uncertainties, respectively.

Utotal=percentage of uncertainty in the product of the amounts (half the 95 percent confidence interval)

divided by the total and expressed as a percentage)

Ui = percentage of uncertainty associated with each of the quantities

Amount of *Uncorrelated Input*

EXAMPLE : A steam boiler using heating gas as fuel for the production of process steam

is being run. The heating gas used is supplied to the boiler by ten different pipes. of the gas

The amount is determined by ten flow meters. Annual heating gas for steam boiler

The uncertainty associated with the determination of consumption is calculated by the following formula:

$$U_{toplam} = \frac{\sqrt{(U_1 \cdot x_1)^2 + \cdots + (U_n \cdot x_n)^2}}{|x_1 + \cdots + x_n|} \qquad (Denklem\ 1)$$

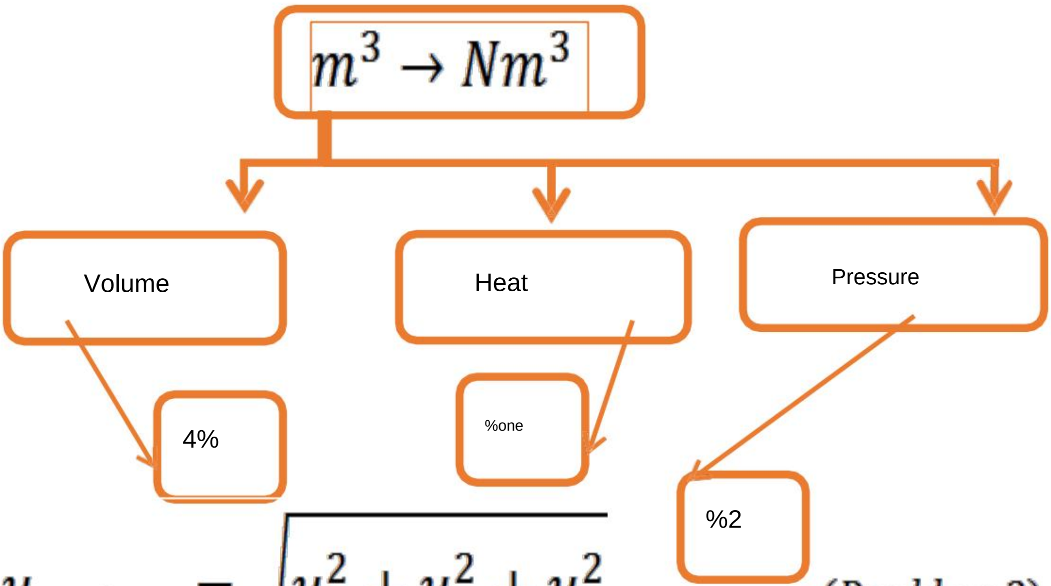
U_{toplam} = *Isıtma gazının belirlenmesi ile ilgili toplam belirsizlik*

x_i = *Farklı cihazlar tarafından ölçülen ısıtma gazı miktarı*

U_i = *Her bir ölçüm cihazının belirsizliği*

Amount of uncorrelated input + uncertainty of sum

Amount of uncorrelated input + Uncertainty of product



$$u_{toplam} = \sqrt{u_V^2 + u_T^2 + u_P^2} \qquad (Denklem\ 2)$$

$$U_{toplam} = \%4{,}58$$

It will occur if there is more than one measuring device used for natural gas measurement.

uncertainty calculation:

	Uncertainty	Source
Volume measurement	4%	Producer by determined features
temperature sensor	%one	
Pressure sensor	%2	

Amount of Correlated Input

Example: To determine the combustion loss, use the same scale before and after the combustion process.

the product is weighed. The uncertainty associated with the determination of the combustion loss is calculated by the equation below.

is calculated:

$$U_{toplam} = U_1 + U_2 \quad (Denklem\ 3)$$

$$U_{1,2} = Yanma\ öncesi\ ve\ sonrasındaki\ kütle\ ölçümündeki\ belirsizlik$$

$$U_{toplam} = Yanma\ kaybının\ tespiti\ ile\ ilgili\ toplam\ belirsizlik$$

Correlated input amount

One of the major resource flows of Tesis A.ÿ. is the coal resource flow. Coal entry to the facility

After this source flow is burned in two different boilers. Total at the entrance of the facility

There is no scale that measures the amount of coal, but there is a scale at the entrance of the boiler.

There is a total coal consumption of 250,000 tons at the facility.

Boiler 1: There is a consumption of 100,000 tons of coal per year.

• The uncertainty of the scale, in which the amount of coal used in this boiler is measured, is 1.5%.

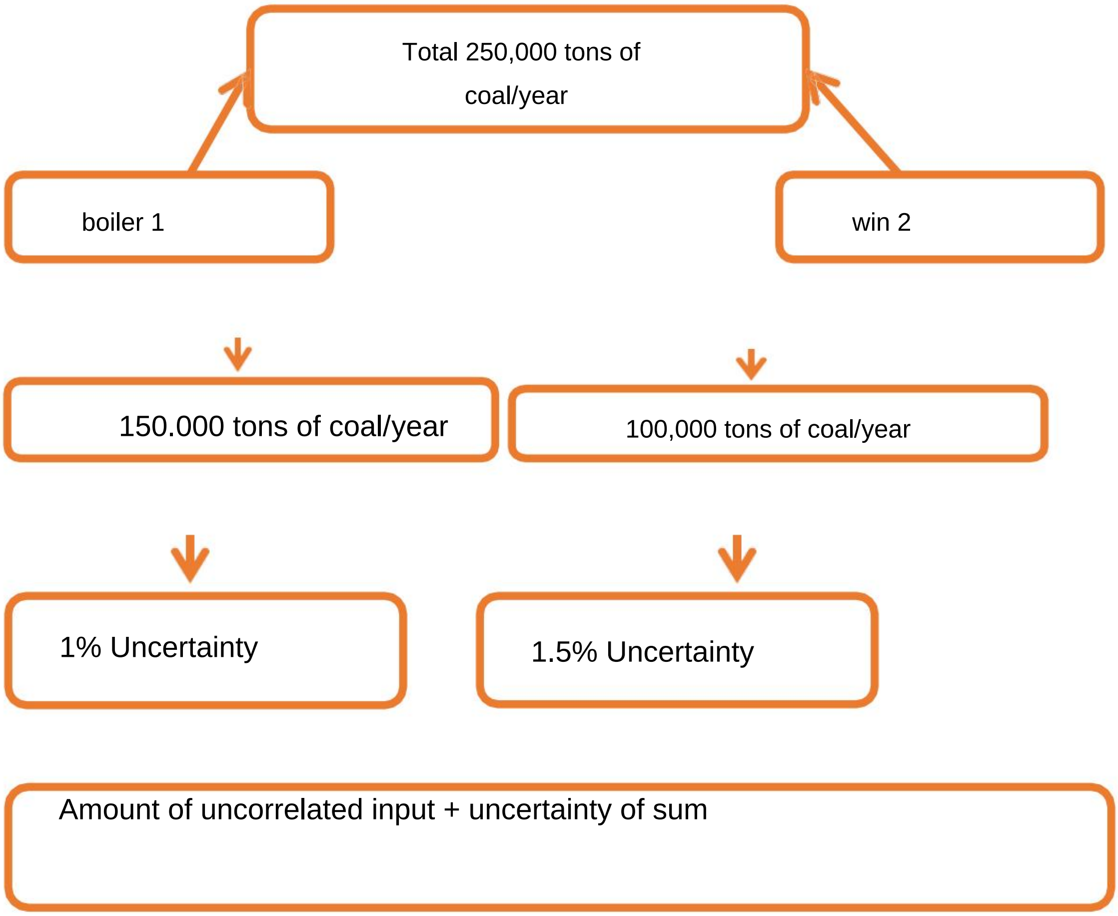
specified.

Boiler 2: There is a consumption of 150,000 tons of coal per year.

• The uncertainty of the scale, in which the amount of coal used in this boiler is measured, is 1%.

specified.

Determine the uncertainty of the coal resource flow based on the above information.



Amount of uncorrelated input + uncertainty of sum

$$\boxed{U_{toplam} = \frac{\sqrt{(U_1 \cdot x_1)^2 + \cdots + (U_n \cdot x_n)^2}}{|x_1 + \cdots + x_n|}} \quad (Denklem\ 1)$$

Ukantar,1 x_1 = 100,000

Ukantar,2 , *x2* = 150,000

$$\boxed{U_{toplam} = \frac{\sqrt{(U_{kantar,1} \cdot x_1)^2 + (U_{kantar,2} \cdot x_2)^2}}{|x_1 + x_2|}}$$

Utotal = 0.85%

x1 + x2= 250,000

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Calculation Period	Calculation Release Date	Calculation Revision No
2020	20.09.2022	00

Purpose:

To inform the Turkish national electricity grid emission factor calculated annually.

Scope:

This information sheet contains the calculated values of the Operating Margin-OM, Build Margin-BM and Combined Margin-CM Emission Factors for the relevant year.

Calculation Methodology: The

Clean Development Mechanism Tool 07-V07.0 method of the Intergovernmental Panel on Climate Change (IPCC) was used.

Data Set:

1. TEÿAÿ Turkey electricity generation-consumption and losses statistics, 2.
Electricity generation (1.A.1.ai) in the Common Reporting Format (CRF) tables prepared within the scope of Turkey's National Greenhouse Gas Inventory Report) emission values,

3. Commissioning dates of electricity generation plants in chronological order from TEÿAÿ Load Dispatch Department, plant names, fuel types, installed power values, electricity generation amounts for the calculated year,
4. Gold Standard (GS), Verified Carbon Standard (VCS) and Global Carbon Council (GCC) web addresses for voluntary carbon reduction certificate ownership and 5. Clean Development Mechanism (CDM) Tool 09-
Plant efficiency figures from V03.0 are used.

Electricity Network Emission Factor:

Factor Type	**year**	**Value (tCO2/MWh)**
Activity based margin emission factor	**2020**	**0.7424**
Development based margin emission factor	**2020**	**0.3680**

The activity-based margin and growth-based margin emission factor figures are used to calculate the combined margin emission factor.

Using the calculated activity-based margin and the development-based margin, **two different combined margin emission factors** are calculated for solar and wind power generation plants and other renewable power plants.

Factor Type	year	Value (tCO_2/MWh)
Combined margin emission factor (solar and wind)	**2020**	**0.6488**
Combined margin emission factor (other renewable)	**2020**	**0.5552**

Combined margin emission factors calculated according to the source type can be used in the greenhouse gas emission **(SGS) reduction calculations** to be provided by electricity generation from renewable energy .

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Legal Disclosure:

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Calculation Period	Calculation Release Date	Calculation Revision No
2020	09.08.2022	00

Purpose:

To inform the Turkish Electricity Production and Electricity Consumption Point Emission Factors calculated annually.

Scope: In this information form, Turkey General Electricity Production Emission Factors, Electricity Production Emission Factors for Power Plants by Fuel and Electricity Emission Factors by Consumption Point calculated for the relevant year are included.

Calculation Methodology:

Based on the methodology included in the "Database Documentation" of the International Energy Agency's "Emission Factors 2021" study.

Data Set:

1. TEÿAÿ Turkey electricity production-consumption and losses statistics, 2. Turkey's National Greenhouse Gas Inventory Report within the scope of the Common Reporting Format- Common Reporting Format (CRF) spreadsheets prepared by EVÇED only for electricity generation and combined- Emission values of electricity generation in heat power systems and

3. In order to calculate the emission intensity of imported electricity, the electricity generation emission intensity values of the countries published by the European Environment Agency (EEA) were used.

Electricity Generation Emission Factor:

Factor Type	**year**	**Value (tCO_2/MWh)**	**Value (tCO_2-eq./MWh)**
Türkiye in general Electricity Generation Emission Factors	2020	0.437	0.440

Turkey-General Electricity Generation Emission Factors represent the amount of total greenhouse gas emissions in terms of only CO_2 and CO_2 equivalents released per unit net electricity production on average by power plants in Turkey .

Factor Type	year	Fuel Type	Value (tCO2/MWh)	Value (tCO2-eq./MWh)
By Fuels for Power Plants Electricity Generation Emission Factors	2020	Lignite	1.274	1,279
		Coal	1.095	1,100
		Asphaltite	1.171	1,177
		Imported Coal	0.868	0.872
		Natural gas	0.371	0.376
		Fuel Oil	0.643	0.644
		Diesel	0.644	0.645

The Electricity Production Emission Factors by Fuel for Power Plants represent the amount of total greenhouse gas emissions from fossil fuel power plants in terms of only CO2 and CO2 equivalents released per unit net electricity production.

Electricity Consumption Point Emission Factors:

Factor Type	year	Value (tCO2/MWh)	Value (tCO2-eq./MWh)
Connected by Transmission Line Consumption Point Emission Factor	2020	0.444	0.447
From the Distribution Line Connected Consumption Point Emission Factor	2020	0.481	0.484

Electricity Consumption Point Emission Factors represent the amount of total greenhouse gas emissions in terms of only CO2 and CO2 equivalents released per unit electricity consumption for electricity consumption points connected to the transmission line and electricity consumption points connected to the distribution line. These factors can be used in carbon footprint and reduction calculations based on electricity consumption, which will vary depending on the connection point.

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COUNCIL

	DATA REQUESTED		Big city municipality	Affiliate 1	Affiliate 2	Affiliate 3	u Sewerage Administration	Affiliate 4	People buses room	vans room	drivers and automakers chamber of trades	EMRA	Teleferik AS
FUEL	**Static Burn**	*Fuel oil(liter)* *Diesel (liter)* *Natural gas (m3)* *LNG(m3)* *LPG (kg)* *coal (tons)* *coke coal (tons)*	x *(Support Service. data to be taken)*	x	x	x	x	x					
	Motion Incineration	**Vehicle fuel consumption** *gasoline (liter)* *Diesel (liter)*	x *(Data will be received from Support Service)*	x	x	x	x	x					
		Employee transportation surveys	x *(A transportation survey will be conducted for municipal employees)*	x	x	x	x	x					
		Public Transport *diesel (liter)*		x *(bus and BUDO data will be requested)*					x	x	x		
		Business flights *Domestic flights* *short-international* *long-intercontinental*	x *(Data will be taken from the protocol)*										
ELECTRIC	**Municipal Electricity Consumption**	*> Municipal units electricity consumption.* *> Street lighting and traffic lights* *> Loss-leakage*	x *(Municipal service buildings consumption SUPPORT Speed. Data will be retrieved*	x *(In addition to building consumption, metro and tram electricity consumption data will also be requested)*	x	x	x *(In addition to service buildings data wastewater treatment plants and water pumping stations electricity consumption data. will be requested)*	x				x *(Lighting and traffic light data available on site)* *There are also the percentages of lost and illegal Uludaÿ distribution.*	x *(Cable car electricity consumption data will be requested)*
LEAKAGE	**Fugitive Emissions Cement Calcination Emissions**	*> Municipal air conditioners > Cement Clinker ???*	x *(Municipal air conditioner inventory list pcs/ BTU/ kg gas type data Mali Service/ Support Service)*										

CITY

	DATA REQUESTED		EMRA	TurkStat	Big city municipality	Affiliate 1	Water Sewer	Provincial Directorate of Environment and Urbanization.	Provincial Directorate of Agriculture
FUEL	**Static Burn**	*Fuel oil(liter)* *Diesel (liter)* *Natural gas (m3)* *LNG-CNG(m3)* *LPG (kg)* *coal (tons)* *coke coal (tons)*	*x* *All data is available in EMRA annual reports and will be taken from the reports.*					x *Coal* *Data* *Province Environmental Status* *in their reports* *Available*	
	Motion Incineration	**Urban Vehicles** *Gasoline* *Diesel* *LPG*		*x* *The number of city vehicles can be obtained from the TUIK website (automobile, minibus, bus, truck, etc.).*					
		BUS STATION *Entry/ Exit* *Over 100 km Intercity carrying international passengers Under 100 km Intercity* *transiting* *Parking* *Number of free exit vehicles*				x			
		AVIATION *aviation fuel*	*x* *In the oil section of EMRA annual reports available.*						
ELECTRIC	**Kent Electric Consumption**	*Housing* *Commercial* *Industrial* *lost-leakage*	*x* *In the oil section of EMRA annual reports available.*						
	Urban Solid Waste	*>Regular Storage pitches* *>Rehabilitated pitches*			x *(Data available in the Department of Environmental Protection and Control)*				
	Urban Wastewater	*All treatment plants*					x *(List of treatment plants, populations they serve and data whether industrial wastewater is treated or not)*		
	Kent Agriculture	*Agriculture and land use*							x *(Data are available in the Annual Report of the Provincial Directorate of Agriculture*

NOTE: Vehicle fuel consumption (annual average), fuel economy (average of vehicles per 100km) fuel consumed) is accepted as in the old inventory. will be. data if needed from the relevant institutions.

Note: The detailed data to be requested are available in the inventory table. Details of intercity vehicles according to the number of seats

2

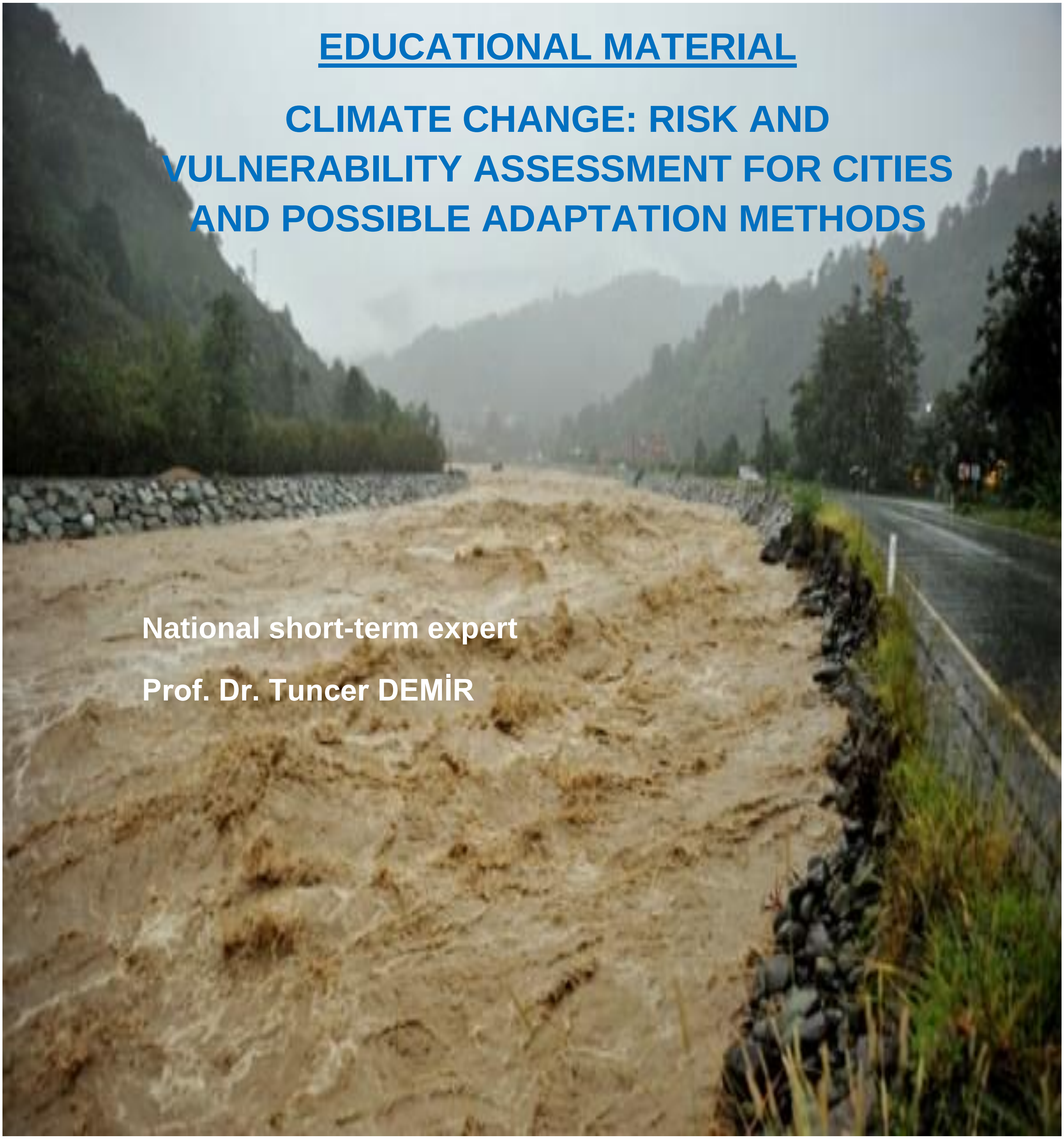
RISK AND VULNERABILITY ASSESSMENT (RVA)

TRAINING MATERIAL

Prepared by:
Prof. Dr. Tuncer Demir

Funded by the European Union

CPVA CENTRAL PROJECT MANAGEMENT AGENCY



EDUCATIONAL MATERIAL

CLIMATE CHANGE: RISK AND VULNERABILITY ASSESSMENT FOR CITIES AND POSSIBLE ADAPTATION METHODS

National short-term expert

Prof. Dr. Tuncer DEMİR

*The attached document titled "**Climate Change Risk and Vulnerability Assessment and Possible Adaptation Methods for Cities**" has been prepared as Training Material for Observer Municipalities receiving training within the scope of "**EU4 Energy Transition: Covenant of Mayors in the Western Balkans and Türkiye".***

The topics covered by the document and related adaptation actions are listed below. This document cannot be used or reproduced in any way for academic promotion, academic performance or commercial purposes. The references used in the preparation of this document have been referred as much as possible and the list of references are listed in the last pages of the document.

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ABBREVIATIONS

AFAD	Disaster and Emergency Management Presidency (DEMP)
BEI	Baseline Emission Inventory
CoM	Covenant of Mayors for Climate and Energy Initiative
EU	European Union
GCoM	Global Covenant of Mayors for Energy and Climate
GD	General Directorate
GHG	Greenhouse gas emission
IMM	Istanbul Metropolitan Municipality
JRC	Joint Research Center of EU
LULC	Land Use and Land Cover
MoEUCC	Ministry of Environment, Urbanization and Climate Change
MoTI	Ministry of Transport and Infrastructure
SECAP	Sustainable Energy and Climate Action Plan
RES	Renewable energy resources
TUİK	Turkish Statistics Institute
UHI	Urban Heat Island

1. INTRODUCTION

Currently, almost half of the world's population lives in cities, and it is estimated that this rate will reach 60% by 2030 and approximately two-thirds of the world's total population will live in cities by 2050. In parallel with this increase in the urban population, it is predicted that urban areas will grow even more (UN-Habitat, 2011: 17). According to the researches, it is estimated that there will be an increase of 1.2 million m2 in the surface area of urban areas between the years 2000-2030 (UN-Habitat, 2015a: 3). It is expected that the urban area will increase by 2.5 times between 2005 and 2030 due to the decrease in urban density, even in the cities of developed countries where population growth is slow. (UN-Habitat, 2012a: v) (Kaya, 2018).

the effects of climate change and rapid urbanization have currently become increasingly dangerous and have begun to threaten the future of humanity. Because cities, as settlement areas where population and economic activities are concentrated, have a very important share in anthropogenic greenhouse gas emissions. Therefore, cities are the areas most affected by the negative effects of climate change (Kaya, 2018).

According to UN-Habitat's Cities and Climate Change Report, the share of cities in greenhouse gas emissions caused by human activities is approximately 40% - 70% in calculations based on production; on the other hand, it is approximately 60% - 70% in calculations based on consumption (UN-Habitat, 2011: 16). On the other hand, the change in the area cover due to the increase in the amount of urban area changes the heat balance between the atmosphere and the surface. While the rate of areas covered with natural vegetation decreases, the rapid increase in the rates of reinforced concrete structures exacerbates the effects of climate change in many areas by increasing the temperature holding capacity of the surface many times over (Kaya, 2018).

The most important negative effects of climate change on cities can be listed as increasing temperatures and related heat waves, river floods, water insufficiency and drought, and sea level rise (Revi et al., 2014: 552-556; EC, 2013: 2; Balaban, 2012: 23). Although the effects of these negative factors will undoubtedly vary from one area to another, the effects of climate change will continue to be serious problems for the population living in cities (Kaya, 2018).

Cities are both the most important producer of greenhouse gas emissions that cause climate change and the places that suffer the most from climate change. However, due to the different special conditions of cities, the amount of greenhouse gas emissions released by each city and therefore its negative effects on climate change are also different. For this reason, the measures to be taken for greenhouse gas emissions should also be suitable for the special conditions of the cities. Because, even if there are similar effects due to climate change, the specific conditions of the cities can change the severity of the possible effects. In other words, city-specific conditions can create city-specific vulnerabilities; It can change the city's risk of exposure to danger, its sensitivity or its potential to combat danger (Kaya, 2018). For this reason, the first step to be taken in determining the measures to be taken locally should be to identify the city-specific vulnerabilities.

INFLUENCE OF CLIMATE CHANGE ON CITIES

Scientific studies have shown that from the beginning of the century to the present, there has been an increase of approximately 1 oC in global average temperatures due to human anthropogen-induced greenhouse gas emissions (IPCC, 2015: 2). According to the results of the Intergovernmental Panel on Climate Change, the average temperature of the world will increase by 2^0C at the end of the current century, and perhaps it will be above 4.5ºC according to the most pessimistic estimates (IPCC, 2015: 10). In addition, it is estimated that the global temperature increase will continue to increase for a while, even if the existing greenhouse gas emissions can be completely prevented. Depending on the changes that may occur in the climate parameters in parallel with this temperature increase, it is predicted that the existing negative effects in many areas of the earth will be experienced both more frequently and more severely. These effects;

− A tendency to increase in the number of hot days and nights, while a decrease in cool days and nights in summer

− Unexpected increases in the frequency and duration of heat waves

− Increase in the frequency and severity of extreme meteorological weather events

− Expansion of drought-affected areas on earth

- Increased frequency of tropical storms and hurricanes

− Sea level rises (UN-Habitat, 2011: iv, UN-Habitat, 2012b: 46-47).

Many studies on the negative effects of climate change on cities have revealed the fact that the risks associated with climate change are more pronounced and felt in urban areas (Kaya, 2018). The IPCC's 5th Assessment Report states that the risks arising from climate change in cities tend to increase day by day. Indeed, the unique conditions of the cities increase the severity of these effects, and the negative effects of climate change in cities are clearly seen in many areas from infrastructure services, public services, and ecosystem services, from areas where there is intense infrastructuring. This situation undoubtedly threatens the livelihoods of people living in cities and even causes mass migrations especially in the cities of underdeveloped and underdeveloped countries (Revi et al., 2014).

One of the most important problems caused by climate change in cities is the increase in the rate and duration of extreme temperatures. Excessive increase in temperatures, especially important health problems, significant decrease in labor productivity, effective use of public spaces and social life are restricted (UN-Habitat, 2012). High temperatures also damage the infrastructure of cities; It seriously destroys the transportation routes and causes disruptions in transportation. High temperatures and heat waves cause intense use of cooling devices such as air conditioners, especially in summer, increasing intense energy consumption. High temperatures also increase the intensive use of water, causing the problem of water shortage in cities. The decrease in air circulation and wind speed in cities in hot summer months causes air pollution and as a result, various respiratory system diseases occur in those living in cities and especially in the elderly population (Kaya, 2018). In particular, the disorganised urbanization areas, where the vegetation is removed to a significant extent, exacerbates the temperature increase with the urban heat island effect, which is frequently seen in the summer season.

Another negative effect of climate change on cities is the increase in flood and overflow events caused by heavy and sudden precipitation. Climate change causes flood and overflow risk in cities in four different ways. These; The flood risk that may occur due to heavy precipitation can be summarized as the flood risk that may occur due to both heavy precipitation and the early melting of the snow water, the flood risks affecting urban areas due to sewage and groundwater floods, and the flood risks due to coastal flooding as a result the rise in sea level and storms (Kaya, 2018).

Although floods are mostly included in the group of natural disasters, a significant part of the floods occurring in metropolitan cities with inadequate infrastructure and therefore unplanned urbanization are anthropogenic. In such cities, various factors such as impermeable surfaces such as asphalt and pavement, inapropriate construction in river floodplains, various structures that prevent the infiltration and direction of water flowing into the surface after precipitation, aging and inadequate sewer systems, and the mixing of rain water into the sewerage cause the risk of flooding to increase in cities (Kaya, 2018).

Floods are one of the leading disasters that cause the most life and economic loss in many cities of the world and especially in the cities of underdeveloped countries that have serious infrastructure problems. In such cities, floods due to the severity of sudden precipitation and snowmelt cause serious damage to all kinds of settlements, workplaces and public buildings, public areas, various roads and avenues, electricity, gas and water networks, as well as the loss of life reaching significant numbers. In addition, floods cause an increase in epidemic diseases (EEA, 2012: 36).

Another important effect of climate change on cities is drought and its inevitable result, water shortage. Water insufficiency has become more evident especially in the subtropical climate zone, which also includes the Mediterranean Basin. As a matter of fact, researches and related climate projections indicate that the total annual precipitation in the Mediterranean Basin will decrease by 25% towards the end of the current century. This will undoubtedly cause serious water scarcity and drought risk in the Mediterranean Basin countries, including Turkey (EEA, 2012: 55).

Climate change will lead to changes in precipitation regimes in many parts of the world, and a remarkable decrease in snowfall and a decrease in drinking water amounts. This will affect urban water resources in different ways. On the one hand, extreme temperatures will increase the amount of evaporation and cause water shortage, on the other hand, extreme temperatures will increase the need for water and water consumption in many sectors. As a matter of fact, even today, some cities such as Ankara, Istanbul, Paris and Athens meet their increasing water needs by transferring water from other regions (EEA, 2012: 57).

Controlling the impacts of climate change but increasing the resilience of human systems and ecosystems requires the development of nature-based solutions and an in-depth assessment of vulnerabilities and solutions. From this perspective, two basic concepts emerge: increasing the resilience of cities and society instead of implementing a circular economy. The more efficient a system's ability to protect and use its energy resources, the higher its adaptability and resilience to internal and external threats (such as climate change or other threats). A flexible approach always requires correctly defining spatial policies and taking into account vulnerabilities and multiple risk assessments in cities. Resistant and realistic solutions for adaptation to climate change only require a measurable socio-economic benefit using nature-based approaches. Therefore, compliance and risk management policies and practices are more successful if they take into account the dynamic nature of vulnerability and exposure in society.

Istanbul is one of Europe's most vulnerable coastal cities, according to scientific estimations. Istanbul and Izmir are ranked first and third, respectively, in an investigation conducted in 2016 by the Center for Climate Change in the Basque Country in Spain that ranked European coastal cities according to their risk factors.

Istanbul is one of the most climate change susceptible cities in Europe, according to the Istanbul Climate Change Action Plan Summary Report, hence adaptation efforts have higher priority therein. Turkey had one of its driest years in 2017. Events of heavy rain and hail that occurred in the same year's summer had an impact on the transportation system and significantly damaged homes and automobiles. Istanbul once again takes the top spot in a research measuring the potential economic harm caused by catastrophic weather events in 15 coastal cities in Europe.

The Mediterranean basin will reportedly become one of the climate change regions that is most vulnerable because of its location, length of its coastline, and human exposure, according to scientific predictions. Considering to this knowledge, Turkey's summers will be significantly hotter and drier than usual, particularly in Istanbul and other coastal and interior towns. Floods and overflows, drought, rising sea levels, the urban heat island effect, and issues with air quality are among the issues that could specifically affect Istanbul, according to research.

By the end of current century, it is anticipated that many Turkish cities' annual average temperature values would have increased even further. The urban heat island effect and potential heat waves will make the summer months the time when this increase will be most pronounced. On the other side, substantial drops in yearly total precipitation amounts are anticipated. Even if there is less precipitation, it is predicted that the precipitation will be more intense, which will result in flash floods. The Mediterranean Basin, where our nation is located, will experience the following effects of global climate change: higher average temperatures, wet and dry season drift, increased erosion rates, changes in annual precipitation, excessive evaporation, and mean sea level rise.

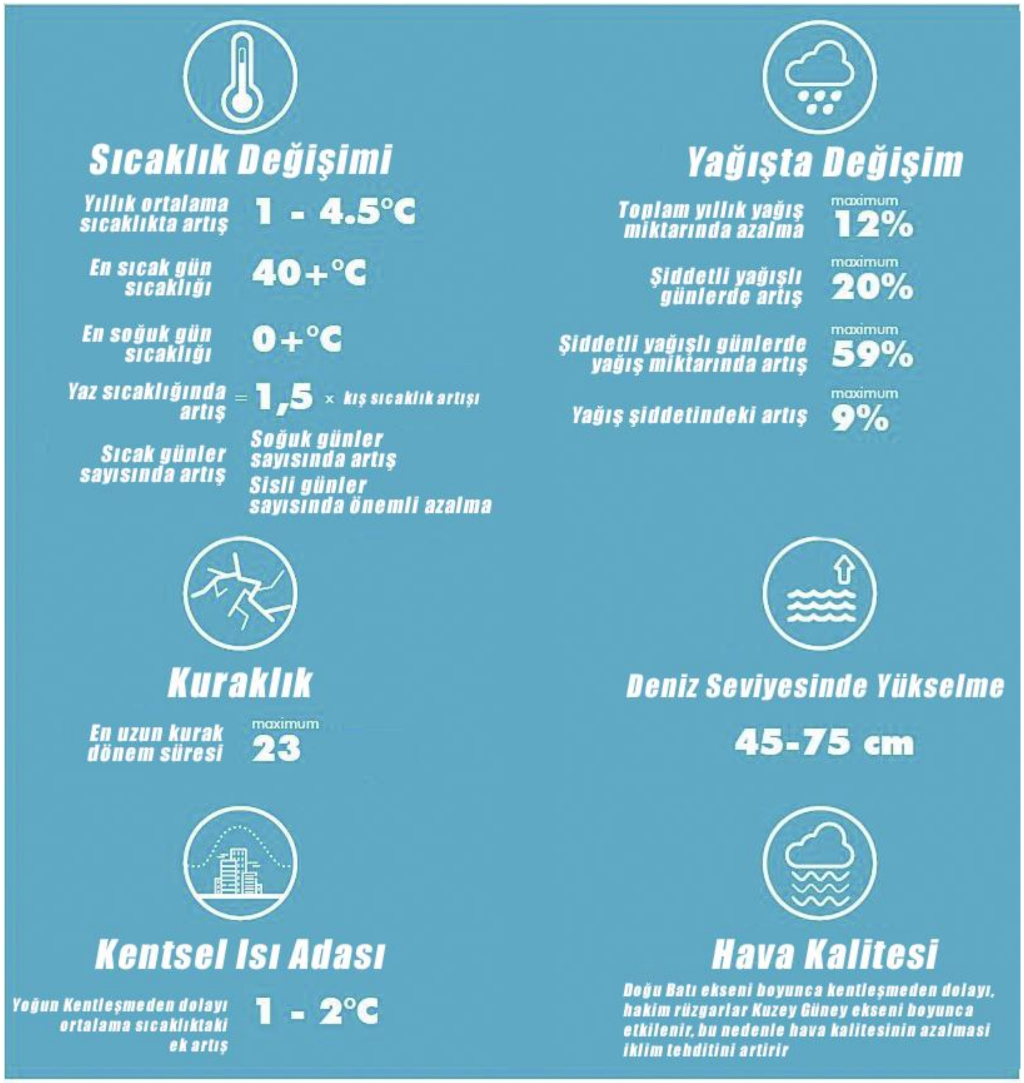

Figure 1. Expected climate changes (Source: Istanbul Climate Change Action Plan Summary Report, 2018)

2. RISK AND VULNERABILITY ASSESSMENT

2.1. InVEST Modelling Program

The InVEST model program is a free, open-source software model suite for modeling cities' ecosystem vulnerabilities, mapping and evaluating ecosystem services in order to make cities a more comfortable and sustainable place for people. The multi-purpose modular design feature of the InVEST modeling program has made it an important program used in different fields. lnVEST helps the decision makers to make quantitative evaluations in the areas where it is applied and provides advantages in establishing the planned regulations on more concrete foundations. Thus, this program assists in finding and processing input data and understanding and visualizing outputs as well as different ecosystem service models designed for terrestrial, freshwater, marine and coastal ecosystems.

InVEST models include spatial results that use maps as a source of information and produce maps for various purposes as output. Although InVEST models appear as a standalone application, mapping software such as QGIS or ArcGIS is needed to view the results.

Using the InVEST model, the districts or regions where risk factors such as habitat degradation, urban floods and overflows, coastal floods and heat island are concentrated are determined by using the InVEST model below.

Habitat Quality

The InVEST Habitat Quality model uses habitat quality and rarity as proxies to represent the biodiversity of a landscape, estimating the extent of habitat and vegetation types across a landscape and their state of degradation. The model combines maps of land use land cover (LULC) with data on threats to habitats and habitat response. Modeling habitat quality alongside ecosystem services enables users to compare spatial patterns and identify areas where conservation will most benefit natural systems and protect threatened species. This model does not attempt to place a monetary value on biodiversity.

Urban Flood Risk Mitigation

Flood hazard comes from different sources, including: riverine (or fluvial) flooding, stormwater (or urban) flooding, and coastal flooding. Natural infrastructure can play a role in each of these. Related to stormwater flooding - the focus of the InVEST flood risk mitigation model, natural infrastructure operates mainly by: reducing runoff production, slowing surface flows, and creating space for water (in floodplains or basins). The InVEST model calculates the runoff reduction, i.e. the amount of runoff retained per pixel compared to the storm volume. It also calculates, for each watershed, the potential economic damage by overlaying information on flood extent potential and built infrastructure.

Urban Cooling (Heat Islands)

Urban heat mitigation is a priority for many cities that have undergone heat waves in recent years. Vegetation can help reduce the urban heat island by providing shade, modifying the thermal properties of the urban fabric, and increasing cooling through evapotranspiration. This has consequences for the health and wellbeing of citizens through reduced mortality and morbidity, increased comfort and productivity, and reduced need for air conditioning. The InVEST urban cooling model calculates an index of heat mitigation based on shade, evapotranspiration, and albedo, as well as distance from cooling islands (e.g. parks).

Coastal Vulnerability

Sudden events of torrential rain represent one of the potentially most dangerous conditions for coastal cities worldwide. While climate change rapidly increases the frequency of extreme and sudden extreme meteorological events, it exposes coastal areas with high population and settlements to potential damages and dangerous situations. In addition, coastal cities established in places where the mountains behind the coast rise like a wall from the coast may be exposed to floods in a short time due to sudden heavy rains. In particular, urban settlements located on the densely populated Mediterranean coast are frequently exposed to catastrophic floods and overflows as a result of flooding caused by rivers originating from the mountainous areas behind the coast after heavy rains.

The InVEST Coastal Vulnerability model uses geophysical and natural habitat characteristics of coastal landscapes to compare their exposure to erosion and flooding in severe weather. When overlaid with data on coastal population density, the model's outputs can be used to identify where humans face higher risks of damage from storm waves and surge.

2.2. Determining the Vulnerabilities of Istanbul with the InVest Modeling Program

2.2.1. Urban Flood Risk

Cloudburst events represent one of the most potentially dangerous conditions for coastal cities worldwide. In fact, climate change is rapidly augmenting the number of extreme events while exposing the densely inhabited coastal areas to potential damages and dangerous situations. Besides, mountainous coastal cities have an idiosyncratic vulnerability to be flooded, which is intended as an urban system's propensity to be inundated during a cloudburst event. In particular, numerous high-dense Mediterranean urban areas are developed on hillside terrains along the coastline, on poorly hydraulically-conductible soils, with a limited capacity to drain the rainwater and a favorable terrain to create run-off streams.

The urban flood mitigation model represents one of the first explicitly designed tools for urban mapping vulnerabilities. The model assumes that flood-prone areas are impermeable material of artificial surfaces built upon low drainage soils. The model considers that the water on the impervious surface moves directly to the area next to it, contributing directly to a surface flow accumulation. The exact biophysical estimation of the run-off in urban land can be significantly difficult to compute since the discharge volume during a cloudburst can be affected by many factors (quantity, quality, and surface of buildings, sewer systems capacity, the presence of dust/leaves in the ground).

The output calculates the run-off retention index (i.e., the percentage of run-off retained per pixel compared to the storm volume) and, on the contrary, the millimeters of water that undergoes the run-off process. The land use classification was entirely built around the United States Department of Agriculture (USDA) classes, employing the Imperviousness High-Resolution Layer (HRL) database[1].

The model produced the following results in **Error! Reference source not found.** and in

Table 1. Biophysical output table with flow and retention parameters

Municipality	Ground Flow Retention index	Flow Retention Amount (m^3)	Flood Volume (m^3)
GÜNGÖREN	0,47	167.544,74	189.025,26
GAZİOSMANPAŞA	0,47	275.031,13	309.108,88
BAHÇELİEVLER	0,48	401.568,71	433.866,27

[1] available at https://land.copernicus.eu/pan-european/high-resolution-layers/imperviousness , accessed on 15 May 2021

Municipality	Ground Flow Retention index	Flow Retention Amount (m^3)	Flood Volume (m^3)
BAĞCILAR	0,48	541.186,74	580.393,29
BAYRAMPAŞA	0.49	233.403,03	243.621,98
ZEYTİNBURNU	0.50	286.003,21	287.821,79
BEYOĞLU	0.50	225.198,38	222.466,62
ESENYURT	0,51	1.088.888,44	1.061.571,56
FATİH	0,51	399.572,80	383.057,21
ŞİŞLİ	0,51	273.537,95	261.977,05
KAĞITHANE	0,52	382.310.33	355.644,66
ATAŞEHİR	0,54	681.554,97	585.855.00
ÜMRANİYE	0,58	1.321.758,88	976.626.08
KADIKÖY	0,58	724.623,56	524.831,35
KÜÇÜKÇEKMECE	0,58	1.053.886,50	760.718,50
ESENLER	0,62	574.877,20	347.547,75
KARTAL	0,64	1.224.243,58	701.261,35
BAKIRKÖY	0,64	939.189.31	533.975,57
ÜSKÜDAR	0,64	1.133.478,86	638.906.03
BEYLİKDÜZÜ	0,64	1.211.933,90	681.686.02
SULTANBEYLİ	0,65	947.628,96	499.655,96
AVCILAR	0,66	1.292.799,91	674.564,97
SULTANGAZİ	0,68	1.197.724,42	572.920,49
MALTEPE	0,68	1.792.470,73	855.469.15
BEŞİKTAŞ	0,68	609.686,47	289.503,50
BÜYÜKÇEKMECE	0,69	5.212.635,42	2.333.348,84
SANCAKTEPE	0,69	2.115.323,83	932.456.01
TUZLA	0.70	4.356.541,63	1.825.657,89
BAŞAKŞEHİR	0,71	3.718.184,67	1.519.539,93
PENDİK	0,75	6.774.635,01	2.220.049,43
ŞİL	0,78	85.90	24.10
ARNAVUTKÖY	0,79	16.937.233,61	4.480.634,38
EYÜPSULTAN	0.80	9.035.110,04	2.223.489,22
SİLİVRİ	0,81	34.511.597,12	8.002.120,32
SARIYER	0,83	7.251.436,96	1.534.392,70
ÇEKMEKÖY	0,83	6.213.852,90	1.228.301,83
BEYKOZ	0,85	13.097.619,74	2.364.439,61

The districts in Istanbul are listed according to their vulnerability level, the most vulnerable districts being Güngören and Gaziosmanpaşa.

In order to explain how the data **Error! Reference source not found.** should be read, Bağcılar district is t aken as an example. According to this data, Bagcilar district is the fourth most critical district in terms of run-off retention. According to the modelling output, only 48% of the rain volume (of a simulated single rain event of 50mm), can be retained by the soil. It means that most of the rain volume (52%) will undergo a run-off process. More specifically, the model calculated that in that specific flash flood event (50mm) the potential flood volume is of 580,393.29 m3. Then, to empirically measure if this results can be considered sustainable for the district, the discharge rainwater capacity of the channel in the district should be evaluated against the results to see if potential stormwater floods can occur during huge rain events in the city.

Shows the pluvial flooding vulnerability levels in Istanbul. A low score in a grid cell (darker shade on the map) means urban flooding risk in the cell is high relative to other cells. The streams are partially in seminatural condition in the northern areas, until they enter the densely and compact built-up catchment. From there, their pattern change: they are semi-channelized and only partially overlap with the natural stream water. The more an anthropic system alters the natural stream water path and the more can be considered vulnerable. In case of flash floods, if the anthropic system has a failure, the probability of huge inundations is high. While considering how to adapt the system to this specific problem (pluvial flooding), it is important to give priority to all those areas that present a huge vulnerability and then, once defined the critical areas for intervention, check whether streams or upstreams cross these areas according to the flow accumulation analysis.

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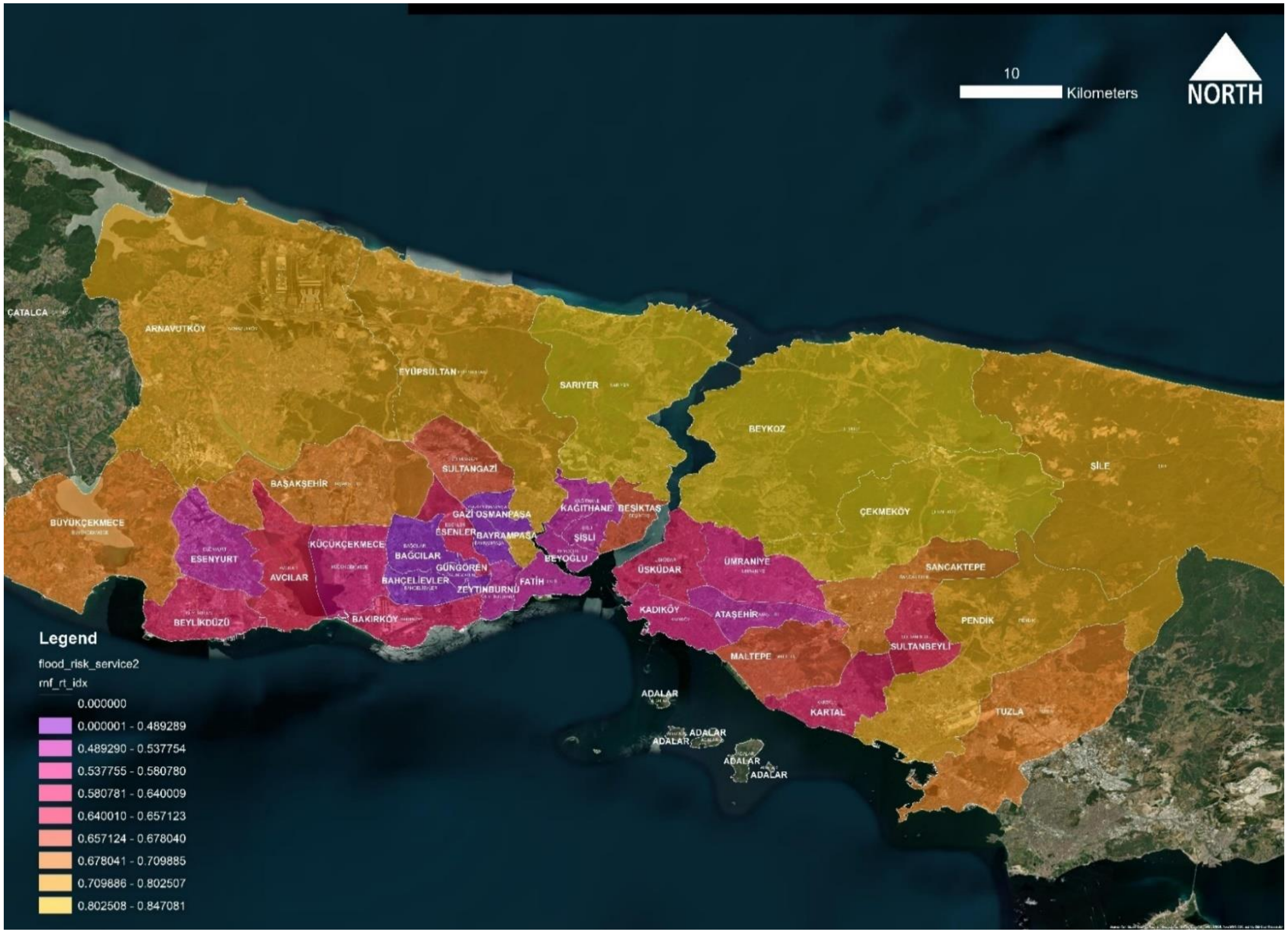

Figure 2. Flood Vulnerability Map of the City of Istanbul for Rivers According to the InVEST Model (The areas shown in reddish and purple indicate districts with high vulnerability).

2.2.2. Istanbul's Coastal Region Districts Flood Vulnerability Model

Faced with an intensification of human activities and a changing climate, coastal communities need to better understand how modifications of the biological and physical environment (i.e. direct and indirect removal of natural habitats for coastal development) can affect their exposure to storm-induced erosion and flooding (inundation). The InVEST Coastal Vulnerability model produces a qualitative estimate of such exposure in terms of a vulnerability index, differentiating areas with relatively high or low exposure to erosion and inundation during storms. By coupling these results with global population information, the model can show areas along a given coastline where humans are most vulnerable to storm waves and surge. The model does not consider coastal processes that are unique to a region, nor does it predict long- or short-term changes in shoreline position or configuration. The results provide a qualitative representation of coastal hazard risks rather than quantifying shoreline retreat or inundation limits.

The model computes the coastal exposure index. **Error! Reference source not found.** shows the final o utputs of the model.

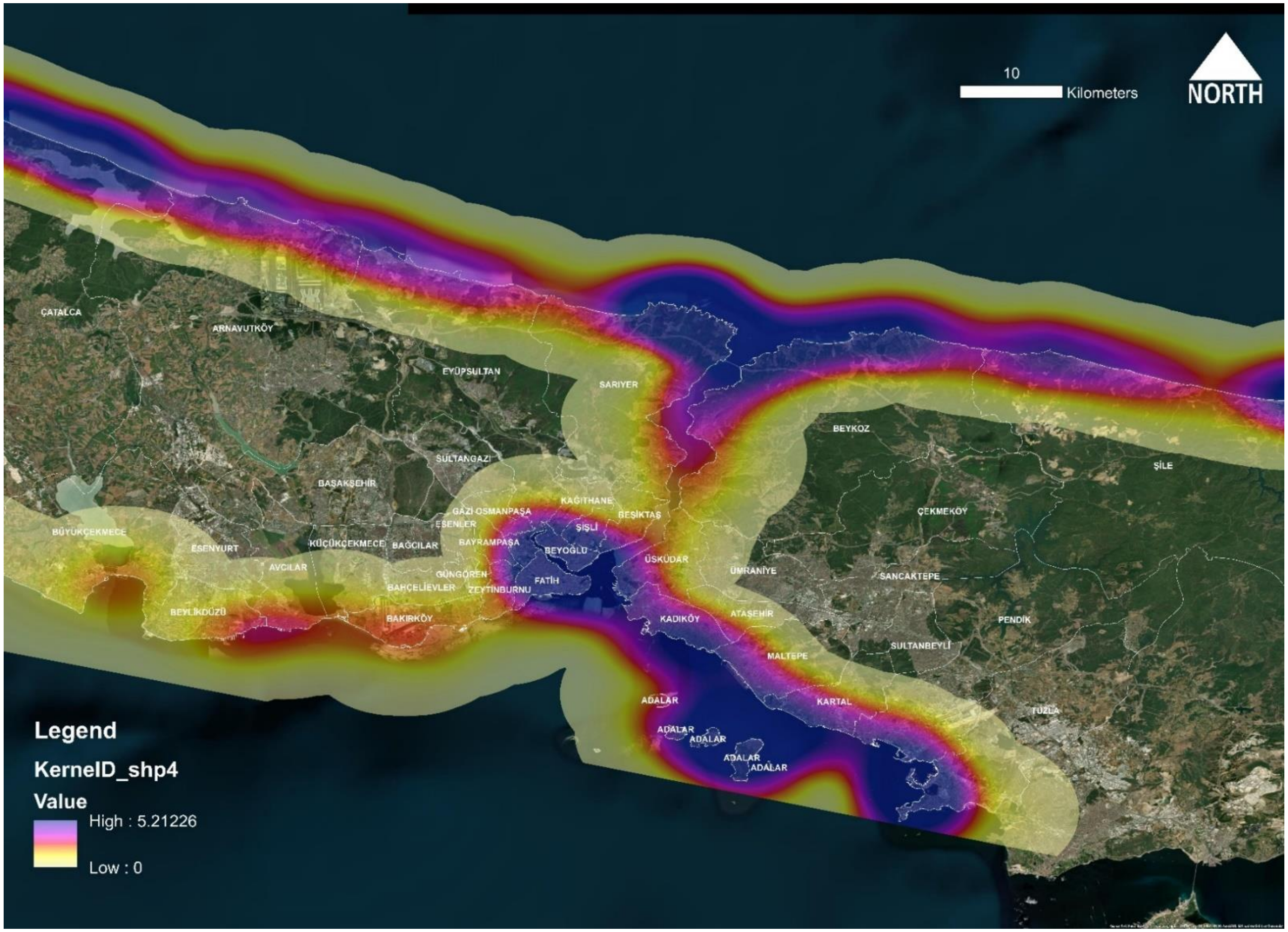

Figure 3. Coastal Vulnerability Mapping of Istanbul Cıty by InVEST Model

Istanbul has more than one type of coast. Two types of coasts can be seen, especially in Istanbul, divided into Ria and Lagoon-Port Coasts. The coastal type formed by the inundation of river valleys under sea water is called the Ria coastal type. It has the coast type of Istanbul-Canakkale Strait and Golden Horn Ria. On the map, the coasts in Sarıyer, Beykoz, and Beyoğlu, Fatih, Zeytinburnu, Üsküdar districts, which are places with the Ria coastal type, show high coastal vulnerability distribution with the effect of the Black Sea, but Beşiktaş, while the south-western part of Beykoz and the northern part of Üsküdar, located in either side of the middle of the Bosphorus show low coastal vulnerability. It has been examined that it does not contain as much vulnerability as the risks found in its environment. The reason for this is that, since it is between two lands, the salt water inflow is less compared to its surroundings, and the coastal vulnerability such as erosion and storm waves is less than the environment. Kadıköy, Maltepe, Kartal, Pendik and Tuzla coasts running parallel to Heybeliada, Adalar, Büyükada, Kınalıada and Golden Horn have coastal vulnerability due to factors such as wind, distance and depth of the Marmara Sea.

The other coastal type that is unique to Istanbul is coastal with Lagoon-Harbor. The coastal that are closed by the accumulation of waves in front of a cove is seen in Büyükçekmece and Küçükçekmece. Although these two coast types have less coastal vulnerability index than the other mentioned coast, the coastal vulnerability index is moderate. Considering the future climate change, Bakırköy, Küçükçekmece, especially Avcılar and Beylikdüzü may find themselves at a great coastal vulnerability risk in the future.

As for the coastal vulnerability, the sea level rise prediction of 75 cm has been used as a new input layer to map this specific vulnerability in the Istanbul metropolitan area. The model has been re-launched using only the scenario evaluation that considers the sea level rise hazard. Results indicate that two coastal hotspots will be threatened with higher intensity: all the Gold Corn coast, including the eastern coast facing the Bosphorus Strait, and the northern coastal areas of the Bosphorus Strait can be impacted by the seal level rise. Since the northern coast is less anthropized, the exposure of people, buildings and other aesthetic and historical values in this part of the metropolitan area is minimized. On the other hand, the extremely vulnerable situation due to sea-level rise in the city's most ancient, historical, dense and touristically attractive area represents a serious problem that should be faced by employing various technique of Adaptation through re-design and re-develop of the waterfront.

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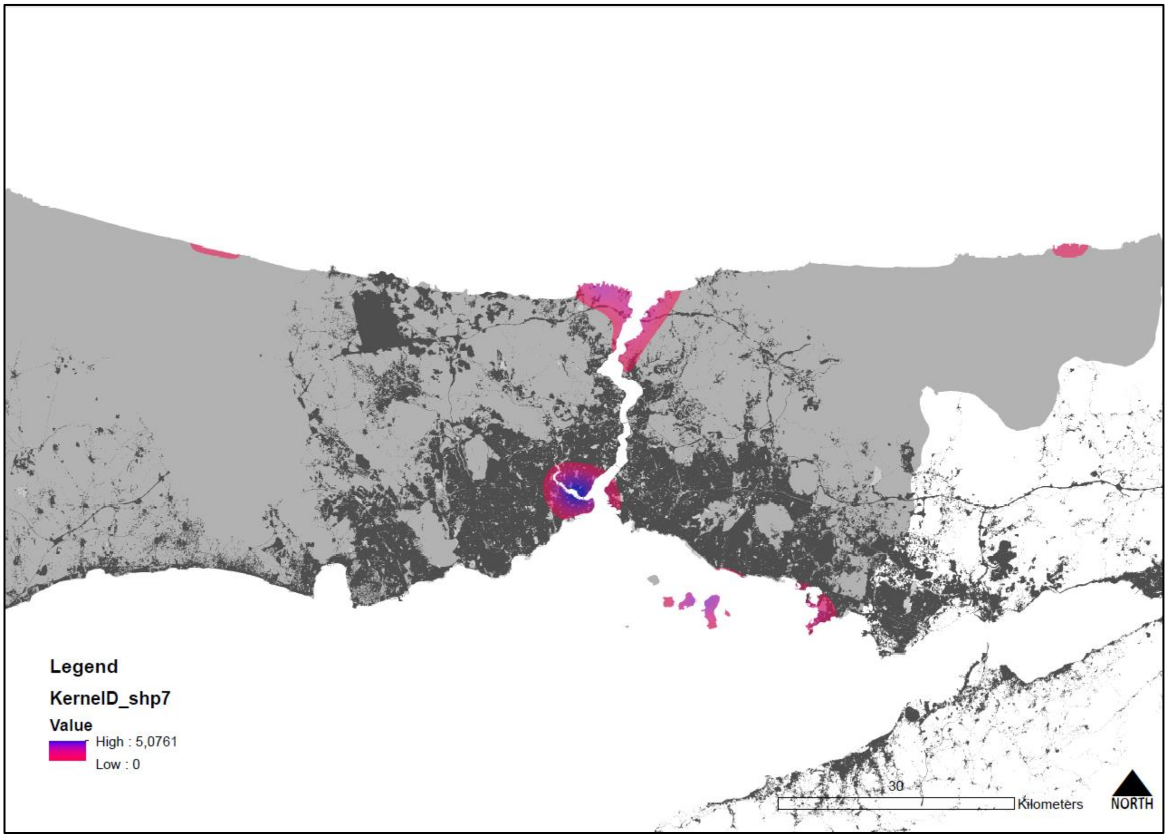

Figure 4. Sea Level Rise Vulnerability map

2.2.3. Habitat Quality

InVEST's habitat quality model combines information on land use and land cover (LULC) and biodiversity threats to create habitat quality maps. The habitat degradation section of the model shows the extent and configuration of natural land cover types in the current or potential future landscape relative to the extent of similar natural land cover types at some reference time.

The first step to modeling consisted on selecting the borders of Istanbul. Then, imperviousness data was selected as a threat to habitat quality and has been clipped according to the study area boundary. The land use data to be used in the Sensitivity table was downloaded from Copernicus.eu for 2018.

Using the zonal statistic as table tool, min, max and mean values of imperviousness were calculated for each land use class, and the database was then post-processed in excel. The relative values of imperviousness were used as a proxy for the evaluation of habitat values (e.g. if dense urban settlements are impervious at 80% it means their degree of naturalness is the opposite – 20% thus selecting 0.2 as the input value for the Habitat in the sensitivity table of InVEST model.

The model produced the relative level of habitat quality on the current landscape of Istanbul. Higher numbers (darker shade on the map) indicate better habitat quality vis-a-vis the distribution of habitat quality across the rest of the landscape. Areas on the landscape that are not habitats get a quality score of 0. This quality score is unitless and does not refer to any particular biodiversity measure. A high score in a grid cell (darker shade on the map) means habitat degradation in the cell is high relative to other cells. Grid cells with non-habitat land cover get a degradation score of 0.

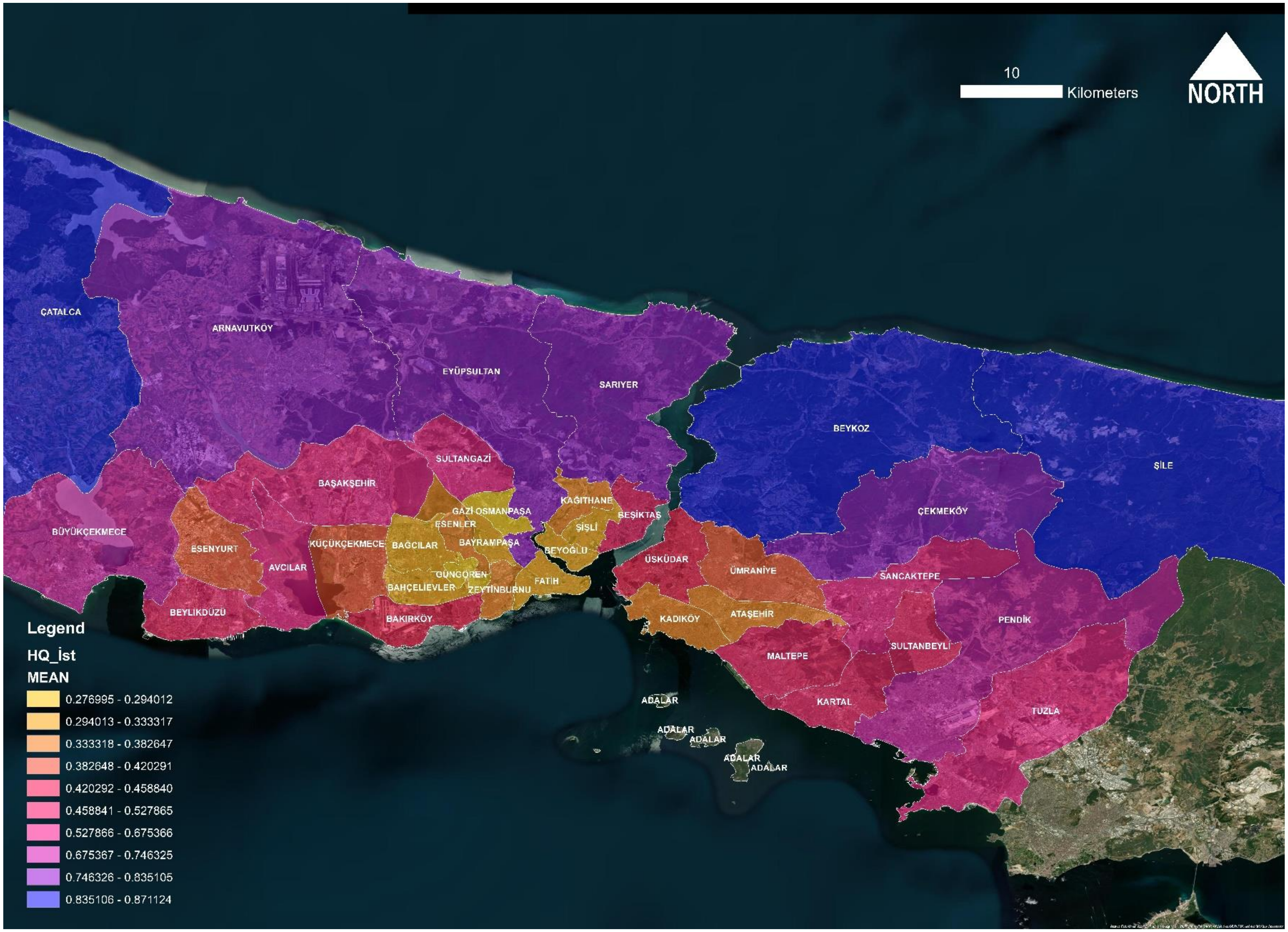

Figure 5. InVEST Modeli ile İstanbul İli Habitat Kalitesi Haritası

Figure 6. InVEST Modeli ile İstanbul İli Habitat Bozulma Alanları Haritası

The Habitat Quality output layers represent the biophysical spatial distribution of the potential biodiversity of İstanbul and the spatial distribution of threat values for the same catchment. The lowest habitat quality values; are continuous urban areas, discontinuous urban areas, construction areas, and industrial and commercial areas (with a value of 0.35). These areas are not susceptible to threats because they do not have any habitat value. Areas sensitive to threats; are broad-leaved forest, coniferous forest, mixed forest (with a value of 0.95), natural grasslands and transitional woodland shrubs (with a value of 0.85), pastures (with a value of 0.95), agricultural lands (with the value of 0.84). Since these areas contain high habitat values, they are the most sensitive land uses in the area.

In short, it is observed that there are no sensitive habitat values in the coastal areas of the province, namely Üsküdar, Kadıköy, Bakırköy, Avcılar, Zeytinburnu, Eminönü, Fatih, Bahçelievler, Güngören, Beyoğlu, Şişli, Beşiktaş, Sarıyer, Umraniye, Pendik, Kağıthane, Eyüp, Bağcılar and Bayrampaşa districts where urbanization is intense. and habitat quality values were observed to be 0.35 and below.

It is seen that habitat values increase, and sensitive land uses increase as you go from the coastal part to the northeast and northwest directions. In the north of Pendik and Tuzla districts, the habitat quality value is 0.85 and above. Habitat quality value is 0.78 and above in the north and northeast of the Beykoz district. In the northwest of Sarıyer district, the value is 0.85 and above. It has been observed that the values increase from 0.78 to 0.95 towards the outer borders of Eyüp district. In addition, Aydos Forest, which is surrounded by residential areas of Kartal, Pendik and Sultanbeyli districts, is one of the most sensitive areas in the middle of residential areas, with a value of 0.95.

The interaction between the habitats and the impervious surfaces shows how the distribution of habitat values is spatially clusterized in İstanbul province in Figure 5. The highest degradation value (with the value of 0.80) is observed around the previously mentioned Aydos forest, which is located in the northernmost part of Kartal district. It is clear how urban areas affect habitat quality and fragment the landscape (Figures 7 to 10). The white areas in Figure 5 clearly show how the quality of natural and seminatural areas decreases exponentially as they approach urban areas, emphasizing the ecological edge effect. Degradation values were also observed to be high around two large forest areas in Maltepe district, west of Aydos forest, with a value of 0.90. The sharpness of the edge effect and high degradation values were observed between urban areas and sensitive areas such as Alemdağ Forest, Polonezköy Nature Park, Sultançiftliği Taşlıtepe State Forest, 164th Yıl Police Memorial Forest, Istanbul Butterfly Farm in Beykoz and Ümraniye districts. Bentler Nature Park in Sarıyer district, Mehmet Akif Ersoy National Park, Ministry of Forestry Fatih Forest Recreation Area, Atatürk City Forest, Belgrad Forest, Kömürcü Bendi National Park and in Eyüpsultan district, Irmak Nature Park, Fatih Fountain Nature Park, Kurt Kemeri Recreation Area, Ayvat Bendi National Park, in The deterioration between sensitive areas (with degradation value is 0.008 and habitat quality value 0.95) and urban areas is clearly visible.

In short, habitat decay of İstanbul displays a lot of white colored areas which are not suitable for habitat Fragmentation and impermeability are concentrated in these areas while representing a barrier to the ecological continuity of the İstanbul province.

*Figure 7. Visualization of Habitat Degradation - A - Overview **

(*) Brown areas indicate the most vulnerable places for habitat degradation. These areas form the transition areas between the areas where the natural habitat has been completely disappeared due to intense urbanization (light colored areas) and the areas where the habitat is in a relatively good condition (green and light green).

Figure 8. Visualization of Habitat Decay – B - particular view, brown areas

Figure 9. Visualization of Habitat Decay -C- particular view, brown areas

Figure 10. Visualization of Habitat Decay (D particular view, brown areas)

2.2.4. Kentsel Isı Adası

The Urban Heat Island (UHI) phenomenon is mainly caused by the physical structure of the built environment, which absorbs solar radiation and releases more heat than the natural landscape. The urban microclimate is highly influenced by urban design due to the complex interactions between outdoor conditions (e.g., air temperature, humidity, wind speed, solar radiation) and the morphological parameters shaping cities (e.g., urban density, building form, roads, streets and canopies geometry, building orientation). The impacts of UHI include the citizens' health (particularly children and elderly) leading to respiratory and cardiovascular problems, dehydration, heat exhaustion, and potentially life-threatening heatstroke, more than exacerbating existing medical conditions such as heart and kidney disease.

In the future, the UHI effect will be one of the major challenges to be managed in urban areas; it can be reduced by making planning decisions oriented towards the performance-based design of public and private spaces, for example, ensuring the permeability and the reflectance of paved materials, or introducing densely green planted areas and vegetation which could increase the cooling process due to evapotranspiration and shading surfaces, while absorbing short-wave radiation.

For the modelling, reference air temperature was inputted as 30°C; the difference between the rural reference temperature and the maximum temperature observed in the city was inputted as 3.5°C. Where the average temperature anomaly is shown, the tangible effect on urban comfort provided by the peri-urban open spaces of the northern seminatural land of the city is visible. While obviously, the internal part of the densely inhabited system presents critical values, showing a low cooling capacity. The InVEST urban cooling model calculates an index of heat mitigation (HMI) based on shade, evapotranspiration, and albedo, as well as distance from cooling islands (e.g. parks). The index is used to estimate a temperature reduction by vegetation. is a map of the modelled HMI for Istanbul city, where the lighter colors show the cooling effect of green areas on temperature.

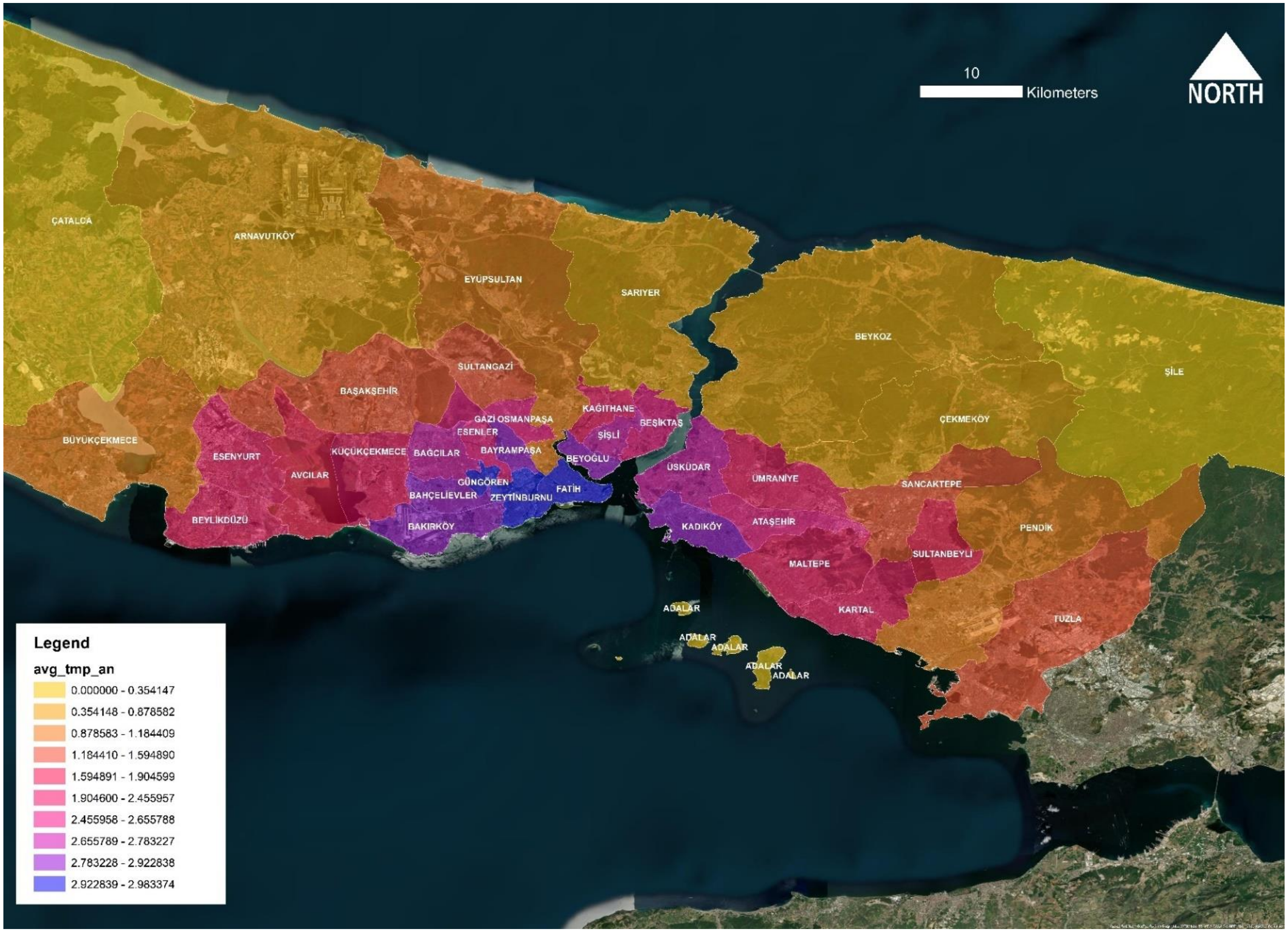

Figure 11. Average temperature anomaly of Istanbul Cıty by InVEST Model

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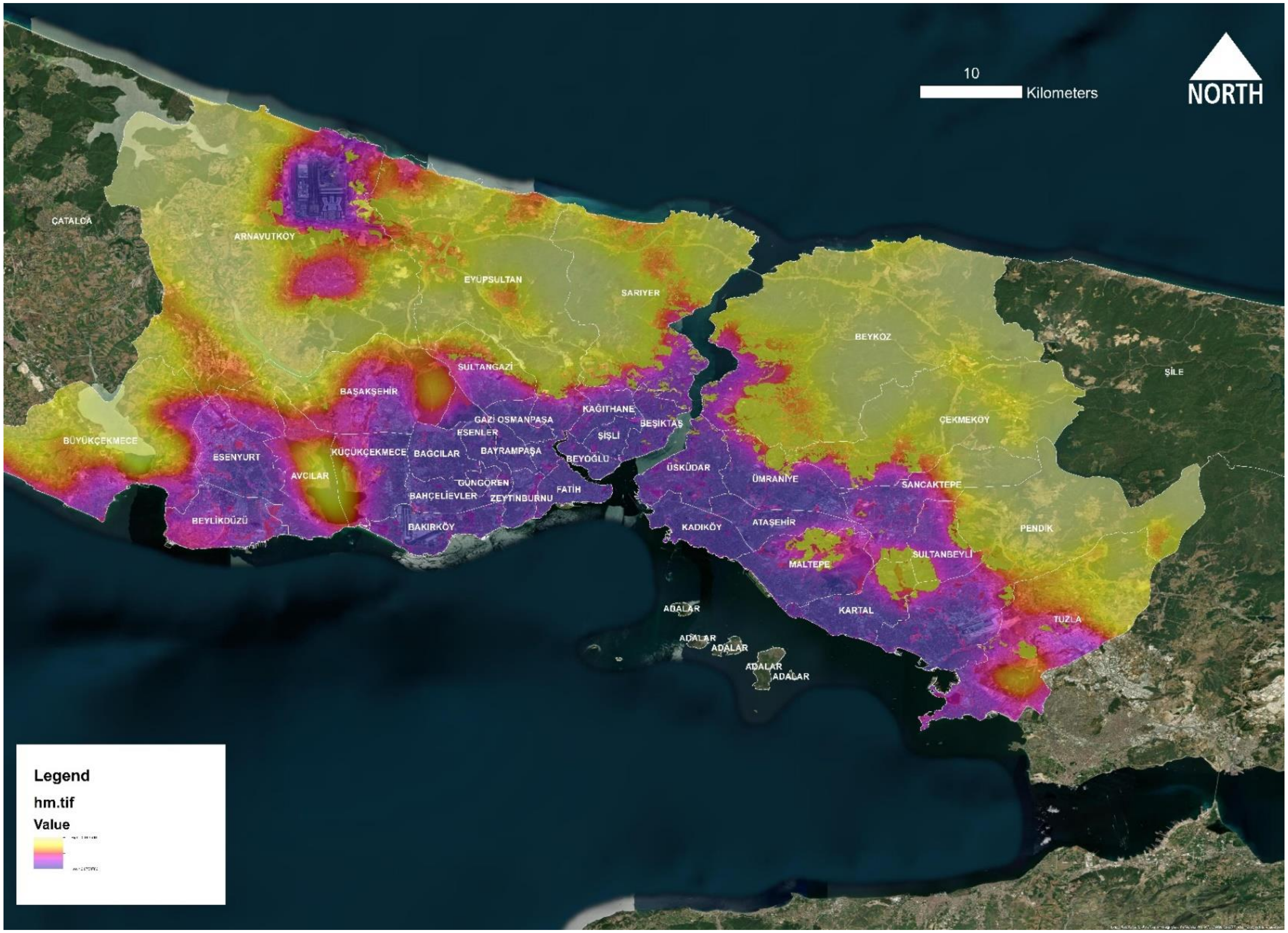


Figure 12. Heat Mitigation Index of Istanbul Cıty by InVEST Mod

3. CLIMATE CHANGE ADAPTATION ACTIONS FOR CITIES

Floods are a danger that is frequently seen in many parts of the world and in Turkey, and if it turns into a disaster, it causes loss of life and property, partly as a result of human influence and partly as a result of natural factors. Although the concepts of Flood and flash flood are often expressed as the same meaning, in fact, floods mostly occur in the upper parts of the river basins. flashfloods, on the other hand, occur in the lower parts of the river basins and mostly on the valley floors (Uzunsoy/ Görcelioğlu 1985). Floods adversely affect social and economic activities and human life by damaging agricultural lands and settlements, underground and surface infrastructures, various facilities and living creatures in nature, especially humans, in proportion to the magnitude of precipitation and the amount of water that passes into the surface flow. Especially in the last century, global warming as a result of developing industrialization and increasing world population has caused many natural disasters of meteorological origin, especially floods and overflows.

The effects of climate change taking place at the global level are felt in various degrees in almost every aspect of life. Especially in the last 50 years, floods, hurricanes, droughts and similar meteorological natural disasters are among the most prominent of these effects. Prevention, forecasting and preparedness planning for such disasters has become a vital necessity for many sectors.

Due to the rapid increase in the world population, flood risk has currently become an important problem for cities. For the first time in the world, the population of cities has become equal to half of the world's population as of 2008, and approximately two thirds of this population live in cities in underdeveloped and underdeveloped countries. If this increase continues at a similar rate, it is expected that the total population of the world will reach 60% in 2030 and 70% in 2050. As a matter of fact, it is estimated that 6.2 billion people from the total world population will live in cities in the next 40 years. Such a rapid increase in urbanization will undoubtedly increase the number and impact of urban floods, together with inadequate infrastructure and unplanned urbanization, overpopulation and other negativities (Ceylan et al. 2022)

The main feature of floods and overflows, which is one of the most important disasters that occur as a result of natural or human intervention, is that they create a permanent problem for people whose effects can never be completely eliminated. Although people have faced flood threats and dangers for centuries and have developed different methods of struggle to control this event, today this problem is growing day by day due to extreme meteorological weather conditions due to climate change. Floods and floods are still more effective both in our country and in many parts of the world (Ceylan et al., 2022).

Flood events occur almost every year in Turkey and their effects cause an increasing degree of loss of life and property. Compared to the 1900-1950 period, the cities grew both in population and area in the 70-year period between 1950 and 2020, as a result of this, the planned housing needs could not be fully met and the deficiencies in the city infrastructures resulted in an increase in the pressures on the river beds (Ceylan et al. 2022) Irregular urbanization, especially caused by unplanned land use, has also increased the risk of flood and overflow disasters. As the cities grew spatially in order to meet the needs of the increasing population, unplanned settlement patterns emerged in natural river beds or adjacent areas both on the coast and in inland. Urban population growth and spatial expansion in the world occur at a very high rate in dense and low standard settlements that can be defined as "slum areas". These areas are usually located both in the city center and in the surrounding suburbs and often constitute high-risk areas. Negative effects of city floods; over population density, unplanned urbanization, insufficient infrastructure and other negativities are increasing, making the work to be done on management more problematic and costlier (Figure 13).

Climate change is another large-scale global impact that increases the risk of flooding. Meteorological changes due to global warming have been factors that directly or indirectly increase the risk of flooding (Ceylan et al. 2022).

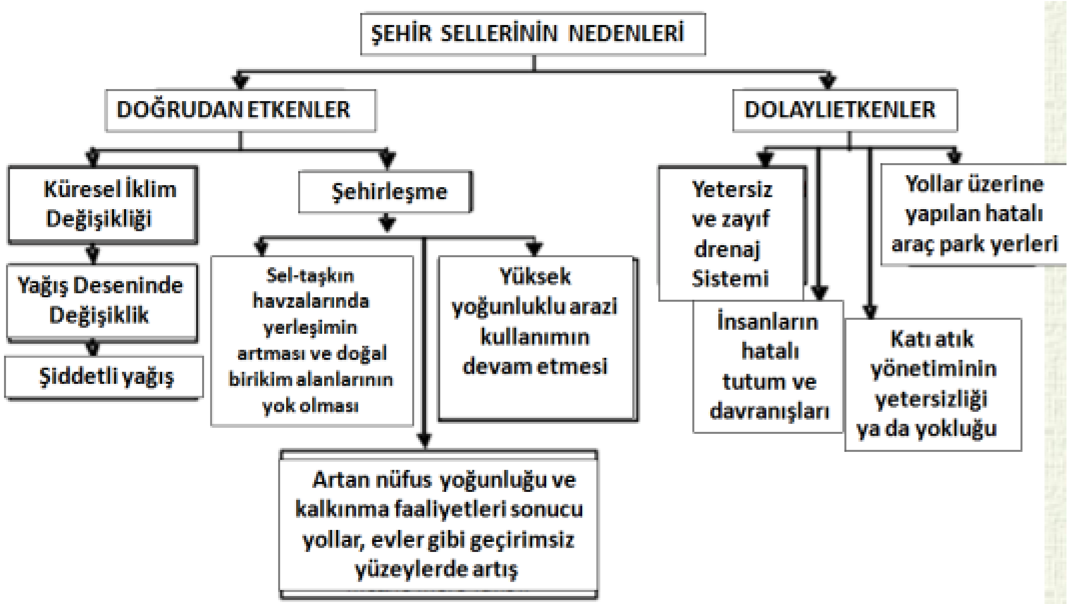


Figure 13. Causes of city floods (Adapted from Ceylan et al. 2022)

According to a study conducted by the World Bank (Worldbank, 2011), the causes of urban flooding were attributed to the following reasons (Yılmaz and Kaya, 2020):

• *Impact of climate change:* According to the World Meteorological Organization (WMO) reports, it has been stated that some climate anomalies observed in recent years are effective on the occurrence of urban floods.

• *Changes in land use:* Although heavy rainfall is the main factor that causes floods, improper land use also has a major impact on floods.

• *Increasing urbanization and spatial expansion of cities:* Constructions and infrastructures that make it difficult to drain water in areas with potential for flooding.

• *Reduction in the permeability of open areas:* Green areas and unconcrete surfaces increase the permeability of the ground and provide temporary storage for rainwater. Otherwise, the flowing water creates a danger.

• *Old, inadequate infrastructure systems, their lack of repair and maintenance:* Infrastructure should be given great importance in order to prevent floods and floods, and it should be built in a robust and long-term way. In addition, it should be ready for a disaster that will occur at any time by making timely maintenance and repairs.

• *Lack or overload of drainage systems:* Another important reason for flooding is the low carrying capacity of the existing system.

• *Impact of urban microclimate:* Urban heat islands can change the hydrology of a region due to urban microclimates, especially lack of vegetation and dense construction**.**

In addition to these, other factors are;

• *The groundwater level:* The groundwater level is high in flat areas close to the sea level, and it is not possible for the soil to absorb the surface waters in heavy rainfall, which prevents the discharge of surface waters in a short time.
• *Transportation networks that cross the stream beds vertically*: Factors such as elevated roads parallel to the sea shore, tram lines enclosed in concrete channels prevent flood waters from reaching the sea easily.
• *Providing settlement to the ground floors:* Instead of keeping the ground high in risky areas, sometimes negative floors are allowed to be built as residences (doorman's flat), sometimes as shops, and sometimes as warehouses (Yılmaz and Kaya, 2020).

Examples of Incorrect Intervention in River Beds in Cities and Possible Measures to be Taken (Kerim and Süme, 2019):

1. construction of structures/buildings into the stream bed or in the floodplain areas.

2. Covering the river beds in cities

3. Reducing the cross-section of the stream beds due to road and fill construction.

4. Inappropriate culvert, abutment, etc. to the stream bed. construction of transitional structures.

5. Unauthorized and illegal bridge construction on the stream bed

6. Illegal sand and gravel extraction activities from stream beds

7. Failure to meet the downstream condition of the stream bed

8. Other activities that narrow the stream bed section

9. Unplanned Urbanization

10. Narroving of natural stream beds in flood protection projects.

Kerim, A., Süme, V., Türk Hidrolik Dergisi: Taşkın ve Taşkın Koruma Yapıları, Cilt (Vol) : 3, Sayı (Number) : 1, Sayfa (Page) : 01-13 (2019)

Possible Measures to be Taken (Adapted from Kerim and Süme, 2019):

Stream beds should not be used as solid waste storage areas.

2. Instead of closed channels, open channels that are easy to clean should be built.

3. Areas close to stream beds should not be used as residential areas, and zoning plans should be implemented based on flood recurrence rates.

4. By multiplying the forest areas, the lands should be terraced and afforestation should be done.

5. Weirs, dams or ponds should be built on streams to contain the water.

6. Necessary infrastructure works should be done for the diversion of water

7. Underground sewage and waste water channels should be built large and wide, and these channels should not give their outlets to the seas or river basins.

8. Necessary invesments should be made to prevent the accumulation of water on streets, roads and bridges.

9. Just as in the case of an earthquake, one should be on the alert and vigilant, emergency response teams and organizations should have sufficient water discharge pumps, vacuum trucks and boats, and comprehensive scenarios should be prepared for emergency response.

Possible administrative problems of the flood events turning into disasters in Turkey (Çetinkaya, C.P):

- Inappropriate Management or Non-Management
- Lack of holistic management
- Bringing local solutions to local problems
- Failure to observe sustainability
- Lack of information, measurement and observation
- Refuge in the excuse of global warming
- Ignoring risks,
- The rate of taking action is lower than the rate of development of the problem.
- Undeveloped or unhealthy and complete management policies.

*(**Çetinkaya, C.P** http://docplayer.biz.tr/58292873-Su-kaynaklarinin-surdurulebilir-kullanimi-ve-butunlesik-yonetimi.html)*

3.1. Adaptation Actions for Urban Floods

3.1.1. Structural (Hard Engineering) measures

Structural measures are engineering practices applied to reduce the risk of flooding. These measures are divided into two as Extensive and Intensive engineering applications.

Measures Applied at the Extensive Basin Scale: It consists of very wide-ranging practices that are effective in the basin, aiming to change the relationships between precipitation and flow, such as changing the vegetation of the river basin, reducing and delaying the flood peaks and controlling the flood and erosion in the basin.

• ***Vegetation***: can store some of the rainwater by reducing the velocity of surface runoff of water in the basin by interfering with vegetation. When vegetation is removed, there is a tendency for the runoff and stormwater volume to increase by one. Increasing the vegetation cover is a comprehensive flood mitigation measure, but is most applicable to small catchments (<10 km2).

• ***Control of soil erosion***: Soil erosion can be controlled by reforestation, small reservoirs, stabilization of stream riparian areas and good agricultural practices. This precaution helps reduce the impact of flooding.

Intensif Measures:

These measures are divided into two groups; Flood Protection Structures as Flood Control Structures.

Flood Control Structures: These are the structures built to control the waters that are likely to spread to the environment in the event of a flood. Some of those; planting trees, flood banks and walls, flood traps, overflow channels, maintenance and repair works of river channels, river rehabilitation through diversion channel, construction of dams, ponds and dams, and practices aimed at preventing flood waters from entering settlements (Kerim and Süme, 2019).

Flood Protection Structures: These are engineering applications to protect agricultural lands or settlements in case of sudden floods. Structures such as Brits, flood walls, embankments, spurs and diversion channels are built to prevent the overflowing water from the river valleys from damaging the residential areas (Kerim and Süme, 2019).

Information on the Structural (Engineering) Measures and Techniques (Flood Protection and Control Structures structures) applied to prevent floods and on a basin basin and in cities is given below.

3.1.1.1. Dams

Regardless of the purpose of their constructions, the effect of dams in terms of flood prevention is very important. Since the dams store the excess water during the rainy season, less water is left downstream during the flood. Therefore, its functions such as reducing the risk of flooding and flooding are very important (Figure 14).

Figure 14. A dam built for Flood Control

Advantages of dams

- *By controlling the flow of water, floods and overflows can be brought under control or their effects can be reduced.*

- *Water potential in dams can be used as drinking water. Thus, the drinking water need of the region where the dam is located is met.*
- *Hydroelectric energy production.*
- *Lake fishing can be done in the dams.*
- *With evaporation in the dams, the air in the region is humidified and a softer climate is provided.*
- *The water in the dams can be used for irrigation of agricultural fields.*
- *Dam water can be used in fire extinguishing activities in emergency situations..*

Disadvantages of dams at local and regional level:

• Extinction of species and natural habitats: Dams change the natural structure and flow of streams. It can lead to the destruction of the habitats of living things and the extinction of their species.

• Recession of delta: Sediments that will reach the ends of the delta and contribute to the expansion of the delta remain in the dam. The delta, which cannot advance, begins to regress with wave erosion. The amount of food that needs to reach the sea is reduced because of the dam.

• Weakening of natural lakes and groundwater: Dams in areas with insufficient water keep the existing waters in the higher parts of the basin. In the lower parts of the basin, groundwater and lakes are damaged.

• Economic inefficiency: Dams are sometimes more expensive than expected, and the expected revenue cannot be generated after completion. The fertile plain lands under the dam are irreversibly lost. After the dam construction, the damages continue along the stream. Fishing and reed cutting decline in this area.

• Social and economic deterioration: People in the dam area are forced to migrate to other areas. He has difficulty in adapting to the new conditions. Rural information about immigrants is lost. Dams can only stop expected floods, they cannot prevent large floods. There are settlements with the belief that there will be no flooding in the area after the dam, and more damage occurs in a sudden flood.

• Negative impact on the physical environment: Stream flow patterns change, dam lakes flood large areas, groundwater rises, the soil becomes salty, and the severity of erosion increases due to the extra miles in the waters coming out of the dam.

• Affecting the living environment: Parasites that love humid environments are becoming widespread due to the constant humidity of the environment. Organisms that cause diseases such as parasites, yellow fever, malaria, and liver trematode multiply. There are more disease-causing organisms in the environment than the natural rainfall-drought cycle.

• Due to the decrease in the sediment carried in the stream in the lower part of the dam body, more beds are carved downstream of the dam,

• Coastal erosion as a result of reduced alluvial transport to the coasts. (https://en.wikipedia.org/wiki?curid=155950).

3.1.1.2. Walled Stone Fortifications or Embankments

It is an artificial fill built along a stream bed for the purpose of protective measure to prevent the flood from overflowing from the stream bed.

Figure 15. Duvarlı Taş Tahkimat veya Sedde Örneği(http://taskinyonetimi.tarimorman.gov.tr/_engine/_engine/file.axd?file=%2FDokumanlar%2FTask%C4%B1n_Yonetimi.pdf).

Advantages and Disadvantages of Walled Stone Fortifications and Embankments

• It prevents the river from overflowing at the application sites, but the same amount of flow may be transmitted downstream and may pose a danger to the settlements in the lower course.

• The connection of the stream with the natural flood plain is cut off and the ecology of the stream environment is damaged.

• The speed and flow of water increases, causing increased erosion in the downstream.

• The natural dynamics of the stream bed changes.

• Often costly to build and maintain.

3.1.1.3. Flood Trap

Especially in the upper parts of the river basins, they temporarily store the water and spread the flood current that occurs at a certain time over a longer period of time. Thus, in the lower part of the basin, they are small dams that provide water outflow equal to the river bed capacity and are generally of low height (Figure 16).

Figure 16. Example of Flood Trap

3.1.1.4. Sediment Collection Bars

Sediment Collection Bars are the transverse structures built on the river beds in order to store the sediment in the channel without being transported to the downstream in the rivers that carry a lot of sediment and therefore cause many problems in the urban settlements located in the lower part of the river basin (Figure 3.5). Permeable Sediment Collection Dam, which is a type of weir, is a transverse engineering structure that, unlike other collection dams, allows the targeted size and amount of material to be kept in the reservoir or the desired diameter of erosion material to pass to the lower part of the basin. They need to be cleaned regularly, especially after floods and floods (Figure 17).

Figure 17. Example of a Sediment Collection Weir built upstream to contain excess sediment.

Figure 18. Permeable Sediment Collection Weir

3.1.1.5. Reclamation Terrace

They are (systematic) engineering structures that are built to prevent erosion in the basin by reducing the velocity of water, thus reducing erosion and carrying capacity, in order to reduce the slope of the bottom of the river beds, to reduce alluvial transport or to store the excess sediment in suitable places.

3.2.1.6. Channel Streighteening

Elimination of streambed bends constitutes one of the harshest engineering practices. The procedure involves straighteening a meandering portion of the stream bed while deepening the bed to greatly increase the flow of water at the same time (Figure 19).

Figure 19. Examples of streambed straighteening

Advantages and disadvantages of shortening/flattening the streambed

• As a result of the shortening of the river channel, the waters move away from the application area rapidly, reducing the risk of flooding in the area.

• Stream floodplain ecology is damaged.

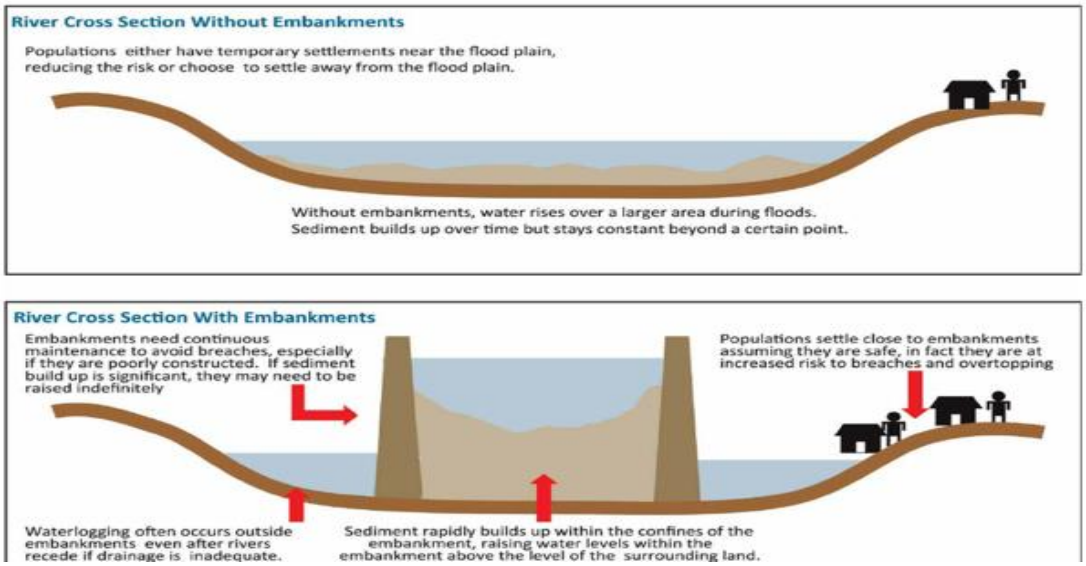
• As the speed of the water will increase, the stream habitat will be damaged.

• Increased risk of erosion and flooding for the downstream.

• In the application area, the naturalness of the stream channel is deteriorated and the ecology is damaged.

3.1.1.7. Flood Embankments/Embarkments

By increasing the stream channel depth, these structures increase the maximum water capacity of the channel and reduce the risk of flooding where they are built. Flood embankments are structures made of soil or materials of various shapes designed to contain high water levels, built on the bank of stream channels (Figure 20). These structures are usually grass-covered, but may need additional protection against erosion due to rapidly flowing water or flooding. Most embankments are between 1 meter and 3 meters high. However, sets of 5 meters and higher are rarely encountered. Modern improvements to this design include building an internal central core made of an impermeable material such as clay or concrete, some even using metal posts.



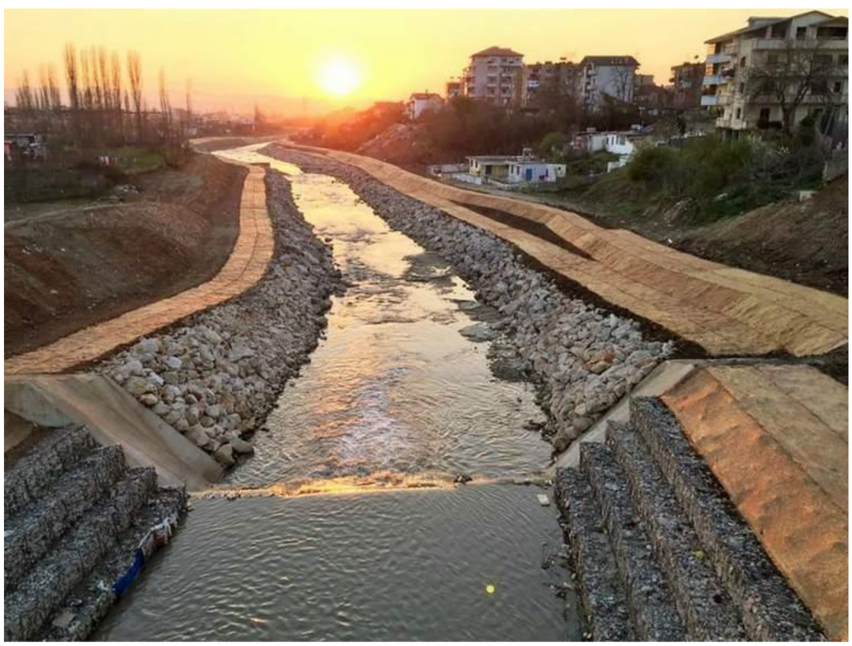


Figure 20. Stream channel Enbarkments

Advantages and Disadvantages of Embarkment

Advantages

• They reduce friction and increases water velocity in the stream channel, thus removing water from the applied area faster.

• Bank (coastal) erosion is reduced.

• Increasing the cross-sectional area of the stream increases the hydraulic radius. This also reduces the risk of flooding.

Disadvantages:

• They are costly and unnatural, so ecology will be damaged significantly in areas with such structures, and habitat areas will be destroyed.

• In areas where there are no weirs, and especially in the lower course, the probability of flooding and flooding may increase.

• Under heavy rain conditions, dams can sometimes collapse and cause bigger problems.

3.1.1.8. Flood Dischage (Relief) Channels

Flood discharge channels are secondary channels built parallel to the main river channel when there is a possibility of flooding, and it is aimed to divert excess water that will occur in the main river channel during the rainy season and thus reduce the flood risk on the main river (Figure 21). For example, in order to reduce the amount of water carried by the main river, one or more flood relief channels to be built parallel to the main river and a town or city can be by passed to reduce the risk of flooding and flooding in the settlements in question. However, obtaining land for the construction of flood containment channels can be difficult and they are very expensive to construct.

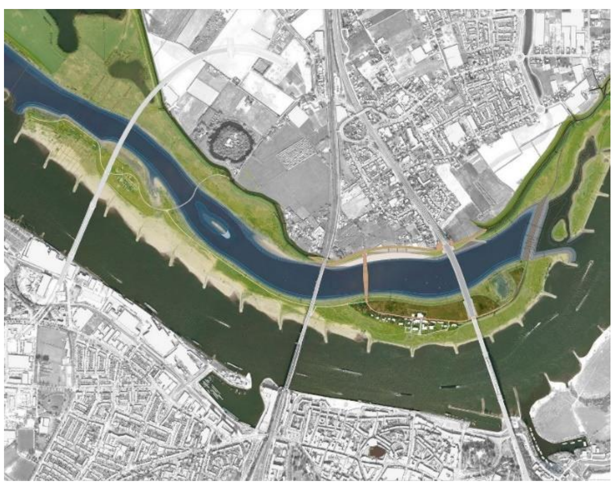


Figure 21. Example of Flood relief channel

• *Advantages:* They reduce the pressure on the main channels when floods are likely, therefore they reduce the risk of flooding.

• *Disadvantages:* It is sometimes difficult to find land to build such drainage channels, they are expensive.

• . It is also possible for the drainage channels to overflow if the water levels rise significantly in the stream beds, especially during heavy rains.

3.1.2. Non-Structural (Soft-Engineering) Measures

• No Structural measures can provide full protection for all floods and overflows that may occur.

• These measures are designed to protect against the highest possible flood level. Structural measures are often physically and financially impossible and costly.

• Structural measures can create a false sense of security by allowing greater settlement of flooded areas that could cause significant future damage.

• Non-structural measures can significantly minimize losses at lower cost.

• The cost of protecting a flood-prone area with structural measures is often higher than non-structural measures.

Non-structural (Soft Engineering) measures are generally less costly than hard engineering options and a more sustainable approach is taken. Therefore, these measures have less negative impact on the environment.

Hard engineering options include building artificial structures that try to control natural processes. They tend to be expensive and also often have a negative impact on the landscape or environment.

Non-structural (Soft Engineering) measures include techniques that care about working in harmony with nature instead of controlling nature. Some examples may include: weather forecasting systems, flood warning systems, floodplain land use management, wetland/riparian protection and river restoration.

The advantages of a soft engineering strategy include its low cost compared to hard engineering strategies that often require more construction materials and time to implementation.

Soft engineering strategies are much more environmentally friendly than hard engineering strategies as they encourage people to work with the environment rather than against it, and are therefore seen to be more sustainable.

However, especially in big cities, since the floodplains of rivers are usually occupied by settlement, etc., non-structural measures may have a limited area of use, especially in large metropolises such as Istanbul, Izmir and Ankara. Some of the Non-Structural (Environmental) Measures are*;*

3.1.2.1. Akarsu Havzalarının Yukarı Kesimlerinin (kaynak alanları) Ağaçlandırılması

One of the most important ways to prevent the occurrence of floods in a basin is to prevent or slow down the flow of water to the surface. Increasing afforestation and vegetation (bio-retention) and constructing reservoirs or water ponds of various sizes capable of holding water significantly facilitates the infiltration of rain and snow waters into the ground, primarily on a basin basis (Figure 22). In this way, the passage of water to the surface flow is significantly limited. The water that seeps into the ground is used by plants and feeds underground water reserves. If the access of surface waters to the river beds is prevented or slowed down by leakage or other means, the water carried in the river bed will never exceed the bed capacity, and thus the risk of flooding and flooding will be eliminated to a great extent.

Figure 22. Afforestation and natural water retention areas of the upper parts of the river basins (source areas)

3.1.2.2. Re-connecting a Stream Channel to its Floodplain

A floodplain is an area of flat land adjacent to a river or stream and usually composed of alluvium. It starts from the edge of the stream and extends to the outer edges of the valley. Floodplains are very fertile areas for agricultural production as they consist of alluvium (silt accumulated from river flood) carried and deposited by the river (Figure 23). Such fields are usually a wide, flat area caused by meanders moving along the valley.

Flood walls and embankments have historically been built along rivers to reduce flooding. However, these practices have brought with them various environmental problems. Embankments often limit river waters to a small area, which causes the waters to move faster and deposit more sediment, thus increasing the likelihood of erosion and flooding. However, if the river floodplains are connected with the river, the excess water that exceeds the river bed capacity and spreads to the environment during heavy rains accumulates in the flood area. Thus, these excess waters are carried downstream and do not pose a flood and overflow hazard for the settlements there, but at the same time, they slowly seep into the ground and feed the groundwater. These floodplains also form a natural habitat for many living creatures.

Figure 23. Akarsu ve kenar kısımlarını oluşturan taşkın ovaları (Floodplains)

Advantages and Disadvantages of Creating Stream Floodplain Areas

Advantages

- In case the stream overflows from its channel during rainy periods, excess water overflows into the floodplain and excess water is stored in these areas, slowly seeping into the ground, and thus these waters do not pose a danger to the settlements in the lower course. Thus, it reduces the risk of flooding and overflowing downstream.

- It contributes to the improvement of water quality.
- Protects people and property from the negative effects of floods.
- It creates highly fertile soils on flooded areas.
- It causes ecological richness.
- These areas can be used for agriculture and recreation.
- It is very useful for recharging groundwater.

Disadvantages

- Re-establishing of floodplains can be costly, especially in densely populated cities.

To create natural barriers that reduce and delay the access of surface waters to the stream channels by clearing the river flood areas without construction and to use these areas as parks, gardens, etc. use for recreational purposes.

- Establishing green roofs, green corridors on the roadsides and green park areas in neighborhoods and districts where the natural cover is significantly damaged.
- Establishment of parks and gardens that will facilitate the infiltration of surface waters into the soil in new urbanization areas (Figure 24).


Figure 24. Occupation of river floodplains by structures and damage to settlements after flooding (Left). An example of using floodplains for recreational purposes (on the right)Park, garden, etc.).

3.1.2.3. Akarsu yatak şeklinin resore edilerek doğal haline getirilmesi

Restoring the shape of the stream bed to its natural state

Straighteening a stream bed by changing its natural shape causes water to flow faster through thechannel with more energy. This change may destabilize the stream, causing faster erosion, loss of soil, loss of aquatic habitat or other problems (Figure 25).

Over the years, many stream channels have been relocated or smoothed to accommodate road construction and minimize the need for bridges. In particular, the velocity and energy of the water tended to increase in every section where streamchannel smoothing was performed. Unless absolutely necessary, changing the stream channel location and straightening the bed is not a recommended method as it creates more problems. For this reason, it is recommended to restore the channel shape in the sections where stream channel straightening is made.

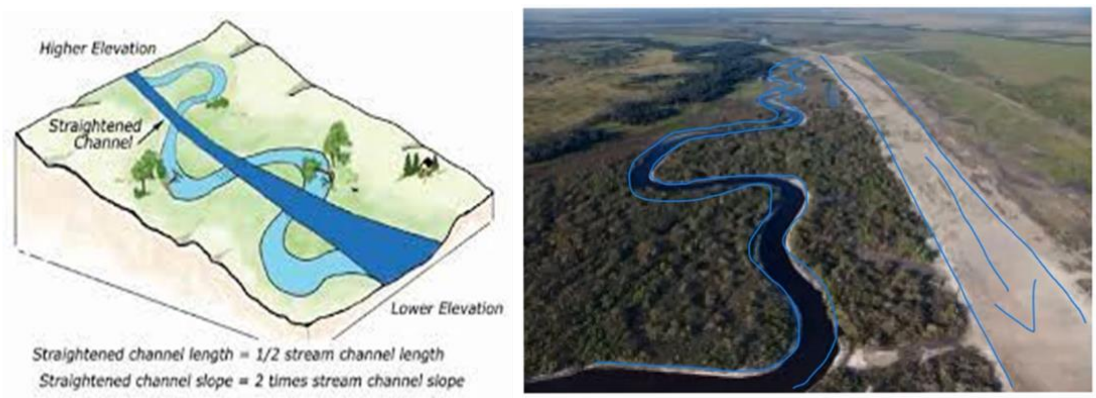


Figure 25. Conversion of the naturally deformed (straightened) and deepened stream bed to its original state (meandering state) by engineering applications.

Advantages and Disadvantages of Stream Channel Straihteening

• Since the friction of the water to the ground will decrease in the section where chnnel straihteening and deepening is made, the water moves faster in the stream channel and the risk of flooding is reduced in this section.

• Since the water will be transported downstream faster from the area where the channel straighteening takes place, the risk of flooding that have never experienced before increases for the settlements (cities and villages) located in the lower course of the basin. In addition, the rapidly increasing and high energy waters downstream will create more erosion in the stream channel.

3.1.2.4. Sustainable Drainage: Permeable Sidewalks, Paths and Gardens

Permeable pavements or pavements are either made of a porous and permeable material that allows rainwater to seep into the ground, or of non-porous blocks that are spaced so that water can flow through the gaps. Permeable pavements can also be applied using various surfacing techniques for inner city roads and streets, parking lots and pedestrian walkways (Figure 26). Such permeable pavement surfaces may consist of permeable concrete, porous asphalt, pavers, or interlocking pavers. Unlike impermeable pavement surfaces such as concrete and asphalt, permeable pavement surfaces allow rainwater to seep through the pavement into the sandy strata and/or soil below. Permeable coating systems, in addition to reducing runoff, can retain suspended solids, thereby keeping rainwater free of contaminants.

Figure 26. Geçirgen kaldırım ve kaplama örnekleri (Hepcan, 2019).

Permeable pavements are also commonly used on all roads, trails, and parking lots that are subject to light vehicular traffic, such as service or emergency access lanes, bike paths, road and airport shoulders, and residential sidewalks and driveways. The permeable coating method can be applied in many regions where it is not possible for the people living in the neighborhoods at risk to move to other places, especially in mega cities such as Istanbul.

Advantages:

- Permeable pavement surfaces are very useful in managing runoff from paved surfaces and recharge groundwater aquifers. They can reduce downstream flooding and protect key flows in rivers to allow ecosystems to be self-sustaining.
- By controlling contaminants in surface runoff, they can reduce suspended solids and harmful chemical concentrations in groundwater.
- Permeable pavements provide better water retention in urban areas that are more vulnerable to high temperatures due to the heat island effect. In other words, permeable pavements and green roofs keep water within micro-ecosystems, which are cooler environments compared to impermeable surfaces.

Disadvantages:

- They may be slightly more expensive during initial setup than those made using conventional methods.
- They may not be durable for a long time in places where heavy vehicles pass in the city. Therefore, they may not be suitable for airports and major roads.

• Excessive precipitation can cause the water table to rise below the porous pavement surface and prevent precipitation from penetrating the ground.

• Special problems may arise in cold climates. Permeable paved surfaces can be damaged by the use of salt against icing in winter.

• Permeable pavement systems, especially those with porous surfaces, may require periodic maintenance to keep the pores free of fine particles and to allow rainwater to penetrate the ground.

From an economic point of view, it can be difficult to compare the cost aspect between conventional impermeable surfaces and permeable surfaces, given variables such as lifetime, climatic conditions, quality of the permeable pavement system, and specific factors such as site landforms and slope conditions, etc. For this reason, the right pavement type should be selected for Istanbul and cost calculations should be made accordingly (Dikici, 2021).

3.1.2.5. Separating rainwater from the sewer system in cities

Sewage systems that collect wastewater and rainwater together in a settlement are called Combined System, systems in which rainwater is collected in one channel and wastewater in another channel are called Split System. The cleaning of the sewer where the waste water is collected is the responsibility of the water and sewerage administrations. Maintenance and repair of stormwater channels requires a faster operating network. Rainwater channels and grates must be cleaned during and after each rainfall. The situation is more difficult in residential areas that do not have a rainwater channel. Surface waters enter the waste water collectors together with all kinds of organic or inorganic materials such as dust, soil and garbage. This causes leaks and kickbacks from the weir points of the collectors. Sections that are sufficient under normal conditions cause such operational problems with the mixing of rain water. Mostly, flash floods occur at low elevations without storm water channels (Dikici, 2021).

In order to improve water management and protect the sewer system from damage, it is very important to distinguish the storm water drainage systems from the wastewater sewage system in the city. Separation ensures that the wastewater treatment plant operates properly without being overloaded by large volumes of rainwater (Fig. 27-28).

Figure 27. Separating rainwater from the sewer system

Figure 28. Establishing green (grass) corridors around open parking areas that will facilitate the infiltration of surface waters into the ground.

3.1.2.6. Re-emerging the Natural Stream Drainage Network Destroyed by Urbanization

The most important factor controlling the natural environment in a region is the stream systems and basins. Considering the river floodplains as cheap land and easy access to water have caused these areas to be occupied more uncontrolled than other natural habitats. As the balance in nature is ignored and irregular and distorted urbanization continues; flood, drought, air pollution, etc. warns and reacts in the form of many disasters.

The natural river drainage network of a city is the natural and cultural heritage of that city. Land use decisions and practices that do not give priority to nature in urbanization cause the loss of streams by changing their natural structure, and decrease the quality of life; threatens the health of the city.

Restoration of river beds passing through cities is very important in terms of flood risk. Therefore, in cities where the natural drainage system has been significantly altered by anthropogenic effects, it is of great importance to determine the location of the natural river drainage system by examining historical records, if any, and to adapt the existing defective drainage to the natural system (Figure 29). Indeed, studies have shown that the places where floods occur in cities are mostly places where natural stream beds once passed. Today, however, these streams have disappeared to a great extent for quite different reasons, especially in big cities such as Istanbul. That's why it has a name for sustainable urbanization, but its own lost streams need to be brought to light.

To give a striking example of this; Once upon a time, there were many large and small rivers in Istanbul, and the rivers were maintaining their naturalness to a great extent. But today, most of these rivers have been destroyed partially or completely due to unplanned urbanization. As a matter of fact, the investigations showed that only 15 of Istanbul's 106 main rivers (about 14 percent) preserved their natural characteristics from the upstream to the downstream on the basis of all their basins. On the other hand, roads have been passed over many stream beds or filled with various public or private buildings. The physical, that is, the natural structure of the rivers in Istanbul, from the upstream to the downstream, 85 percent has lost or is about to lose its natural quality due to pollution, occupations, wrong land use decisions, industrial-domestic wastewater.

As a result of unplanned urbanization, construction of structures on stream beds passing through settlements in cities, narrowing of the stream section, construction of culverts or bridges on the stream bed contrary to the rules of science and art without permission, construction of embankments and fillings contrary to the technique, pouring solid waste and rubble material into the stream beds, Factors such as discharging industrial and domestic wastewater, laying the wrong sewer network cause important problems. Likewise, unauthorized removal of sand and gravel from stream beds can result in the loss of fish spawning grounds and some species. Destruction of streamside floodplains disrupts the habitat of aquatic fauna.

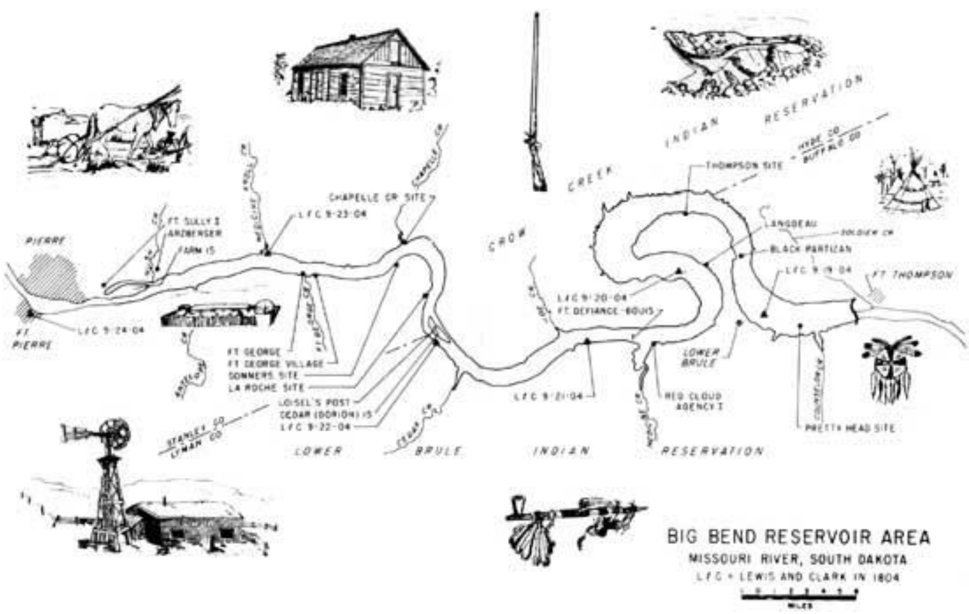


Figure 29. Re-discovery of natural river drainage networks, which have been significantly destroyed by human impact in cities, by examining historical records.

Use of River Beds as Landfills in Cities

Especially in cities that do not have a sewage infrastructure system, stream beds have been used as open channels where wastewater can be evacuated easily. The use of stream beds as open channels and the mixing of clean water from streams with domestic wastewater cause significant pollution of clean water resources.

By mixing the domestic wastewater with the natural waters of the streams;

• To increase the pollution, odor pollution and the amount of clay/sand in the stream water,

• Decrease in the ratio of dissolved oxygen in the water,

• Increase in water ratios,

• It causes heavy metals and intense siltation problems in water.

Both DSI and municipalities prefer to cover the streams with concrete so that the residents of the city do not see the wastewater and are not exposed to odor pollution. Such misapplications can trigger flood disasters, especially in rainy weather conditions.

Concreting and Asphalting

The increase in the rate and amount of impermeable surfaces in cities prevents the penetration of rain water into the soil, causing the formation of urban impermeable surfaces. Such areas cause faster and greater accumulation of water than naturally permeable areas, even during periods of low rainfall intensity, and encourage the surface runoff of water. Today, in many of our cities, unfortunately, stream beds have disappeared to a great extent due to concrete and asphalt surfaces, roads, parking lots and buildings have been built on stream channels. If cities are not planned according to storm water flow, precipitation will turn into floods and the cost of damage will be very high. Therefore, the opinions of meteorological engineers should be reflected in the reports in urban planning works.

As the forest cover and green areas around the stream chanels are destroyed and the stream beds are narrowed by concrete, their water carrying capacity is significantly reduced. Rain water is prevented from meeting with the soil, buildings/roads such as walls are built around stream beds, wrong bridges are built on stream beds, urbanization is seen as only building buildings, planning studies are not done according to the direction of storm water flow, there are barriers in the flow of rain water, there is no green texture in the city. Flood and overflow disasters will continue to be seen more frequently in all cities and in different regions as long as they are taken into consideration.

In fact, in many of our cities today, the places where flood disasters occur frequently after rains were once natural stream beds. Therefore, floods and flood disasters that occur in such cities are not caused by climate change, but due to wrong urbanization. In these cities, sudden and severe anomalies have become more common with climate change.

Improperly Implemented Stream Rehabilitation Studies (Stream improvement by concreting/narrowing)

If the surroundings of stream beds and coastlines in a city are built like walls with reinforced concrete structures, it is not possible for clean and fresh air to penetrate the city. Unrenewable/non-fresh air in such cities undoubtedly leads to the emergence of some infectious diseases. In fact, the rivers, which once maintained strong ties with the inhabitants of the city with their natural structure, have become over time to break their ties with the city due to the crushing pressure of the building density developing around them and increasing concrete surface areas (Figure 30).

Figure 30. Examples of narrowed and reclaimed stream channels. In fact, the stream channel was not rehabilitated, on the contrary, it was concreted. Rehabilitation works carried out in this way trigger flood disasters during heavy rain events.

In the improvement application techniques, the benefits of the river channel to the city and the citizens should be taken into consideration. In rehabilitation studies, the first thing that comes to mind is to protect the natural structure of the rivers and to establish their relationship with the environment with a nature-centered approach, strategic plan, law and technical implementation tools, and it should be planned to regain the lost ones. water collection areas and rivers to the city (https://www.indyturk.com/t%C3%BCrkiyeden-sesler).

Figure 31. Stream improvement work by embedding in concrete.

3.1.2.7. The zoning of the river floodplains exposed to flooding

Floodplains are areas of flat and flat plain, highly fertile soil covered with alluvium in the immediate vicinity of the stream channels and adjacent to the stream. These areas are covered by overflowing water from the stream channels during rainy periods and may become temporary wetlands. These wetlands are referred to as a type of temporary floodplain. Floodplains can hold excess water and buffer the effects of heavy rainfall, thereby protecting economic activities and people and settlements downstream from flood damage. However, unfortunately today many former natural floodplains, especially in large cities, are under increasing pressure due to urban sprawl, infrastructure developments and agriculture. Up to 90% of floodplains have been lost in the past centuries, both in many major cities of Turkey and in Europe, or they no longer serve as natural ecosystems and habitats that support high biodiversity, losing their functions in reducing flood risk.

The zoning of floodplain use reduces the risk and cost of damage caused by flooding. Local governments can enact flood zone laws restricting land use for such areas. These laws prevent or limit construction and development on floodplains to reduce flood-related risks.

This process includes the following stages (Figure 32):

- Identification of flood risk areas;
- Mapping of floodplains;
- Separating the basin into zones according to the purposes of use.

Figure 32. Example of zoning river floodplains based on intended uses

3.1.2.8. Flood Planning and Management

It should take a holistic approach to flood management or planning that includes scientific and engineering challenges such as precipitation, runoff and flooding, as well as human and socio-economic issues. Flood protection and damage minimization are the objectives of flood management plans. In order to reduce the consequences of the flood disaster in the city, the preventive measures taken before the flood and the structural and non-structural measures taken during and after the flood should be considered as a whole and implemented by the authorized institutions. These methods form the basis of flood management.

Flood Management Plan; Flood Risk Pre-Assessment consists of Flood Hazard Maps and Flood Risk Maps.

The Turkish State Hydraulic Works produces flood risk maps. At this time, the following decisions for change are suggested:

• Preparation of flood plans to reduce loss and damage in cooperation with DSI and management of floods,

• Integration of Flood Risk Maps into city planning and regional planning applications for all sensitive hotspots to prevent future losses,

• Collaboration with geomorphology experts in developing Flood Risk Maps.

Five types of flood risk management strategies can be proposed for cities in Turkey, especially in Istanbul;

1. Preventing flood risk: People/property etc. are protected by methods that prohibit or deter construction in areas with flood risk (for example, spatial planning, reallocation policy, expropriation policy, etc.). reducing exposure.

2. Flood protection: Activities aimed at reducing the probability of flooding through infrastructure works such as dykes, dams, and weirs, often referred to as "flood protection" or "structural measures", through measures that increase the water carrying capacity of existing channels.

3. Flood risk reduction: Activities focused on mitigating the effects of floods through measures taken within the flood-sensitive area. Intelligent design of the flood-prone area can be made, including spatial layout, water retention within a designed area, or a flood-proof building.

4. Flood preparedness: The consequences of floods can also be mitigated by preparing for a flood event. Measures include developing flood warning systems, preparing disaster management and evacuation plans, and managing a flood when it occurs.

5. Post-flood recovery: This strategy facilitates a good and quick recovery after a flood. Measures include the preparation of construction plans as well as compensation or insurance systems.

Advantages:

- If flood planning is done on a watershed basis, it can be highly feasible.
- The organizations created will serve as an excellent model for disaster preparedness in general.

Disadvantages

- It requires serious cooperation between institutions. Some institutions may not have the necessary information about floods.
- Measures may require significant financial resources
- There may be difficulties in finding personnel with technical and theoretical knowledge in the field.

3.1.2.9. Infiltration Trenches, Sponge Cities, Green Roofs

Infiltration Trenches, Sponge Cities and Green Roofs applications are made with the aim of accomplishing many purposes. One of the primary purposes may be to stop/slow down the access of water flowing to the river beds as a result of heavy rains and heavy snow melts, especially in big cities, and thus to reduce the risk of flooding and overflow, as well as to reduce the urban heat island effect that frequently occurs in cities during summer seasons.

Rainwater infiltration ditches or channels (biological canals) are vegetated ditches in a narrow and long structure formed on the roadsides that allow the collection and retention of the rainwater passing to the surface flow and filtering the pollutants and filtering the water (Figure 33) (SPSMM, 2016). These are linear ditches that collect rainwater from adjacent surfaces, and the high permeability characteristics of these ditches allow water to seep quickly into the ground. As they are horizontal ditches, they are very practical to be installed parallel to roadsides or around parking lots.

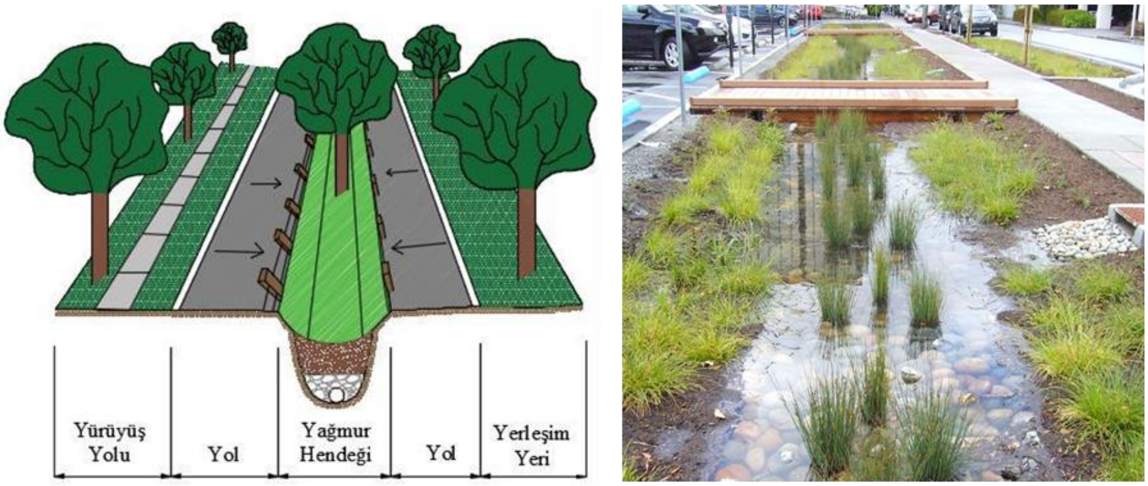


Figure 33. Rain Trenches for Sustainability

Advantages

- The primary advantages of the infitration ditch are water quality treatment, reduction of peak flows in sewer systems and groundwater recharge; thus reducing peak flow across the surface and slowing the amount of surface water entering river channels.

Disadvantages

- Such filtration systems are prone to clogging with sediment suspended in rainwater.

3.1.2.10. Sünger Şehir

Sponge Cities are designed to hold as much water as possible. These areas are designed as a combination of storage tunnels, permeable pavements, rain gardens, built ponds and wetlands to store excess water.

There are many replaceable base components in the city of Sponge. On a large scale, protecting or restoring forests and natural ground cover helps water seep into the ground. Smaller scales have several options. Using permeable pavements on roads, sidewalks and footpaths to allow water to seep into the ground rather than run directly into the local stormwater system. Retaining ponds and constructed wetlands help filter water by trapping it, allowing water to seep slowly into the local water table. Rain gardens perform a similar function on a smaller scale, and these spaces can be combined with the city's public green spaces.

Sponge City; It denotes a particular type of city that absorbs rainwater like a sponge and then seeps into the ground, allowing this water to be naturally filtered by the soil, stored in urban aquifers, and then used by drawing these waters from aquifers. As a matter of fact, these waters can be easily treated and used for city water supply. Thus, surface waters formed due to excessive precipitation in sponge cities seep into the soil instead of causing floods, reducing the severity and frequency of urban floods and preventing possible loss of life and property (Figure 34). However, in order to initiate a sponge city implementation, infrastructural changes are required in the city. The primary need is to create permeable areas through which surface water can seep into the ground, rather than just impermeable concrete and asphalt.

Figure 34. Sünger şehir örnekleri (Çin)

Sponge cities include the following applications:

- Work on creating adjacent open green spaces, interconnected waterways, canals and ponds that can naturally capture and filter water, while at the same time nurturing urban ecosystems, increasing biodiversity, and creating cultural and recreational opportunities.
- Practices to build green roofs that can trap rainwater and filter it naturally before it is recycled or released into the ground.
- Applications of porous design throughout the city, including the construction of bio-ditches and bio-retention systems to stop the surface flow of water and facilitate its infiltration; leaky roads and pavements facilitate the penetration of water into the ground and feed the groundwater; practices in the creation of drainage systems that allow water to seep into the ground or allow rainwater to flow directly into green spaces for natural absorption.

Advantages

• Reduction in flood risk as the city offers more permeable areas for water to naturally retain and seep through.
• Renewed groundwater and therefore more self-sufficiency
• Cleaner groundwater through increased volume of naturally filtered rainwater.
• Reduction of the load on drainage systems, water treatment plant, artificial channels and natural streams. Lower costs for drainage and treatment infrastructure.

• Greener, healthier, more enjoyable urban areas, increased quality of life, recreational areas, increased land values
• Enriched biodiversity around green open spaces, wetlands, city gardens and green roofs

Disadvantages
• Free space requirement for sponge city applications
• Financial requirements for the implementation and maintenance of systems

3.1.2.11. Yeşil Çatılar

Green roofs serve a variety of purposes in cities, including absorbing rainwater, providing thermal insulation, creating ecological habitat for wildlife, and helping to lower urban air temperatures and mitigate the heat island effect.

Green roofs, also known as "vegetative roofs" or "living roofs," consist of a waterproofing membrane, growing medium (soil), and vegetation (plants) that covers a conventional roof. Well-designed and maintained green roofs provide numerous environmental, social, economic and aesthetic benefits.

Green roofs are suitable for retrofit or redevelopment projects and new buildings and can be installed in small garages or larger industrial, commercial and municipal buildings. They effectively use the natural functions of plants to filter water and purify the air in urban and suburban landscapes.

Advantages

• Financial benefits accompanying the green roof, such as increased property value and reduced energy use for heating and cooling. Green roofs allow buildings to retain their heat better during the colder winter months, while reflecting and absorbing solar radiation during the hotter summer months, keeping the buildings cooler.

• A green roof can extend the life of the roof by covering the roof with a waterproofing membrane and growing media and vegetation that protect the membrane from ultraviolet radiation and physical damage.

Disadvantages

- The initial cost of building a green roof can be higher than a regular roof.
- The weight of the soil layer added to the roof and the retained water body can cause an additional load and pressure on the structural elements of the building. For heavy green roofs of this type, the lack of buildings capable of supporting the large amount of additional weight and the additional cost of retrofitting buildings to support this weight can make it difficult to implement widely. Some types of green roofs have more stringent structural standards, especially in seismic regions of the world.
- Green roofs may require significantly more periodic maintenance and repairs than a standard roof. Standard maintenance for green roofs includes removing debris, controlling weeds, pruning plants, checking moisture levels and fertilizing. Maintenance costs can also vary depending on the type of green roof.
- Considering the advantages and disadvantages of green roofs, the districts where Istanbul's old building stock is dense are the places where the chance of such roofs to be installed is low.

However, the focus could be on new buildings being built in newly urbanized neighborhoods and preferably public buildings as pilot projects.

Below is a checklist for Structural and Non-Structural measures that should be taken within the scope of a flood management plan prepared in international standards for local governments by Kadıoğlu (2019).

"Is there a daily flood monitoring network, a flood forecasting and early warning system that can assess the water, air and soil conditions from a single source and predict the water level of rivers on a daily basis whether there is a flood hazard or not, is it established and operated by meteorological engineers?

- *Has the use of natural functions and green infrastructures (wetlands, flood plains, etc.) together with the management of runoff on a watershed basis (appropriate agricultural practices and forest management, etc.) has been pursued in order to reduce the risk of flooding?*
- *Is there a way to reduce the peak flow by slowly releasing it over time (absorbing the water flow by percolation, refilling the aquifers by percolation or providing a natural environment for growing species and rainwater harvesting)?*
- *Are applications such as green roof, water permeable asphalt, water permeable pavement, super and combined gratings included in the project to slow down the peak runoff?*
- *On-site water storage, retardant storage, inter-building storage, basement storage, recreation areas, etc. Are flood water traps sufficiently included in the project?*
- *Have the floodplains been avoided by afforestation, terracing, etc., and thus landslides and flood disasters that may occur in order to preserve the natural vegetation and topography so that the floodplain continues its natural function?*
- *By creating areas where flood waters are stored and reducing flood velocity, flow rate and sedimentation, slope lining, etc. Landslide, coastal scour, erosion and sediment control were targeted, albeit partially, for this purpose, are flood traps / weirs (sediment traps) / ponds / dams planned, with emphasis on upper basin protection works?*
- *Debris, waste and garbage removal, sediment, vegetation and waste, woody debris removal, stream bottom dredging, ditch, etc. in the stream bed. Are/will inspection, repair, cleaning and maintenance work be carried out by qualified personnel?*
- *Construction, infrastructure facility, etc., debris, waste and garbage storage, etc., which reduce the storage capacity of the flood bed in areas where zoning is prohibited. If there are activities, are they blocked?*
- *Are the dry creek beds rehabilitated according to the highest rainfall and the coastline and its immediate surroundings are turned into green areas?*
- *Is the intake of sand and gravel, which disrupts the bed structure of the stream beds and significantly affects the hydrology, prevented?*
- *Have the precautions in the "Climate Change and Disaster Precautions" circulars of the Prime Ministry on 2010/5, 2006/27, 2010/7 and the Ministry of Environment and Urbanization on 22.01.2019 been taken?*
- *Covering sand, gravel, quarries and mining areas in a way that will not harm the environment and not provide large amounts of water to the receiving environment in heavy rains, afforestation, etc. Has attention been paid to hydration?*
- *Trees, plant materials, excavation, garbage, etc. that can narrow the cross-section of the creek bed and/or bridge abutments in the direction of the stream beds. Is the discharge/holding of wastes*

prevented and periodic cleaning, maintenance-repair works of the rivers carried out in order to ensure appropriate flow conditions?

- *Stream beds and floodplains are covered with or without permission, and a building is built on them, such as squares, roads, fields, etc. Are the streams that have been transformed into open channels by being rehabilitated?*
- *Are the Technical Bulletin and/or Flood Zone Building Regulations prepared and used so that the construction materials to be used in areas below the foundation flood (or sub-basement) level are resistant to the damages that may be caused by flood waters?*
- *Preventing the narrowing of the stream sections by closing the side openings of the bridges with the multi-leg and low construction of the bridges, cleaning the accumulated sand, gravel, garbage, floor covering, etc. "Bridge Regulation" for correct applications such as, etc. Have standards been developed and implemented in such a way?*
- *If streams are crossed with box culverts whose roads are dimensioned and constructed according to storm data of at least 100 years (basic flood water height), is this corrected and is climate change taken into account in dimensioning?*
- *Port, highway, etc. Due to the culverts, the flood water that comes with the culverts, prevents the rapid and shortest way to reach the sea, route change, section narrowing, etc. If there are applications, is this situation fixed?*
- *If a drainage system separated from the sewerage system is not installed with the increased number and capacity of gratings to collect the rain water on the roads, remove it from the settlements and transport it to the discharge site harmlessly, is this situation corrected?*
- *Are public education, awareness campaigns, public service announcements and risk communication campaigns carried out within a calendar by determining the target audience (area, cultural levels, education, technical content of the information) and accurately determining how the messages will be delivered to the target audience, so that the public can perceive the flood warnings and take the right precautions and be cautious?*
- *Have signs reminding of flood hazard and past floods placed in flooded areas?*
- *Are the people encouraged to develop and use Compulsory Flood Insurance according to the difference between the subbasement level of the building and the flood water level and the type of foundation in order to transfer the flood risk?*
- *Have exposure avoidance areas (such as floodplain zones, expropriation, enforcement of laws, renewal of flood maps, suitability for settlement, low-density zoning, closure for construction, etc. and freezing of all projects that will encourage false land and building speculation) in the floodplain that may remain under water (basic floodwater height) with 100 years of rainfall in the relevant laws, plans and regulations, and*
- *Have administrative actions been taken and/or public lawsuits against those who make, have and approve local plans in violation of planning principles, and those who do not issue licenses for wrong and unplanned buildings in a way that will increase the exposure to flooding in the stream bed, which cannot be licensed even according to current laws and regulations? ?*
- *In such a way that none of the construction activities in the watershed will cause an increase in the 100-year floodwater level and replacement of the old floodplain (constructing buildings and similar facilities, tilling, planting trees, buying or placing materials such as stones, soil, sand and gravel, etc.) In the form of .) is the intervention to the flood beds prevented?*

  • Are technological developments utilized in the follow-up of invasions and interventions to stream beds and flood facilities (such as Drone, Google earth, etc.)?

• Are the reasons for intervention in stream beds and flood facilities investigated and necessary precautions taken?
• Have measures been taken to protect drinking water, heating, cooling and ventilation (HVAC) systems, fuel systems, electrical systems, sewage management systems and drinking water systems from flood waters, if any, below 30 subbasement (foundation flood water) level?
• Is a check valve system installed in the sewer where necessary so that it does not cause different problems such as physical damage caused by flood waters, sewage system and waste water collection lines in buildings (such as pipes, septic tanks, distribution boxes and pipelines) and health risks related to pollution?
• Moving/transfer/relocation of the buildings in the flood bed to another safe place, raising them on the embankment or columns where they are, strengthening, wet and dry flood protection, barrier, etc. reducing vulnerability with measures and/or is an urban transformation carried out that also takes into account floods?
• Have precautions such as raising the windows, closing the doors with a portable cover, etc.
• Are appropriate gaps created under the buildings that are fully grounded in the floodplain to prevent destruction around them and to balance the hydrostatic forces?
• Possibility/necessity of carrying out flood hazard prevention studies and taking preventive measures in order to completely or partially reduce the floods in the project area (flood trap, river rehabilitation, improvement of the drainage system, supporting and strengthening the slopes, correcting the deformations on the walls, maintenance road, etc.). is there?
• Determining and complying with the maximum water depth that water can reach with 100 years of precipitation for each parcel in the flood-hazardous region. Is the mandatory "flood level" in transactions determined by taking into account the global climate change?
• Has a comprehensive Strategic Environmental Assessment (SEA) been carried out on a basin basis, instead of an Environmental Impact Assessment (EIA) for large flood protection structures that will be envisaged to combat floods?
• Have the measures taken so far, project settlements and approved flow rates calculated in a way to prevent loss of life and/or property in all kinds of facilities, designed with correct recommendations?
• Is the aim, type and capacity of the measures or structures taken and/or proposed so far the most appropriate project in terms of Social, Economic, Environmental, Technical, Administrative and Legal (ELECTIVE) aspects? (Have the proposals such as embankment, embankment, canal, drainage, wall, culvert, etc. been determined individually according to SEÇTİK, not to cause problems in terms of environment and water rights?)
• Will the profitability of the project exceed 1 in line with the expected population growth, development and climate change in the project area, with the measures taken so far?
• City council, etc. Was it decided to shift the stream bed to another place on the paper and to open that area for development?
• Are the adaptation to climate change for floods and flood risk management studies for flood disasters carried out jointly by all relevant institutions and organizations within the scope of Climate Risk Management?" (Kadioglu, 2019)

Table 2. River Management Strategies for Mitigating Flood Risk

Channel Enlargement (widening/deepening): Making the width and depth of the river wider and deeper to increase its cross-sectional area.	**Advantages:** By enlarging the cross-sectional area you are increasing the bankfull discharge of the river along with its hydraulic radius. This will increase the velocity of the river and reduce the chances of it flooding in the immediate area by moving the floodwater further on downstream.
	Disadvantages: If buildings are built up to the river bank it might not be possible to enlarge the channel. Also the process can be expensive and can cause problems to areas downstream who are receiving more flood water quicker, but with an un-enlarged channel.
Channel Straightening: Removing meanders from a river to make the river straighter.	**Advantages:** By removing meanders the velocity of the water through a settlement will increase. This will stop a backlog of water and should reduce the risk of flooding. It also improves navigation.
	Disadvantages: By changing the course of the river, you might remove flowing water from industries that depend on it. There might also be building that have to be demolished to allow straightening. Again it is expensive and may cause flooding problems downstream.
Flood Relief Channels: Building new artificial channels that are used when a river nears bankfull discharge.	**Advantages:** They take the pressure off the main channels when floods are likely therefore reduce flood risk.
	Disadvantages: It can be hard find land to build relief channels, they are expensive and when empty can become areas to dump rubbish, etc. If river levels rise significantly it is also possible for relief channels to flood as well.
Artificial Stores: Creating reservoirs or lakes that can store excess water in times of flood.	**Advantages:** They can remove pressure of the main channel and can become new habitats and serve other purposes e.g. leisure, drinking water.
	Disadvantages: Building dams, sluices, diversion channels are all expensive. They also involve flooding areas of land which may be hard to find near large vulnerable urban populations.
Flood Embankments (levees): Like levees these increase the channel depth of a river, raising its bankfull discharge and reducing the risk of flood.	**Advantages:** They increase the cross-sectional area of the river and therefore its hydraulic radius. This should reduce the risk of flooding.
	Disadvantages: Like in New Orleans under extreme conditions, embankments may fail causing even bigger problems. They are expensive to build and again may cause problems downstream.
Controlled Flooding: Allowing low value land e.g. farmland to flood, therefore protecting higher value areas.	**Advantages:** By allowing the river to flood naturally you are taking the pressure of high value areas, you are letting the river behave more naturally and it adds alluvium to the floodplain.
	Disadvantages: You have to make the decision what is worth protecting which is always going to upset someone. You also have to protect areas that you don't want to flood which costs money (cost benefit analysis)

Afforestation / Reforestation: Simply planting more trees in a drainage basin.	**Advantages:** This is a natural process, increasing the amount of interception, transpiration and root uptake. People would not normally protest against trees being planted.
	Disadvantages: It is not possible to cover the whole drainage basin in trees, so if it rains in an area with no trees, then there is no reduction in flooding. Also most trees lose there leaves in autumn and winter reducing interception in those months.
Flood Proofing: This is making property less vulnerable to flooding or flood damage. This might be temporary like using sandbags or design by removing carpets downstairs.	**Advantages:** This can be done on an individual level and can be relatively cheap. Temporary protection can be removed under normal circumstances so it does not change the aesthetics of properties.
	Disadvantages: Temporary defences can usually only protect against minor floods. Not everyone will be happy with having to redesign their houses.
Insurance: Although it doesn't prevent flooding, it can help individuals and industries to recover and protect against future flooding.	**Advantages:** It helps individuals and settlements to recover after flood events and may help them protect property and be less vulnerable in the future.
	Disadvantages: They do not actually prevent flooding. Not everyone can afford insurance and insurance companies may not insure high risk areas.
Land Use Planning (zoning): Mapping areas by looking at there likelihood to flood and then only building low value uses on areas with high flood risk.	**Advantages:** Very good at removing high value areas and high density populations from hazardous areas.
	Disadvantages: It is not always possible to change land uses that already exist in an area. You have to decide what size flood to map for e.g. a once in ten year flood or once in one hundred year flood. Often poor will still choose to live on marginal land.
Contour Ploughing and Strip Cultivation: Either ploughing with the contours creating temporary surface stores or leaving vegetation to increase interception and transpiration	**Advantages:** Contour ploughing is simply a cheap and easy change in existing farming methods, Keeping vegetation is natural and relatively cheap.
	Disadvantages: Won't protect against big floods and farmers may not be happy giving up farmland, simply to grow trees.
Interception Channels: These are channels that divert a rivers' discharge around settlements. The old channel remains but with a smaller discharge.	**Advantages:** They remove pressure of the main river and areas of high land value. They may also develop into new habitats for plants and animals.
	Disadvantages: They are expensive, may flood themselves in times of heavy floods and may restrict future urban
Settlement Removal: Moving settlements from high risk flood areas to less vulnerable locations often on higher land.	**Advantages:** Is probably the most effective because you remove high value property and humans from vulnerable areas.
	Disadvantages: It is usually not practical to move whole settlements, because of the cost and the problems of finding alternative locations. Also many settlements depend on water for their survival.

Dams: Often built as part of a multipurpose scheme, they create artificial stores which can hold water in times of increased precipitation.	**Advantages:** They can store large amounts of water and can be used for other purposes.
	Disadvantages: If rain is downstream of the dam then they have no effect. In large flood events they are vulnerable to breaking and are expensive to build.
Wing Dykes: Barriers placed out into a river, these can be used to divert the cause of rivers by shifting the thalweg of rivers. This may move the channel away from high value areas.	**Advantages:** They can move the main channel from vulnerable areas to protect high value areas.
	Disadvantages: They are expensive to build and during big flood events the flood water may go over the wing dykes. Also if there is property on both sides of a river, which side do you protect.
Electronically Controlled Sewers: Advanced sewers which can control the flow of rain water to stop increased discharge into rivers and therefore flooding.	**Advantages:** They can be very effective at controlling smaller floods. They are underground so do not cause any visual pollution.
	Disadvantages: This involves a complete redesign of sewers. Sewers usually have to be increased in size and electronic sluices have to be added. They also have to be operated from a central command centre and with all electronically operated equipment can break. Also they might not be able to cope with large scale floods, so water has to be released into rivers anyway.
Channelisation: The concreting of beds and banks.	**Advantages:** Reduces friction and increases velocity of river, removing water from the channelised area quicker. Bank erosion is also reduced.
	Disadvantages: It is expensive and is not natural so vegetation and animal life will find it harder to grow and live. Flooding maybe caused downstream of the channelised area.
Dredging: The removal of material from the bed of the river deepening it.	**Advantages:** Channel cross-section is increased so the river can hold greater discharge. It can look more natural because no structures are built.
	Disadvantages: Deposition can mean that dredging needs to happen regularly.
River bank conservation: Protecting the banks and sides of the river to reduce erosion. This can be done through planting vegetation.	**Advantages:** It looks natural, promoted wildlife and is relatively cheap compared to hard-engineering.
	Disadvantages: During large flash floods vegetation can be easily removed.
River restoration: Returning a river to its natural state before it had been managed. This might involve removing channelisation.	**Advantages:** This looks natural, is attractive and can attract wildlife. Can allow the floodplain to become more fertile.
	Disadvantages: Can't protect against big floods and may have to coincide with zoning

Source: *https://www.thegeographeronline.net/uploads/2/6/6/2/26629356/river_management_strategies.docx*

3.2. Coastal Region Floods

The severity of the global climate catastrophic events is getting worse every day. The recent fires and flooding are the first obvious indicators of the disaster and we are about to witness events that will change the world's geography for the next 100 years. As the average temperature of the world increases, it will become inevitable to experience very rapid changes in the oceans and polar regions, especially in the ratio and amount of gases in the atmosphere composition. The waters in the oceans will warm up, heat waves will be experienced more frequently, the acid levels of the waters will increase while the oxygen levels will decrease. These developments, which are directly related to human activities, will affect both the ocean ecosystems and the people and lives connected to these ecosystems. These changes are expected to continue at least until the end of this century. It is estimated that extreme sea level events, which occurred once in 100 years in the past, will become more or less experienced annually towards the end of the century.

According to the results of the Intergovernmental Panel on Climate Change (IPCC), the global average sea level rise is expected to be approximately 1 meter until 2100. A 1 meter rise in sea level means that the sea enters 100 meters of land. In other words, a significant part of the areas 100 meters inland from the coast are at risk of being submerged under sea waters. Likewise, it is claimed that there will be an increase in the intensity and frequency of meteorological and hydrological events such as hurricanes and storms with climate change. With the rising sea level, floods caused by storm waves are expected to be more frequent. Even a mere rise in sea level can result in increased coastal flood risks and permanent inundation of coastal low-lying lands. It therefore indicates that coastal flooding associated with sea level rise will become a significant problem in the next 100 years, especially as the human population continues to grow and occupy the coastal area.

Scientific research has shown that; The regions that will be most affected by sea level in Türkiye will be the Aegean and Marmara Regions. Especially, it is expected that a large part of İzmir will be under water. It is predicted that especially in the southern districts of Istanbul, the neighborhoods close to the sea will be more likely to be at risk. Likewise, it is estimated that low altitude areas in many provinces of Marmara such as Bursa, Balıkesir, Yalova and Çanakkale will also face the risk of being submerged. By 2100, it is expected that a significant part of Turkey's most productive agricultural lands in the Marmara and Aegean coasts and the eastern parts of the Mediterranean coasts (around Çukurova) will become unusable due to sea water floods and almost all of the delta plains on the coasts will be flooded. Ergene in Thrace; Biga, Gonen, Karacabey in Southern Marmara; Gediz and Büyük Menderes in the Aegean; Finike, Antalya, Silifke plains and Çukurova in the Mediterranean; It is estimated that the Bafra and Çarşamba plains in the Black Sea region will become non-farmable in 80 years.

The most important way to prevent flooding in coastal areas is to reduce global sea level rise. This can only be achieved by further reducing greenhouse gas emissions on a global scale. However, sea level rise is expected to continue for a while, at least until the end of the current century, even if significant strides are gained in emission rates. As a matter of fact, some international conventions have been implemented in this regard. International climate change policies, such as the Kyoto Protocol, seek to reduce the future effects of climate change, including sea level rise.

Türkiye is a country surrounded by seas on three sides, and the total length of its coasts is 8483 km. (Black Sea coast 1719 km), Marmara coast 474 km, Mediterranean coast 2025 km and Aegean coast 3265 km). Istanbul is surrounded by the Black Sea from the north and the Marmara Sea from the south. The Bosphorus connects the two seas. The bathymetry map clearly shows that sea depth increases sharply over short distances from the coast to the open sea on both the Black Sea and the Marmara Sea coasts. This situation, especially in severe weather, creates wave breaks near the shore, and the breaking and cracking waves rapidly advance to the shore, causing coastal flooding and significant erosion. The fact that the prevailing wind directions in Istanbul and its surroundings are generally northeast-southwest and southwest-northeast makes this situation difficult.

It should be noted that not all floods occurring in the coastal areas of the districts on the coast of the Marmara Sea are related to strong waves coming from the open sea. Even in districts such as Avcılar, Bakırköy, Zeytinburnu, Kartal, Maltepe, Pendik, Göztepe, Kadıköy, Bostancı, Eminönü, the streams flowing into the sea have either disappeared or their natural flow paths have changed significantly due to intense urbanization. Especially in these districts, the reinforced concrete residential areas built in the style of housing estates have almost turned into small local artificial water collection basins. The reinforced concrete structures in these basins completely destroyed the permeability of the ground. Especially after heavy downpours, rain water accumulating in such small basins, before it has time to infiltrate into the soil, passes into the surface flow and flows to the shore.

The most important factors that disrupt the dynamic balance of the coast are either natural factors such as the formation of large storms as a result of abnormal changes in the seasons, or artificial (man-made) factors that occur as a result of various human activities. While the effect of natural factors manifests itself in long periods that can be expressed in decades, the results of artificial factors can be seen in short periods of a few years or even a few months (High, 1995).

The most important artificial factors that disrupt the coastal balance are; It is the deterioration of the solid material transport regime of the coast as a result of uncontrolled material taking from the coast, preventing the material feeding the coast and making unconscious construction. Today, problems caused by these negativities are frequently encountered. Erosion caused by harbor and shelter breakwaters and shallowing of the harbor basin, scour caused by coastal walls and fortifications, and coastal change problems caused by coastal structures such as spur and offshore breakwater are just a few of the most current and important examples that can be given in this regard.

Curently, a number of engineering and natural defense measures and methods have been developed to prevent coastal flooding and reduce coastal erosion rates. Some of these methods are more costly but longer lasting than others, while others are less costly, unsightly and durable structures. Details of these adaptation methods are given below.

3.2.1. Hard Engineering Methods:

- Hard Engineering Structures: Various structures are constructed using engineering techniques in order to reduce or completely stop the flood and erosional processes that are effective on the coast. With this type of techniques, it is aimed to reduce the breaking or erosion power of the waves on the coasts, which are generally composed of high cliffs. They are built on flat coasts with a slight slope, especially in stormy weather, in order to prevent the occurrence of sea waves, floods and overflows on the coast.
- Structural solutions “Hard Engineered Structures”; These structures consist of structures built on the coast (Coastal walls, breakwaters, artificial headlands) or in the more open sea (sea breakwaters). These structures are built to prevent or reduce coastal erosion and coastal flooding.

    1. Seawall,
    2. Revetments,
    3. Spurs or groins,
    4. Curtain walls (bulkhead),

5. Breakwaters

Such structures often provide local solutions for coasts in danger from strong sea waves.

3.2.1.1. Coastal protection structures

3.2.1.1.1. Seawall

Coastal walls are a form of coastal defense that are built when the sea and marine-related coastal processes directly affect coastal landforms. The purpose of construction of sea walls is to protect human settlements and various structures from normal sea or tsunami waves. Since sea walls have a static feature, they prevent the functioning of natural dynamic processes effective on the coast and prevent the exchange of sediments between the land and the sea. Coastal walls are structures that protect the coast from wave action and are built parallel to the coastline (Figure 35). These types of structures come in many different designs; can be used to protect a cliff from wave attack and improve slope stability, and can also dissipate wave energy on sandy shores.

Şekil 1. Kıyı duvarı (Sea Wall) örnekleri

The advantages and disadvantages of these structures are as follows:

• They provide excellent defense in places where wave energy is high.

• They are long lasting

• It causes the waves to divert to other areas and supports the transport of sediment in the sea.

• Holes occur at the bottom of eroded beaches.

• It disrupts the natural balance on the beach.

• Must be built along the entire coastline; Otherwise, erosion will occur in the adjacent shoreline.

• It can be quite expensive to build

• Creates an ugly image on the shore

• They can make it difficult to access beaches

• Curvy seawalls can cause further erosion at the base of the wall.

3.2.1.1.2. Revetments

Revetments consist of stone, concrete units or slabs and similar structures constructed to protect a cliff or the foot of a dune, a barrage or a seawall from erosion by wave action, storm surge and currents (Figure 36). This definition is very similar to the definition of a shore or sea wall, but the covering does not provide protection against flooding. Also, cladding often supplements other types of protection, such as seawalls and embankments.

Figure 36. Examples of shoring or coatings (revetments)

3.2.1.2. Coastal Stability Structures

3.2.1.2.1. Groynes

The breakwater that protects a harbor or coastal area from the destructive waves of the sea is called "Groyne". Groynes can be built at sea regardless of the port or as an extension of the port. Groyne can also be defined as ports built on the sea shores by means of a breakwater. Groynes built on the coasts are mostly built perpendicular to the coast in order to prevent or reduce the amount of solids transport along the coast, to prevent coastal erosion, and to create a new shoreline or protective beach (Figure 37).

- The part of the groyne connected to the shore is called the spur root, the part extending towards the sea is called the groyne head, the upstream side is called the groyne front, the downstream side is the back side, and the water section between two groynes is called the groyne area.

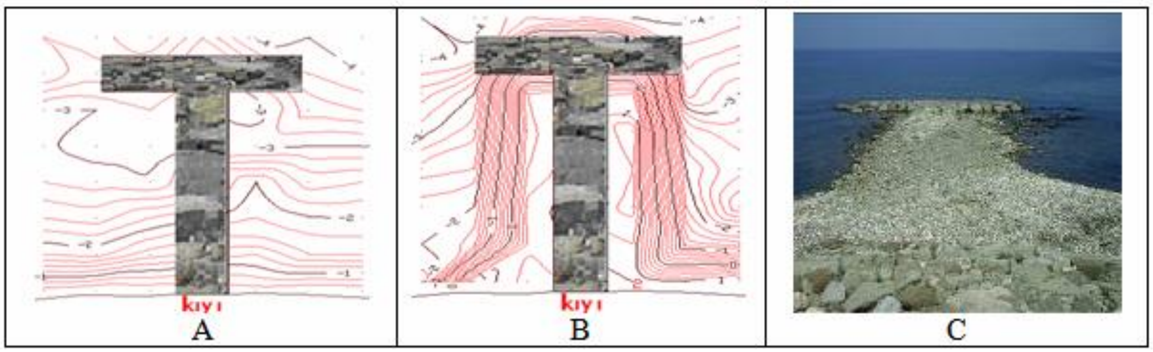


Figure 35. Mahmuz veya mendirek (Groyne) örnekleri

These structures, which are built perpendicular to the coastline from the coast to the sea, are built to stop the transport of sand (sediment) along the coast or to control the speed and direction of the coastal currents. These types of structures are easy to construct from a variety of materials such as wood, stone or concrete and are normally used on sandy shores.

Offshore breakwaters provide protection of the coast from erosion and strong wave energy by weakening the wave energy in the area between the coast and the coast where they are built. The waves reflected or propagated by striking these structures become smaller and their energy decreases due to wave rotation as they pass by the edges of the breakwater. As a result, the waves, the sand on the shore, etc. As the transport energies are weakened, the accumulation of solid material begins on the coastal sides of the structures and this agglomeration moves from the shoreline to the structure over time. This accumulation may sometimes reach the structure and merge with the mole and the shore (Figures 36, 37 and 38).

Advantages:

• Significantly reduces the energy of high waves that cause cliff erosion.

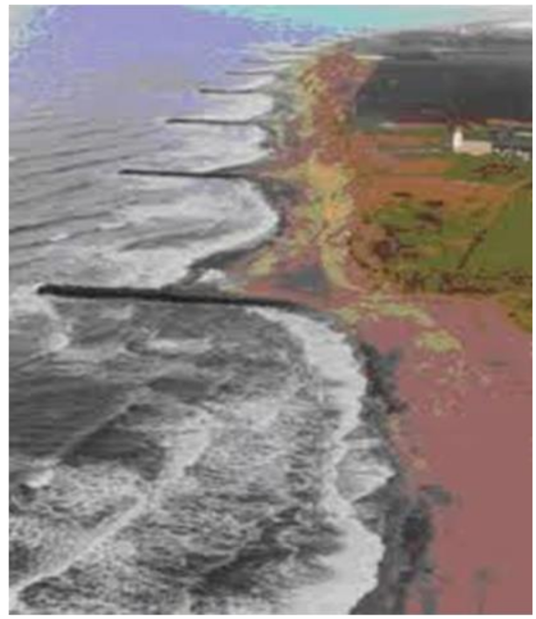
• It is a cheaper method compared to other engineering methods.

Disadvantages:

• While they cause erosion in some places along the coast, they cause excessive sand accumulation in some places.

• The shoreline becomes irregular and a bad appearance appears.

• The balance created by natural processes over a long period of time on the coast is disturbed.



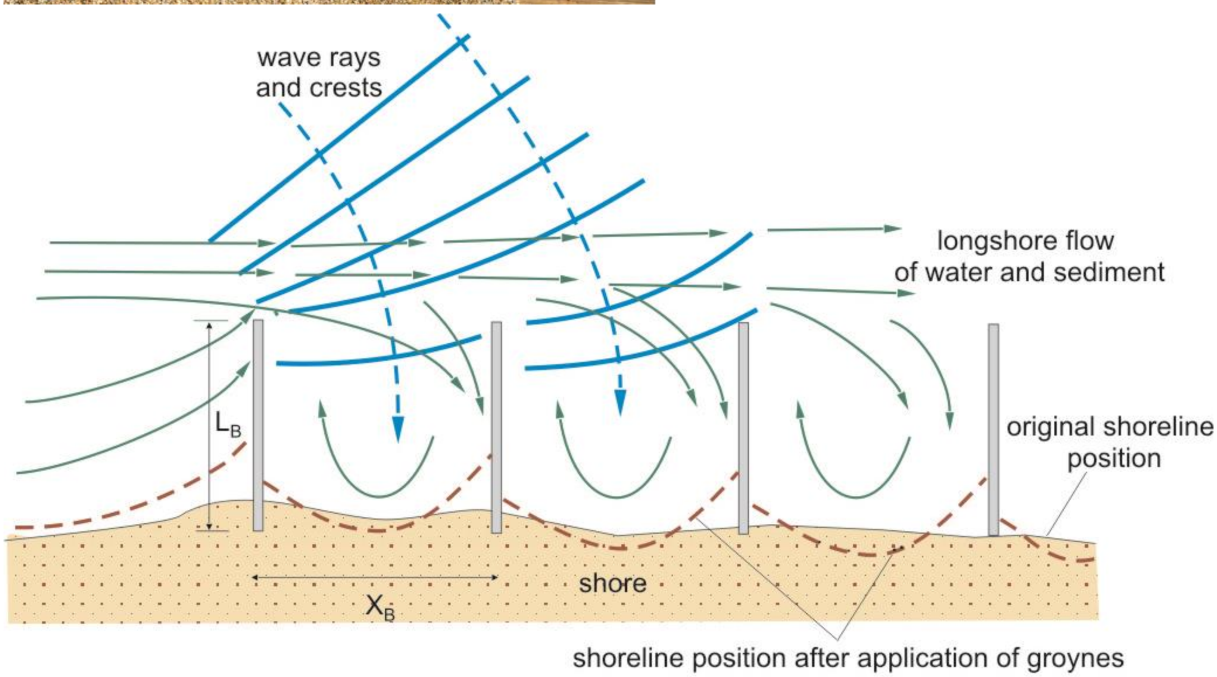


Figure 36. The interrelationship of groynes, waves, currents and shore

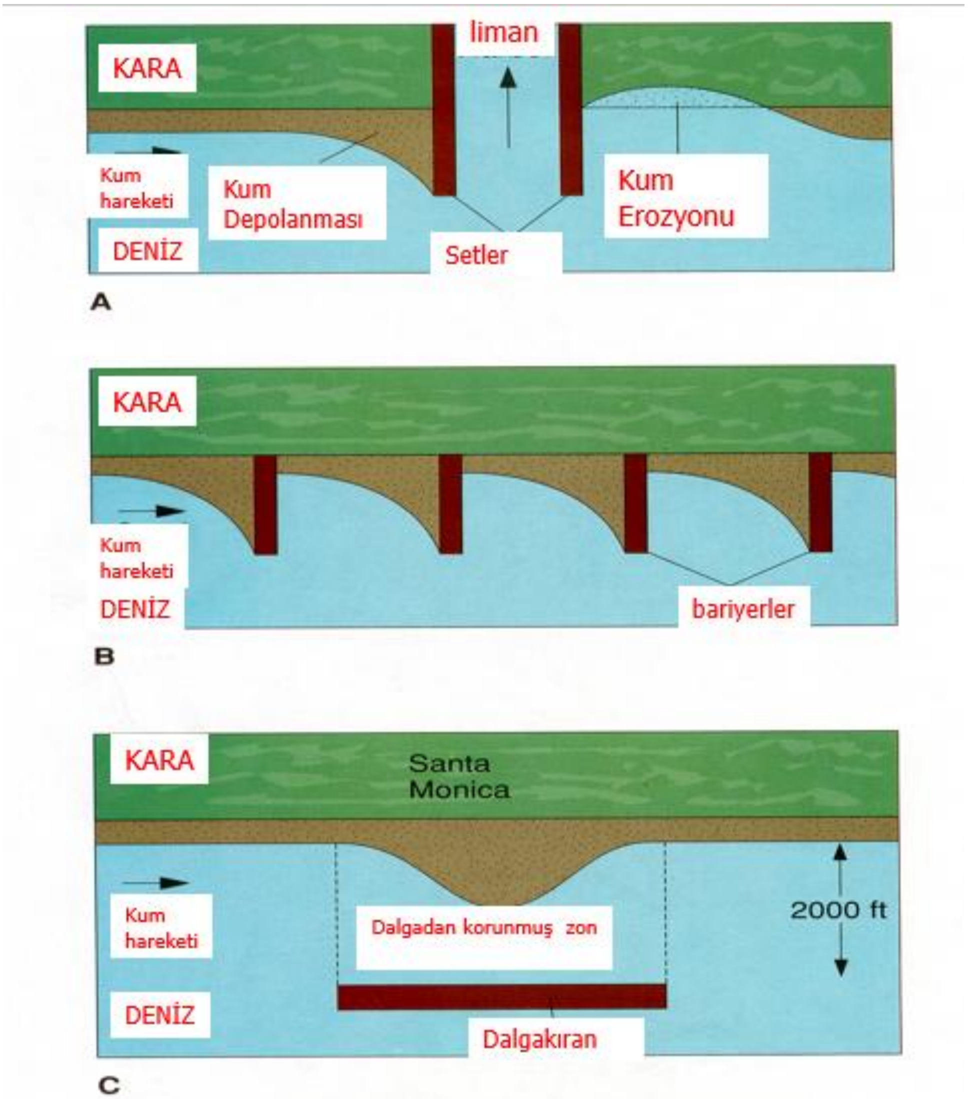


Figure 37. Schematic diagram showing the interrelationship of Groynes, waves, currents and shore

3.2.1.2.2. Rip-Rap, Rock Armor

Rip-Rap or Rock armor – structures made of large stones piled on the beach to prevent wave erosion and thus erosion on the shore. They usually consist of large rocks placed along the base of a cliff to absorb the energy from the waves (Fig. 40).

Rip-Rap is man-laid rock or other material used to protect shoreline structures from scour and erosion by water, wave or ice. Ripraps are used to shield shorelines, stream beds, bridge piers, basic infrastructure supports and other shoreline structures against erosion. Common rock types used include granite and modular concrete blocks.

Advantages:

They are very low cost structures and significantly slow down erosion

Disadvantages:

They create an ugly appearance on the shore

They pose a danger to believers' access to the beach

The rock used for Rip-Rap making increases costs when imported.

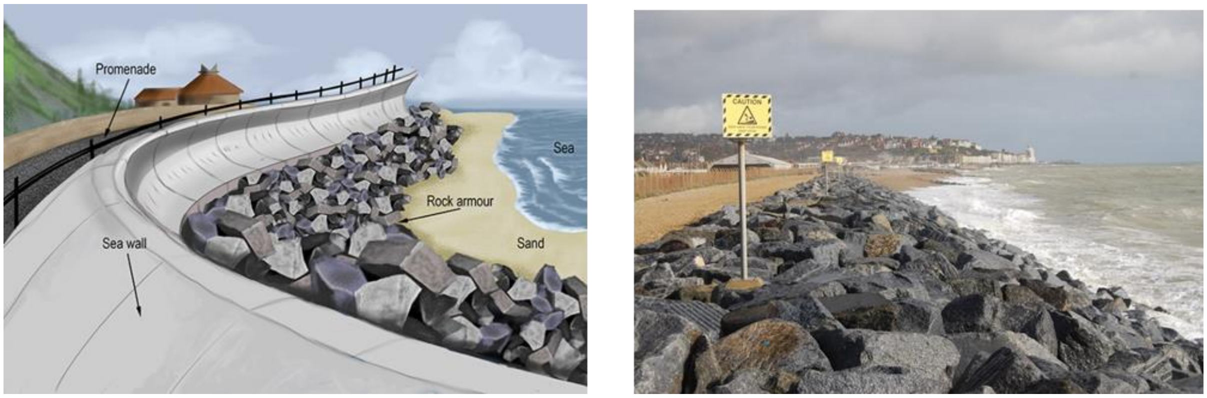


Figure 38. Rip-Rap, Kaya Zırhı kıyı koruma örnekleri

3.2.1.2.3. Gabions

Gabions are basket-like structures made of cobblestones or wire mesh filled with crushed rock or stones (Fig. 39). They are usually filled on-site with locally available material and are therefore relatively low cost. Because they are flexible and porous, they can absorb the energy of a wave, thus reducing the scour problems associated with impermeable marine pavements such as concrete seawalls. Gabions can be placed close to inclined "mattresses" or vertical cubic baskets. Second, it is designed for stabilization of shore or cliffs and is not normally suitable for use in shoreline situations.

The purpose of a gabion cladding structure is to provide short-term (5-10 years) protection against coastal erosion by absorbing wave energy along the dune surface. Their application is limited to the upper part of sandy beaches as they are not durable enough to withstand regular direct wave action.

Figure 39. View of various Gabion structures on the shore.

Advantages:

Construction costs are low

They provide highly effective protection

Disadvantages:

They don't offer a good view

They cannot withstand very strong waves

3.2.1.2.4. Offshore Breakwaters

Artificial offshore breakwaters not only have the potential to protect sensitive beaches, but also have the potential to actively promote beach expansion and growth through sand deposition.

Artificial reefs constructed with geotextile sand containers and various man-made materials such as concrete or stone can cause wave breaking at some distance from the shore, protecting the shoreline from erosion (Figure 40). Wave breaking involves changing the angle at which waves hit a beach. Simply changing the approach angle of prevailing currents can greatly improve a beach's sand agglomeration regime, as sand is removed from shore by currents moving away from shore and deposited by currents approaching shore.

Advantages

• Due to the decrease in wave energy, it causes sand accumulation on the beach.

• Due to these structures, waves break further offshore and therefore their erosive power is significantly reduced.

Disadvantages

• It can be disassembled and difficult to reassemble during severe storms.

Figure 40. Offshore Breakwaters built to protect the harbor-California-USA)

3.2.2. Environmentalist (Soft) Coastal Protection Structures

Environmentalist coastal structures include practices aimed at slowing the effects of floods and erosion on the coast. In fact, these options are not long-term solutions or permanent solutions.

3.2.2.1. Coastal Nourishment/Repenishment

Various methods are used to protect the coasts and to contain the material in motion along the coast. Artificial recharge is a soft structure type used as an alternative to hard structures such as coastal fortifications and spurs to protect coasts (Figure 3.31). It consists of applications of placing large amounts of good quality sand offshore (Dean, 2002). Shore recharge practices are expressed as shore regeneration or artificial shore recharge. Artificial coastal feeding is generally made to protect the coast and the back coast on the coasts that are subject to erosion and to enable people to use them for recreation and recreation. For coasts, coastal erosion due to the sand deficit in the system is a serious problem. Adding sand to the system with artificial feeding is one of the techniques applied to solve the problem. Protecting the coast with rigid structures such as fortifications, spurs and coastal walls can only be effective in that area.

Beach Repenishment is the process of dumping or pumping sand from an eroded beach strip to create a new beach or expand an existing beach (Figure 41). Beach repenishment does not stop erosion, it just delays the erosion created by the waves for a while. Instead of destroying homes, roads or parking lots, waves erode sand deposits added to the site. Since repenishment does not permanently stop erosion, the repenishment process must be repeated at regular intervals to protect the beach. Renewal of the coasts with sand feeding is a method that is generally preferred in recent years (Yüksel, 2005).

Figure 41. Beach nourishment/ replenishment views

Advantages:

-Preserves the natural appearance of the beach

Disadvantages:

The removal of sand and gravel from one part of the shore increases erosion in other areas and can affect ecosystems.

- Since a significant amount of material will be transported on the beach after major storms, compensating this material with the feeding method may cause an increase in cost.

- Depending on the source of the sand, operations can be expensive.

3.2.2.2. Relocation

It covers the applications of moving the coastal structures from the coast to the inland in order to protect them from the effects of erosion and coastal floods. This displacement takes into account both absolute and relative sea level rise and the rate of erosion processes. This practice consists of the processes of moving various types of coastal structures towards inland areas, taking into account the severity of erosion and the possibility of coastal structures being exposed to sea pressure.

3.2.2.3. Ensuring controlled erosion of the coast

This process usually takes place in areas where the land is of low value.

Cost: Depends on the amount of compensation to be paid to people affected by erosion.

Advantages:

• Controlled erosion of the coast preserves the natural balance of coastal systems.

• Worn material encourages the development of beaches and salt marshes.

Disadvantages:

• People lose their livelihoods, eg. farmers. These people will have to be compensated.

3.2.2.4. Changing the slope of the cliff steepness by terracing to increase cliff stability.

• Terraces are structures formed by digging along the contours of the slope and piling the soil to the lower part in the coastal areas where the slope is high. Local large stones and boulders can also be used for terracing.

• Terracing is one of the oldest methods used to reduce flood events on the coast, to protect soil and water assets, and to obtain agricultural land in areas where population density is high and agricultural land is low.

• Terracing works are done in areas where the land slope is high. In general, if the slope of the land is above 5%, it is accepted that the rain water passes to the surface flow without being able to seep into the ground, and accordingly, the risk of erosion begins on such sloping slopes. In case of 5%-12% slope, it is possible to protect from erosion by plowing perpendicular to the slope, without the need for land terracing. The slope range required for terracing can be realized in a wide range between 15% and 60%.

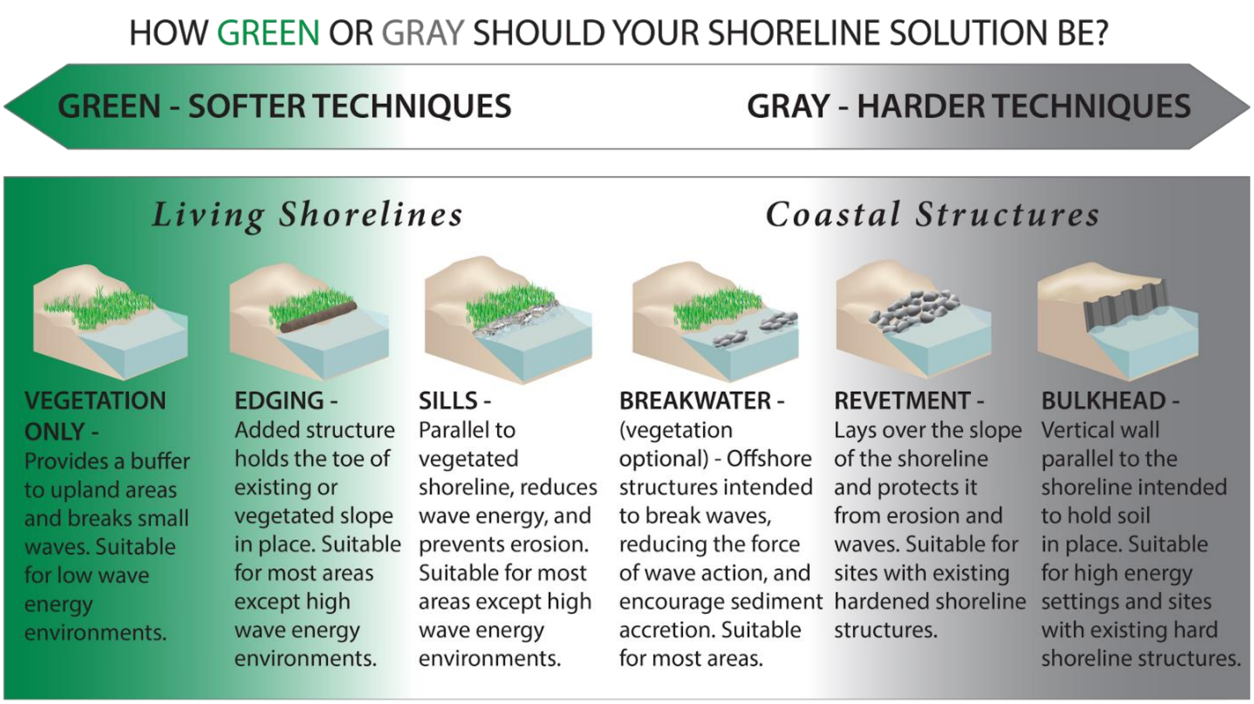
• Local conditions determine the size, shape and effectiveness of terraces. The productivity of a terrace system is enhanced by the application of additional conservation practices such as proper land preparation (contour plowing and planting), proper cultivation of crops (stripe planting, etc.), and maintaining a permanent ground cover.

• Depending on the plant growing conditions of the region, terraces take different names according to their purpose and construction. Terraces created in order to reduce the damages of surface water flow caused by precipitation in rainy regions are called "sloping terraces". In addition to the surface flow prevention and soil protection effects applied in regions with arid and hot growing conditions, the terrace shape that aims to retain water and leak the soil is called "sloping terrace".

• Terraces, thanks to their unique structures, prevent the rapid flow of water on the surface and facilitate its infiltration into the soil, but if its maintenance is neglected, it can trigger soil degradation.

• Türkiye has mostly mountainous and sloping geography. Especially in the Aegean and Mediterranean, where sloping lands are common, terracing and terracing are priority activities to give importance to food safety and soil health.

Figure 42. Changing the slope of the cliff or terracing the cliff steepness to increase the stability of the cliff



4. ECOSYSTEM-BASED ADAPTATION METHODS FOR CITIES TO MITIGATE EFFECT OF CLIMATE CHANGE

Climate change, which occurs in the natural balance of the atmosphere and whose main reason is the increase in the amount of carbon dioxide added to the atmosphere as a result of human activities, creates negative effects in many areas, especially in cities. If climate change, which will make its impact more felt in the coming years, is not taken timely and the process is not managed effectively, irreversible results may occur (Hobbie and Grimm, 2020). Nature-based solutions appear as an inclusive term that includes many concepts related to adaptation and mitigation of climate change in urban areas. The concept emerged from the search for innovative solutions to manage natural systems in a way that can balance benefits for both nature and society, conceptualized to meet global biodiversity and climate change goals (Warren, 2020). The main purpose of nature-based solutions is to support the achievement of society's development goals, protect human well-being in ways that reflect cultural and societal values, and improve the resilience, regeneration capacity and service delivery of ecosystems (International Union for Conservation of Nature (IUCN), 2016). The main features of the applications under this concept are that they are solutions inspired by nature and input from nature, taking into account environmental, economic and social benefits (Yaman and Yenigül, 2022).

The IPCC's science assessment (2007) agreed that most of the observed increase in global average temperatures since the mid-20th century is most likely due to the observed increase in anthropogenic greenhouse gas concentrations, and that this is a human-based development problem (Kayasü, Büyükcivelek, Durmaz). , Karadoğan and Akça, 2020; Karapınar, Özertan, Tanaka, An and Turp, 2020). In addition, the IPCC report estimated that the temperature increases for 2050 will be around 2.5-3°C, and that the increases will reach 4-6°C at the end of the century. He describes the economic, social and environmental risks created by these temperature increases and climate change as one of the biggest risks faced by human history (Cited by Karapınar et al., 2020).

Studies have shown that the effects of climate change on different countries and sectors can be very diverse. While it has been stated that the change will be felt more intensely for the sectors operating in agriculture, forestry and coastal regions, developing countries will be more affected by global climate change than developed countries. While the effects of global climate change will focus on environmental and socio-economic factors, its effects will cause chain effects and cause destruction in environmental, social, human health and economic dimensions. The effects of climate change are outlined below;

• Sea level rise,

• Deterioration in marine and coastal ecosystems,

• Changes in precipitation regimes,

• Drought and desertification, decrease in agricultural product productivity due to changes in precipitation regimes,

• Problems to be experienced in food security and water security with the scarcity of resources,

• Air pollution, acid rain and negative consequences on forests,

• Increase in epidemic diseases

Restoring and protecting nature is one of the biggest strategies to combat climate change, but it's not just because plants absorb carbon from the air. Forests, wetlands and other ecosystems act as buffers against extreme weather conditions, protecting homes, crops, water resources and vital infrastructure. The strategy of using nature as a defense against climate impacts is called ecosystem-based adaptation (EbA). Ecosystem-based adaptation is a strategy for adapting to climate change that leverages nature-based solutions and ecosystem services. For example, mangrove forests protect coastal habitats in tropical regions and provide natural flood protection. Reforestation can stop desertification during times of drought and they feed groundwater resources. Water bodies such as rivers and lakes create natural drainage areas to reduce floods.

Nature-based solutions, which emerged as an understanding of issues such as agriculture and water management, have also become an important tool for the climate struggle of cities, especially in recent years. Because such solutions are both multifunctional and cost-effective, and they also have side benefits that will contribute positively to many issues such as public health, energy costs, and air pollution. Among the ecological-based solutions that can be implemented in cities are green roof and green infrastructure applications against extreme weather events, urban gardens and gardens that can ensure food sovereignty, green corridors and green areas against heat waves. Another benefit of the green infrastructure, which will provide a more comfortable and healthy life in the city, is that the water that falls due to heavy rains is transferred to the soil instead of being discharged out of the city as in the gray infrastructure. In this way, disasters such as floods and floods are not only prevented; At the same time, groundwater resources are fed.

At present, many cities around the world are taking quick steps towards nature-based solutions for a sustainable fight against climate change and implementing innovative solutions suitable for their local conditions. At the forefront of nature-based solutions is the reproduction of ecologically-based green spaces in urban areas within the bounds of possibilities. Because green areas, with their vegetation, primarily cooling the air and reducing the heat island effect, carbon capture and storage, cleaning the atmosphere by removing pollutants, enriching the soil with organic materials, providing food and shelter for wildlife, supporting biodiversity, reducing precipitation waters. They have many functions such as preventing surface runoff, feeding underground and surface water resources, reducing wind and precipitation erosion, filtering noise, reducing energy consumption, and providing recreational opportunities. These ecological, socio-cultural and economic functions contribute to the protection of the health and quality of life of the people of the city (Hepcan, 2019).

Ecosystems provide numerous benefits to all living things in their environments. All of these benefits, products and services that emerge as a part of the ongoing natural processes in ecosystems are defined as ecosystem services. Procurement services are classified under four groups as regulatory services, habitat or supporting services, and cultural services (Hepcan, 2019).

The ecosystem services provided by each component of the green infrastructure system vary depending on the ecological characteristics of these areas (location, size, spatial distribution, structure and density of vegetation, etc.). It is important that cities are built with green networks, in other words, the components that make up the green infrastructure are in physical connection with each other. The ecosystem services provided by the green infrastructure system, which includes green areas with high ecological qualities, designed to form functional links with each other, reduce the effects of climate change (Hepcan, 2019).

Regulatory ecosystem services provided by ecosystems play an important role in reducing the effects of climate change in cities and increasing the resilience of cities against these effects. These services are; The benefits derived from ecosystem processes, in which ecosystems act as regulators. Improvement of air and soil quality, climate regulation, mitigation of natural disasters such as floods and landslides, disease control, water purification, waste management, pollination/pollination, biodegradation or control of harmful species can be counted among the regulatory services (Hepcan, 2019). Ecological-based adaptation methods in many cities of the world are explained below within the scope of combating climate change in cities.

4.1. Sponge Cities

Climate change is having a significant influence on urban infrastructure. Many cities are equipped with infrastructure systems that are built to accommodate existing precipitation patterns and water supplies. However, climate change causes city flooding and water pollution. In response to climate change, existing municipal water cycle regulations have changed, and urban infrastructures have become insufficient. The capacity of people to use water properly has been hampered as a result of climate change. Precipitation regimes have shifted, and droughts or storms with heavy precipitation have caused significant challenges for cities. For example, urban infrastructures designed to collect rainwater are no longer adequate. This circumstance compels towns to adopt a climate-friendly and ecologically sound green infrastructure strategy.

The primary goal of Cities with Permeable Surfaces, or "Sponge Cities," is to ensure that precipitation is absorbed by the biological surfaces of the city with carbon sink areas and used by plants, and that the city's infrastructure is more flexible and resistant to potential floods and overflows. This reduces conditions that can have a negative impact on urban life, such as floods, that can cause significant damage in cities, and heat island impacts.

Several countries now consider sponge city techniques as one of the most effective ways to mitigate climate change (Figure 43). It is viewed as a long-term solution that will allow surface waters, particularly those created after heavy rains, to enter, absorb, and store for various reasons. The primary purpose of sponge city applications is to keep rain water from entering surface flow and to build surfaces that absorb rain water like a sponge. Water storage and usage in urban areas, as well as soil absorption and use by plants and animals, give benefits not only in terms of catastrophe and flood, but also in terms of supply. Cities can utilize this technology to meet part of their water demands. Cities can utilize this technology to receive some of their water needs from precipitation. Floods, floods, and the loss of life and property caused by them can be avoided in sponge cities; on the other hand, water supply can be provided without carbon emissions using low treatment levels such as garden irrigation and toilet reservoir water, and the city's water demand decreases. Sponge cities can become resistant to shifting climatic circumstances in terms of water supply in this way.

Figure 43. Views from Sponge city applications in Chine.

4.1.1. The Importance of Sponge City Approach in Stormwater Management

Sponge city, Green Infrastructure Techniques, and Water Sensitive Urban Design are all ways based on ecological-based rainwater management that have been developed as an alternative and support to these systems in addition to classical or traditional urban drainage systems. Without these measures, all current infrastructures constructed using traditional methods would have to be considerably altered in order for cities to become more robust to climate change, the consequences of which are already being felt severely. This strategy will likely result in significant infrastructure development and expropriation expenses, as well as a variety of economic and environmental consequences, such as traffic congestion, as city transit in established corridors would be closed during construction.

It is critical to control stormwater utilizing green infrastructure approaches, particularly in metropolitan settings. The main method in this management is to collect, store, and leak rainwater as much as possible in the region where it falls. Thus, minimizing runoff on streets and highways relieves existing infrastructure systems and prevents flooding. Furthermore, the natural environment improves, biodiversity rises, and urban heat island effects are decreased as a result of the green infrastructure approaches used.

With changing climatic circumstances, greater volumes of precipitation fall on cities in a shorter period of time, putting a strain on the city's current storm water infrastructure. "It is expected that the Sponge City Project will eliminate these strains on the infrastructure through the use of various green infrastructure techniques such as rain gardens, biological ditches, permeable roads, above ground tanks, and infiltration ponds."

4.1.2. The Importance of Green Infrastructure Designed as Part of the Sponge City Application in Stormwater Management

Stormwater management tries to absorb, store, and filter water before it into the deeper winter by utilizing green infrastructure approaches and nature. In this regard, stormwater infrastructure reduces urban flooding and the urban heat island effect, while also improving the built environment and biodiversity. It tries to improve the environment by minimizing pollutants in runoff waterways. Rainwater collected or gathered is utilized for irrigation or residential uses.

4.1.3. Rainwater Harvesting in Sponge Cities

The sponge city concept aims to collect, purify, and reuse rainfall while also replenishing groundwater. This notion is supposed to provide an answer for floods. In other countries, sponge city applications are referred to as Green Infrastructures, Sustainable Cities, Smart Cities, or Sponge City Applications. Sponge cities are simply nature's imitations. When we don't mess with nature, the waters naturally meet the land and groundwater. Water is also collected by nature on various water surfaces, marshes, and lakes and is naturally presented to animals and plants. Imitating nature while developing cities is a high-tech prerequisite.

4.1.4. How Does the Sponge City Work?

The sponge city concept is currently not common in Turkey. The sponge city concept implemented by China has also started in the Netherlands, Germany and the United States for a long time. In projects of this type, cities are generally designed to absorb water as a whole. In this context, formerly waterproof surfaces such as asphalt roads and pavements are made permeable, so that the water collected on such surfaces is collected in “bioswale” or rain gardens and sometimes in ditches or underground pools. With this application, the amount of water mixed with groundwater increases significantly. Another application is the water collection pools and open canals established in the city. These areas are used as green infrastructure both to prevent floods and overflows and to collect water.

4.2. Green Roofs and Vertical Gardens

Urban green spaces, green roofs and vertical gardens are also very important in sponge city designs. Some of the biotope areas in the city are vertical gardens. The use of vertical surfaces is critical when there is no space left on the floor. These areas, which capture and use water, also meet the green needs of the city. On the other hand, the excess water collected on the roofs can be conveyed underground with the help of channels (Figure 44).

Figure 44. Various uses of Green Roofs and Vertical Gardens.

4.3. Ecologically Based Surface Flow Control Methods in Cities

4.3.1. Roof-top Techniques

• Green Roofs

• Intense Green Roof

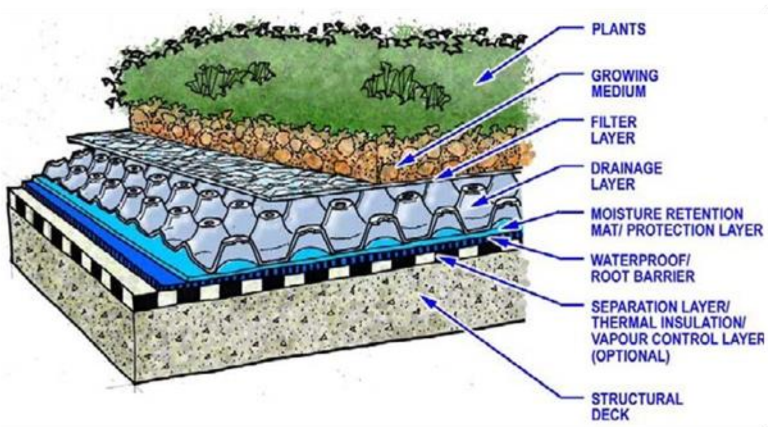
• Roofs Without Cover

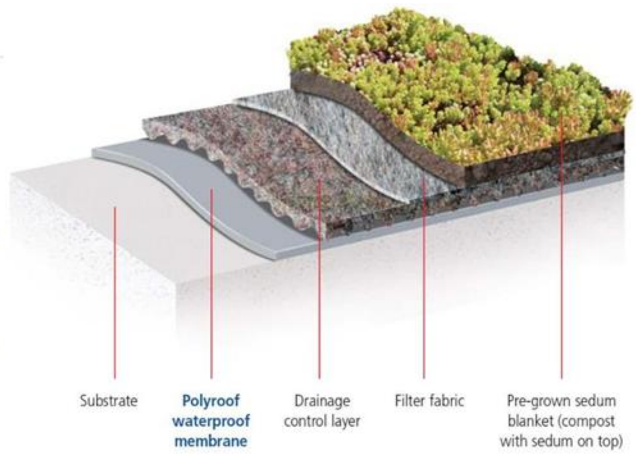
4.3.2. Green (Grassed) Roofs:

Roof gardens moderate the hot air generated by the city's dense concrete architecture and make cities more habitable (Figures 45 and 46). Roof gardens are the only constructions that will help to green the city. These gardens are locations that may be enjoyed by both building inhabitants and people, as well as cleansing the air and minimizing overheating and heat loss in the winter. Rainwater collected by plants and soils on the grassed roof seeps into the ground and is progressively channeled through pipes.

Figure 45. View from the grassed roof samples

Dense Grassed Roof **Comprehensive Green Roof**





Components

Figure 46. Intensive and Comprehensive green roof components

4.4. Permeable Roads and Pavement Surfaces

Permeable or porous pavements and pavements allow water to seep slowly into the ground, rather than run off and flow quickly into rain gutters. Permeable concrete, with its sustainable design and application-oriented features, enables our environment to be shaped more qualified. The permeable concrete road surface or sub-base, designed and applied in accordance with the standards, has many advantages. One of its most important advantages is that it provides rapid drainage of rain water and reduces the risk of slipping on the road. Permeable concrete consists of components that have been carefully selected and the required amount of use has been determined to ensure the formation of a highly porous (void) structure. A properly designed and applied permeable concrete surface or sub-base has many advantages (Fig. 47). One of its most important advantages is that it provides rapid drainage of rain water and reduces the risk of slipping on the road. The permeable concrete coating, which can be applied for all kinds of local roads, byways, highways, bicycle paths, pedestrian paths, pavements, bus stops and parking lots, has to meet many conditions in terms of both the components in the mixture and the hardened concrete properties.

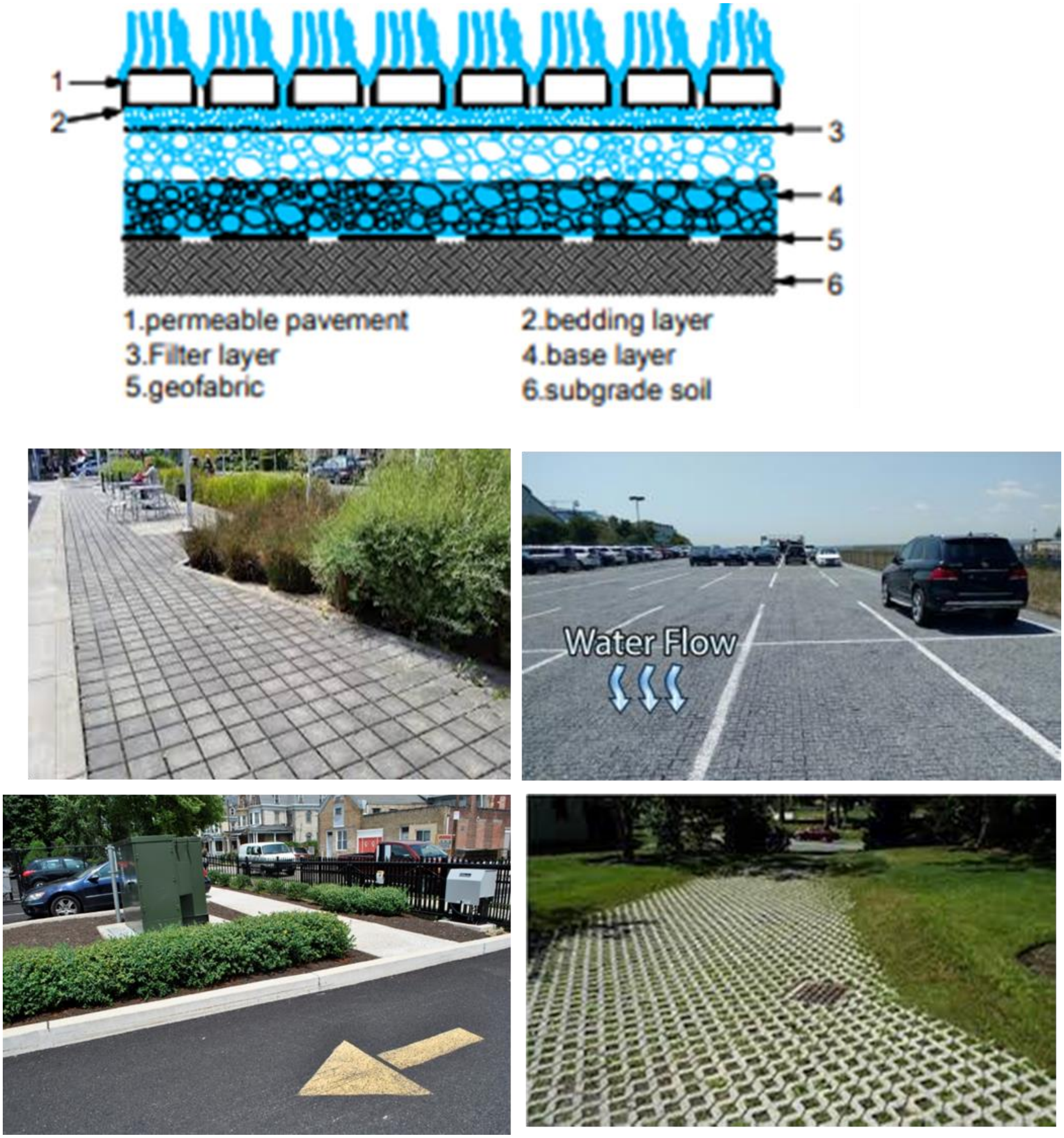


Figure 47. Views from Permeable Roads and Pavement Surfaces

4.5. Rain Gardens

Shallow pit areas where rain water is directed without any treatment and where plants can be grown are called “rain garden” or “bio-retention” (Demir, 2012). Basic function; It is the collection of the water that comes with the surface runoff after precipitation in areas such as roof gutters, vehicle - walkways, parking lots and improving the water quality by treating it with biological treatment methods (Hepcan, 2019; Jaber et al., 2012). With the runoff to the rain garden, the water height increases and a ponding occurs. This ponding varies depending on the intensity of the rain, the infiltration capacity of the water, the vegetation and the structure of the rain garden. Generally, since the speed of the surface flow is higher than the infiltration rate of the water, a ponding of 5-10 cm occurs in the first place. This water, which is then ponded, slowly infiltrates the ground from the bottom of the rain garden (Hepcan, 2019). Rain gardens used to reduce the amount of runoff after precipitation, to improve groundwater recharge and to keep non-point source pollutants before they reach the receiving waters; It is an extremely simple and cost effective rainfall water management tool for homeowners, municipalities and other public spaces (Hepcan, 2019).

Figure 48. Example of the Rain Garden. Eugene, US (United States) (adapted from Hepcan, 2019).

4.6. Rainwater Plant Strips

The purpose of this application is to encourage the retention and infiltration of the rain water, which passes to the surface due to precipitation, with the plant strips formed on the road and sidewalk edges (Hepcan, 2019). They are designed to include plant species specific to the area in different shapes and sizes according to the characteristics of the area to be applied. It includes engineering and design solutions that enable water to be absorbed and purified from pollutants with its permeable soil structure and natural plant species (Hepcan, 2019). Some lanes have water tanks that collect excess runoff water. The collected water is used for plant irrigation or feeding groundwater systems (Eugene, 2014; Hepcan, 2019).

Figure 51. Example of Rainwater Vegetation Strip (Hepcan, 2019)

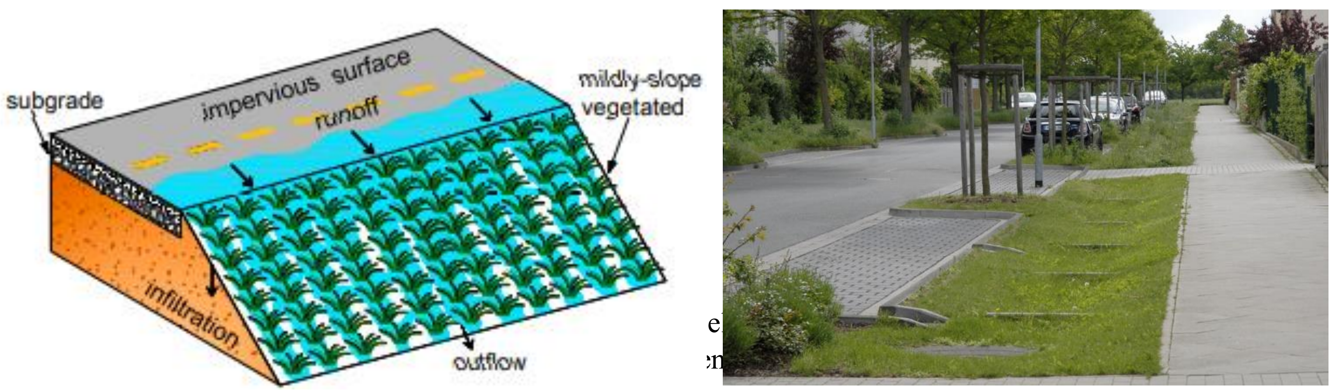
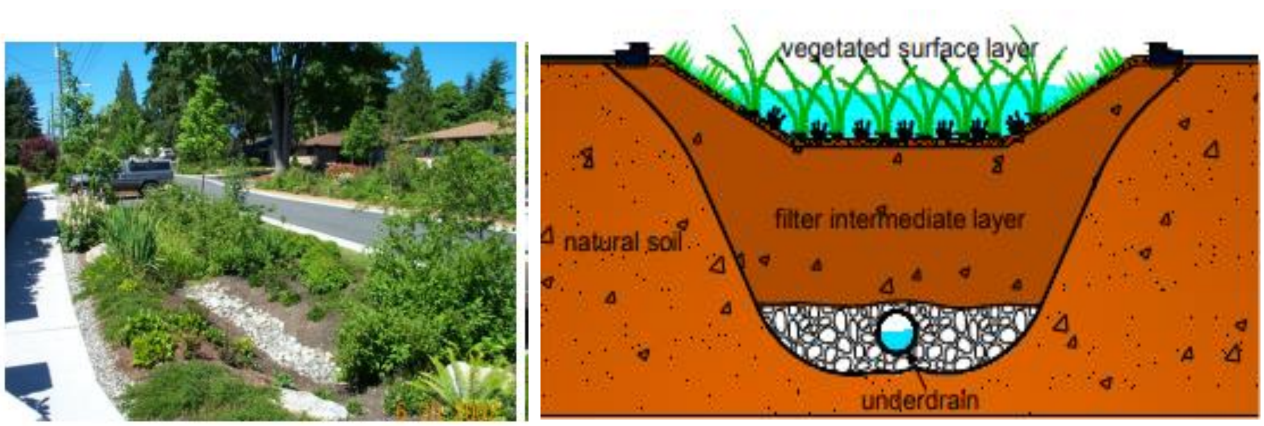


Figure 49. Example of a planted trench (Hepcan, 2019).



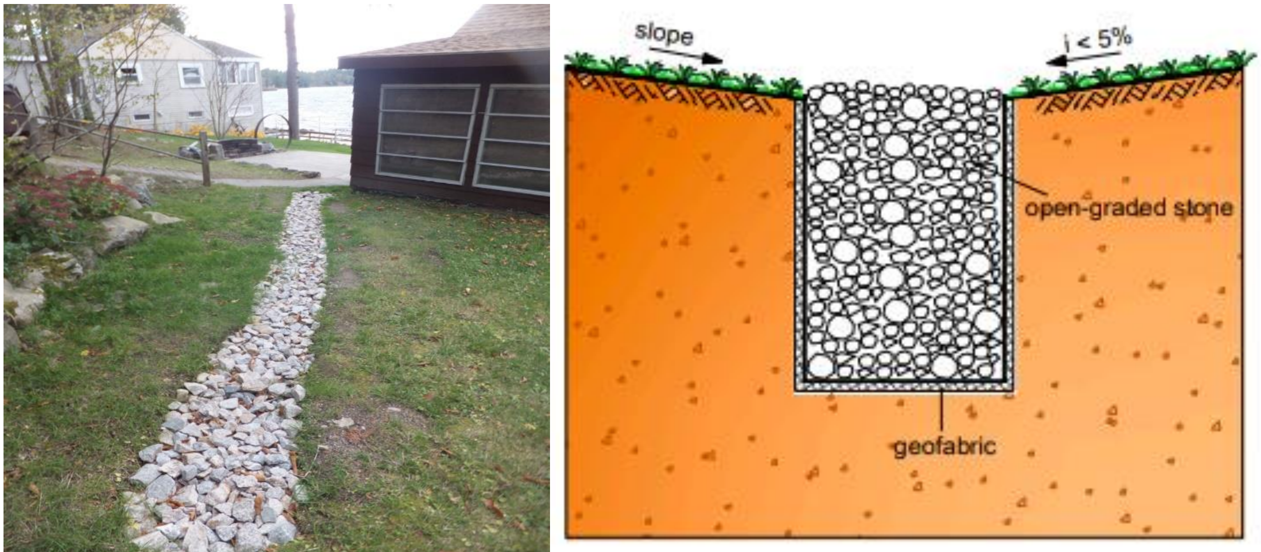


Figure 30: Examples of sto

5. REGULATIONS/LAWS ON THE PROTECTION OF BIODIVERSITY IN TÜRKİYE

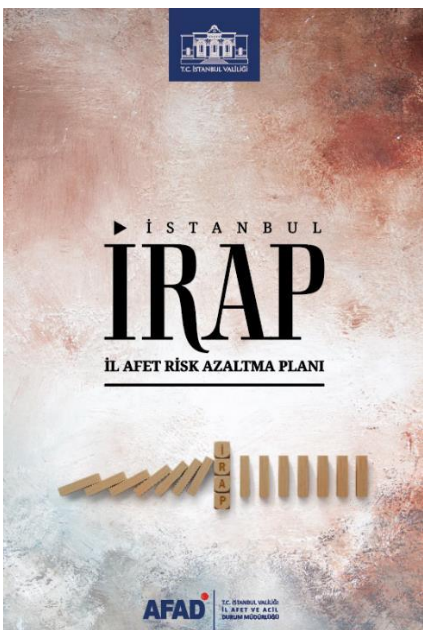
Conservation of biodiversity is crucial not only because of its intrinsic value, but also because it provides people with clean air, potable water, quality soil and crop pollination. Conservation of biodiversity not only helps us fight and adapt to climate change, but also helps reduce the impact of natural hazards.

The extinction of all living species living in the world in the past years has forced the states to take measures in the international and national field for the protection of these species. The Convention on Biological Diversity, which is one of the most comprehensive arrangements among these measures, aims to protect species and the ecosystems in which they live in the countries they live in. In line with this goal, the Convention asks the states that are party to it to take the necessary measures in their domestic law in terms of legislation and administration. Turkey, which is one of the states party to this treaty and is very rich in terms of biological diversity, has started the necessary studies to fulfill its obligations. These studies are mainly aimed at eliminating the deficiencies in the legislation and increasing the scientific and technical capacity. There is no special regulation in Turkish law to protect biodiversity, and this issue is subject to different laws, regulations, etc. It is subject to the rules in the regulations (Şimşek, 2014).

Milli Parklar Kanunu ve Yönetmeliği	Çevre Kanunu	Orman Kanunu	Hayvanları Koruma Kanunu
Tarım Kanunu	Veteriner Hizmeleri, Bitki Sağlığı, Gıda ve Yem Kanunu	Kültür ve Tabiat Varlıklarını Koruma Kanunu	Biyogüvenlik Kanunu

Şekil 2. Türkiye'de Biyoçeşitliliğin Korunmasına Yönelik Müktesebat

Figure 51. Strategies and Policies for Conservation of Biodiversity in Turkiye



AFAD-IRAP

• Majority of the areas rich in terms of biodiversity are not in the legal protection status, and the legislation cannot be fully implemented in the conservation areas,

• Rapid population growth and urban expansion threaten biodiversity-rich areas and agricultural lands,

• Natural disasters.

National Biological Diversity Action Plan (2018-2028)

• Identifying and reducing or eliminating the pressures and threats on biodiversity and ecosystems as much as possible.

• Ensuring sustainable management of areas exposed to agriculture, forestry and fishing activities by protecting their biological diversity.

• Increasing the awareness of the public and administrators on ecosystem services; duplication of benefits from ecosystem services and sustainable biodiversity management.

• Rehabilitation and restoration of ecosystems damaged for various reasons; development of measures to prevent damage to healthy ecosystems.

Stakeholders of the National Biodiversity Action Plan

- Ministry of Agriculture and Forestry
- Environment and urban ministry
- Ministry of Industry and Technology
- Ministry of Commerce
- Ministry of Interior
- Ministry of Foreign Affairs
- Culture and Tourism Ministry
- Strategy and Budget Department
- Ministry of Health
- Ministry of Justice
- Universities

- **ECOSYSTEM SERVICES, BIODIVERSITY AND FORESTRY**

- **<u>Related Institutions and Organizations</u>**

  • Ministry of Agriculture and Forestry

  • DSI

  • General Directorate of Meteorology.

  •Forest management

  • General Directorate of Nature Conservation and National Parks.

  •Environment and urban ministry

  • Ministry of Energy

  • TUBITAK

  • Ministry of Treasury and Finance

  • Ministry of Transport

  • Local Authorities

  •Universities

  • Governorates

  • NGOs

MEASURES TO REDUCE BIODIVERSITY LOSS

HABİTAT ALANLARI

KENT-HABİTAT GEÇİŞ ALANI

KENTSEL ALANLAR

HABITAT ALANLARI

	Şehirlerde ilgili paydaşlarla ortak çalışma ve eşgüdüm geliştirilmesi (DKMP, OGM vb. Taşra teşkilatları)
Bozulmuş ekosistemlerde rehabilitasyon, restorasyon ve denetim yapılması	Ekosistemlerde izleme ve denetim
Yerel Yönetimlerin veri toplama paylaşım, planlama, strateji geliştirme aşamalarında ulusal ve uluslararasi çalışmalara dahil edilmesi	Belediyelerin kontrolünde olan tüm çalışmalarda biyoçeşitliliğin korunmasının entegre edilmesi

KENT-HABİTAT GEÇİŞ ALANI

Şehirlerde ilgili paydaşlarla ortak çalışma ve eşgüdüm geliştirilmesi (DKMP, OGM vb. Taşra teşkilatları)	Şehir/imar planlamasında habitat alanlari ve habitat gecis alanlarinin gözetilmesi
Bozulmuş ekosistemlerde rehabilitasyon, restorasyon ve denetim yapılması	Büyükşehir Belediyeleri/İlçe Belediyesi bünyesinde kapasite arttırımı çalışmaları
Yerel Yönetimlerin veri toplama paylaşım, planlama, strateji geliştirme aşamalarında ulusal ve uluslararasi çalışmalara dahil edilmesi	

BİYOÇEŞİTLİLİK KAYBININ AZALTILMASI İÇİN ÖNLEMLER

İstanbul'da ilgili paydaşlarla ortak çalışma ve eşgüdüm geliştirilmesi (DKMP, OGM vb. Taşra teşkilatları)	• Şehirlerde biyoçeşitliliğin korunması konusunda bilgilendirme çalıştayları • Biyoçeşitlilik kaybını önlemeye yönelik işbirliği olanaklarının incelenmesi, vb.
Ekosistemlerde izleme ve denetim	• İlgili kamu kurularıyla eşgüdümlü olarak denetim yapılması
Şehirlerde belediyelerin kontrolünde olan tüm çalışmalarda biyoçeşitliliğin korunmasının entegre edilmesi	• Şehirde mevcut habitat alanlarının artırılması ve korunmasi • Özellikle kimyasal madde kullanımını gerektiren çalışmalarda (örn. Ilaçlama) doğal yaşamın zarar görmemesine yönelik maddelerin tercih edilmesi; şartnamelerin buna göre hazırlanması
Şehir/imar planlamasında habitat alanlari ve habitat gecis alanlarinin gözetilmesi	• İmar planları yapılırken ve imar izinleri verilirken minimum yeşil alan standartları oluşturulması ve gözetilmesi.

6. URBAN HEAT ISLANDS

One of the most important problems caused by climate change on cities is the increase in temperatures. Excessive increase in temperatures causes significant health problems and decreases in labor productivity, effectively restricting the use of public spaces and social life (UN-Habitat, 2012). High temperatures also damage the infrastructure of the city; It causes deformation of roads and railway lines, causing disruptions in transportation. High temperatures and heat waves increase urban energy consumption by increasing the use of cooling devices such as air conditioners, especially in summer. In addition, high temperatures increase water consumption and put pressure on the city's water resources. In hot periods, the decrease in air circulation, that is, wind speed, in the whole city leads to deterioration of air quality and, accordingly, to an increase in respiratory system diseases (Kaya, 2018). Urban-specific conditions exacerbate the temperature increase with the urban heat island effect.

Cities create special environmental conditions by changing the regions where they are established in many aspects. In this respect, cities change the physical appearance, ecological structure and atmospheric conditions of the area on which they are established, and have a different ecology and a different atmosphere, so to speak. As a result of effects such as the presence of concentrated heat generating sources in the cities, the surface materials of the cities storing the heat from the sun during the daytime and leaving it at night, dust domes begin to form on the cities as a result of effects such as air conditioning devices used in summer and winter. Thus, cities create different atmospheric temperatures from natural environments by creating artificial areas as a result of human activities. One of these different features is the urban heat island, which is one of the most important issues of today, causing climate changes and regional temperatures (Tomaz and Bulut Karaca, 2018).

In rural areas, solar energy is unobstructed and penetrates deeper into the ground compared to cities, as it is mostly used for evaporation of water in plants and soil. In cities, due to the low vegetation and natural land cover, some of the incoming solar radiation is absorbed by high-rise buildings, asphalt roads, streets and reinforced concrete elements in cities, causing delays in the back-radiation of heat. The sun rays absorbed by these structures in cities throughout the day are then transformed into heat and released back to the environment, increasing the air temperature in the city considerably. At night, the buildings and asphalt roads in the cities slowly send the solar energy they have absorbed throughout the day into the atmosphere. Therefore, while the temperature of the atmosphere cools quickly in rural areas, it causes significant temperature changes since it occurs slowly in cities. In open areas, more cooling occurs at night than in city centers. It has been determined that the night temperature in the areas surrounded by buildings in the city center is up to 4°C compared to the open area. This temperature phenomenon, which causes urban areas to be warmer than the surrounding natural areas, has been defined as the "Urban Heat Island". Urban heat islands have different properties for different layers of the atmosphere and have different formation mechanisms (Tomaz and Bulut Karaca, 2018). Due to these differences, it is possible to consider them under two headings as urban atmospheric heat island and urban surface heat island.

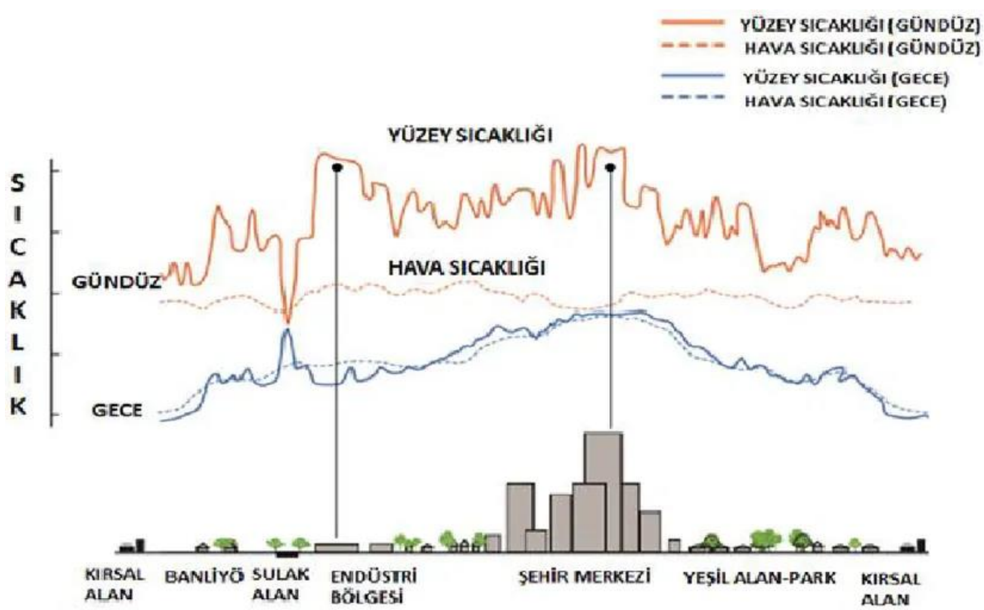


Figure 52. Surface and Atmospheric Temperature Changes in Cities (Tomaz and Bulut Karaca, 2018)

Surface and atmospheric temperatures vary according to the usage areas of the land and day and night events.

While the surface and atmospheric temperature values at night do not show significant differences; There are differences between the daytime surface and atmospheric temperature values. The urban atmospheric heat island deals with the studies on the determination of the air temperature in the city or in a certain part of the city, in the climatic variations that occur as a result of dense construction and the reduction of green areas. Urban atmospheric heat island can be decomposed as “urban cover layer” and “urban boundary layer” (Tomaz and Bulut Karaca, 2018).

6.1. What is the urban heat island effect?

The Urban Heat Island effect is that the average air temperature values in the city are higher than in rural areas. According to the measurements made, these air temperature differences can be up to 5-6°C in some cases. The Urban Heat Island phenomenon plays an important role in climate change, although it does not have as strong an impact as greenhouse gases.

6.1.1. Factors that cause cities to turn into heat islands

Factors such as the fact that the cities are covered with concrete and asphalt surfaces, the vegetation and soil cover is weak, and the suspended particles in the air are more, cause more solar energy to be absorbed in the cities and the cities to turn into heat islands with high average temperatures. In addition, the irregularity of the settlement plans in cities, high buildings, green areas and even earthquake gathering areas are opened for development, and the wrong practices such as residences and shopping malls create a barrier to the air corridors and do not allow air circulation, causing cities to turn into local heat islands.

Surface and atmospheric temperatures vary according to the usage areas of the land and day and night events. While the surface and atmospheric temperature values at night do not show significant differences; There are differences between the daytime surface and atmospheric temperature values. The urban atmospheric heat island deals with the studies on the determination of the air temperature in the city or in a certain part of the city, in the climatic variations that occur as a result of dense construction and the reduction of green areas. Urban atmospheric heat island can be decomposed as “urban cover layer” and “urban boundary layer” (Tomaz and Bulut Karaca, 2018).

6.1.2. Adaptation Methods to Mitigate Urban Heat Island Impact

• The reflection rate of sun rays is different for each material in nature. The specific heats and colors of urban surface materials are factors that affect urban warming and cooling.

• The color of the surface can determine its ability to reflect and absorb incoming sun rays. “Objects of dark color tend to absorb incoming rays. Therefore, their heating capacity is high. Light-colored, shiny and polished objects, in contrast to dark colors, tend to reflect the incident light and do not get too hot.

• The specific heats of the objects also affect the temperature distribution.

• When the same energy is given to objects with different specific heats in unit time, unit volume, the temperature of the material with lower specific heat increases more.

• Likewise, in the heat loss period, materials with low specific heat lose more heat and cool quickly.

• Depending on this feature, it can be seen that two adjacent surfaces on the earth have different temperature conditions.

• Rapid heating and cooling are observed in rural areas due to the low specific heat of soil and stone surfaces.

• In cities, because materials such as asphalt, brick, and concrete have high specific heat, the temperature increases slowly and decreases slowly in these areas. For this reason, urban surface materials, which also determine the framework of this study, are important.

• Urban surfaces such as roofs and pavements are 27-50 °C on a hot sunny summer day, while rural areas are generally cooler due to their more shady and humid surfaces.

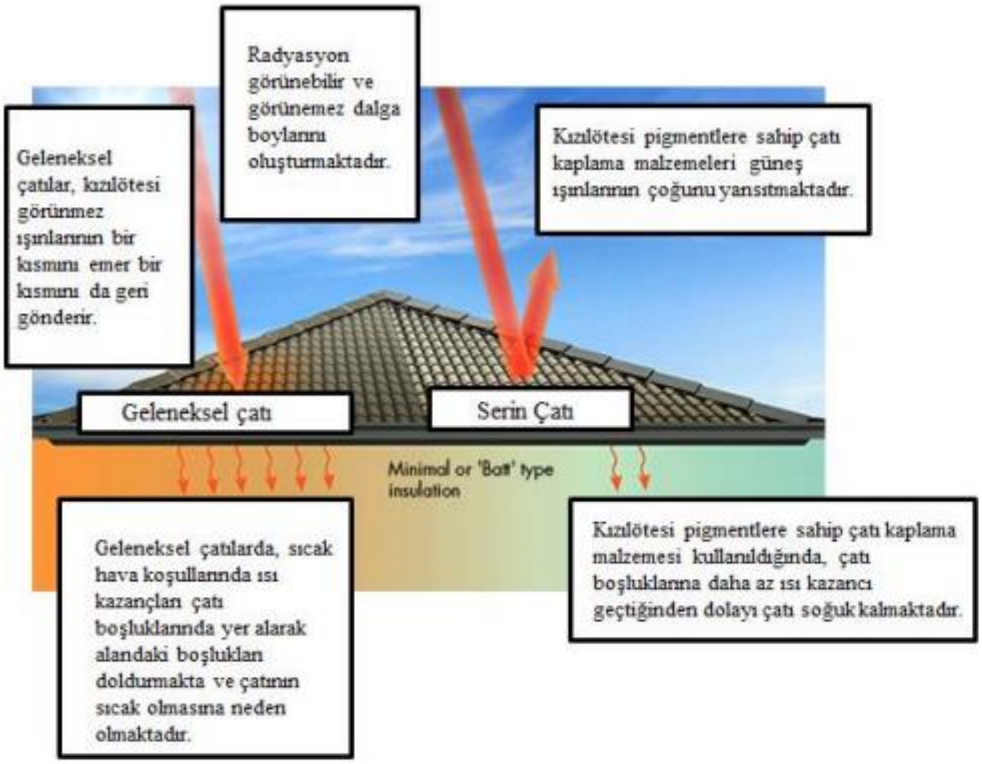


Figure 53. Comparison of Cool Roof and Traditional Roof Surfaces (Tomaz and Bulut Karaca, 2018).

6.1.3. Cool Roofs and Cool Materials

• White Coatings and White Colored Materials

• Aluminum Pigmented Cool Materials

• Cool Colored Materials

• Cool Membranes

• Thermodynamic Materials

• Materials that Change State

• Green (grassy) Roofs

Figure 54. Spraying of Plaster on Low Sloped Roof, Installation of Photovoltaic Solar Panels on a Cool Roof (Tomaz and Bulut Karaca, 2018).

Cool Bituminous Cover, Flat Cool Roof, Cool Metal Roof Examples

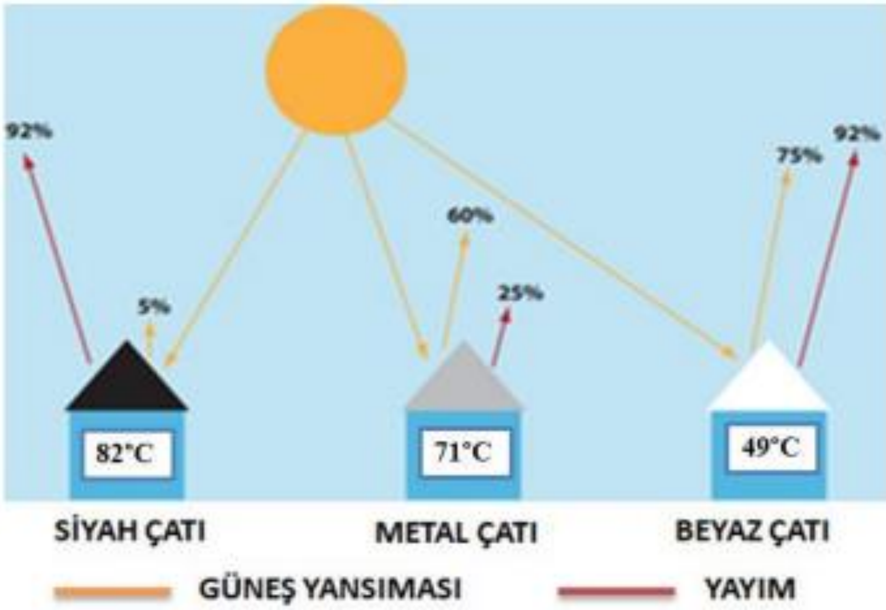


Figure 55. Different Roof Surfaces and Reflection of Roof Surface Temperature

6.1.4. Other Applications to Mitigate Urban Heat Island Impacts

• Green roof and green walls

• Green infrastructure (park, gardens, rain water gardens) in the city

• Use of renewable energy sources

• Creating shady areas in the city (passages, columns, pergolas and awnings)

• Giving importance to tree planting

• Cool streets, sidewalks and roofs on light colors (white and shades).

• Artificial wet areas (Pools, water channels, green areas with water fountains,

• Use energy efficient devices and equipment

• Knowing and disseminating heat reduction policies and regulations

• Reducing air pollution

Figure 56. Various examples of green infrastructure in the city

Figure 57. Various examples of canopy areas

RECOMENDATIONS

• Heat gain from roof surfaces in hot regions in summer negatively affects occupant comfort in the building and increases energy consumption for cooling. Therefore, it increases both air pollution and urban heat island effect.

• The effects of the decisions to be taken at the scales of building, urban design and urbanism on environmental problems are known. Urban heat islands are one of these environmental problems. In order to prevent this problem, it is important that the actors at this different scale approach the issue sensitively. In addition to urban planning decisions, local governments such as the municipality, which has the authority to regulate roof and facade design, will contribute to the prevention of this problem with the decisions that can be taken (Tomaz and Karaca, 2018).

• As a result of urbanization and changes in land use, the city should first be mapped by starting studies on a micro scale. As a result of the mapping, the regions where the urban heat island effect is intense can be determined and intervened. In areas with intense urbanization, existing roof surfaces can be converted to cool roof applications.

• In this context, the reflectivity potential of flat and pitched roofs with different roofing materials can be calculated. With cool roof applications, energy savings at the building scale and mitigation measures against urban warming can be achieved on a micro scale.

• Energy savings can be achieved with the reflective surface to be provided as a result of the white paint that can be applied directly to the roof surfaces of the existing buildings. Photovoltaic (PV) panels to be used together with cool membranes can provide an energy efficient roof surface, considering the benefit of solar energy as well as protection.

• The reflectivity of cool roof materials may decrease over time due to both atmospheric effects and weather conditions. For this reason, periodic washing or brushing of the surfaces on which these materials are applied can extend their useful life and improve their performance.

• Apart from the urban geometry and building orientation, a mitigation measure against urban warming can be achieved on a micro scale with cool colored materials to be applied on the facades (Tomaz and Bulut Karaca, 2018).

Source: ***Tomaz ve Bulut Karaca, 2018;*** *9. Ulusal Çatı & Cephe Konferansı 12 - 13 Nisan 2018 T.C. İstanbul Kültür Üniversitesi – Ataköy Yerleşkesi – Akıngüç Oditoryumu*

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3

FINANCIAL PLAN AND FINANCIAL ATTRACTION MODELS

TRAINING MATERIAL

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Funded by the European Union

CENTRAL PROJECT MANAGEMENT AGENCY

Guidelines for attracting of financing for activities foreseen under SECAPs

Contents

List of abbreviations

BM	Bağcılar Municipality
CoM	Covenant of Mayors for Climate and Energy Initiative
GCoM	Global Covenant of Mayors for Energy and Climate
GHG	Greenhouse gas emissions
IBB	Istanbul metropolitan municipality
IPCC	Intergovernmental Panel on Climate Change
SDG	Sustainable development goals
SECAP	Sustainable Energy and Climate Action Plan
M@E	Monitoring and evaluation scheme
MRV	Monitoring, reporting and verification scheme
NCAP	National Climate Action Plan
RRF	Recovery and Resilience Facility
W2E	Waste-to-energy incineration

Status quo

In the U.N. Intergovernmental Panel on Climate Change (IPCC) report[1] concluded that Turkey will experience three accelerating trends: rising temperatures, dehydration, and rising sea levels. Thus, the country is likely to experience more frequent and more severe weather conditions throughout the year. By 2050 temperatures are predicted to increase by 2.5° Celsius in east and central Turkey, and by 1.5° Celsius on the coasts. Temperatures exceeding 40° Celsius are expected in the summer for extended periods. Additionally, Turkey’s annual precipitation is expected to decrease by about 10%, especially in the west and along the Mediterranean coast. his will result in increased water scarcity and periods of drought, problems that will be exacerbated by glacial retreat and decreased snowfall in the mountains, from which half of the country’s water is derived. Turkey’s vanishing lakes are another alarming indicator of this phenomenon.

This threat calls for immediate and strong action. And the action includes addressing of climate change via reduction of greenhouse gas (GHG) emissions.

Turkey became a party of the Kyoto Protocol in 2009 and the Paris Agreement in October 2021. By taking these steps, Turkey committed to achieving net-zero carbon emissions by 2053.

In late 2021 President Erdoğan declared Turkey's "Revolution of Green Development." This goal includes various sorts of climate actions such as tree-planting, recycling, and even the "made in Turkey" electric car. Transformation of such ambitions will be boosted by the World Bank’s €3.1 billion loan, tied to the ratification of the Paris Agreement.

Ambitious national goal is further replicated by actions at regional and local levels. Turkey’s Eleventh Development Plan (2019-23) acknowledges its commitment to undertake a “green transformation” and lists substantial economic and social steps needed. One of such steps is the National Green Building Certificate System, part of the broader effort to create "green cities". Additionally, Turkey's Ministry of Environment, Urbanization, and Climate Change launched a Regional Climate Change Course of Action, in which it identified necessary actions to combat the adverse effects of climate change. In adopting the National Climate Adaptation Strategy and Course of Change (2011-23), the ministry underlined its awareness of the need for new strategies to preserve water sources, reduce water consumption, increase rain harvests, recycle water, and install drip-irrigation systems. The critics, however also note that Turkey still lacks a binding law that can regulate state mechanisms, as well as civil society.

Turkish society is well aware about the challenges of climate change. The 2020 Konda survey on public perception of environmental problems in Turkey indicate increasing awareness about climate change: Around 70% of respondents recognized it as a serious problem.

This trend is also well recognized by Turkish local authorities with 41 municipality having signed the Covenant of Mayors agreement as of early 2022. The Covenant of Mayors, a pan-European initiative, was launched in 2008 with the ambition to gather local governments voluntarily committed to achieving and exceeding the EU climate and energy targets. It introduced the first-of-its-kind bottom-up approach to energy and climate action. The initiative so far has gathered

[1] *Climate change 2021, Intergovernmental panel for climate change (IPCC), IPCC AR6 WGI SPM-1, 2021*

over 9,000 local and regional authorities across 57 countries and works as a structure, providing its stakeholders with technical and methodological support offered by dedicated offices for context-driven framework for action.

However, the achievement of ambitious goals requires financing. Energy saving and global warming reducing technologies are often expensive and difficult implement in heavily populated areas, such like most of the Turkish cities. Although there are multiple sources for financing of the Green Transformation, they also do require multiple efforts to secure funding.

As of the early 2022, several Turkish municipalities have already begun the development of their Sustainable Energy and Climate Action Plans – strategic planning documents, which would combine respective municipal efforts into a single action, aimed to promote more sustainable usage of resources, to reduce climate impact of the cities and improve living conditions of their residents now and in the future.

Another aspect, complicating the financing of the green transformation project is related to Turkey being recognized upper middle revenue country. This status of national wealth means that the country is not eligible for development assistance and its beneficiaries have to provide their own, sometimes rather significant, co-financing. Notably, it took five years for the Turkish parliament to ratify the Agreement because it wanted to be recognized as a developing rather than a developed country under the agreement, which imposes more substantial — and costly — obligations on the latter category.

Another sources of funding – the loans, despite often being offered at the preferential or below-the-market rates, frequently are too costly for public sector, especially from not so well-off areas. Furthermore, preparation of the good application, be it for the grant or a loan, requires specific knowledge and expertise, not always available at the local level.

This paper is intended to provide Turkish stakeholders with some guidelines and recommendation on the development of bankable (i.e. those regarded favourably by banks and other financing institutions) projects in the field of Green transformation.

1. GENERAL GUIDELINES FOR FINANCING GREEN TRANSFORMATION PROJECTS

Each project has at least four stages: pre-investment, investment, operation and ex-post evaluation. Each of these stages is equally important, with the level of uncertainty and number of options available reducing and experience increasing when moving from the early to the late stages of the project. This guide focuses mostly on the pre-investment phase, with some insights into further consequences of particular decision taken at the pre-investment stage.

The time necessary to prepare a climate project depends on its technical, financial and institutional complexity. The preparation phase of each project consists of approximately eleven steps, some of which could be combined together. The pre-investment stages are:

1. Development of a causal chain map
2. Alignment of planning instruments
3. Mapping of internal and external actors

4. Definition of the engagement strategy
5. Establishment and alignment of commitments
6. Definition of the starting point
7. Evaluation of alternatives and selection of the most appropriate one
8. Definition of the management mechanisms
9. Identification of the local government priorities
10. Collection of data and mapping of potential funding sources
11. Securing of funding

Climate adaptation and mitigation projects are defined as initiatives with the aim to reduce greenhouse gas emissions thus avoiding or reducing the impact of climate change. Such projects are both deriving from public strategic planning: international, national, regional or local programs, policies and plans as well as from the initiatives of non-governmental actors (NGOs). With the latter ones usually being of small scale and requiring less preparation, we will focus our attention on the aspects of the larger scale public interventions.

Public interventions are usually deriving from the political goals (e.g. reaching carbon neutrality by certain year), defined in multi-annual planning documents. The latter ones indicate a set of projects whose results allow reaching the main objective and social evaluation of the various investment options considered. When progressing through the stages, technical and financial uncertainties become smaller, reduced as project development progresses.

The financing of a Green transformation or climate change mitigation and adaptation project depends on three main guidelines that must be taken into account:

- Institutional position of the project;
- Alignment of the project idea with public priorities: (sometimes international), national, regional, local;
- Ensuring of financial resources for the implementation of the project.

1. Understanding the **institutional position of the project**: project governance and public policy guidelines for managing the climate challenge:
    - **Institutional position of the project**. The climate crisis is a cross-cutting theme for different sectors. In most of the countries at national and local levels there is usually an inter-institutional coordination framework for climate change management. In this context any climate change-related project, such as any activity under the SECAPs, shall fit into existing national and, depending on the foreseen funding sources - also often – international legal framework.

    - **Project governance**: recognizing that there are multiple actors and the relationship between them – territorial and national entities, industry, unions, academia, development banks, commercial banks, cooperation agencies, investors, regulatory bodies, community, etc. Access to resources from each source has specific conditions, which must be mapped and analysed according to their adherence to the project and local government priorities. It is worth noting that some financial institutions may prioritize the financing of projects that meet specific criteria.

2. **Alignment of the project** with national, regional and municipal priorities, needs and objectives:
   - The actions proposed for financing must **respond to the guidelines of public policies on climate change at international, national, regional and municipal levels**. Thus, they must demonstrate that they meet the needs identified at these levels of governance and that they contribute to respective commitments and goals. As projects comply with this alignment, it will be much easier to get government approval for their implementation.

3. Ensure financial **resources to make the project viable**:

Access to resources from each source of funding often has specific conditions, which must be mapped and analyzed according to their adherence to the project and local government priorities. It is worth noting that some financial institutions may prioritize the financing of projects that have specific criteria, such as:

- **Ex-ante estimates of impacts** (reduction of GHG emissions in the case of mitigation projects, reduction of vulnerability and beneficiary population in the case of adaptation projects);
- Definition of a **mechanism to monitor project impacts**;
- Demonstration of **gender equality and diversity** approaches;
- Analysis of environmental, social, cultural, economic risks that may affect project implementation.

The actions proposed for financing must respond to the guidelines of public policies on climate change at international, national, regional and municipal levels. Thus, they must demonstrate that they meet the needs identified at these levels of government and that they contribute to their respective commitments and goals.

Therefore, the first task after having made a rough description of the project idea is to see how it fits with the international, national, regional (if available) and local development goals and commitments in the field of climate action.

1.1. Development of a causal chain map

A good climate action project is closely connected to the public policy objectives in social, economic and environmental matters. Agendas such as the Paris Agreement, the Sustainable Development Goals (SDGs) and the Pact of Mayors for Climate and Energy (GCoM) are some of the main international agreements that serve as a basis for national governments to propose their roadmaps and plans. These must be converted into concrete and measurable actions at the local level.

Basically the project initiator has to answer a question: what will be impact of the climate investment idea?

Thus, it is recommended to develop a causal chain map. A causal chain is a conceptual diagram that orders events in such a way as to show that they occur sequentially, one chained to the other.

From the identification of a problem and the definition of actions to respond to it, this tool will help to understand how changes in behavior, practices or technological adoptions are connected by cause-and-effect relationships to the desired impacts of the proposed action.

Likewise, it is possible to identify which benefits of a different nature can be generated with the project, as well as potential negative impacts and risks associated with intermediary effects. In short, the causal chain is responsible for linking and aligning the macro-existing objective in climate action policies and plans to the projects to be implemented. The tool also exposes the intermediate effects of projects.

The main questions to be answered for the development of your causal chain are:

- What are potential effects caused by climate change mitigation and/ or adaptation measures we want to achieve?
- What are the intermediate and final effects of the project?
- What are the foreseeable consequences of the project?
- What are other sustainable development benefits not related to GHG emissions?
- What will be the changes in behavior or practices in the target group?
- Who will be affected by the project?

With the project's intermediate and final impacts assessed, mitigation or adaptation objectives can be defined. At this stage it is possible to identify the public policy framework within which your climate financing project can be framed. Examples: Climate Change Policy, Priority Lines in the NDC, Priority Lines in the SECAPs or other Climate Change Management Plans of the region / municipality / locality, National Development Plan. Likewise, the construction of the causal chain will allow the initial identification of the actors and groups of actors that will be affected by the project, as well as the boundary conditions for its implementation.

1.2. Alignment of planning instruments

The effectiveness of public action depends on the alignment between the different planning instruments: policies, laws, regulations, programs, plans and projects. In this context, it is extremely important to identify the main planning instruments that form the regulatory framework in which the project will be fitted. For example, the signatory countries of the Paris Agreement must submit their Nationally Determined Contributions (NDC) to strengthen climate mitigation and adaptation measures. The action of local governments is essential for countries to achieve their NDC. At the municipal level, governments establish instruments such as SECAPSs, Climate Action Plans or Environmental Sustainability Plans, which establish priorities linked to urban development and environmental protection, among other objectives aligned with the SDGs. Furthermore, there are specific plans and regulations for the different sectors of climate action, such as energy, sanitation and mobility.

In general, the project initiator has to answer the question: what policies, programs and plans are related to and support the climate action brought about by the project?

1.3. Mapping of internal and external actors

For the project to be successful, the articulation and participation of all interested parties (stakeholders) is necessary, ensuring successful implementation and continuity of actions. Stakeholders are all those who influence or can influence the project and its beneficiaries.

The creation of a multi-sector working group for climate action is considered a good practice of local public management. In this mapping, gender inclusion and diversity are often important aspects to be considered. It is recommended to form a team capable of leading the processes in the elaboration of your project, commonly called the Work Group (WG). Such group shall be a multidisciplinary team that brings together different institutional approaches, often represented by the different departments of municipal or regional administration or public authorities and NGOs. Such team manages or helps to the manage implementation of the project (or several projects) from beginning to end.

It is important to define a responsible person (or responsible department/secretariat) to lead the committee. Thus, the group will have a focal point of the process, responsible for facilitating the integration between the different secretariats and departments and guaranteeing the efficiency and speed of the processes necessary for the elaboration of the project.

There are also external actors who can and should make up the governance structure of the project. In climate mitigation and adaptation projects, one can mention water and energy suppliers, civil society institutions, financial institutions, universities and teaching centers, private companies, the beneficiaries themselves and the local community, among others.

Communication and integration among the members of the Work Group is a very relevant factor in the project's success, both with internal and external government stakeholders. Therefore, it is recommended to establish a frequency for WG's meetings and official communication channels. Clear and frequent communication allows continuous identification of opportunities for collaboration on projects of interest to the city.

Examples of internal actors:

- Mayor Office: formally approve and support the project, in addition to promoting it publicly;
- Head of the WG: ensuring integration and articulation between municipal departments, in addition to the participation of other stakeholders;
- City Council: propose and approve projects within the city's work schedule.
- Public Works Department: plan the operational aspects of project implementation.
- Culture/Heritage, Public Procurement and Logistics Departments: provide available information about the buildings participating in the project, in addition to facilitating access to the data needed for project calculations.
- Environment Department: promote transversal action, ensuring alignment of the project with the municipality's environmental, sustainability or climate change mitigation and adaptation policies.

- Public Health Department, if in hospitals, clinics, UPAs etc.; Education Department, if in schools; or other departments: expertise and leadership position, participating in all stages of the project design and implementation process.

Examples of external actors:

- Universities and Teaching Centers
- Civil Society Institutions (NGOs)
- Local community
- Multilateral or development banks, and development funds or sustainable investment funds, whose objectives include not only generating returns, but also environmental and/or social benefits.
- Public or private commercial banks, whose purpose is associated with generating profitability.
- Utilities providers, both public and private companies, with interest and/or availability of capital to invest and generate profitability.

In general, the project initiator has to answer a question: which actors are related to the climate action project? How can they contribute or benefit? Answering it, at the end of this step, all actors and stakeholders who can contribute to, benefit from or be affected by the project, shall be listed.

1.4. Definition of the engagement strategy

After identifying the different groups of actors necessary for the project's success, which ones have priority for involvement and engagement must be defined.

It is important to highlight that this assessment is internal to the Local Work Group and must be carried out periodically by the WG, as projects are very dynamic and the participation of internal and external actors may change during the timetable.

The project initiator has to answer the following question: which actors are priority for the development of the project?

With the identification and prioritization of actors, they can be placed in different categories, which correspond to different engagement strategies, within a project's communication plan. For actors with high prioritization, they can, for example, be integrated into the Work Group and establish a constant alignment to monitor the project's progress. For actors with an intermediate rating, periodic meetings can be established to update the project's progress, and for those not directly involved in the project at the time of analysis, it is recommended to keep them on the radar for possible future collaboration.

At the end of this step, an engagement strategy will emerge, leading to a communication plan to keep all stakeholders attentive and aligned with the project's development.

1.5. Establishment and alignment of commitments

The Work Group should establish and coordinate clear objectives so that all group members and stakeholders have clear answers to the following questions:

- What is the main objective of the project?
- What are your environmental, social, financial, educational and/or political motivations?
- What impacts are anticipated?

A key condition in ensuring the engagement of each member of the project governance structure is to understand what their needs and expectations as well as roles in the project are.

1.6. Definition of the starting point

The key condition to start an action is to define the current internal situation and the effort required to achieve desired change. This step refers to a project baseline survey. A baseline essentially presents the current scenario: how it is now, how all works and who are the actors engaged. This allows you to compare and track the project's progress over time and verify how objectives have been met.

Without definition of the starting point this, subsequent evaluations lose their reliability.

There is a regular set of questions to be asked: where is the project located, what is the state of the sector addressed, how does it relate to the local flora or fauna, which communities will be affected and how, what are the positive and negative impacts on the environment (energy demand, use of fossil fuels, greenhouse gas emissions, pollution, services provided, etc.)? The analysis should include a characterization of the problem and how the situation is affecting the city and its citizens; the infrastructure challenges; the impacts in terms of emissions or pollution; the situations of vulnerability or empowerment that are generated for the different groups affected. This list is not exhaustive and can be updated basing on the project idea, location and other attributes.

While this mapping of the current situation is developed, it is possible to generate alternative solutions and consider the different projects that could satisfy one or more of the challenges identified in the diagnosis.

After this stage, there shall be a diagnosis and clearer understanding of the variables and factors that interact and are related to the current situation (baseline).

1.7. Evaluation of alternatives and selection of the most appropriate one

After defining a starting point, the next step is to analyze a range of intervention options in order to select the most suitable to achieve the impacts intended by the causal chain elaborated. For this, it is essential:

- To identify technical requirements for each workaround
- To map risks, their management needs and mitigation strategies
- To map the co-benefits of each alternative. co-benefits are positive consequences associated with the other environmental, social and economic components of the project.
- To define time horizons and project location
- To provide preliminary economic analysis that reveals the alternative's investment needs and possible monetization of its benefits. Such analysis can also include the economic gain

from positive health impacts, mitigation of emissions and savings due to lower energy costs or operational efficiencies.

- To conduct cost-efficiency (not benefit) analysis that allows evaluating the project's non-monetary results and their potential impacts.

To wight the value of an alternatives, it is advisable to develop comparison matrices. There is no single way to develop these comparisons. It is important to note that the criteria are consensual and respond to the particular needs of the project and the context. They can include the financial cost of independent, the cost of maintenance, the expected life-cycle, the need for expertise, the generated health, social and economic benefits – just to mention a few assessment criteria.

After the most suitable alternative is selected, it is necessary to clarify its execution schedule, details on where the project will be developed, what are the necessary inputs, costs and contractual requirements.

At the end of this phase, a sufficiently detailed intervention strategy should be available to make the most important spending and investment decisions for the subsequent phases of the project: investment, operation and ex post evaluation.

1.8. Definition of the management mechanisms

The next task is to define management mechanisms for the implementation and operation of the project. This task shall include at least general description of the responsibilities, procedures and structure of the organization that will be responsible for activities in the investment and operation phases, as well as the instruments to improve the institutional arrangements.

It is noteworthy that this stage is essential for the economic feasibility and attractiveness of the project to potential funders. Presence of a robust management, implementation and operation plan, will indicate that part of the mapped risks can be mitigated through these mechanisms. It is important to mention that the roles of Work Group members may change when the project moves from the pre-investment to investment and operation phase. Often, those directly responsible for monitoring project implementation and ensuring the start of its operation may be teams and employees who work directly with the project's core activity (for example, education, transport, health, etc.).

One key element of the project that investor or funder will be interested in are the main components and mechanisms of a management system for the implementation and operation of the project:

- Team and responsibilities of each member;
- Definition of project progress and performance indicators;
- Detailed implementation schedule, with definition of responsibilities and those responsible;
- Communication plan between the team dedicated to the project, as well as the tools to be used;

- Communication plan with other stakeholders, definition of reporting format and progress reports;
- Maintenance and operation plan after project investment/installation, with budget forecast and preventive maintenance actions schedule;
- Review of legal obligations related to authorizations, licenses or any other type of prerequisite for the execution of the project, as well as the technical standards that apply to infrastructure projects.

It is important to evaluate these management mechanisms before and after obtaining funding. Before, to give credibility to the project and get funders, and then, having clarity about the funding sources, a management that meets the criteria established in these contracts must be included.

1.9. Identification of the local government priorities

Ensuring the financial resources to implement the project is an essential step for its feasibility. Local government priorities regarding access to the resource should be reviewed. The identification of these priorities will be a guide for the analysis of the potential sources of funding and, finally, for the indication of the source considered most appropriate. To facilitate the organization of information, the analysis regarding the relevance of the main elements might be considered in identifying local government priorities:

- **Restrictions**: All situations and/or conditions associated with the city hall that inhibit a relationship with a type of resource provider or with a particular provider, or that impose some specific form of action in any case. Some types of restrictions are (i) contractual: for example, the municipality cannot contract with certain term conditions, counterparts or types of contract; (ii) acquisition: for example, restrictions on values; (iii) guarantees: whether one can offer guarantees or not, (iv) others: any other restriction that prevents the municipality from obtaining financial resources, such as budget, indebtedness capacity and authorization and guarantee from the federal government.
- **Conditions of access to resources** (asset properties): ranges from a mutual financial contract to leasing contracts (lease), in which the asset is leased for a specified period and, only after the contract is concluded, the city hall can choose to purchase it.
- **Conditions of access to resources** (payment term): preference and ability to have short-, medium- or long-term obligations
- **Conditions of access to resources** (amount paid): value associated with all costs/expenses to be borne by the project initiator (usually the municipality) regarding the financing. These values impact the city's budget and can determine the feasibility of municipal decision makers to agree or not of a given financing.
- **Conditions of access to resources** (operation and maintenance cost): each type of financing mechanism creates different obligations. National legislation defines the limits of municipal competence and in some cases the desired project activities may be incompatible with the area of the competences.
- **Conditions of access to resources** (need for initial or counterpart investment (co-financing)): the need for the municipality to have its own resources in order to develop the project.

- **Conditions of access to resources** (financial cost): the amount of interest paid – applicable to mechanisms that include some form of loan of financial resources.
- **Bureaucracy**: set of activities and procedures necessary to access each of the sources of funds, such as requesting a debt installment to apply for a loan. Some examples: licenses and procedures related to financial and/or administrative areas.
- **Externalities:** anything that can have any indirect impact, positive or negative. An example: the ease or difficulty of the staff hiring process.

1.10. Collection of data and mapping of potential funding sources

2022's is a good time to look for funding for climate change-related projects with the climate change becoming more and more a mainstream topic of political agenda, it is also becoming the key priority of various financial institutions – from European Union down to various international development banks and designated funding programmes.

Despite the plethora of available funding options, there is a high chance that there will be no single funding source, which would perfectly fit the project idea. This paradox is caused by different formulation of funding priorities, by not always convenient schedule for calls for proposals, as well as by the fact that most of the funding sources, especially those providing grants, will fund only a part of the project costs. Furthermore, the is no guarantee that the first funding source you will apply to, will approve the project. Therefore, it would be smart to identify several funding sources and consider alternatives or possibilities to combine funding from several sources.

Another good practice in securing financing derives from the need to get as much as possible information on the funding possibilities. Reading booklets and websites will provide grant seeker with significant knowledge, but adding an interview with the representative of the fund might help filling in the gaps of awareness the grant seeker may not even know having.

As it was already discussed above, even the most generous grant programmes will not be able to provide 100% financing to the project. The co-funding will have to be provided by the project initiator. As the amount of own resources, disposed by the public sector institutions, is usually rather limited, it is always noteworthy to check the possibility to secure co-financing via preferential (below-the-market rates) loans from various dedicated funds.

The latter practice will become more and more important, as the co-funding rates European Union funds have a tendency to get lower, especially for the countries with relatively high development indicators, such as Turkey.

1.11. Securing of funding

Choosing source of financing is no less important task than drafting the project. The financing contract creates a series of obligations for the project initiator. Therefore, one shall not forget that it is not only the funding institution, which assesses the bankability of the project; it is also the project initiator, who shall carefully assess the suitability of source of finance.

Below is a non-exhaustive list of conditions that a project initiator, especially a local self-government unit or any other public sector body, shall put to any proposal for financing:

- Project initiator's eligibility for the resource: whether the institution meets the criteria of the funding source for access to the resource;
- Project eligibility for financing: whether the public sector institution meets the criteria of the financing source in terms of project feasibility due to its size;
- Ease of fundraising procedure; for example, bureaucracy, need for authorization and guarantee from the regional or national government, single or multiple funding;
- Deadline (time restrictions) for signing the contract and launch of the project activities;
- Need for counterpart (project partner) and its type / geographical location;
- Relationship between public sector organization and funders (current contracts, trust, etc.);
- Financing schedule (will the pre-financing be provided, schedule and sizes of the installments, conditions for obtaining next installment, etc.);
- Modalities for contract alteration (possibilities to extend contract, possibilities to secure additional funding in case prices for project activities will go up in the future, etc.)
- Possibility of accessing resources for project replication.

Although it is a common rule that the grant giver and grant seeker have different negotiating powers, the current situation with the funding for green projects suggests the existence of multiple sources of financing, thus meaning the possibility to find alternative source of funding.

2. MAIN SOURCES OF FUNDING

Sources of funding can be roughly divided into two main groups: **grants and loans**.

The main difference between a grant and a loan is repayment. A loan requires you to repay the money you borrow, whereas a grant does not. Grants are, essentially, a gift. In other words, they're non-repayable.

Depending on the regulations of the provider of particular grant, grants may be awarded by government departments, trusts, or corporations and given to individuals, businesses, educational institutions, or non-profit organizations.

Loans are generally provided by banks to both individuals and businesses. Regardless of who disburses the loan, the borrower is required to repay the borrowed amount usually with interest and within a certain period of time. The contract may foresee that in case of borrowers' failure to repay, the lender may have the right to take the borrower's asset if they put up collateral. Public sector usually can benefit with lower (preferential) rates of loans.

Grants offer a number of benefits that any person in need of funding should consider. The grant usually foresees no repayment. Once you're awarded the grant money, it's yours without any strings attached. There's no need to worry about monthly payments or piling on more debt. Repayment is the fundamental difference between a grant and a loan, and also what makes grants more valuable than loans.

No risk: Grants are a no-risk way to obtain the financing you need. If a loan is not repaid, you put your credit rating and assets in jeopardy. Grants do not require repayment and will only benefit you or your business.

2.1. Grants

Grant is a fund given by an end entity grant – often a public body, charitable foundation, or a specialised grant-making institution – to an individual or another entity (usually, a non-profit organisation, sometimes a business or a local government body) for a specific purpose linked to public benefit. Unlike loans, grants are not to be paid back.

The European Union provides significant share of its assistance in various forms grants.

European Commission provides financing through numerous specific calls for project proposals. The EU funding is mostly arranged Framework Programmes. Most of such programmes planned within 7-year long multiannual budget also called Financial Perspectives. These may be structural funds, research and innovation programmes (e.g. Horizon), youth programmes (e.g. Erasmus, Discover EU, Eures, etc.), education programmes (e.g. Erasmus), development assistance (e.g. EuropeAid). EU also provides one-off grants to deal with unforeseen aspects or special projects and themes.

Most of EU grants for the non-EU member states are administered directly through the respective European Commission agencies, located in Brussels. Due to the complexity of the funding mechanisms involved and especially the high competitiveness of the grant application processes, professional Grant Consulting firms are gaining importance in the grant writing process.

Grants are usually provided only for a part of the project. The EU grants, depending of the type of programme usually cover 50-85% of the total value of the project. The remaining part of the project budget shall be funded by the beneficiary. EU rules usually do not allow to fund the project from the two or more different sources of funding (so called cross-funding).

See the respective part of this document for a list of sources of grants, available for SECAP-related activities.

2.2. Loans

In mature renewable energy markets like some Western European countries or the United States of America, it is common to finance an energy project based off of solely the cashflows or electricity savings, with the bank having recourse only to the energy system itself. With Turkey's economic indicators steadily moving upwards, it is likely to expect that the share of self-financing green energy projects will continue to increase.

As there are little if any energy company or public sector body capable to finance anyhow larger infrastructure project solely from its own resources, the loans are and are likely to remain key source for funding of any "hard" investment.

Although being way more available than grants, loans are also more costly to the recipient. Loans can be seen as falling in two different categories – loans available at the commercial market and loans provided by the international development agencies. The latter ones are usually provided at the reduced rate and are granted for longer periods of time.

There are some advantages to taking out a loan instead of applying for a grant. The loan provides greater opportunities. There is a limited number of grants available. Loans, on the other hand, can be given by banks, private lenders, or even individuals. This creates more opportunities to obtain the financing.

Grants are also limited in the amount of financing they can provide. In most cases, grant programs are sponsored by government or international organization and only a certain amount of funding is available each year. With a loan, it is possible to obtain as much financing as borrower's credit and ability to repay will allow.

For well over a decade the green investment project can benefit from various preferential investment schemes and lower than the market rates, provided by various international organisation, banks and governments. The key condition to secure such funding is meeting the ecological and sometimes economical and political criteria set by the respective financial institution.

3. BANKABLILITY OF THE PROJECT

The key condition for securing a loan is defined the bankability of the project. Bankability means that lending establishment, usually a bank or a fund, considers project idea and its implementation plan worth risking investors' money.

This definition includes several elements:

- Acceptable risk of investing in particular country and/or its region
- Acceptable risk of investing in particular sector of the economy
- The project will use the proven / reliable technology
- The project will be owned by reliable owner and will be run by reliable operator(s)
- The project has secured or will be able to secure long-term contracts
- All project partners will have their share of benefit

3.1. Acceptable risk of investing in particular country and/or its region

Any business includes a certain degree of the risk: it might turn out that the investment may not bring the foreseen benefits. Therefore, the key task for any business decision maker is to reduce all sorts of risk. The first sign of low investment risk is the stability. The first thing the investor or lender needs to know is whether the course of business can be forecasted at least for the term of the loan or for a lifespan of the project.

Therefore, a stable political regime, transparent and stable regulations of the market, stable social situation makes the first step, for assessing is the country or a region.

The investment environment of particular country or region is assessed by several large international credit rating agencies (CRA). CRAs provide investors with information about whether sovereign bond and debt instrument issuers are likely to meet their obligations. The global credit rating industry is highly concentrated, with three agencies: Moody's, Standard & Poor's, and Fitch. As the CRAs decisions can have major influence on credit markets and even on the states' policies, the CRAs are heavily regulated at several different levels, including their internal processes, record-keeping, and business practices.

The rating is usually marked in letters, with A being the largest, and D being the lowest. The ratings are usually defined as "investment" or "non-investment". The latter rating means that any investment is associated with the high risk of different natures – be it political, economic, financial, social or any other.

Example

The Fitch agency, established in 1913, provides its assessment in a scale from AAA through D. Its ratings are based on ratings on company debt and its sensitivity to changes like interest rates. When it comes to sovereign debt, countries request Fitch—and other agencies—to provide an evaluation of their financial situation along with the political and economic climates.

Investment grade ratings provided by Fitch agency range from AAA to BBB. These letter grades indicate no to low potential for default on debt. Non-investment grade ratings go from BB to D, the latter meaning the debtor has defaulted.

Moody's agency, operating from 1900, assigns countries and company debt letter grades in a slightly different way. Investment grade debt goes from Aaa (the highest grade), to Baa3 (the lowest which indicates that the debtor is still able to pay back short-term debt). Below investment grade is speculative grade debt, which are often referred to as high-yield or junk. These grades range from Ba1 to C, with the likelihood of repayment dropping as the letter grade goes down.

Standard & Poor's, tracing its history back to 1860's, has a total of 17 ratings to define corporate and sovereign debt. Anything rated AAA to BBB- is considered investment grade, meaning it has the ability to repay debt with no concern. Debt rated BB+ to D is considered speculative, with an uncertain future. The lower the rating, the more potential it has to default, with a D-rating being the worst.

Alongside with the credit rating, the CRAs indicate their forecast on its further development, usually indicating if they expect the credit rating to get better (positive), remain stable (neutral) or decrease (negative).

The CRAs provides the credit ratings both for the public sector – be it countries, self-governing regions, municipalities as well as for the private sector. The credit rating of sub-national sector (regions, municipalities) usually equals or is slightly worser than the one of the national government. For example, on April 1, 2022 Fitch Ratings has assigned a B+/Negative rating for USD 305 million fixed-rate bond of five years to be used for financing of Istanbul Metro project. National Turkish rating at the same date was B+/Negative.

The credit rating of the commercial enterprises usually is less related to the one of its country of origin and is much more dependent on actual market conditions. The credit rating of public sector entities (regional, municipal administration, public services providers such as water, electricity or heat suppliers, etc.) is usually equal or lower than the one of the state.

The analyses and assessments provided by various credit rating agencies provide investors with information and insight that facilitates their ability to examine and understand the risks and opportunities associated with various investment environments. With this insight, investors can make informed decisions as to the countries, industries, and classes of securities in which they choose to invest. The credit rating is usually not the sole factor defining investors' decision to invest.

From mid-1990's to early 2020's Turkey's credit caring provided by all three major CRAs increased to B+ (Fitch) or BB- (S&P) from BBB- (Fitch), thus making a notable margin above the lower threshold of investment rating. In early 2022 all three agencies assessed Turkish public sector credibility rather well (Fitch and S&P – as B+, Moody's – as BB-), yet they were indicating possible negative trends, which may mean a reduction of credit rating in the future.

However, the credit rating of the country, region, municipality or business sector heavily influences the rate at which the lender would agree to issue the credit or the return which the investor will expect.

Advise for Turkish municipalities:

Turkey has relatively high investment rating. Turkish public sector has a reputation of stable, transparent and capable of good financial management and the one, capable to pay its debts within schedule. This reputation may be used in negotiating better financial conditions for loans to public sector projects.

Another key element, related to the acceptability of risk derives from the potential of project initiator to meet the requirements for the project activities – to secure all required permits and licences. There are many infrastructure-related activities which require certain qualifications and

/ or permissions from national and local authorities (e.g. need for qualified personnel for overall supervision of construction works, permits from environmental authorities for construction in environmentally sensible areas, permits from municipal authorities to implement certain types of works, just to mention a few). Frequent changes of legal regulation in such fields causes additional risk to the project results and therefore makes the project riskier. Clear and sound legal and regulatory environment indicates low risk area.

Municipal and regional administrations, acting both as project initiator or as project partner are an indicator of lower project risk, as they usually can mobilize more specialized staff, are in position to obtain or issue relevant permits, etc. This aspect shall be taken into consideration when building up the project partnership.

3.2. Acceptable risk of investing in particular sector of the economy

The next set of investment risk assessment is related directly to the economic and technological potential of the receiving sector of the economy. The investor, be it commercial or public, assesses the profit potential of the market. Old, stable sectors, like traditional agriculture, where many actors compete using already well established, proven and widely available technologies are likely to generate stable yet low yield. Yet new, emerging markets, where only few innovative enterprises propose their new and little tested products, based on new and little tested technologies are likely to generate large profits. However, such investments may also result in market failures of the project and financial losses to the investors. This is one of the reasons why some public or partially public lenders or investors, like international development banks, are reluctant to invest their funds into highly innovative initiatives especially in the emerging sectors of the economy.

The public sector is the one, associated with lower risks. Regional and municipal authorities have their stable sources of revenue, which although rarely being abundant, usually provides cash flow for co-funding of some project or repayment of credit. Furthermore, development investors are usually aiming for more goals than just return of their investment. International development banks, donor states are investing into projects which are to foster the development of the recipient region or entire country or improve situation in certain sector. The guidelines for the expected progress are defined by international development strategies, such as United Nations development Goals, EU Green Deal or others.

2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals[2] is keystone for SECAP development

Building on the principle of “leaving no one behind”, the new Agenda emphasizes a holistic approach to achieving sustainable development for all. The goals, to be achieved by 2030 worldwide, are:

GOAL 1: Eliminate poverty
GOAL 2: Eliminate hunger
GOAL 3: Ensure Good Health and Well-being

[2] *https://sdgs.un.org/goals*

GOAL 4: Provide all children with Quality Education GOAL 5: Ensure Gender Equality GOAL 6: Ensure Clean Water and Sanitation GOAL 7: Ensure Affordable and Clean Energy GOAL 8: Ensure Work and Economic Growth GOAL 9: Invest into Industry, Innovation and Infrastructure GOAL 10: Reduce Inequality GOAL 11: Build Sustainable Cities and Communities GOAL 12: Foster Responsible Consumption and Production GOAL 13: Take necessary Climate Action GOAL 14: Ensure Life Below Water GOAL 15: Crete better conditions for Life on Land GOAL 16: Ensure Peace and Justice Strong Institutions GOAL 17: Build Partnerships to achieve the Goals

In this case the recipient aiming to secure the preferential loan from the international development agency, will be expected to demonstrate that the project in concern will:

- Contribute to the development goals fostered by the donor – such as UN Sustainable Development Goals, EU Green Deal, national development goals, regional development strategies, Municipal development plans, etc.
- Have an impact of desired project in certain sector or overall economy
- Serves the community
- Generate sufficient return to repay back the investment and interest
- Is based on realistic assumptions -

In general case of SECAP-related project, the project initiator has to answer a single question:

- Will the project contribute to the overall reduction of the negative androgenic (caused by humans) impact to the environment?

This goal can be achieved in various ways – starting from reduction of greenhouse gas emissions (e.g. acquisition of electrical buses for public transportation, installation and starting to use solar power panels), altering residents' behaviour (promoting usage of walking or biking for short trips or use public transportation instead of driving own cars, promoting energy and water conservation, promoting energy acquisition from renewable sources), even such schemes as shifting time of energy use (e.g. shifting energy use in a off-peak times) can also be applied.

The expected investment shall also be very thoroughly checked against the rules of the donor or credit organisation. Some technologies, although often promoted as "green", are considered to be "green-washing" or just "not-green". This first and foremost applies to so-called "clean coal" technologies, which foresee further usage of coal (a fossil fuel) for energy (electricity and sometimes heat) generation. Although proponents of this energy claim it fitting the requirements of the green energy, as it foresee usage of various filters to capture hard particles and carbon dioxide, such statements are questioned by multiple energy and environment experts and as a result – the technology is not considered green by multiple sources of funding.

Another sector of economy, which balances on the definition of the "green" is waste incineration (waste-to-energy incineration, W2E). In general, the idea to burn waste and to produce energy is way greener than the one dump it into the landfills. There are multiple technologies, which allow to burn waste collected by the households with very low emissions. This model looks rather tempting, as the sale of electricity produced in this process may help to lower the municipal waste collection charges.

On the other hand, the technology is still based on production of greenhouse gases what may not be acceptable for some funding sources. Another negative aspect is that such technology deprives local resident from engagement into another key activity of circular economy – sorting of waste and recycling. There is a notable case of Lithuania, a small country which in 2000's build too much of waste-to-energy incinerating capacities and only then launched a large scale waste sorting policies, what 2020 resulted in too little of household waste to fuel the W2E power plants.

Therefore the W2E project initiator shall very carefully weight the risks, related to possible overcapacities, which may arise in the future, due to expansion of waste sorting and recycling. The acceptability of W2E as a "green technology" shall also be checked very carefully with respective funding establishments.

The next in line might be the hydropower, generated by the dams, creation of which has significant negative effect on the flooded areas. As flooding river basins to create water reservoirs for electrical power generation also means that significant land areas with habitats of vigorous flora and fauna will be submerged, fish migration routes altered or severed, such changes might not be considered meeting the criteria of sustainability. Besides expected popular protests against such initiatives, it is also likely that some donor organisation might reject request for funding of such idea.

There is no simple solution for this challenge, however, close work with the environmental activists, search for least damaging solution (such as installation of fish paths through the river dams) are likely to lead to compromise between the needs of economy and ecology.

This is the homework which has to be done or at least started before engaging into funding negotiations with the investor or donor. The latter ones are obliged to carefully assess all the factors which may compromise their investment and the sooner they will be presented with the list of challenges and their solutions, the less risky the project will be considered.

3.3.Proven/reliable technology

The nest stage of project bankability assessment is the reliability of the proposed technology.

The principles of good administrative practices and proof-based decision making requires to base each decision made by the public sector. Therefore, the donor agency will require a proof that the technology used by the project will be able to generate expected results. This requirement limits the usage of emerging technologies.

In general, the project developer has to answer at least four questions:

- Is it a known and proven technology?
- Is it used by others successfully?
- Is it built by a creditworthy firm?
- Are the supplier warranties creditworthy?

The investor or donor most likely will be interested in what reliability criteria will be set for the technology and service providers of the project.

Most of the donors require the equipment purchased in the course of the project to function immediately and serve at least throughout the project as well as certain period after it. The rules differ depending on the sector and the type of activities; therefore, it is worth to check the corresponding part of the call for proposal or general rules of the fund.

Knowing and being able to show that suggested technology is successfully used by other regions or countries will reduce the risk of the project in the eyes of the donor. Another key element is the presence of personnel to service the equipment foreseen to acquire or infrastructure to be built. Possession of workshops where similar equipment is services and presence of engineers who are working with similar equipment is also seen as investment risk-reducing factor. However, there is no obligation to own all the required service capacities. The project initiator can easily bypass this requirement by having a service contract with local or even foreign companies. However, in such case it would be a very good idea to ensure the presence of procedures for rapid and smooth service procedures, which would be well planned according to the technological cycles (e.g. electrical bus will be taken over for annual inspection for a clearly defined number of days each year and for that time the municipal bus company will have another bus to replace it whilst undergoing maintenance).

The investor or donor will also like to know how the project initiator is going to ensure that only trustworthy suppliers will be invited to submit their tenders. The key problem here is reliable technologies are usually way more expensive than those will the less reliability. On the other hand, the public sector has both rather limited resources and an obligation to spend them in the savviest way. The answer to this dilemma is usually in national law on public procurement. Such document, usually drafted basing on the principles of the European Union Directive on Public Procurement (at the time of drafting this document the regulation No. 2014/24/EU was in force). It foresees two criteria to define the winner of the tender: the lowest price or the most economically advantageous.

The criterion of lowest price is the simplest – the winner is announced and the contract is signed basing on who offered the lowest price for the required works, services or goods. This however omits the question whether the supplied works, services or goods will be of adequate quality and how much this purchase will cost latter, after the contract will be finalized. This question is of crucial additional importance for the green projects: as one of the goals of such projects is to promote usage of green technologies among local residents, the reliability of used technology is a paramount. There are few better ways to compromise popular belief in the potential of new technology, than to announce its acquisition and then demonstrate that it does not work.

Therefore, it would be highly advisable to consider using the second criteria – the one of the most economically advantageous proposal. The core idea behind this criterion is to assess the cost of acquired work, supplied or services throughout their full life-cycle.

This means that the purchasing organisation shall evaluate how much it would cost acquire, deliver, build, maintain, repair, and at the end of the life-cycle, when the outcome of the purchase will be work out or no longer needed – how much it would cost to dispose and/or recycle acquired goods. The list of criteria may also be updated, as suggested in EU Directive on Public Procurement with the "costs imputed to environmental externalities, such as pollution caused by extraction of the raw materials used in the product or caused by the product itself or its manufacturing, provided they can be monetised and monitored" and even "social life cycle costing should be examined, taking into account existing methodologies such as the Guidelines for Social Life Cycle Assessment of Products adopted within the framework of the United Nations Environment Programme." The latter ones are still of recommendatory nature and the methodology of their calculation is under development.

However, the rule of the thumb suggests that as the project initiator will bear the financial burden of maintenance of acquired equipment or end product of the work and services, it would be wise to consider assessing how much it would cost not only at the moment of purchase, but throughout all life-cycle. For example the diesel bus might cost just one fourth of the electrical bus, but taking into consideration that both of them are expected to serve for a couple of decades and the energy and maintenance bills of the electrical bus will be just a tiny fraction of the diesel one, the acquisition of the electrical vehicle may start looking as both ecologically and economically more viable.

Having life-cycle calculations is also a beneficial tool in making long term forecast of financial flows, to develop project financial model and will also be positively assessed by the donor of credit organisation.

In case if all the questions above are answered positively, the project developer can progress further. In case if not – it might be worth considering risk capital investment or research financing instruments.

The testing and pilot project with the emerging technologies is usually funded by their developers. The funding for such initiative is often provided as various research or innovation grants (see Horizon), by so-called risk investors or by risk capital funds.

As such investments are often associated with the risk that the technology may not generate expected results, the public sector rarely engages into such initiatives. The rule of the thumb for a public sector is to limit its involvement up to the level where it can participate without taking financial obligations. The good examples in this field are provision of areas for testing technological expertise (e.g., leasing a land plot at reduced rate or free of change for installation of pilot equipment, providing engineering staff, which would monitor the project and assess its connectivity and compatibility to the existing public networks (e.g. possibility to connect innovative electricity generation devices with the local grid; suitability of available water supply lines with the demands of some new technology; etc.).

3.4. Reliable owner and will be run by reliable operator(s)

Immense number of good ideas was killed by bad management. This is a well-known lesson and the donor most likely would be interested to know the names, and experience of the people and institution who will manage the project.

In general, the project developer has to answer at least two questions:

- Is the owner/operator experienced in the sector / does the institution has administrative capacity to successfully deal with implementation of the project?
- Are they financially viable as an operator?

The first question is about the chance that the project will be implemented in a way it is described in project application. The most reliable way to predict the future is to combine the results of the past with the trends of today. Therefore, the donor will definitely be interested in how the institution – initiator of the project was dealing with the similar challenges in the past and what capacities it has for today. Even if the past experiences are not-so-perfect, this negative note can be reversed by presenting reliable team, who will manage the project in the future. The project management team usually consist of three tiers:

- Managerial (project manager of a team leader, depending on the project size and type it may also include various junior managers and assistants);
- Financial (project financial manager or managers, sometimes public procurement specialist);
- Expert (depending of the nature and scall of the project its activities may require supervision by various line experts, such as IT, environment, legal, etc.);

The donor usually expects the recipient institution to have a project management team set up, at least indicatively (no contract signed, just roles attributed in case of success) before the launch of the project. The project team is expected to have relevant education, training and, depending on the nature of the project – some experience with projects of similar nature and size.

Most of the donors do not expect the project initiator to employ all the required project management team at the moment when the project proposal is submitted. Often the definition of conditions for the staff recruitment (e.g. experience, qualification, possession of relevant certificates) might be enough. Of course, it is highly likely that the implementation of these conditions will be verified by the donor itself or by the verification agency.

Another key issue the donor will be interested in is the economic viability of the project initiator or of the entire project consortium. Some sources of funding, usually grants, are provided as the compensation of expenditures. This means that the project partners have to fund project activities from their own sources and then claim back the funds from funding organisation. Quite often the project is divided into several reporting periods. The reporting period for which the payment claims are prepared can differ, depending on the fund, on the type of the programme or even on the agreement between the donor and beneficiary. It usually varies between three and six months. This means that project partners will have to fund project activities from their own sources for three months, then prepare a financial report and submit it to the donor organisation. Often this procedure will have to include an audit report, usually taking significant amount of time. The donor, after receiving such intermediate report will have to check it and only then pay back the funding to the beneficiary.

3.5. The project has secured or will be able to secure long-term contracts

Projects which are expected to generate financial returns are also expected to demonstrate the ways how those returns will be secured. The simplest way to prove this element of bankability is to have a contract with the company with the obligation to acquire the goods produced by the project outputs.

The renewable energy project will likely be considered less risky and will be offered lower interest rate if its initiators will have a contract with the local energy company, stating the latter's readiness to acquire produced energy. Some public sector bodies, e.g., those who intent to build the solar energy plants on or arounds their buildings, can bypass this requirement by providing statement that they expect to use the generated energy for heating or cooling of the latter ones, this way reducing their energy bills and releasing funds, which otherwise would be used to cover respective energy charges.

In general, the project initiator has to answer at least three questions:

- Is there a long term off take contract in place?
- Does the contract allocate economic and operational risks fairly?
- Is the payer creditworthy?

This means that the investment project shall have a clear and verifiable financial plan, which would include estimated cash flows from the investment. It is important to have a clear vision about who will buy the results of the investment and what will be the revenues. Although public sector usually lives by often, non-profit rules, its investment also shall have a clear vision on who will benefit from the investment (in ideal case – the general public, all society, although narrower, niche investment are usually accepted) and does the expected public benefit align with strategic public goals.

3.6. All project partners have their share of benefit

Partnership and feeling of benefiting from the project is among the key reasons of its success. This derives from human nature – people as well as organisations like to feel getting return from their activities. Practice shows that the projects where only one or few partners are benefiting are less stable and produce lower quality results.

Therefore, establishing mutually beneficial partnership is among the key reasons for projects success as well as often makes a basis for the new common project. Both project developers and especially their political leadership shall bear in mind that this project might not be the single event in their partnership with other institution.

In general, the project initiator has to answer at least four questions:

- Will they invest in the project?
- Do they have experience with similar project technology?

- Do they have experience in the region?
- Do they have a financial incentive to meet/improve on the base case?

The questions stated above are of crucial importance for the success of the project. Both the project partners and the funding institution would highly benefit from knowing beforehand what they will be required to contribute to the success of the project. Equal partnership is not a necessary pre-condition: quite often each project has one key beneficiary, whilst the other project partners benefit whether indirectly from the project results, whether provide their expertise and knowledge to its achievement. The institution, providing funding, will also be interested in knowing the balance between partners contribution – this way it can be assured about the strength of the partnership.

Another core element is the relevance and experience of the project partners in the field. Although this may not always be a precondition, the experience of working with the similar technology or experience in the similar type of activities usually indicates higher probability that the project partners will manage to implement the project successfully.

Advise to the Istanbul Metropolitan and Bagcilar municipalities

Show your strong sides: there is no need to prove your skills experience in all fields, related to the project. Having a strong proof that you have done and are still doing successfully in some fields will serve as a good assurance that you can do well also in other fields.

As it was already discussed above, having the experience in particular region usually helps to reduce the assessment of the risk. Different countries and even different regions of the same country often have their own peculiarities – from the very formal legal requirements down to the ways how people do daily businesses. Although learning local rules might not be a hard task, it usually takes time and increases the risk of mistakes or other negative impact to the project results. Therefore, it is always a good idea to have at least one partner with the experience in the region.

Las, but not least is the financial capacities of the project consortium. We have already discussed the need for pre-financing, as well as the (hopefully will never arising) need to cover the expenses, considered to be unacceptable by the audit.

Therefore, each project partner is expected to make sure if they will be able for such advance funding.

Having secures positive answers to all the questions, discussed above, the project idea will be sufficiently developed to progress to the next stage – the one of describing technical details.

3.7. Getting into project details

When it comes to the technical details, the project initiator has to put effort to fill in multiple pages of application form in order to implement two following tasks:

- To provide a project description
- To present a project financial model

Project description is a detail description of project idea and its implementation plan, and usually includes the following elements:

- Geographical location of the project
- The sector and how the project fits into the sector
- The technology used by the project
- Description of the owner/operators
- Track record of the operators
- Description of the long-term cash or public benefit generating contracts

A project financial model usually includes the following elements:

- Summary of the project economics
  - Revenue
  - Contracted revenues
  - Tax incentives
  - Potential incremental revenue
- Expenses
  - Operations and maintenance
  - Management & employees
  - Parts, overhaul / replacement account
  - Cost of financing
  - Fuel
  - Taxes
  - Rent/Lease

3.8. What is measured by the donors?

The donors for the climate action projects have a clear aim – to contribute to the reduction of GHGs. Also according to the general principles of project bankability, they will pay significant attention to the performance of the project and its contribution to the climate goals.

The rule of a thumb says that the grant seeker shall demonstrate its commitment to show how the proposed action will contribute to the achievement of these goals. Knowing what the donor expects is big benefit in this process. Usually, each call for proposal also describes the goals what the donor is trying to achieve. Often the project assessment sheet is also annexed with the call for proposals' documentation. Reading it and matching with the aims of the project can significantly reduce the efforts to prepare the project application.

Although, each particular call might differ, there are several basic principles on how the project application assessors regard the project application.

First and foremost, the project application shall include the measurement and presentation of the impact of a climate action. This is a way of showing the project's contribution to local (as example

SECAPs) and national (as example NCAP) goals in reducing GHG emissions and increasing adaptation to climate change. It also enables a progressive improvement in climate action, improving political and regulatory frameworks and keeping up with the advances achieved.

In addition, often an impact monitoring is a requirement for accessing international and development bank resources to finance this type of project. In mitigation projects, the practice of monitoring the impact of projects should be oriented towards defining the monitoring, reporting and verification scheme (MRV).

In adaptation projects, practice should be oriented towards establishing a monitoring and evaluation scheme (M&E). Both schemes include measuring the technical aspects of the project through indicators estimated at certain review periods and reporting these progress/results through specific reports. For the specific case of climate mitigation projects, the MRV scheme should include the provisions for monitoring, reporting and verification.

Monitoring the project is not just about measuring its ultimate impact. It also takes into account the measurement of the performance of activities linked to the implementation of the initiative:

- **Management**: represent an indicator in which the performance of activities, tasks, processes and procedures related to project implementation is measured. It is usually expressed as **progress in implementing activities** [%] and as **financial execution** [€/year];
- **Intermediate results**: represent an indicator in which progress is measured in the implementation of activities and intermediate milestones that enable the achievement of the final objectives. The achievement of intermediate results is usually measured as **progress in implementing project activities** [%];
- **GHG impact**: a very popular indicator, that describes the impact on emission reduction, in tons of CO_2 equivalent. For example, the project impact on GHG emissions can be measured as saved CO_2 expressed in tons due to energy efficiency actions;
- **Non-GHG impact**: is also often used indicator. In this case, the economic, social and environmental benefits associated with direct projects results are measured in monetary equivalent. For example, the health benefits from the bicycle path can be assessed as the reduction of expenditures, related to healing of lungs patience and the improvement of quality of air.

The reporting part of the project includes the results and methodologies in quantifying project GHG emissions and co-benefits, as well as progress on enabling activities (e.g. institutional arrangements). Reporting of GHG emissions and the efforts undertaken to mitigate and adapt to climate change in the Unified Reporting System CDP-ICLEI is suggested, as this task provides a way to centralize data and monitor progress. The platform provides cities with all publicly available data, assesses emissions and compares performance with other cities.

The verification element of the project covers all quantitative and qualitative information reported for the mitigation measure. Methodologies are validated and results are verified. This process, depending on the characteristics of the project, can be carried out by a first party (owner of the initiative) or by a third party (an external actor to the initiative). In any case, national guidelines and criteria of transparency, completeness, comparability and accuracy must be followed. It is important that the project impact monitoring described here is consistent with the management mechanism, specifically in relation to project monitoring indicators and instances. A good practice is to carry out, at the end of the project, a documentation of the lessons learned from the entire project design and implementation process, presenting the successes and errors made.

4. Sources of grants for SECAP-related projects

Below is provided a non-exhaustive list of international agencies and programmes, which provide grant funding for SECAP-related projects and activities. The information was compiled in the Spring of 2022 and any latter changes by the donors could have an impact on the modalities of funding, not describes in this paper. Potential recipients are expected to use this information only for preliminary information and to check the respective modalities directly with the funding agency before making any decisions about their project ideas.

4.1. European Union and its assistance to Turkey

European Union supports Turkey's efforts to progress in the process of preparation of EU membership. EU provides financial and technical assistance to political and economic reforms via the Instrument for pre-accession (IPA). These funds help to align Turkish legislation and standards with the EU's, building authorities' capacity for undertaking this harmonisation, and implementing the reforms throughout the accession process. The ultimate aim of pre-accession funds is to improve the lives of individuals, by providing them with better opportunities and ensuring they enjoy standards equal to EU citizens.

IPA financial assistance for Turkey during 2014-2020 cycle had four specific purposes:

- Support for political reforms;
- Support for economic, social, and territorial development;
- Strengthening the ability of the beneficiary country to fulfil the (future) obligations stemming from EU membership by supporting progressive alignment with the Union acquis and;
- Strengthening regional integration and territorial cooperation.

Under IPA 2014-2020 the EU has indicatively allocated €4,453.9 million for Turkey. The priority sectors to be supported were:

- democracy and governance;
- the rule of law and fundamental rights;
- environment and climate action;

- transport;
- energy;
- competitiveness and innovation;
- education, employment, and social policies;
- agriculture and rural development;
- regional and territorial cooperation.

The strategic priorities for IPA financial assistance under these sectors are defined in the Indicative Strategy Paper for Turkey. They reflect the political priorities as specified in the EU's enlargement policy framework and Turkey's national sector reform plans, determining key areas where financial assistance should be used to assist Turkey in meeting the accessions criteria. The new Strategy Paper for a period of 2021-2027 is currently under development.

For the IPA cycle of 2007-2013 a total of €4,483.6 million was allocated under five components: transition assistance and institution-building, cross-border cooperation (CBC), regional development, human resource development and rural development.

IPA funding in Turkey is mostly implemented under indirect management, by entrusted Turkish institutions which meet all the necessary requirements in line with the EU's Financial Regulation. Only Some activities come under direct management, when implementation of the budget is carried out directly by the European Commission's services.

In the indirect management system, the Directorate for EU Affairs under the Ministry of Foreign Affairs as the National IPA Coordinator (NIPAC) holds key responsibilities for overall coordination of the system, including the programming and monitoring processes.

The Undersecretariat of the Treasury functions as National Authorising Officer (NAO), holding the overall responsibility for the financial management of IPA funds in Turkey, and ensuring the legality and regularity of expenditure of EU funds. The NAO is responsible for the management of IPA accounts and financial operations as well as the effective functioning of the internal control systems.

The Central Finance and Contracts Unit (CFCU), which is administratively linked to the Treasury, has the responsibility for the budgeting, tendering, contracting, payments, accounting, and financial reporting aspects of IPA procurements.

There are four additional contracting authorities entrusted with implementing the IPA funds that deal with multi-annual sector operational programmes:

- Ministry of Environment and Urbanisation for the environment and climate action sector;
- Ministry of Industry and Technology for the competitiveness and innovation sector;
- Ministry of Transport, Maritime Affairs and Communication for the transport sector;
- Ministry of Labour, Social Services and Family for the sector education, employment and social policies.

Furthermore, the implementation and payments of IPA funds in selected provinces from IPA Regional Development programme (IPARD) is coordinated by the Agriculture and Rural Development Support Institution.

Further information about the IPA, including its legal basic documents, can be found on the European Commission's DG NEAR website.

4.2. Horizon Europe 2021-2027

Horizon Europe is the ambitious EU research adn innovation framework programme for 2021-2027 with a budget of €95.5 billion.

Its overarching goals are: to strengthen the EU's scientific and technological bases and the European Research Area, to boost Europe's innovation capacity, competitiveness and jobs, to deliver on citizen's priorities and sustain our socio-economic model and values. with a particular focus on creating impact or the European Green Deal, the digital and sustainability transition and recovery from the coronavirus-crisis[3].

4.3. Cross-border cooperation programmes

Cross-border cooperation is an EU initiative, aimed to facilitate development of the regions along its internal and external borders[4]. Usually such programme covers areas alongside international borders, going up to 150 km (or to the closest border of the territorial unit, higher than municipality) into the depth of the partner state.

Part of the Turkey is covered by two EU cross-border cooperation programmes: Bulgaria-Tukey Cross border cooperation programme and Black Sea Cooperation programme.

5.Sources of loans for SECAP-related projects

- **European Bank for reconstruction and development**

EBRD is providing dedicated financing at preferential rates to various climate initiative both directly and via dedicated joint financial instruments[5].

- **InvestEU**

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[3] *https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/programmes/horizon*
[4] *https://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/cross-border/*
[5] *https://www.ebrd.com/cf?1=1&filterKeyword=Climate%20finance%20news%20and%20updates*

InvestEU Fund[6] is a European Union market-based and demand-driven instrument, with a strong emphasis on EU policy priorities. The fund provides financing for SECAP-related activities including development and implementation of SECAP (also for infrastructure investment) as well as hiring of experts and preparation of bankable projects. InvestEU is a financial instrument, which provides loans, guarantees and equity investments.

It provides support for **climate action projects in 4 areas** (so called Policy Windows):

- **Sustainable infrastructure**. The fund provides financing for projects in sustainable energy, digital connectivity, transport, the circular economy, water, waste, other environment infrastructure and more.
- **Research, innovation and digitalization**. The fund provides financing for projects in research and innovation, taking research results to the market, digitisation of industry, scaling up larger innovative companies, artificial intelligence and more.
- **Small and medium-sized companies**. The fund provides financial assistance facilitating access to finance for small and medium-sized companies (SMEs), small mid-cap companies. This includes capital support for SMEs that were negatively affected by the Covid-19 crisis.
- **Social investment and skills.** The fund provides financing for projects in skills, education, training, social housing, schools, universities, hospitals, social innovation, healthcare, long-term care and accessibility, microfinance, social enterprise, integration of migrants, refugees and vulnerable people, etc.

Eligible countries include all European Union Member States as well as partner countries Albania, Armenia, Azerbaijan, Belarus (suspended), Georgia, North Macedonia, Moldova, Montenegro, Serbia, **Turkey** and Ukraine.

The fund is managed **European Investment Bank,** European Commission and implementing partners. EIB Group and other InvestEU implementing partners provide direct and intermediated financing solutions for both private and public projects promoters (‘final recipients’). Project promoters are expected to apply directly to implementing partners who will offer tailor-made financing solutions based on the financial products supported by the EU guarantee. Financial intermediaries should also consult the offering of implementing partners active in their regions proposing relevant products: it is up to them to select financial intermediaries through procedures such as calls for expressions of interest - eligible InvestEU Implementing Partners.

Small mid-caps, SMEs and social or micro-enterprises should apply to their local commercial or public banks whose financial products are covered by the EU guarantee in their country or region. The local intermediary will inform them if a particular financing programme is covered by the InvestEU Fund - access to finance.

[6] *InvestEU Fund (europa.eu)*

Eligible applicants include private entities, such as special-purpose vehicles or project companies, large corporates, midcap companies, including small midcap companies, and SMEs, public sector entities (territorial or not) and public-sector type entities as well as mixed entities, such as public-private partnerships and private companies with a public purpose. Non-for-profit organisations are also welcome. The projects require no partnership.

EU countries can also use InvestEU as a tool to implement their recovery and resilience plans under the **Recovery and Resilience Facility (RRF).**

InvestEU also includes "Just Transition" scheme. It is a part of the Just Transition Mechanism that will provide a budgetary guarantee under the InvestEU programme across the four policy windows and an InvestEU Advisory Hub that will act as a central entry point for advisory support requests.

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4

SECAP MITIGATION ACTIONS

TRAINING MATERIAL

Prepared by:
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Funded by
the European Union

CENTRAL PROJECT
MANAGEMENT AGENCY

CAPACITY DEVELOPMENT FOR OBSERVER MUNICIPALITIES: SECAP MITIGATION ACTIONS

Prepared by: Prof. Dr. Tanay Sıdkı Uyar

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Content

1. Introduction

Over the next decade, every aspect of national energy systems will be affected by changes in climate and energy policy, and financing, continuous technological advancement, and shifts in energy supply and demand. The rapidly falling costs of renewable technologies have opened up previously unimagined possibilities across the globe. Ongoing developments in many countries offer a promising outlook for the security, inclusiveness, and sustainability inherent in a transformed energy sector. However, the transition needs to speed up significantly and broaden its scope to achieve SDG 7 and align with the goals of the Paris Agreement on climate change, while at the same time achieving implementation of the 2030 Agenda for Sustainable Development.

The energy transition can thus no longer be limited to incremental steps. It must become a transformational effort, a system overhaul, based on the rapid upscaling and implementation of all available technologies to innovate for the future. This is the right moment to reassess long-standing assumptions, perceived barriers, and default decisions. The emerging energy system must promote resilient economies and societies for a more inclusive and equitable world. Ambitious and targeted actions are needed now and throughout the coming decades to ensure the goals of SDG7 are fulfilled and a decarbonized energy system achieved by 2050.

2. Rise of renewables in cities – Energy solutions for the urban future

Cities are increasingly relevant to climate change mitigation and adaptation, not only because of their high contribution to global carbon emissions, but importantly because of their large potential to mitigate emissions of all kinds – as well as the rising need to build climate-resilient urban infrastructure for the future. Cities will need to accommodate twothirds of the world's population in a liveable, lowcarbon environment by 2050. Integrating renewable energy technologies into local energy systems has become part of the transformative action that is needed to realise such potential, backed by strong political will and technological advancement. Cities will also benefit greatly from the positive impacts that local development of renewables has on gross domestic product (GDP) and employment. This report explores three key pillars of knowledge – on renewable energy resource potentials and renewable energy targets, technology options and urban energy system planning – that will enable cities to scale up their use of locally available renewables as they move to decarbonise their energy systems. Setting renewable energy targets is an important component of cities' efforts to boost deployment of renewables. However, setting the right level of targets relies on good understanding of the availability of renewable energy resources, among other key factors. An analysis of targets set at the city level in relation to both locally available renewable energy resources and renewable power plants sited near cities reveals that:

● A growing number of cities have set renewable energy targets, but they are concentrated in Europe and North America, areas that have higher economic wealth and temperate-to-cold climates. Globally, more than 80% of the cities that have set a renewable energy target (671 cities in total) are in Europe and North America. Meanwhile, cities in Asia and Africa are falling behind in renewable energy target setting, even as their energy demand is expected to grow.

● Cities with renewable energy targets fall most commonly in the population range of 100 000 to 500 000 inhabitants. The majority of large and mega cities that have set renewable energy targets have pursued only a modest share of renewables in their energy mix.

● Hydropower, bioenergy and waste-to-energy already play a clear role in helping cities achieve their renewable energy targets and in decarbonising the energy mix. The use of solar and geothermal energy in cities is rising – although huge potential remains untapped – while the ability to harness wind power within cities is progressing but remains marginal.

Integrating local renewable energy technologies in cities faces various challenges, including legislative, policy, regulatory, financing, human capacity, aesthetic, design and urban planning barriers. To some extent, these barriers result from a lack of awareness of the renewable energy options and of the benefits of harnessing locally available renewable energy resources. Enhanced knowledge of applications of urban renewable energy technologies would help cities to plan and deploy renewables in urban areas. This report also provides an overview of the most commonly used renewable energy technologies in cities, which include the following:

● **Solar photovoltaics (PV):** Urban-based solar PV systems are generally smaller in scale than ground-mounted systems located on the outskirts of cities. The median size of an installed residential PV system in 2018 was around 6.4 kilowatts. These systems are usually installed on, or integrated with, the roofs and façades of buildings. Scaling up PV applications in cities faces unique challenges including land constraints, the potential impact of rising shares of variable renewable energy on the local grid, and a lack of understanding of the economic implications of solar PV systems for local power suppliers and utilities.

● **Solar thermal**: Solar thermal systems, which rely on different types of solar collectors, are usually used for water and space heating and in some cases for industrial process heat. Increasingly, cities and countries have adopted building codes mandating the use of solar water heaters for all new buildings. In some cities, large solar collectors deliver the produced heat via district heating networks. Solar district heating was enabled by the transition of thermal networks towards low-temperature (below 60–70 degrees Celsius) district heating systems, known as the fourth generation. The solar system can be installed on the ground or on a building roof to supply heat for the building, community, district or city. However, in countries where natural gas is cheap and is the dominant heating source, solar thermal systems are less competitive in the absence of incentives or promotional schemes to support their social and environmental benefits.

● **Solar thermal cooling**: With the growth in global cooling demand – tripling from 600 terawatthours (TWh) in 1990 to 2 000 TWh in 2016, and projected to at least triple again by 2050 – solar thermal energy has gradually extended into the cooling sector. For cooling purposes, solar thermal is typically coupled with absorption chillers to lower peak demand on the grid during hot summers, reducing blackouts and the costs for grid enhancement.

● **Bioenergy and waste-to-energy:** These biomassbased energy sources can provide a relatively reliable and consistent supply of energy in comparison with solar PV. For cities, wasteto-energy offers a promising way to create a circular economy. However, the uncertainties of obtaining a sustainable supply of feedstock need to be addressed, and public acceptance remains a barrier to adopting waste-to-energy technologies.

● **Urban wind power:** Wind power has been used only marginally in cities and faces huge challenges to scaling up. While examples exist of urban wind turbines generating electricity, their performance needs to be improved substantially, and largescale implementation is scarce. The use of wind turbines in urban environments is mainly in the research and development phase. The lack of experimental data is a big drawback in the development of urban wind turbines.

● **Geothermal energy for direct use**: With the need to decarbonise the heating sector, and recognising the potential and advantages of direct use of geothermal energy, applications in cities have been growing. Globally, the installed capacity of geothermal direct use has more than doubled since 2010, reaching 107 727 megawatts-thermal deployed across 88 countries in 2019. Geothermal technology is used mainly for space heating and cooling as well as for hot water in cities, through both stand-alone and district heating systems. For new cities or for the expansion of existing cities, installing geothermal energy systems would be much more cost-efficient than integrating the systems into established infrastructure.

For most cities, integrating the renewable energy technologies described above would require upgrading the urban infrastructure to accommodate them, without compromising on operational reliability and stability. This report highlights the importance of developing “smart” grids through innovation and the adoption of enabling technologies such as electric vehicles, energy storage systems and intelligent energy management systems to facilitate the integration of renewables into urban infrastructure. Smart grids present opportunities for using higher shares of variable renewables and for improvements in system efficiency. This is particularly important because future urban energy infrastructure will be highly integrated among different sectors, including power, heating and cooling, and transport.

Similarly, district heating networks that focus on integrating renewable energy sources offer new opportunities for renewables – such as solar thermal and low-temperature geothermal energy – to play a greater role in the energy supply. Through sectorcoupled technologies such as heat pumps, electric boilers and thermal energy storage, thermal energy networks have been increasingly integrated with power systems.

Urban energy system planning that is focused specifically on integrating renewables into energy infrastructure is essential to advancing the world’s energy transformation. Choosing the right modelling tool for this planning is critical. This report examines the commonly used modelling tools to support urban energy system planning, as well as the key challenges in undertaking such planning, particularly in developing countries.

These include data challenges related mainly to the accessibility and granularity of city-level energy data covering demand- and supply-side issues. The report evaluates seven modelling tools against a set of criteria to determine their effectiveness for use in renewable-centric urban energy system planning.

Notably, integrating renewable energy systems into the urban infrastructure of a new section or area of an existing city, or in new cities, would be less costly than integrating these systems in established areas because there would be less need to retrofit existing buildings and networks.

Existing or planned cities, therefore, need to shift the paradigm for their urban infrastructure development, with renewables playing a crucial role. This will help reduce the carbon footprints of cities in line with the global move towards a carbon-constrained future and, equally importantly, will enable cities to mitigate the negative impacts of global and local climate change.

To conclude, cities can rarely rely solely on local renewable energy sources to decarbonise their energy systems. However, before cities default to importing renewables from outside their boundaries, they should explore the opportunities to maximise the use of locally available renewable energy sources.

They should encourage distributed energy generation and an integrated approach to developing future urban infrastructure. This means coupling the power, buildings, transport, heating and industry sectors to achieve higher system efficiency and enhance climate resilience.

3. Innovation Landscape for a Renewable-Powered Future: Solutions to Integrate Variable Renewables

A large number of innovations that can be used to integrate high VRE shares are emerging and are being implemented worldwide. IRENA's Innovation Landscape study maps the relevant innovations, identifies the synergies and formulates solutions for integrating high shares of VRE into power systems as a result of implementing these innovations. The Innovation Landscape is based on analysis of hundreds of innovative projects and initiatives being implemented around the globe.

These innovations have been grouped and mapped in categories, resulting in a suite of 30 innovations).

Enabling Technologies

• Battery storage technologies, able to back up the variability of renewables and provide various services to the grid.

1. Utility-scale batteries
2. Behind-the-meter batteries

• Technologies that enable electrification of other sectors, opening doors to new markets for renewable generation as well as new ways to store the generation surplus.

3. Electric-vehicle smart charging
4. Renewable power-to-heat
5. Renewable power-to-hydrogen

• Digital technologies that are introducing new applications in the power sector, changing the boundaries and dynamics of the industry and helping to optimise renewables assets.

6. Internet of things
7. Artificial intelligence and big data
8. Blockchain

• New and smart grids, both large and small scale, that complement each other and enable new ways to manage VRE generation.

9. Renewable mini-grids
10. Supergrids

• Refurbishment of existing assets, to adapt to the new conditions and to the needs of the system.

11. Flexibility in conventional power plants Business models

• Business models that empower consumers, turning them into active participants.

12. Aggregators
13. Peer-to-peer electricity trading
14. Energy-as-a-service

• Innovative schemes that enable renewable energy supply, in both off-grid and connected areas.

15. Community-ownership models
16. Pay-as-you-go models Market design

• **New regulations in the wholesale markets that encourage flexibility from market participants, better signal firming power supply's value, and properly remunerate their grid support services.**

17. Increasing time granularity in electricity markets
18. Increasing space granularity in electricity markets
19. Innovative ancillary services
20. Re-designing capacity markets
21. Regional markets

• **Design and regulatory changes in the retail market that stimulate flexibility on the consumer / prosumer side.**
22. Time-of-use tariffs
23. Market integration of distributed energy resources
24. Net billing schemes System operation

• Distributed generation deployment requires new ways of operating the distribution grid and market facilitation for distributed generation.

25. Future role of distribution system operators
26. Co-operation between transmission and distribution system operators

• New operation procedures that enhance electricity system flexibility.
27. Advanced forecasting of variable renewable power generation

28. Innovative operation of pumped hydropower storage

• New ways to operate the grid that reduce VRE curtailment due to grid congestion reducing the need to reinforce the grid.

29. Virtual power lines
30. Dynamic line rating T

The analysis also demonstrates that innovations are emerging across four key dimensions of the world's power systems:

• **Enabling technologies:** Technologies that play a key role in facilitating the integration of renewable energy.

• **Business models:** Innovative models that create the business case for new services, enhancing the system's flexibility and incentivising further integration of renewable energy technologies.

• **Market design**: New market structures and changes in the regulatory framework to encourage flexibility and value services needed in a renewable-based power energy system, stimulating new business opportunities.

• **System operation:** Innovative ways of operating the electricity system, allowing the integration of higher shares of variable renewable power generation.

Based on the experiences of pioneering countries and companies in piloting and applying these innovations, each of the 30 innovation types has been analysed in detail. A series of briefs prepared aims to help people assess the benefits, risks and suitability of each innovation for any specific context.

Each of the Innovation Briefs contains:

I Description: what the innovation is and how it works.

II Contribution to power sector transformation: how the innovation, through the services and the benefits provided to power systems, could support the integration of VRE.

III Key factors to enable deployment: overview of the risks and challenges, and how to overcome them, for the implementation of the innovation.

IV Current status and examples of initiatives: indicators to track the current progress of the innovation, and examples of ongoing initiatives and projects implementing the innovation around the world.

V Implementation requirements: Checklist is an easy-to-use tool for policy makers, listing the items that need to be in place to implement the innovation.

4. European and Global Experience in Energy Transition

The project Creating Actionable Futures – CrAFt is part of the New European Bauhaus (NEB) initiative of the European Union and will place the transition to climate neutrality at the heart of urban stakeholders.

We cooperate with the Mission Board on Climate-Neutral and Smart Cities and the NetZeroCities platform. And support cities in designing and deploying Climate City Contracts based on the experience from CrAFt's Sandbox Cities —Bologna, Prague, and Amsterdam—, as well as 60 CrAFt Reference Cities.

We will test and share collaborative local governance models to harness the value of inclusiveness, aesthetics and sustainability towards climate neutral cities.

NetZeroCities is part of the Horizon 2020 Research and Innovation Programme in support of European Union's Green Deal. [NetZeroCities has been designed to help cities overcome the current structural, institutional and cultural barriers they face in order to achieve climate neutrality by 2030.

NetZeroCities supports the EU's Mission of "100 Climate-Neutral and Smart Cities by 2030" newly-launched as part of the Horizon Europe programme. The project works as a service-oriented platform supported by world-class practitioners. It helps European cities by providing them with the support and solutions they need to achieve their Net Zero goal in a socially inclusive way.

New and existing tools, resources and expertise are developed and promoted into a one-stop platform accessible to all cities through an online portal. Dedicated services are designed to support cities that are part of the EU's Mission "100 Climate-Neutral and Smart Cities by 2030". In addition, NetZeroCities supports a series of Pilots to help drive rapid learning about how to achieve climate neutrality at city scale, and will run a Twinning programme to enable peer-learning.

What is the EU Mission on Adaptation to Climate Change?
The Mission on Adaptation to Climate Change focuses on supporting EU regions, cities and local authorities in their efforts to build resilience against the impacts of climate change. The Mission's objective is to accompany by 2030 at least 150 European regions and communities towards climate resilience. Read more about the EU Mission on Adaptation to Climate Change.

What does the Mission do?
The Mission contributes to delivery of the EU Adaptation Strategy by helping the regions and local authorities to:

I. Better understand the climate risks that they are and will be confronted with in the future
II. Develop their pathways to be better prepared and cope with the changing climate

III. Test and deploy on the ground innovative solutions needed to build resilience to climate change.

IRENEC conferences provide an International Platform to discuss for the European Union’s Green Plan, which aims to be climate neutral in 2050 by

- •investing in environmentally friendly technologies
- •supporting the industry for innovation
- •providing cleaner, cheaper and healthier private and public transport vehicles
- •decarbonisation of the energy sector
- •to make buildings more energy efficient
- •local, national and global actions required in the energy sector, such as working
- with international partners to improve global environmental standards.

Video Recordings of IRENEC 2021, IRENEC 2022 and IRENEC 2023 conferences are available at EUROSOLAR Türkiye YouTube Channel.

5. How to create a roadmap for your city’s renewable energy transition?

Cities must take bold action now to meet these ambitious – and necessary – energy goals
Mayors and city authorities play a leading role in delivering 100% clean energy. Cities should:

a) Begin by developing a renewable energy roadmap.
b) Incentivise building-scale renewables and lead by example with municipal solar.
c) Leverage the city’s buying power to collectively procure clean energy.
d) Promote clean heating and cooling for buildings, including by supporting the shift away from natural gas and coal.
e) Improve energy access for vulnerable communities.
f) Lobby regulators and utilities to accelerate their pace of action.
g) Make the case for cleaner energy with other levels of government, particularly if your city does not have power over the electricity grid or to decide energy sources.

To achieve this transition, cities need to set out clear goals and impactful, locally appropriate actions. An energy ‘roadmap’ is an informed plan to increase the amount of renewables in the energy mix and accelerate the shift away from fossil fuels. In addition to establishing a city-wide renewable energy vision, it can align with national policies, establish platforms for collaboration within and outside city government, and attract private investment. It should be connected to your city’s climate action plan. This article outlines the key steps your city can take to build a roadmap.

Climate Action Planning Guide

A step-by-step guide to developing a city-wide climate action plan that is consistent with the objectives of the Paris Agreement and addresses the city's wider socio-economic needs.

Getting Started

Begin by understanding why a Climate Action Plan (CAP) is important and the significance of the Paris Agreement in shaping cities' climate action. From this foundation, the first step in climate action planning is to create the enabling conditions for success – from securing the commitment of city leadership, setting up a CAP team and mechanisms for internal collaboration, to appraising existing policies and defining a long-term vision to guide the process.

Governance

Good climate governance is integral to the effective design and implementation of a city's CAP, starting with the governance aspects covered in 'Getting Started'. Here, we outline the principles, tools, resources that can help cities create a supportive policy framework, and governance structure for the CAP, and establish enabling conditions for implementation.

Stakeholder and Community Engagement

An inclusive, collaborative process for climate action planning is as important as the CAP itself. It builds widespread community and political support, fosters credibility and strengthens the resulting plan. This sets out steps, approaches and tools to help cities design and deliver an inclusive, equitable and strategic engagement strategy. It can guide the city's engagement strategy for the overall planning process, as well as strategies for specific steps.

Build Evidence Base

A science-based CAP that delivers the greatest benefits for the city and its residents will need to be underpinned by evidence on the city's emissions, climate risks, and wider priorities. Here, learn how to carry out a citywide GHG emission inventory, climate change risk assessment, and a socio-economic needs assessment.

Strategy Identification

Informed by the evidence base, the next step is to identify mitigation targets and adaptation goals, and the strategies the city can adopt to meet them. This process benefits from the involvement of a large and diverse stakeholder network, who will help the city to develop ambitious and achievable strategies. This step also offers a way to meaningfully engage them, building trust and buy-in that will be critical throughout CAP implementation.

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Action Prioritisation and Detailing

Once evidence-based strategies for meeting mitigation and adaptation ambitions have been established, the next step is to decide which strategies and actions to include in the CAP. This action prioritisation process should again be highly-collaborative, to strengthen the CAP itself and build vital support for its implementation. The need to embed equity and inclusivity into the identification, prioritisation, design and implementation of climate actions is equally critical.

Plan Compilation

The final step in the process of developing a climate action plan is writing it. This outlines best practices for designing, writing and launching a CAP that effectively communicates the city's commitment to climate action, the strategies and actions the city will employ, and the evidence that underpins them.

Monitoring, Evaluation and Reporting

Monitoring, evaluating and reporting (MER) enables the city to track the CAP's implementation and impact, demonstrating the value of actions taken and allowing the city to make informed adjustments – maximising the success of its implementation.

Begin by determining your city's current and future energy needs

Most cities will benefit from working with research institutions such as universities to assess energy needs, though a department or team in your city should lead the process.

Assessing energy demand should include the following steps:

Establish the local context, including, at a minimum, your city's demographics and trends, economic and social drivers, financial conditions and regulatory powers. If your city is home to people living in slums and informal settlements, it is critical that they are included in this assessment.
Conduct a city energy survey to assess current and future energy needs. Gather data to understand energy use within the city's jurisdiction, including the fuels and equipment used, sectoral and end-user demand, and behavioural patterns that affect energy use. Use this data, along with information about the local context and changing technologies and trends, to project future demand. Cities with growing populations and expanding economic activity will see a continued rise in energy demand. Ensure that the assessment includes 'suppressed demand', where an energy source is currently unable to meet demand, or where citizens cannot afford the energy, they need. Also incorporate projected energy efficiency improvements, which is critical to meeting energy demand, as well as any anticipated increases in demand for cooling.

Energy efficiency first

The best way to meet energy demand is by increasing efficiency. Yet, barely more than one-third of global energy use is covered by energy-efficiency policies. Any plan to transition to renewable energy should put energy efficiency at its heart to avoid wasting resources. Five impactful actions cities can take to reduce building energy demand explains the main options.

Bold action is needed now to reduce emissions from buildings, which are major consumers of energy in cities. These are the impactful actions that city governments can take, to optimise building energy performance and achieve net-zero-carbon buildings by 2050.

1. **Lead by example with net-zero-carbon municipal buildings**

    a. Commit to only owning, occupying and developing buildings that are net-zero carbon in operation by 2030. Start by identifying the best opportunities for emissions reductions.
    b. Set performance standards for new public buildings and incorporate zero-carbon building requirements into city-run social housing programmes.
    c. Use public buildings to test and showcase new technologies and models, build capacity in local markets and inspire other building owners.
    d. Finance municipal retrofits by improving the attractiveness of retrofit investments for private investors, leveraging dedicated financing vehicles such as green bonds

and using financing models that enable energy efficiency investments to be repaid over time using energy-cost savings.

2. **Create a transparent evidence base with reporting and disclosure requirements and develop a net-zero-carbon buildings pathway**

    a. Require benchmarking to build a baseline for energy consumption for different building sizes and types.
    b. Require energy audits for priority building types to assess energy efficiency technologies in buildings, and for a more detailed energy consumption analysis.
    c. Make the energy efficiency levels of buildings visible and accessible with energy performance certificates and labels, and with national or international green building rating and certification schemes.

3. **Set performance requirements for new and existing buildings**

    a. Introduce an energy or greenhouse-gas-emission cap for individual buildings to incentivise energy efficiency investments.
    b. Set building energy codes to improve energy performance. Codes are often set at the national level, but cities with the power to do so should set more ambitious codes, set 'stretch' codes to work toward zero-carbon buildings and/ or add a voluntary zero-carbon appendix to a mandatory building code.
    c. Introduce legislation to bring existing buildings up to code at key moments in their lifecycle, such as point of sale or lease, and use retro-commissioning and 'tune-ups' to make sure buildings are performing as they should.
    d. Use bylaws to mandate better building performance as an alternative, or in addition, to a building energy code.
    e. Introduce minimum energy efficiency standards for the highest emitting appliances and equipment.
    f. Use green building rating and certification schemes as a minimum standard for buildings. These schemes are especially useful for cities with limited regulatory powers. Ban the rental of highly inefficient buildings using energy performance certificates and labels.
    g. Scale-up building retrofits by developing ready-made, prefabricated (or 'turn key') solutions.

4. **Incentivise and support stakeholders to meet – and exceed – requirements**

    a. Train developers, builders and inspectors to ensure the city has the necessary skills for implementation and to develop the local market.
    b. Communicate the many benefits of net-zero-carbon buildings and provide guidance and training to building owners to encourage and support action towards this goal.

c. Facilitate energy performance contracting by stimulating the market and reducing transaction costs. Enable financing mechanisms with repayments through property taxes and utility bills.
d. Reduce real and perceived investment risks to support access to finance from private investors by reducing retrofit transaction costs and establishing risk sharing or risk mitigation mechanisms.
e. Use incentives such as grants, tax reductions, expedited building permits and free and/ or convenient building energy performance services to accelerate uptake beyond mandatory measures.

5. **Shift remaining building energy supply – including heating and cooling – to renewables**

a. Incentivise building-scale renewables and lead by example with municipal solar energy.
b. Create demand for large-scale clean-energy generation by negotiating a power purchase agreement with a renewable energy supply, supporting citizens and businesses to aggregate demand and investing in large-scale, city-owned clean energy installations.
c. Promote clean energy sources for heating and cooling buildings.

To achieve net-zero-carbon buildings, cities will need to implement a combination of these actions. Cities should focus first on optimising energy efficiency to reduce energy demand from buildings, and shift remaining energy supply to renewables. Cities can begin by targeting policies at segments of the building stock with the most emissions-reduction potential, informed by data collected through reporting and disclosure policies. We explain how to implement these measures in the related articles linked above.

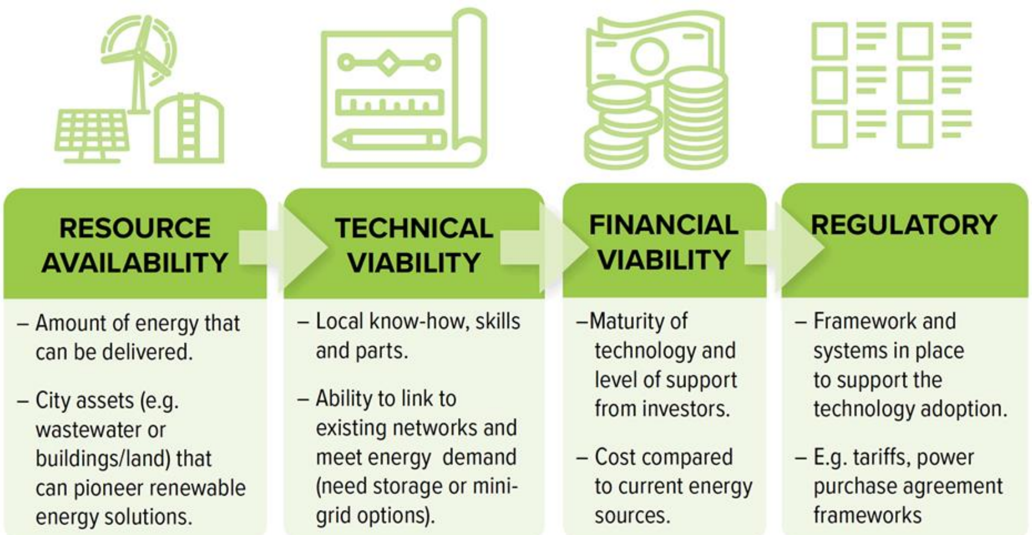
Assess which renewable energy resources are most feasible locally

The main renewable energy sources cities can deploy are solar photovoltaic (PV) power, wind power, tidal and wave power, biomass, geothermal power, landfill gas to energy, wastewater gas to energy and hydropower. The viability of each depends on the natural resources available locally, as well as the technical capacity, financial viability and regulatory barriers, as shown below.

Do not turn to natural gas or ‘clean’ coal as transitional fuels

Both are fossil fuels, producing emissions and air pollution. Both are also likely to be more expensive to develop than new renewables – solar PV or wind now offer the cheapest source of new electricity generation in most markets – and leave cities and residents exposed to volatile energy costs.

It is unlikely that your city can produce all the renewable energy it needs within urban boundaries – at least some supply will need to be imported from neighbouring municipalities, smaller cities and the wider region. This means that the build-out of renewables should be approached as a regional issue, considering where it will be located and who will provide, and planned in collaboration with regional partners.



To analyse these factors, engage external experts, energy companies and national and/or regional governments, and investigate existing projects in your region that could provide insight into what is feasible.

a. **Resource availability**. Develop natural resource maps. Free data portals can support these, such as SolarGIS, the National Renewable Energy Laboratory's (NREL) PVWatts Calculator and C40 Cities' mapping tool for municipal properties.

b. **Technical viability.** Work with experts to understand the renewable technologies being considered, how renewable energy systems could be connected to existing networks, whether additional infrastructure or systems like mini-grids need to be established, and whether the skills and expertise are available locally.

c. **Financial viability.** Understand financing options for locally applicable renewable energy sources and the level of support from private investors. The Clean Energy Business Model Manual explains business models and financial instruments that cities can use to implement clean energy projects and policies. The two most common financing structures, depending on which is enabled by local regulation, are power purchase agreements (PPAs) and lease arrangements. In a PPA, a municipality commits to purchasing power produced by a third party, enabling private developers behind renewable energy technology to raise finance while giving the city a clean source of local energy. Read How cities can create demand for large-scale clean energy generation for more on PPAs. In a lease arrangement, a third party installs the energy technology and leases it to a municipality for a fixed fee.

d. **Regulatory viability**. Analyse the regulatory tools and frameworks in place at regional or national level that can support the deployment of renewable energy technologies, such as feed-in-tariffs, PPA frameworks or net/virtual metering mechanisms. Green tariffs that enable customers to source up to 100% of their energy from renewables can offer a way forward for cities served by a monopoly utility, which can reduce the viability of approaches like PPAs.13

Set targets and map out scenarios for meeting them

To keep warming within the necessary 1.5°C limit, targets for city-wide energy use should aim for 100% clean electricity by 2035 and 100% clean energy by 2050, at the latest.
Involve utilities, large energy-using institutions, relevant civil society groups, the public and other stakeholders in the process to determine local targets that are ambitious but achievable. Informed by the feasibility assessment, an inclusive and consultative target-setting process will help to achieve widespread buy-in for targets. It will also help to identify the most suitable and desirable scenarios for meeting them, ultimately accelerating the transition to renewable energy.

Map out scenarios with different renewable energy combinations and growth rates, and align the targets with existing city infrastructure plans. Host stakeholder workshops and meetings to develop and provide feedback on these scenarios. While focussed on the wider climate action planning process, how to engage stakeholders for powerful and inclusive climate action planning provides relevant advice on involving stakeholders in target- and vision-setting.

Consider setting ambitious targets for municipal operations, in order to provide a clear mandate for city government leadership. Over 50 local council leaders in the United Kingdom, all members of UK100, have set targets for net zero municipal emissions by 2030 alongside 2045 citywide targets.

Sign up to renewable energy campaigns

Joining a renewable energy campaign will help to raise the visibility of clean energy targets and align with other cities doing similar work. Such collaboration can also enable cities to pool resources, share lessons, increase their purchasing power with energy companies or leverage their collective power to put pressure on national governments.
Cities should join the C40 Renewable Energy Declaration, open to all cities globally, whereby they pledge to take all possible steps to accelerate the full decarbonisation of electricity, heating, cooling and cooking and the phase-out of fossil fuels. It promotes targets along three pathways, depending on a city's feasibility assessment. Other relevant global campaigns include Cities Race to Zero, which requires signatories to commit to targets and actions for renewable energy, as well as other key sectors.

The movement is accelerating. By the end of 2020, more than 1,300 cities had set targets or introduced policies to boost renewable energy; more than 600 had made commitments for 100% renewables by a certain date. Most of these cities are in Europe and the United States.16 In the latter, more than 180 cities have signed up to the Sierra Club's commitment to power their communities with 100% renewable energy.

Durban's renewable energy scenarios

After conducting a feasibility study, Durban developed several scenarios, with different technological combinations from inside and outside the city that could be included in the energy mix. Each was evaluated based on qualitative and quantitative factors, such as feasibility and cost effectiveness, to determine their strengths and weaknesses. Through this process, the city determined that solar technology should be the driving force behind the roadmap, enabling Durban to meet an increasing proportion of energy demand from in-city renewables over the coming decades, as the figure shows.

Plan for effective implementation

The following actions and linked resources can support the successful implementation of your city's roadmap:

a. **Take the lead.** Cities can lead by switching municipal energy consumption to renewable energy, and by maximising the use of municipal buildings, brownfield sites and other assets to produce renewable energy. City projects can showcase new technologies and options to stakeholders, develop the local market, and help to pave the way for broader take up of renewables to achieve a city-wide transition. Starting with smaller projects on municipally owned sites also offers a lower-risk way for cities to gain experience with renewables. How to install solar panels on city-owned property and how cities can create demand for large-scale clean energy generation explain two impactful ways to do this. Cities that are supplied by coal-based grid energy can also lead action to phase out coal.

b. **Target building energy use**. Buildings account for a major portion of cities' energy use. As well as implementing policies to reduce buildings' energy demand, cities should promote clean heating and cooling and, where relevant, shift away from natural gas. In addition, encourage residents and businesses to install building-scale clean energy.

c. **Consider a 24/7 Carbon Free Energy approach** – manage demand as well as supply to enable electricity use to be met with carbon-free sources every hour of every day.

d. **Ensure everyone has affordable energy access**. Energy access means that a household is connected to a secure, affordable and sustainable source of energy. Inadequate energy access holds people back from economic participation, damages health and leads to significant greenhouse gas emissions, among other issues.

e. **Ensure energy investments are resilient to climate risks.** Reducing climate change impacts on clean energy supply introduces ways to integrate climate change adaptation into clean energy investments.

f. **Develop structures for continued collaboration and coordination**. In addition to supporting the development of the roadmap, cities should forge partnerships and create forums with expert organisations, such as universities or environmental non-governmental organisations, and create platforms for interdepartmental collaboration to aid its implementation.

g. **Manage data effectively and monitor and report on progress**. Develop processes to manage data and to monitor and evaluate progress, alongside a reporting plan for keeping stakeholders updated. The City Climate Data Management Framework can support this.

6. Modelling tools for urban energy system planning

Urban energy systems are unique in that they involve not only the physical energy infrastructure, but also important social elements such as public acceptance, consumer preferences and behaviours, willingnessto-pay and affordability. Establishing effective local power generation and meeting targets for renewables depend on employing a sound process and tools for urban energy system planning.

The planning process allows the formulation of a wellinformed, sustainable urban energy system plan. Many institutions have developed effective frameworks and practical tools to guide local authorities throughout the planning process (Saheb et al., 2014; Hemis, 2017; UN-Habitat and ICLEI, 2009).

In addition, energy planning must be integrated into urban planning as early as possible, as urban forms, functionalities and zoning have significant impacts on energy demand and increasingly also on energy production, particularly with the proliferation of prosumers (Zanon and Verones, 2013; Rickwood et al., 2008; Nuorkivi and Ahonen, 2013). Further, enhancing urban resilience in response to climate change needs to factor in long-term planning, as urban energy infrastructure typically has a life span of up to 50 years or more (Reckien et al., 2018; Mirakyan and De Guio, 2015).

A sound process also requires the right planning tools for urban energy system development. Although a wide range of modelling tools are available to support urban energy system planning, the tools vary in their ability to address issues associated with different spatial and temporal scales, as well as in their technology representations, underlying methodologies and analytical scopes. Growing shares of local renewables in urban energy systems also requires an increasing understanding of the tools available for urban energy system planning. These can help to determine the feasibility of renewable energy solutions in early planning stages, the design of renewable energy systems (e.g., sizing and operation) at later planning phases, and strategic planning with a special focus on renewable energy.

Local authorities and energy experts must therefore gain a better understanding of the most suitable modelling tools for urban energy system planning, identified and evaluated against their capabilities to consider, identify, integrate and scale up renewable energy technologies in cities. In addition to exploring the available tools, this chapter discusses possible data challenges when applying them, as well as pathways to address these challenges. Lastly, modelling challenges are discussed in the context of developing countries, given that 90% of urban population growth in the next three decades is expected to come from these countries, chiefly from Asia and Africa (UN DESA, 2018).

Modelling tools

A wide range of models and tools are available for urban energy systems planning, spanning different spatial scales, temporal scales, technology representations, underlying methodologies and analytical scopes. A comprehensive study was undertaken to evaluate these models and tools, identify prevailing gaps and challenges in the field, and propose recommendations to improve the tools/ methods and their uptake by urban energy planners.

Based on the thorough evaluation of tools relevant to local-scale renewable energy applications (i.e., from project to city-wide scales), seven stand out as being widely suitable and commonly used: OSeMOSYS, Balmorel, EnergyPLAN, HOMER, TIMES, MESSAGE, and LEAP. These tools – discussed further in the sections that follow – have been identified and evaluated based on their capabilities to consider, identify, integrate and scale up renewable energy technologies in cities.

OSeMOSYS (Open Source Energy Modelling System) has been under opensource development since 2010. It is a least-cost, linear optimisation programme that provides longterm investment and operational decision support. Users can define slices (down to an hourly level) and modelling horizons. The programme can model all renewable energy technologies, conventional energy technologies and storage technologies (Groissböck, 2019).

Balmorel is a partial equilibrium model that supports both long- and short-term investment and operational decision making. It is implemented as a linear, least-cost optimisation problem. It was developed in 2001 and has been maintained as an open-source model ever since. Balmorel can model a wide range of renewable energy technologies and other technology options. It has mainly been applied to analyse and expand existing energy systems, such as the integration of heat pumps into the district heating system of Copenhagen or to analyse that city's CHP system. Most existing studies focus on renewable energy integration and the effectiveness of policy mechanisms to improve uptake of renewable energy technologies.

EnergyPLAN is a bottom-up simulation tool designed to evaluate both greenfield and brownfield (i.e., both new and existing) energy systems. It allows users to explore energy system scenarios for a one-year period with an hourly time resolution. EnergyPLAN has been developed and maintained by Aalborg University since 1999, and the evolving role of renewable energy technologies in the tool is well documented. In 2004, the tool focused on modelling only wind, solar and heat pump technologies. By 2009, however, storage options were added (e.g., battery, compressed air energy storage and hydrogen storage), along with transport options, electrolysers and cooling technologies. Waste-toenergy, geothermal, absorption heat pumps, pumped hydropower, biomass conversion and synthetic gas technologies were added by 2012, alongside grid considerations. By 2017, additional desalination, carbon capture and district cooling features were added as well. Today, EnergyPLAN models all key renewable energy technologies, conventional energy technologies and storage technologies. A wide range of studies, from urban to international scales, have been undertaken using EnergyPLAN (Aalborg University, 2018). Most studies focus on the integration of renewable energy technologies into energy systems. The geographic focus is mostly on European countries, but applications exist in the US, Africa (e.g., Kenya and Tanzania), Central America (Mexico) and China (Hong Kong). With respect to urban-scale studies, in the case of Denmark strategies for 100% renewable energy were developed for Aalborg, Copenhagen, and Samsø, and the transformation of district heating to use renewable sources was investigated for Frederikshavn. Integrated energy systems and local Danish energy markets were also investigated. Additional studies have focused on renewable energy integration to make neighbourhoods self-sufficient in the Netherlands, on renewable energy integration in Humboldt, California, US and on renewable energy scenarios in Hong Kong.

HOMER (Hybrid Optimization of Multiple Energy Resources) is one of the most popular tools for local-scale energy systems modelling. It provides a bottom-up simulation and enumerative optimisation tool, meaning that it simulates all possible system configurations under the given constraints and characteristics, and then identifies optimal solutions. HOMER targets stand-alone and grid-connected power systems modelling and allows for simulations down to a minute level for a one-year period. The increasing importance of renewable energy technologies, storage solutions and environmental concerns in today's energy systems is evidenced by HOMER's continual evolution over time. In 2000, the ability to account for emissions was added to the model, and by 2005 additions included new technologies (hydropower, biomass and hydrogen converters), improved battery storage modelling, hydrogen storage, real-time grid pricing, emission constraints and penalties, and more detailed results for all renewable energy technologies. Given its focus on renewable integration, HOMER enabled simulation time steps of down to one minute in 2007, along with the ability to model temperature effects on PV and new grid/battery control parameters. By 2015, the tool had made notable storage modelling improvements, including the ability to model flywheel storage, specifying the initial battery state-of-charge, and adding more than 50 new battery models. Modelling improvements were also made for solar and wind energy systems (e.g., expanded maximum power point tracker capabilities for solar and temperature effects on wind resources). Since 2015, a new hydrogen module has been added, along with advanced grid features (e.g., scheduled outages and per-rate options) and a greatly expanded component library. Myriad studies from around the world have utilised HOMER. Examples of optimal renewable energy technology planning for new systems, including micro-grid applications and hybrid systems, are presented for urban communities in India (Fulzele and Dutt, 2012; Phurailatpam et al., 2018; Kumar and Bhimasingu, 2014). In China, a hybrid solar-wind energy system for a grid-connected micro-grid is investigated in Liu et al. (2013). African applications include the integration of renewable energy technologies for water-stressed urban areas in subSaharan Africa (Brandoni and Bošnjaković, 2017). US-based studies include optimally designing a hybrid PV-wind-storage system for Catalina Island, storage integration with wind energy at various sites in California and distributed renewables integration into family households in Boulder, Colorado (Huang et al., 2011; Lipman et al., 2005; Johnson et al., 2011). Finally, in Europe, urban tri-generation and teleheating systems were investigated for a community near Rome, Italy (Salata et al., 2015).

TIMES (The Integrated MARKALEFOM System) is part of the MARKAL family of models, developed and maintained by the International Energy Agency since 1980. It is another of the most widely utilised energy planning modelling tools, applied on all scales from local to global. More than 300 institutions in more than 80 countries currently use TIMES. TIMES is a least-cost linear optimisation, partial equilibrium model that can be used for a wide range of analyses. The modelling framework provides users with the freedom to define any process, including all technology types, for time steps down to an hour and for any number of years into the future. It is particularly suitable for long-term energy systems planning and policy analysis. Several local-scale studies have employed TIMES. In Europe, the tool has been applied to investigate longterm decarbonisation pathways through increased local uptake of renewable energy technologies for suburban and urban municipalities across Switzerland. It was also used to model household behaviour impacts on the French residential and transport sectors, to model energy scenarios for an Italian seaside town and to reduce emissions in a city transport sector model (Cayla and Maïzi, 2015; Forsberg & Krook-Riekkola, 2017). In the US, TIMES was used to investigate the environmental and economic impacts of introducing a carbon tax in Long Island and for low-carbon/renewable energy pathways in New York City (Cayla and Maïzi, 2015; Bhatt et al., 2010).

MESSAGE Basic description: MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) is a widely used integrated assessment modelling tool. It was developed by the International Institute for Applied Systems Analysis (IIASA) and has been in use since the 1980s. MESSAGE is a least-cost linear optimisation, partial equilibrium model that supports long-term scenario assessment and investment decision making. There are several MESSAGE variants. Most recently, the MESSAGEix model was developed, which is a more versatile, open-source implementation of MESSAGE. MESSAGEix allows for modelling all energy technologies down to an hourly scale and is suitable for urban-scale modelling. The MESSAGE model has been adapted to evolving energy technologies and growing environmental concerns over the course of four decades (Huppmann et al., 2019). A stochastic implementation to analyse risks was also developed around this time. In 2006, IIASA developed a detailed accounting of pollutants for emissions analysis, and in the mid-2010s researchers developed methodologies to address challenges with VRE technologies (Johnson et al., 2017). MESSAGE has traditionally been applied on the national and global level; however, MESSAGEix is a flexible tool that is applied on any scale. Local-level applications of MESSAGE for India are described for the Indus region and to study household energy consumption (IIASA, 2018).

The **LEAP** (Long-range Energy Alternatives Planning) model is another of the most widely used energy system modelling tools today, with more than 36 000 users in 195 countries (SEI, 2019). It is primarily a simulation tool used to explore long-term scenarios, but it also offers optimisation capabilities through interfacing with the OSeMOSYS tool. LEAP is employed by a wide range of users (including government, non-government, research, consulting and energy utility users) for energy policy and climate change mitigation strategy analysis, from the local to the global scale. It was developed in 1980 by the Stockholm Environment Institute and has seen various changes over the past four decades. As the environmental impact of energy systems became a growing concern in the 1990s, LEAP added an environmental database (funded largely by the UN) and became one of the first tools to address this issue in energy systems modelling. By the mid-1990s, LEAP greenhouse gas mitigation assessment capabilities were developed even further, and LEAP was used by numerous countries in their communications with the UNFCCC. In 2004, multiregion modelling capabilities were introduced. Many local-scale applications of LEAP exist, a small selection of which are described here. In China, LEAP has been used to explore low-carbon (including renewable energy) transition pathways for Beijing and to decarbonise the transport sector in Tianjin (Zhang et al., 2011; Yu et al., 2015; Peng et al., 2015). Urban transport decarbonisation strategies have been investigated for Indian metropolises, and low-carbon electricity and residential sector scenarios were developed for Delhi and Maharashtra (Kadian et al., 2007; Kale and Pohekar, 2014). Nepal has investigated sustainable urban transport pathways for Kathmandu (Dhakal, 2006). LEAP also has been applied in Africa, where the SAMSET project uses it to support African municipalities in developing sustainable energy strategies, including sustainable development pathways for two municipalities in Uganda (Kasese and Jinja) (Mann et al., 2015). In the US and Europe, LEAP has been used to develop energy and climaterelated strategies and action plans to achieve carbon neutrality at the sub-national level (Beaton, 2015; Lazarus et al., 2011)

7. Energy efficient building design

Energy efficient building design involves constructing or upgrading buildings that are able to get the most work out of the energy that is supplied to them. This is realized by taking steps to reduce energy loss such as decreasing the loss of heat through the building envelope. Energy efficient homes, whether they are renovated to be more efficient or a built with energy efficiency in mind, pose a significant number of benefits. Energy efficient homes are less expensive to operate, more comfortable to live in, and more environmentally friendly.

Inefficiencies that are not removed in the building process can pose issues for years. However, keeping energy efficient building design in mind when construction is underway is a more effective way to approach making a home more efficient, which is less expensive for a homeowner in the long run. Building codes exist around the world to ensure that buildings are energy efficient to a certain degree. However sometimes it is wise to go above and beyond these recommendations to have an even more energy efficient home. As well, since a house operates as a system, a home must be looked at as a whole in order to fully increase the energy efficiency. For example, expensive heating and cooling equipment do nothing to improve the energy performance of the house if insulation isn't keeping heat in during the winter and out in the summer.

Building an Energy Efficient Home

There are numerous ways to increase the energy efficiency of a building, and many different parts of a building that can be improved to boost this value. Better insulation, more efficient windows, doors, and skylights, as well as high-efficiency air conditioners and furnaces can all contribute to a more efficient home by keeping warm air inside or outside the home. As well, being able to properly regulate the temperature of a home through the use of a thermostat is a major part of having an energy efficient home, as having the right equipment is just as important as using it properly.

Overall, there are numerous strategies to increase energy efficiency. These steps include:

1. Using proper amounts of insulation in the walls and roof, being sure to reference regional standards
2. Properly weatherizing the building using weather stripping and caulking
3. Installing high quality windows that utilize low-e coatings and gas filling, while choosing the glazing and window frame material that will be most beneficial in the environment
4. Installing high-performance systems and appliances and evaluate their performance over their life cycle
5. Monitoring and verifying performance through energy audits to see where energy is being wasted in a building and where it is most cost-effective to make improvements through retrofitting
6. Overall, the general approach to achieving high efficiency buildings includes cutting the energy demand of buildings, producing energy locally from renewable resources, and sharing energy by creating buildings that generate a surplus of energy that can be fed back into an advanced grid structure.

Buying an Energy Efficient Home

There are numerous ways to determine if a home is in fact, energy efficient. One of the simplest things to do is to check what the Energy Star ratings are on the appliances in the home. If the home was constructed with energy efficiency in mind, it is likely that the appliances will have a good Energy Star rating. R-2000 homes are designated as extremely energy efficient, this includes high levels of insulation and other measures to help protect the environment and save energy. These homes are built to standards developed by Natural Resources Canada, and typically contain high efficiency heating, windows and doors, water conserving fixtures, as well as mechanical ventilation.

Importance

Having an energy efficient building is becoming more and more vital as energy emerges as a critical economic issue due to high demand for energy and unsustainable supplies of energy. This means that even households must evaluate how well energy is being used to heat and light a home. Energy efficient buildings offer opportunities to save money as well as reduce greenhouse gas emissions. As well, the reliance on non-renewable fuels is not sustainable, and it involves using more and more destructive processing means to obtain these fuels. Homes and other buildings account for nearly 40% of total US energy use (Canada is lower with just under 29%), and thus increasing their efficiency will improve the reliance on non-renewable fuels for the future. This environmental benefit of reducing the number of greenhouse gases is both local and global. There are local benefits due to the fact that a buildings energy demand requires a local supply of energy, which causes local pollution and negative health side-effects. This allows communities to focus on investing funds in other places instead of in building power plants.

In addition to overall environmental benefits that arise from a more energy efficient building, there are also personal benefits. Reduced heating and electrical bills are one major benefit to upgrading a home or building a more energy efficient home. As well, installing these energy-efficient technologies effectively works to "future-proof" the building by making investments that will be selling points well into the future. Overall, even though there is an initial amount of money that must be put in to improve energy efficiency, homeowners will often recover these costs in a short period of time due to the reduced energy expenses. This payback time can be short, taking only a few years.

As well, if there is more support and interest in energy saving technologies, associated prices will go down on certain devices while encouraging more and more developments in energy saving technologies to occur. Along with this, the more new practices that are adopted in construction, the more these measures will become standard practice and this in turn will lessen the environmental impact of buildings by making more efficient buildings necessary by law.

The best time to focus on energy efficiency is when a building is first being built, as this new construction offers opportunities to integrate new energy efficiency measures more simply than in a building that is already complete. As well, building a more energy efficient home to begin with is more cost effective than renovating a home to be more energy efficient.

8. Energy Efficiency in Buildings and Transport

Buildings

As a key user of energy in cities, buildings are a high-pay-off target in the process of advancing the global energy transition. A combination of energy efficiency and renewable energy can do a great deal to shrink the carbon footprint associated with the heating, cooling and other energy uses of a city's buildings. The toolbox is large, consisting of building codes and permits, building and zoning regulations, mandates, solar thermal ordinances, tax incentives, targeted subsidies and other financial and fiscal tools.

Cities have extensive power to regulate energy use in buildings through the use of building codes and rating systems such as BREEAM in the United Kingdom and LEED in the United States. Rating systems set standards that cities and developers can incorporate into their building codes, quickly advancing energy efficiency, especially if the standards are mandatory and cover all buildings, existing and new, public and private.

Cities can also release policies for electrifying heating and cooling in urban structures. Heat pumps have a major role to play but need additional policy support to reduce the barriers such as high up-front costs and preferential tariffs. District heating and cooling based on renewable energy hold significant potential and can benefit final consumers through reduced bills. Moreover, many cities now integrate solar energy into social housing projects. By offering clean energy and cutting-edge efficiency, such initiatives provide low-income families access to energy that is at once clean and affordable.

Integrating renewable energy into the building stock need not always be initiated by government action. Grassroots initiatives of co-operatives, non-profit associations, community trusts and other organisations sometimes take the lead in efforts to escape the exorbitant energy charges found in impoverished neighbourhoods. Of course, capital is often an obstacle, but some city governments bridge the financing gap to encourage such grassroots initiatives.

Finally, national governments can be useful in stimulating the use of renewables in buildings, especially by setting nationwide standards for building codes. Boundary-setting activities create incentives for renewables and can help to create markets for cutting-edge products.

Why are buildings important?

The buildings sector, which includes energy used for constructing, heating, cooling and lighting homes and businesses, as well as the appliances and equipment installed in them, accounts for over one third of global energy consumption and emissions.

Why do buildings matter for clean energy transitions?

Global floor area is growing rapidly, especially in developing countries, and growing wealth means more and more consumers are buying air conditioners and other appliances. Because of the long lifetime of structures, heating and cooling systems, and other appliances, design and purchasing decisions made today will shape energy use for many years to come.

Where do we need to go?

Existing technologies can deliver significant energy and cost savings and other benefits, but stronger policy support such as minimum performance standards and building energy codes will be required to put the buildings sector on track with the Net Zero Emissions by 2050 Scenario

Lighting

Why is this important?

Lighting is a major source of energy demand, though it is one area where energy use has stalled or even declined, thanks to new more-efficient options. LEDs are shaping current market dynamics, and competition among manufacturers is driving further innovation, wider product choices and lower prices.

What is the role of lighting in clean energy transitions?

Numerous countries began to phase out incandescent lamps more than ten years ago and many are now beginning to eliminate fluorescent lighting. Half of the global residential lighting market now uses LED technology.

Where do we need to go?

Although some advanced markets have introduced new regulations mandating the exclusive sale of high-efficacy LED lamps, progress in this area must be sustained to ensure that all countries sell predominantly LED technology by 2025, and with increasing efficiency to 2030, to align with the Net Zero Emissions by 2050 Scenario.

Heating

Why is heating important?

Space and water heating account for almost half of global energy use in buildings. Keeping homes warm in winter and providing hot water for sanitary needs are essential energy services.

Worldwide, around 40% of households require space heating during part of the year, with heating being a major component of home energy expenditure, in particular in colder climates**.**

What is the role of heating in clean energy transitions?

Nearly two thirds of heating energy use still rely on fossil fuels. However, efficient and low-carbon heating technologies are on the rise. Sales of heat pumps, a central technology for decarbonising heat, continue to grow at record levels, in particular in North America and Europe. Although heat pumps and other clean heating options are readily available and mature, significantly faster rates of deployment are needed to get on track with the Net Zero Emissions by 2050 Scenario.

Where do we need to go?

In the Net Zero Emissions by 2050 Scenario, the combined effects of a rapid scale-up of efficiency improvements of building envelopes, fuel and technology shifting, and power sector decarbonisation cut buildings' heating-related emissions by half by the end of this decade. These measures reduce the average global energy intensity of heating by around 4% annually through to 2030, double the rate achieved last decade.

Data Centres and Data Transmission Networks

Why are data centres and data transmission networks important?

Demand for digital services is growing rapidly. Since 2010, the number of internet users worldwide has more than doubled, while global internet traffic has expanded 20-fold. The data centres and data transmission networks that underpin digitalisation have led to rising energy use.

What is the role of data centres and data transmission networks in clean energy transitions?

Rapid improvements in energy efficiency have helped limit energy demand growth from data centres and data transmission networks, which each account for about 1-1.5% of global electricity use. Nevertheless, strong government and industry efforts on energy efficiency, renewables procurement and RD&D will be essential to curb energy demand and emissions growth over the next decade.

Where do we need to go?

Since 2010, emissions from data have grown only modestly despite rapidly growing demand for digital services, thanks to energy efficiency improvements, renewable energy purchases by information and communications technology (ICT) companies and broader decarbonisation of electricity grids in many regions. However, to get on track with the Net Zero Scenario, emissions must drop by half by 2030.

District Heating

What is district heating?

District heating involves generating heat in a centralized location and then distributing it to residences, businesses and industry in a local area.

What is the role of district heating in clean energy transitions?

District heating networks offer great potential for efficient, cost-effective and flexible large-scale use of low-carbon energy for heating. However, the decarbonisation potential of district heating is largely untapped, as 90% of the heat supplied in district networks is produced from fossil fuels, especially in the two largest markets of China and Russia.

Where do we need to go?

Aligning with the Net Zero Emissions by 2050 Scenario requires significant efforts to rapidly improve the energy efficiency of existing networks, switch them to renewable heat sources (such as bioenergy, solar thermal, heat pumps and geothermal), integrate secondary heat sources (such as waste heat from industrial installations and data centres), and to develop new high-efficiency infrastructure.

Heat Pumps

What are heat pumps?

A heat pump uses technology similar to that found in a refrigerator or an air conditioner, but in reverse, extracting heat from a source, then amplifying and transferring the heat to where it is needed. Current models are 3-5 times more energy efficient than gas boilers, and global heat pumps sales have been growing at double-digits the past few years.

What is the role of heat pumps in clean energy transitions?

Heat pumps are increasingly recognised as a critical technology for the decarbonisation of heat, receiving increasing policy support in several countries over the last years. The IEA estimates heat pumps globally have the potential to reduce global carbon dioxide (CO_2) emissions by at least 500 million tonnes in 2030 – equal to the annual CO_2 emissions of all cars in Europe today.

Where do we need to go?

Heat pumps still meet only around 10% of the global heating need in buildings, below the deployment level required to get on track with the Net Zero Emissions by 2050 Scenario. Further policy support and technical innovation are needed, in particular to reduce upfront purchase and installation costs, remove market barriers to complex renovations, improve energy performance and durability, and exploit the potential of heat pumps as an enabler of power system integration and flexibility.

Space Cooling

Why is cooling important?

Roughly 2 billion air conditioning units are now in operation around the world, making space cooling one of the leading drivers of rising electricity demand in buildings and of generation capacity additions to meet peak power demand. Residential units in operation account for nearly 70% of the total.

What is the role of cooling in energy transitions?

Over the next three decades, the use of air conditioners is set to soar, becoming one of the top drivers of global electricity demand. As the planet warms, ensuring that cooling needs are met equitably is of primary importance. Efficiency standards are a key measure to reduce emissions, together with passive, nature-based and alternative solutions to air conditioners, and improved design of buildings and districts.

Where do we need to go?

While highly efficient air-conditioning units are available on the market, most efficiency standards – and consequently the units purchased by consumers – have two-to-three times lower efficiencies than the top-of-the class models. To get on track with the Net Zero Emissions by 2050 Scenario, increased adoption of highest-efficiency air conditioners needs to be coupled with building and neighbourhood designs that support passive cooling, as well as behaviour changes such as setting thermostats slightly higher.

Appliances and Equipment

Why are appliances and equipment important?

The appliances and equipment category includes larger devices that are plugged into electricity mains, namely refrigerators, washing machines, dishwashers, dryers and televisions (appliances like air conditioners, heaters and stoves or ovens are treated seperately). Energy consumption by these devices continues to grow despite efficiency improvements, especially in emerging economies.

Where do we need to go?

To get on track with the Net Zero Emissions by 2050 Scenario, most appliances and equipment being sold in 2035 need to match today's best available technologies. Despite improvements in efficiency resulting from stricter minimum energy performance standards in many regions, further gains are needed and must be accompanied by behavioural shifts to reduce household electricity needs.

What are the challenges?

While energy policies have led to efficiency gains, especially for major household goods such as refrigerators and televisions, small appliances and consumer electronics are not aligned with global climate goals and continue to be unregulated in most countries. Expanded policy coverage and increased stringency are needed in all countries.

Building Envelopes

Why is this important?

High-performing envelopes (the parts of a building that separate the indoors from the outdoors, including exterior walls, foundations, roof, windows, etc.) are the most effective way to reduce the thermal needs of buildings. Compared to other solutions, the selection of envelope structure and materials is particularly important given the long lifetime of buildings and the cost of construction.

What is the role of building envelopes in clean energy transitions?

Efficient building design, integrating high-performing envelopes, is the most effective way to reduce the thermal needs of buildings and ensure occupants' thermal comfort. Compared to other solutions in buildings, the selection of envelope structure and materials is particularly important, given the long lifetime of buildings and the associated cost of the envelope.

Where do we need to go?

More than 110 countries lacked mandatory building energy codes or standards in 2022, meaning that over 2.4 billion square meters of floor space were built without meeting any energy-related performance requirements. To be in step with the Net Zero Emissions by 2050 Scenario, all countries need to establish zero-carbon-ready building energy codes for residential and non-residential buildings by 2030 at the latest. Being in step also requires 20% of existing building floor area to be renovated to this level by 2030.

Transport

The central role of transport in generating carbon emissions, and the fact that renewables account for only a small share of energy consumed in the transport sector, makes the sector a worthy target for reform. A combination of policies that *avoid* carbon emissions, promote a *shift* in transport modes and *improve* the sector's efficiency offers a useful toolbox for urban leaders interested in remaking transport into a low-carbon sector.

One key way to avoid carbon emissions is through urban land-use policy, and specifically the redesign of cities to reduce the need for long trips. Cities that pursue dense development and prioritise access to transport essentially restructure urban life such that long, cross-town journeys become less necessary.

It is also possible to shift from private cars to more efficient modes of transport such as walking, biking and public transport, which decreases energy consumption and emissions for each kilometre of passenger travel. A shift can be encouraged by incentive schemes, providing charging infrastructure, setting mandates to blend fuels to burn more cleanly and even banning transport powered by fossil fuels.

It is important to *improve* transport systems by making them cleaner, more accessible and more affordable – and therefore more attractive – to the public. Electric cars tend to be cleaner than those that run on gas, especially if their electricity comes from plants powered by the wind or sun. Electrifying municipal bus fleets and using these in BRT systems can be a powerful combination. This is especially so where the system is powered by renewable energy. Deployment of those alternatives can be accelerated by providing charging infrastructure, setting mandates to blend fuels to burn more cleanly and even banning transport powered by fossil fuels.

Although transport is typically a local responsibility, cities can find help in meeting their visions and plans even at the global level. International associations of cities often showcase best practices and promote knowledge sharing, which can be invaluable for cities trying to think creatively about their transport challenges. Some of these practices, such as congestion pricing, may not promote renewable energy directly, but can be tweaked to do so, as for example, in exempting EVs from congestion charges.

Clean and energy efficient vehicles

Clean and energy efficient vehicles have an important role to play in achieving EU policy objectives of reducing energy consumption, CO2 emissions, and pollutant emissions.

The Directive on the Promotion of Clean and Energy Efficient Road Transport VehiclesEN••• aims at a broad market introduction of environmentally-friendly vehicles. It addresses purchases of vehicles for public transport services.

Clean Transport Systems can fully meet the energy demand of the transport sector. Alternative low-carbon fuels should gradually substitute fossil fuels for transport propulsion in the long term.

Clean Vehicles Directive

The revised Clean Vehicles Directive promotes clean mobility solutions in public procurement tenders, providing a solid boost to the demand and further deployment of low- and zero-emission vehicles. The new Directive defines "clean vehicles" and sets national targets for their public procurement. It applies to different means of public procurement, including purchase, lease, rent and relevant services contracts. Adopted by the European Parliament & Council in June 2019, the Directive needs to be transposed into national law by 2 August 2021.

Which vehicles are concerned?

The Directive applies to cars, vans, trucks and buses (excluding coaches), when they are procured through:

- **Purchase, lease, rent or hire-purchase contracts** under obligations by EU public procurement rules (Dir. 2014/24/EU and 2014/25/EU)
- **Public service contracts** for the provision of passenger road transport services (Reg. 1370/2007)
- **Services contracts** forpublic road transport services, special-purpose road passenger-transport services, non-scheduled passenger transport, refuse collection services, mail and parcel transport and delivery. (Annex I of the Directive)

The Directive will only apply to contracts whose awarding procedure starts after 2 August 2021 (the end date for transposition).

What is a "clean vehicle"?

The revised Directive defines a "clean vehicle" as follows:

a) Clean light-duty vehicle: any car or van meeting the following emission thresholds:
   - until 31 December 2025: no more than 50g/km CO_2 and up to 80% of applicable real driving emission (RDE) limits for NOx and PN;
   - from 1 January 2026: only zero-emission vehicles.

b) Clean heavy-duty vehicle: any truck or bus using one of the following alternative fuels: hydrogen, battery electric (including plug-in hybrids), natural gas (both CNG and LNG, including biomethane), liquid biofuels, synthetic and paraffinic fuels, LPG.

The Directive also sets a separate definition for "zero-emission heavy-duty vehicles", as a sub-category of clean heavy-duty vehicles.

For light-duty vehicles (cars and vans), the definition is in line with the corresponding provisions under the latest CO_2 emission performance standards for cars and vans (Regulation 2019/631). In the first period, until 2025, the focus will be on low-emission vehicles, while in the second period, starting in 2026, the focus will be only on zero-emission vehicles.

Member State	**From 02.08.2021 to 31.12.2025**	**From 01.01.2026 to 31.12.2030**
Luxembourg	38,5%	38,5%
Sweden	38,5%	38,5%
Denmark	37,4%	37,4%
Finland	38,5%	38,5%
Germany	38,5%	38,5%
France	37,4%	37,4%
United Kingdom	38,5%	38,5%
Netherlands	38,5%	38,5%
Austria	38,5%	38,5%
Belgium	38,5%	38,5%
Italy	38,5%	38,5%
Ireland	38,5%	38,5%
Spain	36,3%	36,3%
Cyprus	31,9%	31,9%
Malta	38,5%	38,5%
Portugal	29,7%	29,7%
Greece	25,3%	25,3%
Slovenia	22%	22%
Czechia	29,7%	29,7%
Estonia	23,1%	23,1%
Slovakia	22%	22%
Lithuania	20,9%	20,9%
Poland	22%	22%
Croatia	18,7%	18,7%
Hungary	23,1%	23,1%
Latvia	22%	22%
Romania	18,7%	18,7%
Bulgaria	17,6%	17,6%

For heavy-duty vehicles (trucks and buses), the definition includes all vehicles running on any of the alternative fuels listed in the Alternative Fuels Infrastructure Directive (Directive 2014/95); in order to reflect their performance in terms of air quality and decarbonisation, zero-emission heavy-duty vehicles are given a separate definition.

National targets for procuring clean vehicles

The national targets are defined as a minimum percentage of clean vehicles in the aggregate public procurement across a Member State. This means, Member States have full flexibility in how they distribute the effort across different contracting authorities and contracting entities. A Member State has to meet at least half of the procurement target for clean buses in each period through the procurement of zero-emission buses.

Member State	Trucks (vehicle category N2 and N3)		Buses (vehicle category M3) –half of the target to be fulfilled by procuring zero-emission buses*	
	From 02.08.2021 to 31.12.2025	From 1.01.2026 to 1.12.2030	From 02.08.2021 to31.12.2025	From 1.01.2026 to 31.12.2030
Luxembourg	10%	15%	45%	65%
Sweden	10%	15%	45%	65%
Denmark	10%	15%	45%	65%
Finland	9%	15%	41%	59%
Germany	10%	15%	45%	65%
France	10%	15%	43%	61%
United Kingdom	10%	15%	45%	65%
Netherlands	10%	15%	45%	65%
Austria	10%	15%	45%	65%
Belgium	10%	15%	45%	65%
Italy	10%	15%	45%	65%
Ireland	10%	15%	45%	65%
Spain	10%	14%	45%	65%
Cyprus	10%	13%	45%	65%
Malta	10%	15%	45%	65%
Portugal	8%	12%	35%	51%
Greece	8%	10%	33%	47%
Slovenia	7%	9%	28%	40%
Czechia	9%	11%	41%	60%
Estonia	7%	9%	31%	43%
Slovakia	8%	9%	34%	48%
Lithuania	8%	9%	42%	60%
Poland	7%	9%	32%	46%
Croatia	6%	7%	27%	38%
Hungary	8%	9%	37%	53%
Latvia	8%	9%	35%	50%

Romania	6%	0,07	0,24	0,33
Bulgaria	0,07	0,08	0,34	0,48

* This requirement is lowered to one quarter of the minimum target for the first reference period if more than 80 % of the buses covered by the aggregate of all contracts awarded during that period in a Member State are double-decker buses.

Because the targets are calculated on the basis of the aggregate public procurement across a Member State (i.e. on the basis of the total number of vehicles within the scope of the Directive, which are procured during the respective period). Member States have full flexibility in how they distribute the effort across different contracting authorities and contracting entities.

In other words, the Directive does not directly set requirements for individual tenders, nor targets for individual cities or public authorities. A Member State may decide to set higher and lower targets for different authorities, as long as the total number of vehicles procured during each period includes a minimum share of clean vehicles in line with objectives.

Monitoring and reporting

When contracting authorities or contracting entities procure vehicles through purchase, lease, or hire-purchase contracts within the scope of the Directive, all these vehicles count for the purpose of the national minimum target. In the case of public services contracts, or contracts for services under Annex I, the number of vehicles to be used for the provision of those services are counted.
Monitoring and reporting will happen primarily through the Tender Electronic Database (TED) to reduce administrative burdens.
Contracts falling within the scope of the Directive are already recorded in the TED database, so this approach will not create additional reporting requirements.
At the time of awarding a contract, individual Contracting Authorities and Contracting Entities should indicate how many vehicles are being procured, how many of these are clean vehicles, and how many are zero-emission vehicles. This is all information that is normally already known – and often also already provided in the contract award notice.

Exemptions

The following vehicles are excluded from the Directive:

- Coaches *(vehicles of category M3 other than Class I & Class A)*
- Agricultural and forestry vehicles
- Two- and three-wheeled vehicles and quadricycles *(cat. L)*
- Track-laying vehicles
- Mobile machinery

The following vehicles are included in the Directive, but Member States may decide to exempt them, when they transpose the Directive:

- Special vehicles for use by armed services, civil protection, fire services and police forces
- Special vehicles for use on construction sites, quarries, ports, airports
- Armoured vehicles, ambulances, hearses, wheelchair accessible cars, mobile cranes

The vehicle categories falling outside the scope of the Directive generally present specific technical characteristics and market profiles which do not justify inclusion in the scope of the Directive. On the other hand, vehicles subject to national exemptions are generally vehicles that fall within the categories covered by the Directive, but which are dedicated to specific uses (e.g. police, emergency services, fire brigade...) and are specifically designed, constructed or adapted for this purpose.

Review

The Directive foresees a review in 2027; this should be used to set new targets for the time period post 2030, and to consider possible further expansion of the scope (e.g. to two- and three-wheeled vehicles). If no new targets are set, the targets set for 2026-2030 will continue to apply in the following years, over consecutive 5-year periods (2031-2035, 2036-2040, etc.).

Relevant legislation

- Revised Clean Vehicles Directive (2019/1161)
- Directive on the promotion of clean & energy-efficient road transport vehicles (2009/33/EC)EN•••
- Report on the application of Directive 2009/33/EC on the promotion of clean and energy efficient road transport vehiclesEN•••
- Impact Assessment of the Revised Clean Vehicles Directive (2019/1161)EN•••
- Support study for the Impact Assessment (Final report, annexes, executive summary)EN•••

Green propulsion in transport

Growing concerns over security of energy supply, climate change and health are driving a shift from fossil to alternative fuels and new vehicle propulsion systems capable of delivering long term sustainability. Three quarters of transport greenhouse emissions come from road transport. Transport is especially vulnerable to oil supply disruption and price volatility. Despite huge reductions in emissions of harmful pollutants, there remain concerns over air quality and noise, especially in urban areas.

Transport is an important building block in the EU energy-climate policy. Europe's climate and energy package includes targets for 2020 for energy efficiency, a target minimum share for renewable energy and targets for reducing greenhouse gas emissions. These cannot be reached without a significant contribution from transport.

The Green Cars Initiative, as part of the European Economic Recovery Plan recently adopted by the European Council, is aimed to support the development of new and sustainable forms of road transport.

The Commission is presently supporting three main alternative types of fuels and propulsion technologies which are being developed within the time horizon of 2020. Demonstrations aim to prove vehicle and infrastructure performance and safety with a view to removing market entry barriers.

The candidate fuels and propulsion systems include:

- Biofuels, liquid or gaseous
- Hydrogen and fuel cells
- Battery electric and hybrid electric vehicles with plug-in

Biofuels for transport

- The promotion of biofuels offers clear benefits both for security of energy supply and for mitigating climate change. In addition, biofuels could contribute to reducing urban pollution and to the development of rural areas.

9. Electric vehicles

Electricity as an energy vector for vehicle propulsion offers the possibility to substitute oil with a wide diversity of primary energy sources. This could ensure security of energy supply and a broad use of renewable and carbon-free energy sources in the transport sector which could help the European Union targets on $CO2$ emissions reduction.

Electric vehicle 'tank-to-wheels' efficiency is a factor of about 3 higher than internal combustion engine vehicles. Electric vehicles emit no tailpipe $CO2$ and other pollutants such as NOx, NMHC and PM at the point of use. Electric vehicles provide quiet and smooth operation and consequently create less noise and vibration.

The policy related to battery-powered vehicles is mainly focused on technological optimisation and market development. Future challenges in this field include reliability and durability of batteries and super-capacitors, reducing battery weight and volume, safety, cost reduction, improved hybrid electric power-trains, charging infrastructure and plug-in solutions.

Electrification of transport (electromobility) is a priority in the Community Research Programme. It also figures prominently in the European Economic Recovery Plan presented in November 2008, within the framework of the Green Car Initiative.

The European Commission will support a Europe-wide electromobility initiative, Green eMotion, worth €41.8 million, in partnership with forty-two partners from industry, utilities, electric car manufacturers, municipalities, universities and technology and research institutions. The aim of the initiative is to exchange and develop know-how and experience in selected regions within Europe as well as facilitate the market roll-out of electric vehicles in Europe. The Commission will make €24.2 million available to finance part of the initiative's activities.

Hydrogen and fuels cells for transport

Hydrogen is an energy carrier with great potential for clean, efficient power in stationary, portable and transport applications. It is envisaged as a significant element of the future fuel mix for transport, enhancing energy security, reducing oil dependency, greenhouse gas emissions and air pollution.

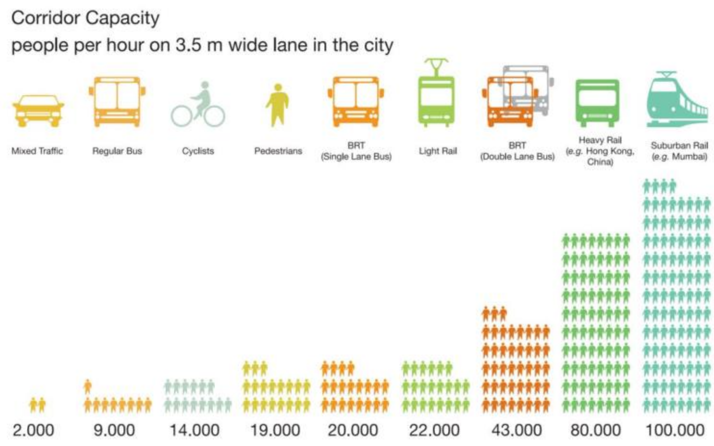
Hydrogen allows a wide diversification of energy sources. In combination with fuel cells, it can also improve energy efficiency in transport and contribute strongly to mitigating climate change – especially when produced by renewable primary energy sources.

Hydrogen and fuel cell technologies were identified amongst the new energy technologies needed to achieve a 60 % to 80 % reduction in greenhouse gases by 2050, in the European Strategic Energy Technology Plan presented along with the Energy Policy Package in January 2008.

The potential for fuel cells and hydrogen to enhance energy security and mitigate climate change was recognised in 2003 with the creation of the Hydrogen and Fuel Cell Technology Platform. The platform brought together key stakeholders in the fuel cell and hydrogen fields who jointly developed an implementation plan. Published in 2007, the plan addressed the technological and non technological barriers to deployment of these disruptive technologies. It identified key issues and priorities for accelerating deployment of portable, stationary and transport applications. The platform led to the formation of a Public Private Partnership - the 'Fuel Cells and Hydrogen Joint Undertaking' (JU) - between the European Commission, industry and the research community. A main aim of the JU is to enable commercial deployment by 2020. In future, the European Commission will channel support for fuel cell and hydrogen research and demonstration through the JU. For the period 2007-2013, European Commission support amounts to € 470 million.

The energy efficiency in transport

The energy efficiency in transport is the useful travelled distance, of passengers, goods or any type of load divided by the total energy put into the transport propulsion means.



BRT = bus rapid transit, m = meters
Sources: H. Botma and H. Papendrecht. 1991. Traffic Operation of Bicycle Traffic. In *Transportation Research Record 1320*. TRB. Washington, D. C.: National Research Council, and based on GTZ calculations (2009).

10. Recommended 9-Step Approach to Energy Management

1. Create an Energy Sustainability Team. Identify an energy program management team with responsibility for implementing the improvement program from start to finish. Create a core team with representatives from all aspects of operations, maintenance and management. Consider appointing an Energy Manager whose only responsibility is energy conservation (and possibly recovery) for your facility.

2. Gather Data. Gather data on energy use (e.g. from gas, fuel oil and electricity bills). Make this data available to the team.

3. Benchmark Performance. Create a baseline of energy performance against which you can measure improvements over time. You can do this using ENERGY STAR's Portfolio Manager for wastewater treatment plants, available online at http://www.energystar.gov/index.cfm?c=water.wastewater_drinking_water. Portfolio Manager has the benefit of converting all types of energy use (e.g., natural gas, fuel oil, and electricity) to a common unit so that they can be added together, and provides an estimate of greenhouse gas emissions. You may also be able to compare your utility's performance to similar utilities if you meet certain criteria.

4. Conduct an Energy Audit. Determine the energy use of various processes and identify opportunities for energy use reduction.

5. Develop Goals. Identify quantifiable energy improvement goals that complement your utility's mission, goals, and strategic direction.

6. Devise a Plan. Identify Energy Conservation Measures (ECMs) and develop a plan for implementing them. Start with “low hanging fruit” and focus on energy intensive operations such as aeration and pumping. Consider renewable energy options and opportunities for energy generation using alternative methods. Determine costs and payback periods for various options.

7. Implement Improvements. Assign responsibilities and establish deadlines. Consider alternative financing approaches. Fully engage and train your operations staff.

8. Monitor and Measure Results. Track performance, review progress towards energy goals, and develop a plan for maintaining energy efficient equipment. Re-evaluate your goals in light of new information and priorities, and make changes to your program as necessary.

9. Communicate Success. Communicate the successes of your energy management program to employees, utility management, and your community.

11. Recommendations for Global Energy Transition

a) **Rapidly scale-up deployment of available energy transition solutions to reach 8000 GW1 of renewables by 2030 with due consideration to different contributions by individual countries.** The abundance of cost-effective renewable potentials worldwide makes them a scalable option that is essential to the decarbonization of the entire economy across all sectors. For many countries, this translates a technical and economic challenge into a set of investment, regulatory and societal opportunities.

b) **Increase the average annual rate of energy efficiency improvement from the current 0.8% to 3% through the implementation of all available technologies while supporting further innovation.** Energy efficiency opportunities are readily available and have positive effects on employment; however, they often need policy support to be implemented. Efficiency measures and strategies must address the main barriers to the adoption of energy efficiency measures and promote structural and behavioural change. Further, they must be considered across different sectors and areas, for instance, standards and norms for buildings and appliances, transport, industrial uses, and heating and cooling, among others.

c) **Invest in physical infrastructure to enable the energy transition.** Updating ailing infrastructure or investing in expansion is an integral part of the energy transition and an enabler of modern technologies. Public finance can be used to attract private investment in the infrastructure needed, which will help create jobs. Investments in infrastructure must be aligned with long-term plans and be reflective of broader strategies, including regional market integration.

d) **Countries of the Organisation for Economic Co-operation and Development (OECD) should phase out coal by 2030 and redirect international energy financing towards the transition. Non-OECD countries should phase out coal by 2040**, noting that many will require support for this process. Coal phase-out will reduce the risk of stranded assets, improve energy independence, and bring about significant health and fiscal benefits. Countries should enact time-bound strategies to manage the social and economic aspects of the coal phase-out.

e) **Mainstream energy policies into economic, industrial, labour, educational, and social strategies.** Policy measures and investments for recovery from COVID-19 must drive a broader structural shift aligned with plans for long-term energy sector transformation. To deliver on energy ambitions and avoid, reduce, or anticipate challenges, coherent, cross-ministerial policymaking is required.

f) **Establish medium and long-term integrated energy planning strategies, define decarbonization targets, and adapt policies and regulations to shape energy systems that boost sustainable development.** Long-term energy scenarios, including net-zero mid-century scenarios, can be used to facilitate the dialogue needed to help reach consensus among all relevant stakeholders. When preparing energy transition, the ambitions of the nationally determined contributions (NDC) should be raised and short-term challenges identified. Engaging sub-national and city-level decision-makers in transition planning and implementation will be essential, given rapid urbanization and the decentralized nature of the modern energy system.

g) **Create regional energy markets to facilitate the integration of renewables, promote cross-border power grid connectivity and trade, and further reduce costs through economies of scale. (INTERLINKAGES WITH SDG 9)**
h) Regional approaches to energy transition can reduce costs and enhance access to reliable and affordable electricity supply through expanded and smarter grid infrastructure; security of supply should be achieved through resource diversification. Regional integration can also enhance the resilience of energy systems to extreme weather patterns, climate variability and climate change, and the reduction of carbon emissions, and generally foster green economic development and employment.

i) **Intensify international co-operation on energy transition to meet the 2030 Agenda for Sustainable Development and avoid future catastrophic climate change impacts. (INTERLINKAGES WITH SDG 10)** A common learning curve will be accelerated through cooperative action and exchange of experiences and best practices across the power and end-use sectors. Underpinned by global solidarity, an overriding priority is to strengthen public resolve and to ensure that no one is left behind.

j) **Develop sustainable transport roadmaps. (INTERLINKAGES WITH SDG 9 AND SDG 11)** Based on an "avoid–shift–improve" approach. Country-specific plans that include urban strategies should include time-bound roadmaps for all modes of transport, with full consideration of mobility needs, efficiency, and renewable options. Across all regions, plans must include solutions such as electrification, sustainable bioenergy or green hydrogen, enhanced public transport and shared mobility, and promotion of regional and international cooperation and action.

k) **Tailor labour and social protection policies to the specific needs of each region and country. (INTERLINKAGES WITH SDG 4 AND SDG 8)** Although clear global gains in job creation will be made, the structural and labour-market impacts of energy transition will vary among locations, job types, and sectors. In cooperation with all involved stakeholders, countries should enact strategies for a just transition, maximizing opportunities, and minimizing hardship for individuals and communities.

l) **Make the energy transition a participatory enterprise. (INTERLINKAGES WITH SDG 7)** Participatory approaches that meaningfully engage all actors, multi-stakeholder coalitions, and public–private partnerships will help shape the desired energy futures and also manage expectations. The private sector must play a significant role in the implementation of the energy transition. Equally important is the empowerment of citizens, youth, local governments, research institutions, and indigenous communities to become part of the energy system.

12. Synergies between Renewable Energy and Energy Efficiency

The Paris Agreement reflected an unprecedented international determination to act on climate change. The focus of climate change mitigation must be on the decarbonisation of the energy system, given that it accounts for almost two-thirds of greenhouse gas (GHG) emissions worldwide. Global energy-related carbon dioxide (CO_2) emissions can be reduced by 70% by 2050 with a net positive economic outlook, according to the report "Perspectives for the Energy Transition: Investment Needs for a Low-Carbon Energy Transition", jointly prepared by the International Renewable Energy Agency (IRENA) and the International Energy Agency (IEA) (IRENA and IEA, 2017). The report, which was prepared to inform the energy and climate agenda of the 2017 German Presidency of the Group of Twenty (G20), shows that increased deployment of renewable energy and energy efficiency (RE/EE) in G20 countries and globally can achieve the emission reductions needed to limit global temperature rise to no more than 2°C. This would avoid the most severe impacts of climate change. In realising the decarbonisation of the global energy system, renewables would account for about half of total emission reductions in 2050, with another 45% coming from increased energy efficiency and electrification.

RE/EE work in synergy. When pursued together, they result in higher shares of renewable energy, a faster reduction in energy intensity, and a lower cost for the energy system. This synergy also has important environmental and societal benefits, such as lower levels of air pollution. IRENA has explored this synergy under its REmap programme, a global roadmap to significantly increase the share of renewable energy by 2030 compared to today's level of 19%, and to explore what this would mean for decarbonisation of the energy system in the longer term, to 2050, in line with the Paris Agreement. REmap also supports initiatives such as Sustainable Energy for All (SEforALL) and the 7th Sustainable Development Goal (SDG7), both of which call for a substantial increase in renewable energy, as well as a doubling of the rate of improvement in energy efficiency by 2030. Achievement of these goals requires a greater understanding of the potential of RE/EE at the country, sector and technology levels. It also needs an energy system perspective that looks at the interlinkages between technologies and sectors. This report starts with an overview of the latest insights from IRENA's study, with a focus on the role of RE/EE in realising decarbonisation of the global energy system by 2050. Subsequently, it pays particular attention to the five largest energyusing countries of the G20, namely the People's Republic of China, Germany, India, Japan and the United States, but narrows down the focus to a shorter term, to 2030. Together, these five countries represent two-thirds of the G20's total primary energy supply (TPES), and around half of global energy demand. Three primary cases are examined from 2010 (the base year of the analysis) to 2030: a businessas-usual case (the Reference Case, which examines change predicted under current national plans), an accelerated renewable uptake case (REmap), and a case that combines accelerated renewables with enhanced efficiency (REmap + EE). In order to put all these scenarios into perspective, a Frozen Efficiency Case is also explored, with no change from today's level of RE/EE. Five conclusions can be drawn from the analysis in this report:

- **RE/EE measures can potentially achieve 90% of the carbon reductions required to limit global temperature rise to a maximum of 2°C above pre-industrial levels with a 66% probability, in line with the Paris Agreement goals.** The remaining 10% would be achieved by fossil fuel switching and carbon capture and storage (CCS). A combined approach of RE/EE offers the most timely and feasible route to decarbonising the global energy system. Both renewable energy and energy efficiency offer roughly the same amount of mitigation potential to 2030, but only when working in synergy. Working in isolation, they do not achieve as beneficial results.

- **All countries can benefit from important synergies between renewable energy and energy efficiency.** Greater renewable energy reduces the demand for energy, and greater energy efficiency results in higher shares of renewable energy. These synergies vary depending on demand growth, the structure of a country's energy demand, local resource availability and climate conditions.

- **The cost-competitiveness of technologies varies by country, but deployment of RE/EE technologies together results in overall savings to the energy system across all countries.** When accounting for their effect on reducing external costs relating to human health and climate change, these savings are significantly higher. However, a better assessment of such externalities is needed, alongside a better understanding of how RE/EE result in reductions in the costs associated with adverse effects on human health and the environment.

- **All countries have significant untapped and economically attractive RE/EE deployment potential, beyond that foreseen in national plans.** While this study identifies the potential of measures to increase both the share of renewable energy and the level of energy efficiency improvement, even greater potential to improve exists, particularly in energy efficiency. Countries need to start deploying the technologies identified in this study today, and to accelerate deployment as more efficient technologies emerge.

- **A greater understanding is needed of which countries and regions require which additional technologies to meet global climate and sustainability targets.** While the five major economies addressed in this study make up around half of global energy demand, the scope of countries and the depth of technology analysis should be expanded to allow global conclusions to be drawn.

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5

ENERGY POVERTY

TRAINING MATERIAL

Prepared by:
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Funded by the European Union

CENTRAL PROJECT MANAGEMENT AGENCY

ENERGY POVERTY

and

SOLUTION OFFERS

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CONTENTS

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INTRODUCTION

Among the actions and reductions to be made for the Sustainable Energy and Climate Action Plan, energy poverty has become an important issue. Although energy poverty is a very new issue, especially for Türkiye, solutions need to be found by both the Central Government and local governments. In this study, we will try to evaluate this issue and offer possible solutions.

WHAT IS ENERGY POVERTY?

According to studies, a household is considered "energy poor" when its total energy expenditures (Electricity + water + natural gas) exceed 25% of its monthly or annual budget.

According to research conducted in the EU, the rate of people who cannot get enough heat at the residential level was 8.2% in 2017, while it was 22.3% in Turkey. The second important result obtained from the study is about households experiencing financial difficulties in paying bills such as electricity, water and gas. While the rate of people having problems paying bills in the EU is 8.1%, this rate was found to be 24.2% in Turkey (Selçuk and Köktaş, 2018).

Considering the electricity sector, households that consume less than 100 kWh monthly or 1200 kWh annually or allocate more than 10% of their total budget for electricity expenses are called electricity poor.

ENERGY ACCESSIBILITY

The International Energy Agency (IEA) defines energy access as "households with reliable and affordable access to both clean cooking and electricity, initially sufficient to provide a basic package of energy services, and then increasing over time to reach the regional average." It defines.

According to Article 7 of the UN Sustainable Development Goals, it is aimed to ensure that "everyone has access to accessible energy by 2030, investing in clean energy sources, reducing electricity consumption in buildings and industry by adopting cost-effective standards, expanding the infrastructure that will provide clean energy in all developing countries and using technology encourage growth and contribute to the environment."

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SOME BASIC CAUSES OF ENERGY POVERTY AND ACCESSIBILITY PROBLEMS

- Low household incomes and income inequality, increase in minimum wage, inflation
- High energy prices and wrong energy policies,
- Energy inefficient housing and buildings, improper use of energy, excessive and unnecessary use, behavioral factors, etc.
- Climate crisis, drought, flood, earthquake, pandemic, war, etc.
- Blocking renewable energy sources by lobbies,
- Economic and political preferences, neo-liberalism, privatizations, etc.

ENERGY POVERTY STUDIES

The research conducted by Okushima in Japan in 2017 explained the nature of energy poverty in Japan, focusing especially on the 2000s when the earthquake in 2011 and the Fukushima nuclear accident took place, and was shaped around the impact of these events on energy poverty (Okushima, 2017). During the research process, Family Income and Expenditure Survey data of 47,797 households were analyzed.

One of the results obtained from the study is that energy poverty rates have gradually increased over the years in Japan. So much so that, while the energy poverty rate in Japan was 3.2% in 2004, this rate increased to 8.3% in 2013. Other results obtained in terms of the relationship between the earthquake disaster and the Fukushima nuclear accident, which are the focal points of the study, and energy poverty are also striking.

For example, before the earthquake, the rate of energy poor single-parent families was 15.8% and the rate of single-elderly households was 14%, but after the earthquake, this rate increased to 18.2% for single-parent families and 16.4% for single-elderly households. Likewise, before the Fukushima nuclear accident, the energy poverty rate in single-parent families was 11.9% and in single-elderly households was 11.3%, but after the accident, these rates were found to be 18.2% in single-parent families and 16.4% in single-elderly households.*

*«A Comparative Analysis for Energy Poverty Discussions in Ankara: Güvenevler and Andiçen Neighborhoods, Master's Thesis: Cemre Pehlivanoğlu-Ankara 2022»

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HIGH ENERGY PRICES, LOW HOUSEHOLD INCOME GAP

Adela Tesarova, who works in the Energy Department of the European Commission, reminded that EU member countries will provide financial support to low-income households affected by energy prices, and a "social climate fund" worth 72 billion euros was created for this. Tesarova stated that the commission focuses on long-term solutions such as renewable energy and energy efficiency and said, "We have the potential to eliminate energy poverty for the first time and radically."*

The reason why the electricity of 2.8 million subscribers who could not pay their debts despite electricity assistance was cut off is that the real number of poor people in Turkey is much higher than those who can receive electricity assistance. According to the data of the Ministry of Family and Social Services, it was aimed to provide electricity assistance to 2 million 168 thousand 157 households in 2020, but the aid reached 1 million 659 thousand 448 households with a realization rate of 76.5 percent.

Assuming that the average household size is 3.3 people, we can say that electricity assistance reached 5 million 476 thousand 178 people in 2020. However, according to TÜİK data, the number of poor people in 2020, calculated according to 60 percent of the median income, is 17 million 921 thousand people. In other words, electricity assistance could reach only 30.5 percent of the number of poor people determined by TURKSTAT. The situation did not change in 2021 and the majority of households considered poor according to TÜİK measurements were not provided with electricity assistance.**

*https://www.bloomberght.com/avrupada- energy-y oksullugu-2295377
** THE DARK AND COLD SIDE OF POVERTY: ENERGY POVERTY, Prof. Dr. Seyhan Erdoğdu,
Ankara University Faculty of Political Sciences Retired Faculty Member, EMO Magazine, SEPTEMBER 2022 • Issue-471

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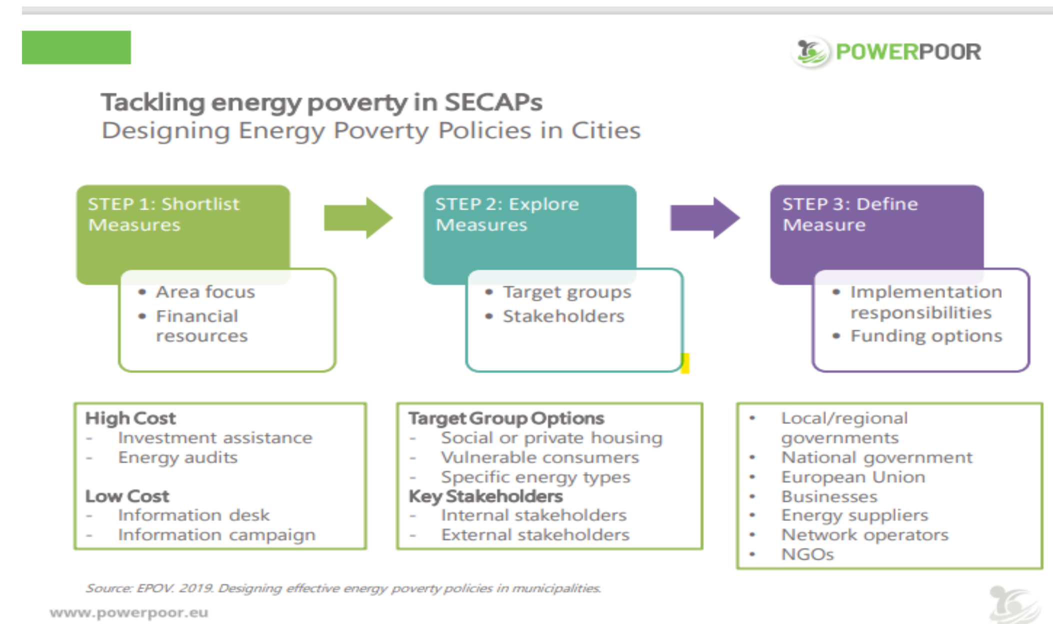
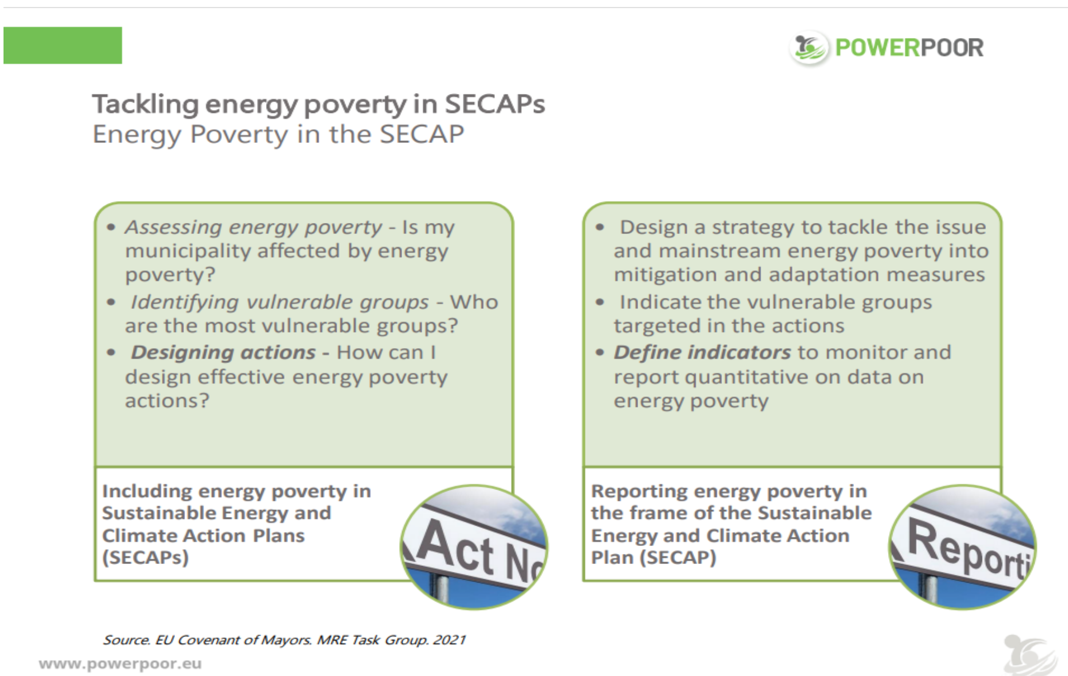
ENERGY POVERTY AND SECAP





The issue of energy poverty and actions related to its reduction are now included in SECAP reporting and are planned to be monitored.

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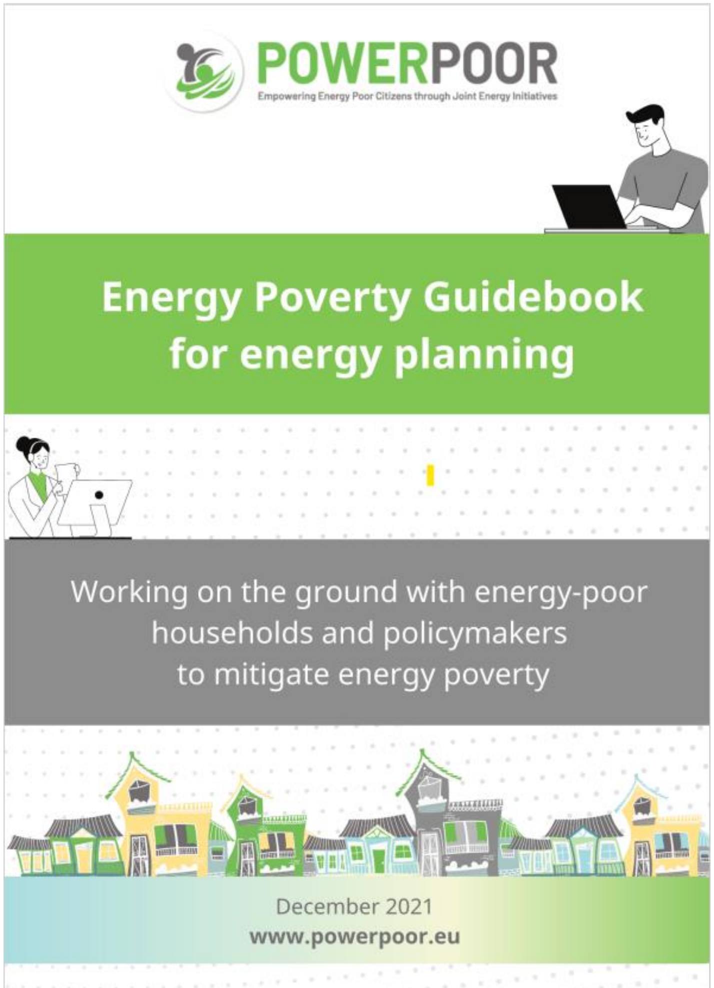
USEFUL RESOURCES ON ENERGY POVERTY



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ENERGY POVERTY SOLUTION APPLICATIONS

Effective interventions on low income, high energy costs and poor building conditions, which are the most important drivers of energy poverty, will support households in this regard and increase their poverty-related capacities.

For example, in England, where the phenomenon first emerged, energy-poor households are supported during the winter months by implementing practices called "Winter Fuel Payment, Cold Weather Payment and Warm Home Discount Program" (Choose, 2020).

In Ireland, with the Warmth and Wellbeing Program, energy efficiency services are provided to households for a warmer house and the quality of life is intended to be improved in order to improve the living conditions of vulnerable consumers with chronic illnesses (SEAI, 2021).

In Turkey, with the "Black Winter Support Package", Ankara Metropolitan Municipality (ABB) provides natural gas payment of 500 TL to households that have difficulty in covering their heating expenses during the winter months and receive social assistance (Sputnik, 2021).*

*«A Comparative Analysis for Energy Poverty Discussions in Ankara: Güvenevler and Andiçen Neighborhoods, Master's Thesis, Cemre Pehlivanoğlu-Ankara 2022»

ENERGY POVERTY SOLUTION SUGGESTIONS-1:

IMPROVEMENT OF ENERGY POOR HOUSES

Municipalities and universities in their provinces, energy with his poverty struggle for cooperation They can plan. This collaboration thanks to university students, energy your bills paying forced in households simple energy inspections make and miscarry costly energy improvements to apply for They will be trained. For example, in Istanbul alone, more than 4 million more digit energy your bills paying difficulty is suffering.

This project has three main goals: to create a database of energy poor households, to implement low-cost energy efficiency measures, and to provide recommendations on how to reduce energy use. University students will take part in this collaboration to help vulnerable households reduce their energy consumption.

During the initial database creation and training phase, a group of fifty students, researchers and university teachers will be trained by experts to conduct social field research and energy audits. Since combating energy poverty is not a part of the curriculum of engineering faculties, the identification of vulnerable households and encouragement to participate in the project will be carried out by municipalities when the project begins.

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With the predicted calculations, it is seen that houses can save up to 500 kg of CO_2 and more than 1000 kWh of electricity and heat per year. As part of the programme, students will make recommendations to residents for the most cost-effective and energy-efficient insulation and remediation investments based on a model. This model allows residential thermal insulation improvement investments to save 30-50% of homes (depending on heating systems and wall materials) with a payback period of 6-8 years or less and other side benefits such as improvement of human health due to better living conditions. shows that it is effective.

Similar ones are also implemented in Lithuania-Vilnius Municipality.

The Spatial Justice Association carries out a similar study in Istanbul.

MEKANDA ADALET DERNEĞİ · CENTER FOR SPATIAL JUSTICE

Hakkımızda Programlar Yayınlar Haberler Bize katılın İletişim

“İklim Değişikliğine Uyum Bağlamında Enerji Yoksulluğu ve Ev İçi Isı Konforu” projemiz, iklim adaletini merkeze alan sivil toplum araştırması yöntemine dayalı bir yurttaş bilimi çalışmasıdır.

NEDİR? · SEN DE KATIL · SÖZLÜK

Bu çalışmayla 2023 Temmuz-Aralık ayları arasında aşırı betonlaşmadan ötürü yüksek seviyelerde kentsel ısı adası etkisine maruz kalan İstanbul'un farklı mahallelerinde aşırı sıcaklara karşı direnç ve enerji yoksulluğunun bir göstergesi olarak **ev içi ısı konforundaki farklılıkları** ve **yurttaşların sıcak dalgalarıyla nasıl başa çıkmaya çalıştığını** tespit etmek amacıyla katılımcı bir araştırma yürütmeyi hedefliyoruz.

ENERGY POVERTY SOLUTION SUGGESTIONS-2: “CPP”

«CITIZENS' POWER PLANT (CPP)»

Consumption-production with renewable energy: For the GENERATION model, "Energy Cooperatives" with municipal technical support should be established and citizens' processes, costs and controls should be facilitated. The "Citizen's Power Plant (CPP)" process should be restarted with the consumption unification regulation of the current "energy cooperative" legislation. Similar ones are implemented in Lithuania, Italy, Denmark, Germany, USA-New York and many EU Municipalities.

Approximately 500 000 Subscribers in Lithuania use renewable energy with the “remote energy” model.

News: World first for solar in Lithuania

Lithuania has achieved another milestone in renewable power generation with the launch of a remote solar energy consumer model. The ‘Solar Community’ project from Sun Investment Group provides an opportunity to buy or rent a remote solar panel via an online platform.

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ENERGY POVERTY SOLUTION SUGGESTIONS-3 :

MUNICIPAL ENERGY ADVISORY DESK (MEAD)

By combining the application demands in the city and combining the consumptions, citizens should be able to own, use and control PV in more suitable places with the right application, engineering and scale-up at affordable prices (scale-up) and a fixed transmission fee. Municipalities can establish a "Municipal Energy Advisory Desk (MEAD)" to ensure that citizens' energy efficiency and solar energy applications are implemented and inspected with the most accurate engineering selection-service, reasonable price and guarantee. Information, technical and facilitation services are provided at this desk. Trained personnel from Professional Chambers, Relevant NGOs and the Municipality can take part in this service.

In 2002-2005, EİE, GTZ and Erzurum Municipality «Energy Consultancy Center» was established in Erzurum. A very important and effective service was provided, especially regarding insulation application, for 3 years.

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ENERGY POVERTY SOLUTION SUGGESTIONS-4:

MUNICIPAL ENERGY CONVERSION NETWORK (MECN)

Since the entire city and its residences must be involved in the initiation of energy transformation, energy efficiency, renewable energy use, climate action and adaptation, and smart city projects in municipalities, firstly some leading Metropolitan Municipalities are required to establish infrastructure, staff, capacity, model and application knowledge and experience in this regard. Municipalities must be able to do this in their own administrations and cities.

For this reason, the "Municipal Energy Conversion Network (MECN)", which will be established under the leadership of some Municipalities and its secretariat, will provide joint trainings, joint projects, sharing of good examples with a common goal, sharing of good examples in the energy transformation of each member municipality and the reduction of housing and energy poverty, and the units that have previously made similar transformation. The project of establishing a platform network where people help and support each other will be very important and useful.

Similar municipal network etc. This "network", examples of which are also in EU countries; It can be established immediately by the municipalities that desire it by developing the most ready, competent and capacity-capable capacity in these matters. "Energy management units (EYB)", "energy consultancy desks (EDM)", "citizens' power plant (YES)" projects to be established within each municipality; It can be carried out more effectively with BEDA, and it can be a project that sets an important role model for other municipalities.

ENERGY POVERTY SOLUTION SUGGESTIONS-5:

WHAT IS İZMİR GLOBAL CLIMATE COMMUNITY?

The Global Climate Community (GCC) Izmir organization was established to plan and supervise the work of the Climate Neutral and Smart Cities Mission, which aims to help cities achieve the "climate neutral" target.
GCC Izmir's goal is for Izmir to become a climate neutral city in 2030 by receiving the title of "Mission City" and to prepare a "Climate City Agreement".

GCC Governance
The Steering Board is the most representative advisory and support body of the mission platform.

It is envisaged that the Steering Board will include Izmir's senior administration and public institutions, Chambers of Industry and Commerce, Associations, Unions, Professional Chambers, non-governmental organizations and private sector representatives.

Based on collaboration and common sense, the Steering Board encourages and supports the development and implementation of Mission strategies.

The Steering Board encourages cooperation between city actors. The mission platform has local, national and international dimensions; It facilitates access to legal, political and financial support tools.

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The City Council realizes the objectives of the Mission process of civil society within the scope of civil society and ensures the participation of civil society in the Mission process. For this purpose, the Mission platform aims to ensure citizen participation.

GCC Working Groups

Working Groups provide information that will form the Action Plan and Investment Plan that constitute the Climate City Agreement, which will enable Izmir to obtain the title of "Mission City". Each working group prepares its own Action Plan, which will be included in the Action Plan and Investment Plan.
With the signing of the Climate City Agreement, Working Groups carry out, renew and report on relevant projects until 2030. Depending on sector-based distinctions;

- Energy Use and Building Applications,
- Energy production,
- Mobility and Transportation,
- Nature Compatible solutions,
- Circular Economy and
- It consists of six categories as Green Industry.

Each of the Working Groups has common topics that concern their fields of activity. These are: Citizen Participation, Finance, Urban Alliance, Regulation Development, Communication, Innovation and Data.

ENERGY POVERTY SOLUTION SUGGESTIONS-6:

HORIZON 2020-HORIZON EUROPEAN PROJECTS

WELLBASED aims to design, implement and evaluate a comprehensive urban health program built on evidence-based approaches in 6 different pilot cities (Edirne-Türkiye, Valencia-Spain, Heerlen-Netherlands, Leeds-England, Budapest-Hungary, Jelgava-Latvia) to significantly reduce energy poverty and its effects on citizens' health and well-being.
Main activities:

1. Designing urban programs to reduce energy poverty and its effects on health
2. Implementation of the urban program in project pilots
3. Development of evaluation and policy recommendations
4. Exploring new business models and alternative ways to finance urban health interventions aimed at tackling energy poverty

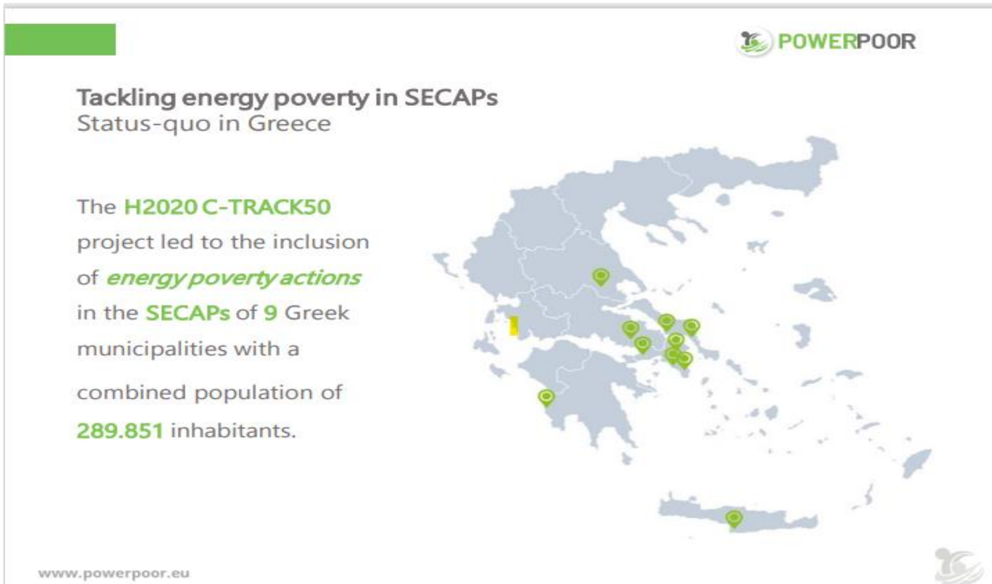
Expected outputs from the project include developing urban policies that will improve urban health, ensuring improvements in public health in terms of physical/spiritual aspects in cities, and reducing inequalities in access to health services in cities.

Establishing a direct link between energy poverty measures and policies and related improvements in health, WELLBASED project implementations target the most vulnerable populations. In Edirne, which is included in the project as a pilot region, efforts are being made to improve health and welfare for those who experience energy poverty and have a low quality of life in the neighborhoods where predominantly Roma people reside.

It contributes to reducing greenhouse gas emissions by using alternative fuels instead of using low-quality fuel such as coal, which causes CO_2 emissions, and thus minimizing the negative effects of climate change and improving the quality of urban life by reducing energy poverty.

While the project provides scientific contribution to the development of urban policies to combat energy poverty and other studies on this subject, the social contribution of the project is to increase the health and welfare of those who experience energy poverty and have a low quality of life. It also provides an economic contribution by ensuring that governments spend less money on health.

It contributes to the development of policy recommendations to reduce energy poverty in cities and to make urban health and quality of life highly sustainable. With the WELLBASED project, in addition to improving the health and welfare of the people living in the pilot areas; It is possible to benefit from the open data created by the project to create new business models for local Small and Medium Sized Enterprises.



ENERGY POVERTY AND SOLUTION SUGGESTIONS-7:

LIVING LABORATORY CENTERS (LIVING LAB.)

Each Municipality should establish a center for the development of smart-digital-sustainable city projects, as well as a center for energy transformation and reducing energy poverty in the city, and a laboratory and innovation center to produce solution proposals on campus and test and develop them there.

Many examples of this have been established in EU cities and US states. Similar initiatives need to be launched in other cities, especially in Istanbul, to monitor energy conversion in residences, conduct surveys and analyses, develop roadmaps, and produce the best applicable technologies and systems. This is essential to generate solutions for the increasing and future energy poverty. Achieving the most important SECAP reduction and adaptation targets requires the initiation of these solutions for monitoring them.

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POWERPOOR

Case Study
Living Labs to alleviate energy poverty

CASE STUDY	Mountain Living Lab in Metsovo, Greece Source: Step-In Project	SCOPE/ LOCATION Metsovo Municipality
DESCRIPTION	The first primary survey that examined the energy poverty problem in the area of Metsovo took place in 2015 and showed that 88% of households in the Municipality were energy poor. 21% of households reported an inadequately heated home, 14% of them reported arrears in energy bills and 13% reported damp-mould problems. The low income-high cost problem is attributed to the harsh climatic conditions, the considerable rise of fuel prices between 2009 and 2014 and, the shrinkage of the average annual income by 29.10%, at the same period.	
STAKEHOLDERS	The LL began with an energy café that involved different stakeholders, i.e. vulnerable citizens, policy- makers, representatives of the local authorities (among them the Major and members of the Municipal Council), representatives of local trade associations, etc., in order to analyse the problem, needs, and opportunities (co-creation). Towards avoiding stigmatising participants and maximise the engagement of vulnerable citizens, the energy café invitation was strictly focused on and limited to energy savings and cost reduction issues.	
IMPACT	While the Living Lab is still ongoing, promising first results can already be seen. Around 35% of the households said that they noticed an improvement in the quality of their life during the V1 operation of the LL. About 35% of them said that they showed a reduction in their energy spending, 30% said that they faced less issues with moisture/mould, 20% claimed that they could pay the energy bills on time and 15% mentioned that the indoor temperature in their homes was more comfort. The owners of two houses were given a nudge to implement insulation measures and another owner replaced an old energy-consuming refrigerator with an energy-efficient one. In addition, several other participants said that they are willing to invest in energy efficiency in the near future and some of them implemented low-cost measures (e.g. replacement of old analogue thermostats) or declared behavioural changes.	

Source: STEP-IN Project. 2019

www.powerpoor.eu

ENERGY POVERTY AND SOLUTION SUGGESTIONS-8:

CENTRAL HEATING AND COOLING SYSTEMS

In particular, the Central Government and Local Governments should establish central heating and cooling systems (from waste heat, geothermal energy, waste, garbage, etc.) in public-private partnership with private companies. Especially Northern EU countries contribute to reducing energy poverty by installing a central heating system in a campus, neighbourhood, town or city.

In our country, Soma Thermal Power Plant and Yatağan Thermal Power Plant provide regional heating system from waste heat, and Balçova and Emet Municipalities provide regional heating from geothermal energy. The Esenyurt Power Plant, which was the first application example in our country, and the regional heating system, which benefited 10,000 households, were unfortunately transferred and the regional heating system was closed after serving for 20 years.

Unfortunately, users who pay 40% less energy bills than combi boilers and individual heating systems are currently faced with "energy poverty".

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ANKARA (Enerji Portalı) – Türkiye'deki ilk Bölgesel Isıtma Kojenerasyon tesisi olan Esenyurt Santrali 20 yıllık Yap- İşlet- Devret süresinin bitişiyle 22 Mayıs'ta EÜAŞ'a devredildi.

Esenyurt Termik Santrali, Türkiye'nin Yap- İşlet- Devret politikasıyla yabancı sermaye kullanılarak ve uluslararası standartlar uygulanarak işletmeye alınan ilk Bölgesel Isıtma Doğal Gaz Kombine Çevrim Kojenerasyon santrali olma özelliğini taşıyor.

ABD kökenli NRG Energy ve Doğa Enerji Yatırım ortaklığının hak sahibi olduğu ve Doğa Enerji tarafından 20 yıldır işletilmekte olan santral 180 MW elektrik 180 MW termal kapasiteye sahip. Santral kurulurken elektrik üretimine ilaveten bölgesel ısıtma hizmeti vermesi de öngörülerek tasarımı kojenerasyon sistemi olarak inşa edildi. Kojenerasyon sistemiyle yakın çevresinde yer alan 10.000 konut eşdeğeri ev, okul, hastane, ofis, dükkân, ticarethane ve benzeri yapının ısıtma ve sıcak su ihtiyacı 20 yıllık işletme süresi boyunca başarıyla karşılandı.

Esenkent'te yaşayanlar bölgesel ısıtma sayesinde doğalgaza oranla %40 daha ucuza ısındı!

Bu hizmet verilirken çevre yapılarda kurulmasına gerek kalmayan 10.000 adet kombinin yaklaşık 10 milyon dolar tutarındaki masrafının önlenmesinin yanında atmosfere salınacak egzoz gazları engellendi, konutlar en verimli ve tasarruflu şekilde ısıtılarak küresel ısınmaya olumlu katkı sağlandı. Doğa Enerji'nin hizmet ettiği Esenkent'te yaşayanlar bölgesel ısıtma sayesinde doğalgaza oranla %40 daha ucuza ısındı.

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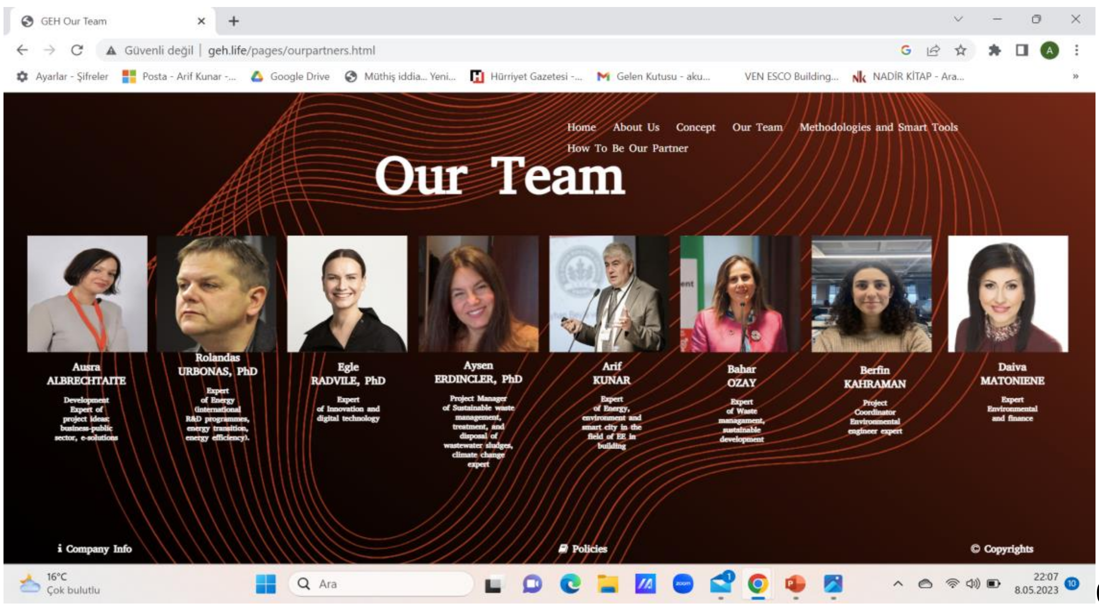
ENERGY POVERTY AND SOLUTION SUGGESTIONS-9 :

«GREEN DEAL-TURKLIT (GEH) PROJECT»

A long-term platform was established between Lithuania Vilnius Municipality and Istanbul Metropolitan Municipality for the development of smart and green ideas. This platform, which will first involve municipalities and then companies, NGOs, universities and other local governments working on these issues, was implemented as the first exemplary project in our country.



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6

TARGETS & SCENARIOS

TRAINING MATERIAL

Prepared by:
Mindaugas Stonkus

Report of good practices for target and scenarios actions to climate change of SECAP

Mindaugas Stonkus

Head of Energy efficiency policy group

Ministry of Energy of the Republic of Lithuania

November 2023

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ABBREVIATIONS

BEI	Baseline Emission Inventory
CoM	Covenant of Mayors for Climate and Energy Initiative
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
EU	European Union
GCoM	Global Covenant of Mayors for Energy and Climate
GHG	Greenhouse gas emission
SECAPs	The Sustainable Energy and Climate Action Plan
IMM	Istanbul Metropolitan Municipality
EV	Electric vechicle
LED	Light emitting diode
JRC	Joint Research Centre of EU
PW	Solar Power
CHP	Central heating system
SECAP	Sustainable Energy and Climate Action Plan
RES	Renewable energy resources
RVA	Climate Change Risk and Vulnerability Assessment

1. THE SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN

1.1. Introduction

The Sustainable Energy and Climate Action Plan concept has been developed by the Covenant of Mayors. It is designed to give a detailed overview on the energy situation and GHG emissions of a municipality and defines quantifiable actions to reduce emissions, identify energy efficiency measures and adopt renewable energy targets. It also offers actions to adapt to climate change taking into account the risks that are relevant to the area such as floods or heat waves. Another goal is taking action to alleviate energy poverty.

Sustainable Energy and Climate Action Plans (SECAP) play a crucial role in guiding municipalities toward a more sustainable and resilient future. As the world grapples with the challenges posed by climate change, local governments are increasingly recognized as key players in mitigating environmental impact and ensuring the well-being of their communities. SECAPs serve as comprehensive roadmaps that empower municipalities to proactively address climate change, energy efficiency, and sustainable development.

SECAPs are instrumental in mitigating the adverse effects of climate change by outlining strategies to reduce greenhouse gas emissions. Municipalities, as primary contributors to emissions, can use these plans to set ambitious targets, implement renewable energy initiatives, and adopt sustainable practices that lead to a more eco-friendly and resilient community.

Each municipality faces unique challenges and opportunities based on its geographical, social, and economic characteristics. SECAPs allow for the development of tailored, localized solutions that consider the specific needs of a community. This targeted approach enhances the effectiveness of climate and energy actions, ensuring that interventions are both relevant and impactful.

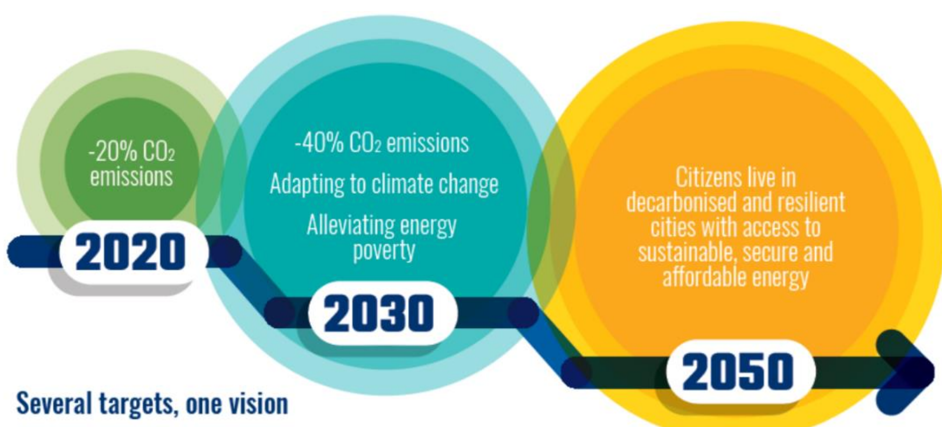
By promoting energy efficiency measures, SECAPs help municipalities optimize resource use and reduce operational costs. The implementation of sustainable technologies, energy-efficient infrastructure, and waste reduction measures not only contribute to environmental goals but also lead to long-term financial savings for the municipality and its residents.

SECAPs provide a platform for community engagement, fostering a sense of shared responsibility and ownership of sustainable practices. Involving local stakeholders in the planning and implementation processes enhances community resilience to climate-related challenges. Building community awareness and participation can contribute to the successful adoption of sustainable behaviors and initiatives.

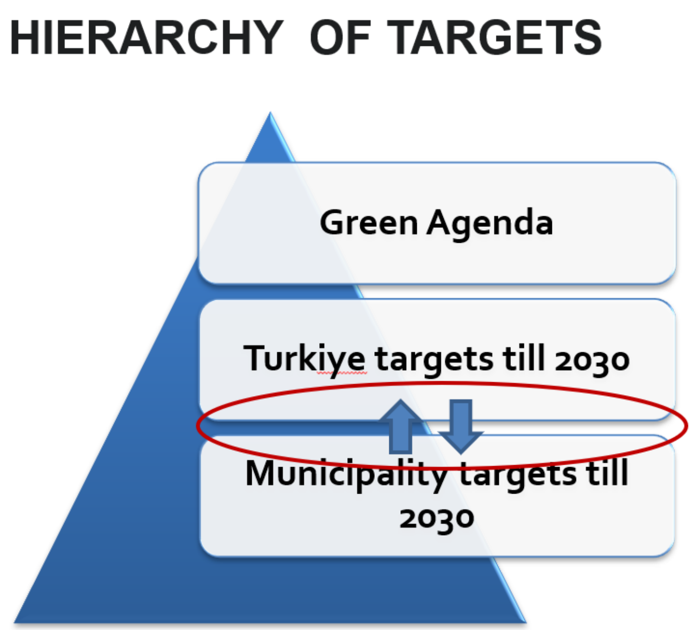
Many regions and countries encourage municipalities to develop SECAPs as part of their commitment to international climate agreements. Having a well-defined plan not only ensures compliance with regulatory requirements but also opens up access to funding opportunities and grants dedicated to sustainable development and climate action.

SECAPs encourage municipalities to adopt a forward-thinking approach, considering the long-term impacts of climate change and developing adaptation strategies. These plans provide a framework for assessing vulnerabilities, identifying potential risks, and integrating adaptive measures to build resilience against evolving environmental challenges.

Signatory local authorities share a vision of decarbonized and resilient cities, where citizens have access to secure, sustainable and affordable energy. Signatories pledge to reduce CO2 emissions by at least 40% by 2030 and to increase their resilience to the impacts of climate change.



These SECAPs targets should be in line with the regions and Turkiye targets as a smaller part of it.



In conclusion, Sustainable Energy and Climate Action Plans are indispensable tools for municipalities seeking to navigate the complex landscape of climate change and sustainable development. By fostering local engagement, promoting resource efficiency, and providing a roadmap for climate action, SECAPs empower municipalities to lead the way toward a greener, more sustainable future.

1.2. The Main steps in preparation of SECAPs

The preparation of a Sustainable Energy and Climate Action Plan (SECAP) involves several key steps to ensure a comprehensive and effective strategy for a municipality's sustainable development. While the specific process may vary based on local contexts and regulations, the following are general steps commonly involved in the preparation of SECAP. According to the JRC guidebook there are 10 most important steps for preparation:

1.2.1 Formal adoption of the plan by the municipal council (or equivalent decision-making body)

Strong political support is essential to ensure the success of the process, from SECAP design to implementation and monitoring (33). This is why the SECAP document must be approved by the municipal council (or equivalent decision-making body).

1.2.2 Definition of clear mitigation and adaptation target(s) / goal(s)

The SECAP document must contain a clear reference to the core emission reduction commitment taken by the local authority when signing the Covenant of Mayors. The recommended baseline year is 1990, but if the local authority does not have data to compile a CO2 inventory for 1990, then it should choose the closest subsequent year for which the most comprehensive and reliable data can be collected. The overall CO2 reduction commitment has to be translated into concrete actions and measures together with the CO2 reduction estimates in tons/year by 2030. For the local authorities that have a longer term CO2 reduction target (for example by 2050) they should set an intermediary target by 2030 **(40% as a minimum)** for the reasons of comparability. In addition to the mitigation commitment, adaptation goals have to be specified coherently with the main outcomes of the vulnerability and risk assessment.

1.2.3 Sound assessment of the local situation (based on the Baseline Emission Inventory (BEI) and a Climate Change Risk and Vulnerability Assessment (RVA) outputs)

The SECAP should be elaborated based on a sound knowledge of the local situation in terms of energy and greenhouse gas emissions, as well as of climate hazards, vulnerabilities and impacted policy sectors. Therefore, an assessment of the current framework should be carried out. This includes elaborating a Baseline Emission Inventory (BEI) and preparing a

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Climate Change Risk and Vulnerability assessment (RVA) – in line with the CoM commitments. The results of both the BEI and BEI and the RVA have to be included in the SECAP document.

The BEI and subsequent inventories are essential instruments that allow the local authority to have a clear vision of the priorities for action, to evaluate the impact of the measures and determine the progress towards the objective. It allows maintaining the motivation of all parties involved, as they can see the result of their efforts. Here are some specific points of attention:

● The BEI has to be relevant to the local situation, i.e., based on energy consumption/production data, mobility data etc. within the territory of the local authority. Estimates based on national/regional averages would not be appropriate in most cases, as they do not allow capturing the efforts made by the local authority to reach its CO2 targets.

● The methodology and data sources should be consistent through the years.

● The BEI must cover at least the sectors in which the local authority intends to take action to meet the emission reduction target. The following are considered key Covenant sectors as they represent significant CO2 emission sources in urban environment and can be influenced by the local authority: residential, municipal and tertiary buildings and facilities, and transport.

● The BEI should be accurate, or at least represent a reasonable vision of the reality.

● The data collection process, data sources and methodology for calculating the BEI should be well documented (if not in the SECAP then at least in the local authority's records).

The RVA enables local authorities to identify their exposure to current and potential Climate Change impacts, vulnerabilities and risks, as well as understand the main city specificities that contribute to aggravating the consequences of a specific climate hazard. Similarly to the BEI, the RVA defines the basis for setting the priorities of investment and monitoring the effectiveness of implemented adaptation measures for a specific region or sector. To this end, indicators of climate vulnerability and risk have to be constructed - on the basis of available data - and regularly monitored and evaluated versus a baseline scenario.

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1.2.4 Comprehensive measures addressing the key sectors of activity – as identified in the signatory's assessments (BEI & RVA)

The commitment taken by the signatories concerns the reduction of the CO2 emissions in their respective territories. Therefore, the SECAP has to contain a coherent set of mitigation measures covering possibly all the Covenant key sectors of activity: not only the buildings and facilities that are managed by the local authority, but also the sectors of activity in the territory of the local authority: residential sector, tertiary sector, public and private transport. Before starting the elaboration of actions and measures, the establishment of a long-term vision with clear objectives is highly recommended.

The adaptation strategy should be part of a stand-alone document (e.g. the so-called SECAP) and/or mainstreamed in separate documents. Based on recognised local risks and vulnerabilities, the local authority should identify actions aimed at enhancing local adaptive capacity to respond to Climate Change impact and/or reducing city sensitivity to climate extremes. The key actions should be implemented within the prioritized hotspots of vulnerability and risk in order to reduce the probability of high losses and damages. Mitigation actions should be looked at through a Climate Change lens, to understand if they themselves are vulnerable to the impacts of Climate Change and/or they can influence the vulnerability of natural and human systems to Climate Change. The SECAP Guidebook contains many suggestions of policies and measures that can be applied at the local level.

1.2.5 Strategies and actions until 2030

The plan must contain a clear outline of the strategic actions that the local authority intends to take in order to reach its commitments by 2030. It has to contain:

● The strategy and goals until 2030, including firm commitments in areas like land-use planning, transport and mobility, public procurement, standards for new/renovated buildings etc.

● Detailed measures for the coming years, which translate the long-term strategy and goals into actions. For each measure/action, it is important to provide a general description, the responsible body, the timing (start-end, major milestones), the cost estimation and financing/source, the indicators for monitoring. In addition, for mitigation actions the following should also be indicated: estimated energy saving/increased renewable energy production and associated estimated CO_2 reduction. For the key adaptation actions, the stakeholders involved, the risk and/or vulnerability tackled and the outcome reached should also be specified.

1.2.6 Mobilization of all municipal departments involved

The SECAP process should not be conceived by the different departments of the local authority administration as an external issue, but it has to be integrated into everyday processes. The SECAP should outline which structures are in place or will be organised in order to implement the actions and follow the results. It should also specify the human resources made available. A coordinated (inter)action between mitigation and adaptation through the mobilisation of all departments involved should be ensured. This implies strong horizontal cooperation among policy sectors that are used to working in separate silos to comply only with their sectoral agenda.

1.2.7 Engagement of citizens and stakeholders

In order to develop successful mitigation and adaptation planning, multiple stakeholder engagement is required. Stakeholder engagement should be carried out since the very first steps of the planning process until the end of it, in order to have a successful planning. The plan has to describe how the citizens and stakeholders have been involved in its elaboration, and how they will be involved in implementation and follow up. Advisory Groups should be created to ensure an exhaustive understanding of city specificities and problems, meet end-user expectations, guarantee a common agreement about selected indicators, and ensure a full uptake of the main outcomes and their inclusion into decision-making.

1.2.8 Financing

A plan cannot be implemented without adequate financial resources. The plan should identify the key financing resources that will be used to finance the actions.

1.2.9 Monitoring and reporting

Regular monitoring using relevant indicators followed by adequate revisions of the SECAP allows to evaluate whether the local authority is achieving its targets, and to adopt corrective measures if necessary. The CoM signatories are therefore committed to submit a "Monitoring Report" every second year following the submission of the SECAP. The SECAP should contain a brief outline on how the local authority intends to ensure the follow-up of the actions and monitor the results. Signatories who had already committed to 2020 targets should continue to monitor and report on the progress to achieve them while starting to report on 2030 targets.

1.2.10 SECAP submission and filling the template

The covenant signatories commit to submitting their SECAPs within two years following adhesion. The SECAP document must be uploaded in national language (or in English) via the Covenant of Mayors' website. Signatories are required, at the same time, to fill in an online SECAP template in English. This will allow them to summarize the results of their Baseline Emission Inventory and of the Climate Change Risk and Vulnerability Assessment as well as the key elements of their SECAP. Dedicated monitoring templates are available to report on the SECAP implementation. The template has to be filled in carefully with sufficient level of detail, and should reflect the content of the SECAP, which is a politically approved document. Specific reporting guidelines are available on the Covenant website.

2 GOOD PRACTICES FOR TARGET AND SCENARIOS IN OTHER COUNTRIES SECAPs

Setting targets in a (SECAP) is important for several reasons, as it helps guide and measure progress in addressing climate change and promoting sustainable practices. Here are some key reasons why setting targets in SECAPs is crucial:

Measurable Progress: Targets provide a quantifiable way to measure the success and progress of climate and energy initiatives. They allow for tracking and evaluation of the impact of specific actions over time.

Accountability: Establishing targets creates a framework for accountability. It helps clarify responsibilities and ensures that relevant stakeholders, including governments, communities, and organizations, are held accountable for their contributions to achieving climate and sustainability goals.

Guidance for Action: Targets serve as a roadmap for planning and implementing concrete actions. They provide clear direction on what needs to be achieved, helping to prioritize initiatives and allocate resources efficiently.

Resource Allocation: Setting targets assists in the allocation of resources, including financial, human, and technological resources. It enables efficient use of resources to implement projects and initiatives that contribute to the overall goals outlined in the SECAP.

Risk Reduction and Adaptation: Targets can address climate change risks and vulnerabilities. By setting goals related to resilience and adaptation, SECAPs can help communities prepare for and mitigate the impacts of climate change.

In summary, setting targets in SECAPs is essential for creating a structured and effective approach to addressing climate change and promoting sustainability. Targets provide a basis for measuring progress, guiding actions, fostering accountability, and demonstrating commitment to creating a more sustainable future.

2.1 Municipality of Florence

2.1.1 Florence in numbers

It is the capital city of Tuscany region and of a metropolitan city with 41 municipalities and about 1 million inhabitants. Florence can be defined as «daily use city» with 380.000 residents, there are daily 140.000 additional users coming in our city. The most of them are commuters (101.000), with only 28.300 residents going out for work. The rest of the users are tourists, a primary resource for our economy: before 2020 there were more than 14 million tourists per year.

2.1.2 Scenarios and targets of CO2 reduction

Florence joined the CoM with conviction and although its particularity due to the cultural heritage, the city has committed heavily to change its emission profile. Each sector was involved and challenged with the leading example of the public one: the result are complex master plans, integrating sectors with sets of feasible and synergic measures selected by a coproduction approach together with local stakeholders. The SEAP unsolved issues (fluctuating millions of non-residents and supra municipal services) have been faced in the Smart City strategy where Florence set a mid term plan to start its ambitious path to climate

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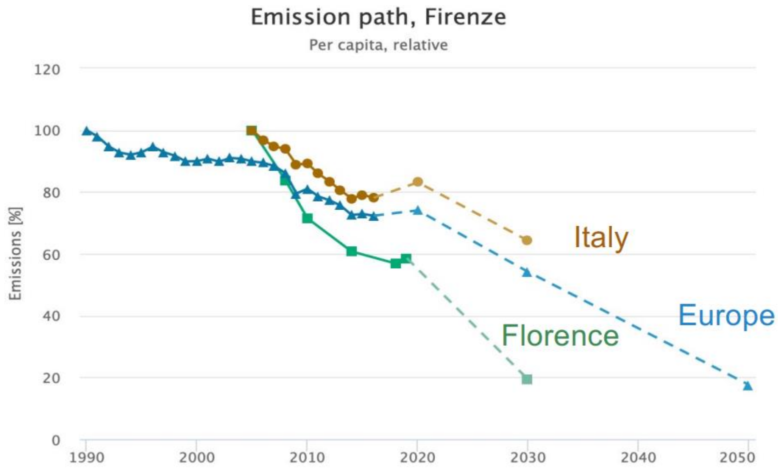
neutrality at 2040, now improved in the SECAP and in the upcoming CCC. The municipality had set 60 % of CO2 emissions reduction till 2030. Foreseen 39 actions with energy saving measures which will save around 1.900 GWh/y, higher share or RES will lead total of 380 GWh and CO2 emissions savings of 806.000 t/y.



2.1.3 Main actions and measures

Public buildings & facilities

Playing an exemplar role for citizens, public sector has started to save energy in buildings (schools, public offices, housing, hospitals & health structures ..), and in public lighting: a virtuous path with a target of 50% at 2020 vs 2005 BEI – Schools (oil boilers displacement, new efficient boilers, PV) – Hospitals (RES and CHP) – Sport centres and markets (PV, CHP, electric mobility….) – Pubblic housing (A label retrofittings, wood buildings, RES, efficiency….) – Parks (Cascine) – Water management – Road cleaning – GPP and green energy purchase.

Florence changes light program

30.000 new LED lights with tech equipment to enable innovative services (WIFI, sensors, traffic control, video surveillance…). Main benefits increased level of security, more smart services available, lower consumption: - 40% - -3.000 t CO2 per year.

Services

All services, involving a wider area, have been improved with ambitious targets.

Water management. Main changes:

Improved consumption savings around -4,5 % in 2020,

Pipe leaks reduction,

Hydroelectric production with a 2400 kW turbine for a total of 3,5 GWh in 2020 biogas from sewage exploitation,

Communication campaigns to reduce water consumption and for the use of public drinking water,

Consumption metering and proportional tariffs, water safety plan adopted in 2020.

Waste management. Main measures:

New waste management plan with ambitious targets (75% sorted),

Rewarding tariffs,

Optimization of collection logistic for each district

Smart Waste Promotion of circular economy

Smart grid. (100% Smart metering)

Advanced remote control and automation on the medium-low voltage grid:

2 primary substations and 60 secondary substations (25.000 users involved) to provide additional services and improve resilience

Number of interruptions per users decreased of the 23% in 2 years

More than 600 Smart Info devices distributed to increase awareness and actively monitor trends

Mobility

Mobility in Florence was the main sector affecting CO_2 emissions (34%). Main measures:

Transport network modernization and mobility efficiency is a complex action to reach important targets with increasement of e-mobility capital.

Public transport: local rails trams, new bus fleet, e-ticketing and infomobility, various sharing systems;

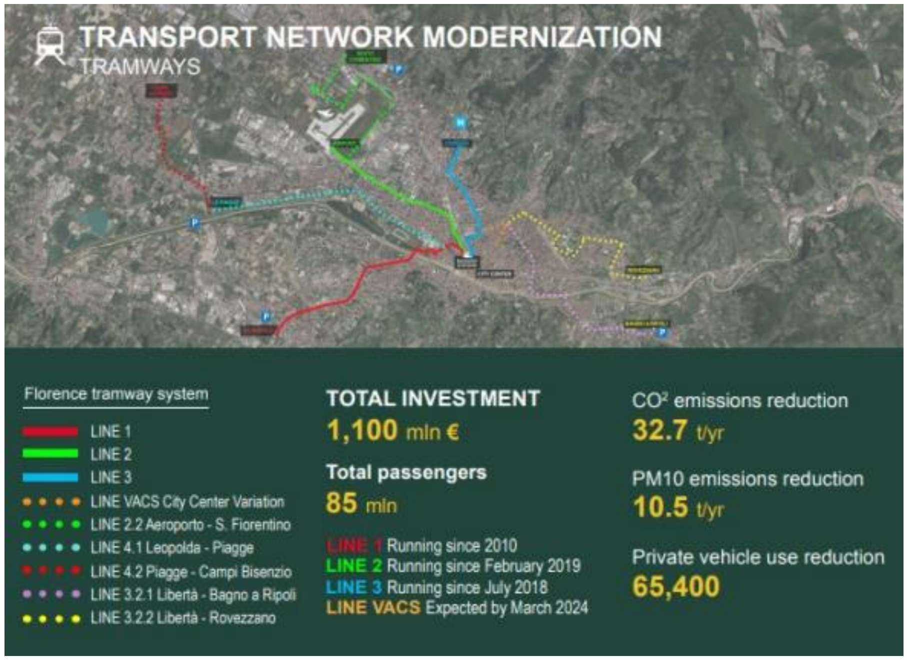
Soft mobility: pedestrian areas, bicipolitana,

parking spaces control, park and ride,

Advanced intermodality,

Information technology: infomobility platform, traffic supervisor, APPs

Communication campaigns



2.2 Municipality of Paris

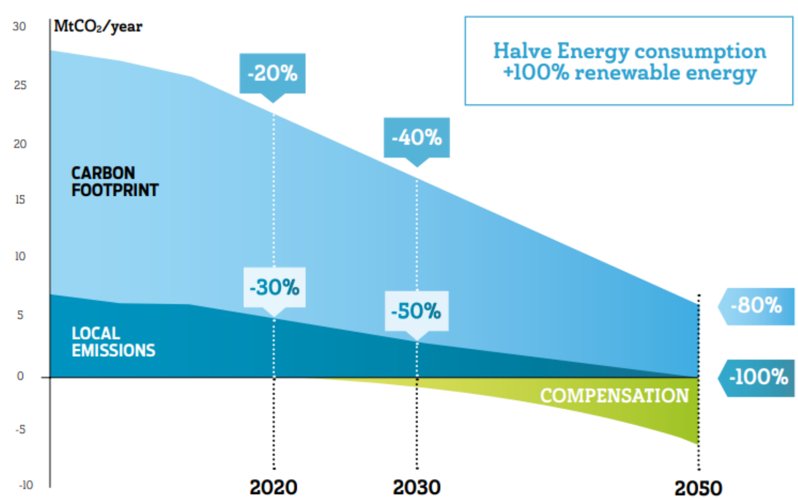
2.2.1 Paris in numbers.

Paris is the capital and most populous city of France. With an official estimated population of 2,102,650 residents as of 1 January 2023 in an area of more than 105 km2 Paris is the fourth-most populated city in the European Union and the 30th most densely populated city in the world in 2022. Since the 17th century, Paris has been one of the world's major centres of finance, diplomacy, commerce, culture, fashion, and gastronomy. For its leading role in the arts and sciences, as well as its early and extensive system of street lighting, in the 19th century, it became known as the City of Light.

2.2.2 Scenarios and targets of CO2 reduction

Paris municipality with hundreds measures in several areas of action (building, transport, energy, food, waste, living environment, mobilisation, finance...), the Paris Climate Action Plan guides the capital towards carbon neutrality by 2050. At the local level, the equation is simple: Paris' energy consumption must be divided by 2 and 100% renewable energy must be used by 2050. Paris will work as a priority to support the renovation of housing and to reduce the most carbon-intensive transport. To achieve 100% renewable energy, the City will take advantage of its territory and will create territorial partnerships to support and participate in the financing of renewable energy production outside its territory.

Paris's greenhouse gas emissions (22.7 million tonnes of CO_2 in 2018) **break down into two major groups:**



2.2.3 Main actions and measures

Paris: A Solar City With 100% Renewable Energies

20% of Parisian roofs equipped with solar panels in 2050

Citizen involvement in energy issues (individual and collective self-consumption, production cooperatives)

New forms of territorial partnerships to reach 100% renewable energy

Intelligent energy networks and 100% renewable energy

Paris, A City With Shared, Active And Clean Transport

More than 1 000 km of cycling lanes in 2020

“Paris Respire” (Paris Breathes) deployed during every Sundays and holidays by 2024

100% carbon-free public transport by 2025

Extension of the Low Emission Zone in the Greater Paris metropolitan area

A network of logistic spaces in the heart of the city by 2030

Paris: 100% Eco-Renovated And Equipped To Be Carbon Neutral

1 million housing units and 50 million sqm tertiary buildings renovated by 2050

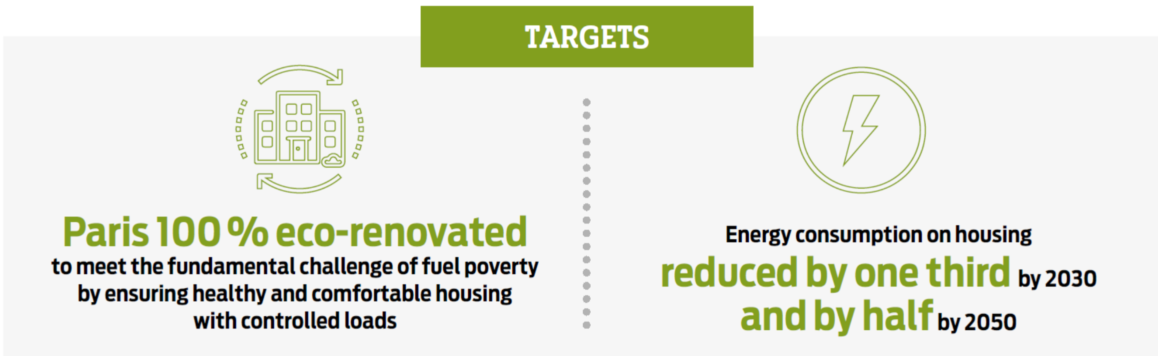
Local professional sectors for a successful works offer and create thousands of new jobs

A new mechanism for pooling energy renovation projects: Concerted Renovation

Zones (CRZ)

100% low-carbon and positive energy new buildings

New buildings designed in a reversible and flexible way with more common and shared spaces



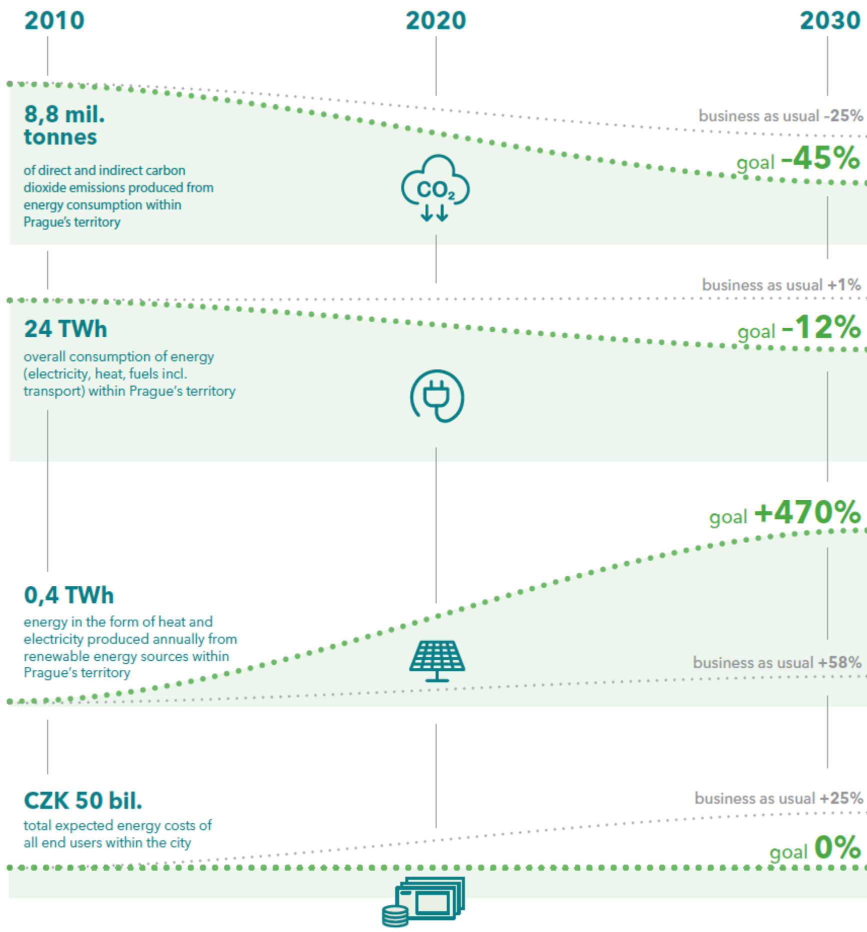
2.3 Municipality of Praha

2.3.1 Praha in numbers

Prague, also known as Praha, is the capital and largest city of the Czech Republic. Prague is the most populous city in the Czech Republic, with a population of around 1.3 million people. The city of Prague covers an area of approximately 496 square kilometers. Prague is a major tourist destination. Before the COVID-19 pandemic, the city attracted millions of visitors annually. Notable landmarks like Prague Castle, Charles Bridge, and the Old Town Square contribute to its popularity.

2.3.2 Scenarios and targets of CO2 reduction

In 2019, the City of Prague adopted a landmark resolution in which the city voluntarily committed to start actively monitoring and gradually reducing its direct and indirect carbon dioxide (CO2) emissions. In doing so, the city officially declared its climate commitment to reduce CO2 emissions by 45% by 2030 compared to 2010, while stating that it does not consider the city's shift away from fossil fuels in energy production, transportation and other economic activities as a threat, but as an opportunity to gradually transform the city into an environmentally friendly metropolis that is attractive to live in.



2.3.2 Main actions and measures

Introducing a system of energy management gradually for all buildings, establishments, and areas of use. Through this tool, the city will be able to evaluate the effects of energy saving solutions, develop further ones, and monitor the fulfilment of the Climate Plan.

The introduction of this system would be funded by a combination of resources from the Capital City of Prague, subsidy programmes co-financing the installation of monitoring devices capable of remote measuring (as part of complex projects focused on energy savings and installation of low and zero emission energy and heat sources), future savings on operating costs as a result of optimised use, and purchases of electricity, gas, and heat, as well as due to the general introduction of smart electrometers as supported by current legislation.

Constructing a biogas station aiming to utilise sorted and biodegradable waste for the manufacture of biomethane and its further use in the existing natural gas infrastructure to power the Prague Services (Pražské služby, a. s.) fleet. The majority of investments involved in these measures can be sourced co-financed through OPE 2021–2027. Operational costs can then be partially supported through bonuses given for the biomethane produced; these conditions will make the station economically advantageous for the city (even when assuming that the investments not covered by subsidy programmes will be financed through a loan). Subsidy proposals are most likely to be accepted starting from 2022 or 2023 at the latest.

Construct new metro line D. Construction of a new metro line will expand the capacity of public transport and replace car and bus travel in the southern part of the city. The purpose behind the inclusion of this project in the Climate Plan is primarily to push forward its implementation. However, the investments and expenses necessary for its construction are notincluded in the financing part of the Plan due to their scope and difficulty in finding financing avenues.

Substituting diesel-powered vehicles with electric buses or battery-powered trolleybuses. At least 75% of the current fleet of buses operated by the DPP HMP (Prague Public Transit Company) or contracted by ROPID from private transport companies will be substituted with zero emission vehicles (approx. 900). A substantial part of initial investments for this measure can be co-financed from IROP 2021–2027 or through the Modernisation Fund the allowance for which is to be expanded. Another possible source of funding is the Renewal Fund (it is necessary to monitor its development and have projects ready to be submitted in case a co-financing opportunity arises).

Founding the Prague Renewable Energy Community, including investments into installations of hundreds of MWp of power through PV integrated into buildings (roofs, façades, balconies, etc.) or located on current paved surfaces in the vicinity of buildings of whole areas in ownership of the city, as well as opening the Community to the public. The majority of the initial investments for this measure can be co-financed through the Modernisation Fund and its programme No. 2 (RES+) – this would make installations of PVs economically advantageous for the city (even when assuming that the investments not covered by subsidy programmes will be financed through a loan).

Realisation of complex energy savings in buildings of the public sector and infrastructure which are in ownership of the city. Main support will be directed towards the improvement of heat isolation properties of outer walls of buildings (through partial or complete insulation of walls and roofs, exchange or whole windows or their glazing and other features). The majority of the initial investments for this measure can be co-financed from the Modernisation Fund and its programme No. 7 (Energy efficiency in public buildings and infrastructure) – securing the investment grant would allow for such savings-oriented projects to become economically advantageous for the city (as is possible to verify through the EPC method which will also cover the remaining expenses through future savings in operations).

Modernisation of street lights and inclusion of public infrastructure of electric vehicle charging stations in new light systems. Retrofitting new public street lighting with more effective LED types, utilising smart regulation of light intensity. The majority of initial investments for this measure can be co-financed from the Modernisation Fund and its programme No. 9 (Modernisation of street lighting infrastructure).

3. SETTING CLEAR TARGETS

Setting targets and objectives can follow the principles of the **SMART** acronym: **Specific, Measurable, Achievable, Realistic, and Time-bound**.

To set SMART targets, use the following questions:

1. Specific (well-defined, focused, detailed and concrete): What are we trying to do? Why is this important? Who is going to do what? When do we need it done? How are we going to do it?

2. Measurable (kWh, time, money, %, etc.): How will we know when this objective has been achieved? How can we make the relevant measurements?

3. Achievable (feasible, actionable): Is this possible? Can we get it done within the timeframe? Do we understand the constraints and risk factors? Has this been done (successfully) before?

4. Realistic (in the context of the resources that can be made available): Do we currently have the resources required to achieve this objective? If not, can we secure extra resources? Do we need to reprioritise the allocation of time, budget and human resources to make this happen?

5. Time-Bound (defined deadline or schedule): When will this objective be ccomplished? Is the deadline unambiguous? Is the deadline achievable and realistic?

For presentation purposes all targets can be presented in table form.

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3.1. RES targets

RES targets	2023, instaled MW	2030 target, MW	Financing	Timeframe	Responsible authority
Electricity	X	X+Y			
Wind	X	X+Y			
Photovoltais	X	X+Y			
Hydroelectric	X	X+Y			
Geothermal	X	X+Y			

RES targets	2023, instaled MW	2030 target, MW	Financing	Timeframe	Responsible authority
Heat	X	X+Y			
Combined Heat and Power	X	X+Y			
District heating (heat-only)	X	X+Y			
Transport	X	X+Y			
Electricity	X	X+Y			
Hydrogen	X	X+Y			

3.2. EE targets

EE targets	2023, energy saved MWh	2030 energy saved, MWh	Financing	Timeframe	Responsible authority
Buildings	0	X			
Renovation Multi-apartments	0	X			
Renovation of family houses	0				
Industry	0	X			
Support scheme for SME	0	X			
Transport	0	X			
New eletric vechicles	0	X			

4 CONCLUSIONS

Setting renewables and energy efficiency targets for municipalities can bring about various benefits, contributing to both environmental sustainability and the overall well-being of the community. Here are some reasons why such targets are advantageous:

Environmental Sustainability:

Reduced Greenhouse Gas Emissions: Increasing the use of renewable energy sources and improving energy efficiency can lead to a significant reduction in greenhouse gas emissions, mitigating the impact of climate change.

Economic Savings:

Cost Savings for Municipality: Implementing energy efficiency measures and transitioning to renewables can result in cost savings for the municipality. Energy-efficient technologies often lead to reduced energy consumption, lowering utility bills and operational expenses.

Energy Independence:

Reduced Dependency on Fossil Fuels: A focus on renewables contributes to a diversified energy mix, reducing reliance on finite fossil fuels. This enhances energy security and resilience, protecting the municipality from price volatility and supply disruptions.

Job Creation and Economic Growth:

Renewable Energy Industry Jobs: Investing in renewable energy projects can create jobs in the local community, fostering economic growth. This includes roles in construction, installation, maintenance, and operation of renewable energy infrastructure.

Improved Public Health:

Air Quality Improvement: Reducing dependence on fossil fuels and transitioning to clean energy sources can improve air quality. This, in turn, leads to better public health outcomes by decreasing respiratory diseases and other health issues associated with air pollution.

Technological Innovation:

Stimulating Innovation: Pursuing renewables and energy efficiency goals encourages the development and adoption of innovative technologies. This can position the municipality as a leader in sustainable practices and attract further investment and collaboration.

Compliance with Regulations:

Meeting Regulatory Requirements: Many regions and countries have regulations and commitments related to renewable energy and emissions reductions. Meeting or exceeding these targets ensures compliance and avoids potential penalties.

Community Engagement:

Community Pride and Involvement: Establishing and achieving sustainability targets can foster a sense of community pride. Residents often appreciate initiatives that promote environmental responsibility, leading to increased community engagement.

Resilience to Climate Change:

Adaptation to Climate Change: Enhancing energy efficiency and incorporating renewables can make municipalities more resilient to the impacts of climate change, such as extreme weather events and disruptions in energy supply.

Global Reputation:

Enhanced Reputation: Municipalities that actively work towards sustainability goals gain positive recognition nationally and internationally. This can attract investment, partnerships, and recognition as a forward-thinking and responsible community.

Funded by
the European Union

References:

1. Covenant of Mayors – Europe
https://eu-mayors.ec.europa.eu/en/about
2. Joint Research Centre
https://joint-research-centre.ec.europa.eu/index_en

7

SECAP REPORTING & MONITORING

TRAINING MATERIAL

Prepared by:
Giulia Melica

Reporting SECAPs through MyCovenant

EU4ETTR - CAPACITY BUILDING FOR OBSERVER MUNICIPALITIES
SECAP REPORTING AND MONITORING ACTIONS
8 November 2023

Giulia Melica, Joint Research Centre

Outline

- The JRC and its role in the CoM
- The GCoM Common Reporting Framework (CRF) and its simplification
- Reporting through MyCovenant
- Possibilities for small-sized municipalities

European Commission

The Joint Research Centre (JRC) and its role in the CoM

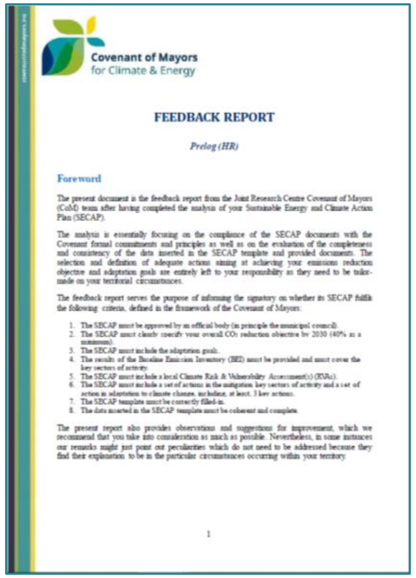
European Commission

Joint Research Centre

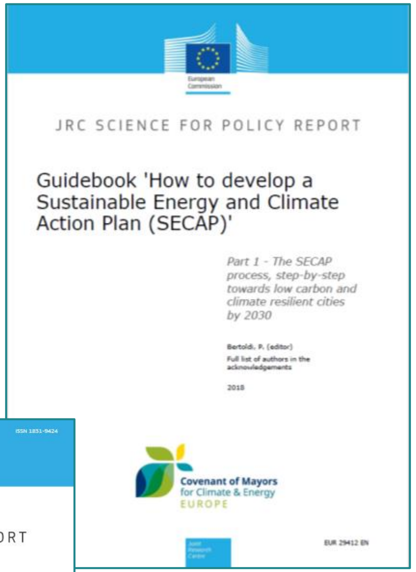
- In-house science and knowledge service of the European Commission.
- JRC mission is to support EU policies with independent evidence throughout the whole policy cycle.
- Headquarters in Brussels and research facilities in 5 Member States
- 2800 staff – 70% researchers

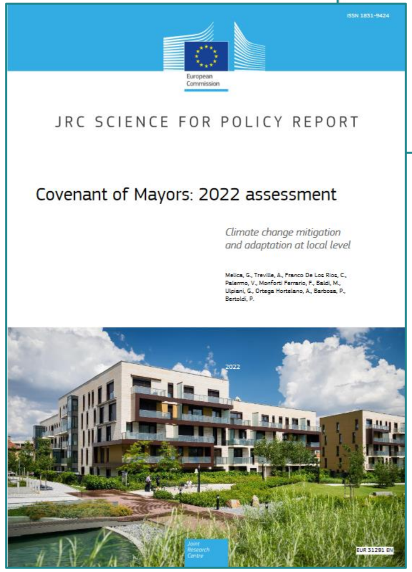
European Commission

Role of the JRC in the Covenant



- Methodologies
- Guidebooks
- Capacity building
- SECAP evaluation
- Data collection and publication
- Overall assessment





The GCoM Common Reporting Framework (CRF)

Main principles and summary of simplification

European and Global Covenant of Mayors

- In 2008, EU Covenant of Mayors (CoM) was launched by EC.
- In 2017, the EU CoM and the Compact of Mayors joined forces becoming the Global Covenant of Mayors (GCoM).
- In 2019, in the GCoM context, a **Common Reporting Framework (CRF)** was developed.
- In January 2020, the EU CoM SECAP template and related reporting guidelines were updated accordingly.
- In 2022, a simplification of the CRF has been discussed and agreed.

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

Covenant of Mayors for Climate & Energy EUROPE

European Commission

Importance of reporting climate data

- Functions as **a simplified MRV system** – measure, report, verify - tracking progress over time
- Enhances **transparency** and visualizes political commitment
- From **data to information to knowledge** that informs local **climate action** and acceleration
- Leads to **improved data quality** with increasing accuracy and coherence over time
- Identifies **data gaps**, to be addressed/resolved with GCoM support
- Clusters and hosts data for city staff, academia and researchers – exchange on experiences
- **Widespread reporting enables mapping** of national, regional and global trends – informs need for improvement and financing/investment
- **Enables data aggregation**, comparison and monitoring over time
- GCoM global streamlined reporting process provides a robust benchmark

European Commission

The GCoM CRF is a **standardized set of reporting requirements** that apply across all GCoM Regional/National Covenants.

It allows for **regional/country context flexibility** to respond to local circumstances and priorities but are also sufficiently consistent for global aggregation and comparison of reported data.

The CRF ensures **robust assessment, target setting, integrated climate action planning and monitoring**, as well as streamlined reporting across all three pillars of the initiative.

European Commission

General Principles

- **Ambitious:** Drives ambitious action and implementation, while considering the local context, encouraging cities and local governments in a more comprehensive and integrated way of planning.
- **Flexible:** Suitable for cities and local governments with varying capacities and resources, allowing for adaptation to regional circumstances.
- **Complementary** to national reporting systems, tools and methodologies to support efficient reporting.
- **Actionable**: Provides a framework supporting city climate action planning, implementation, monitoring and reporting.
- **Transparent:** Promotes open data sharing to enable the exchange of cities and local governments' experiences, opportunities and challenges.
- The reporting framework allows for **consistency with national and/or sub-national requirements** for local governments within their own national contexts. It is also designed specifically to consider the UNFCCC's framework for reporting under the Paris Agreement and, as such, ensure overall consistency with the IPCC framework.
- Greenhouse gas (GHG) emissions inventories, risk and vulnerability assessments, target(s) and goal(s), identifying hazards, climate and energy access plans should be **relevant to the local and regional situation reflecting the specific activities, capacity and regulatory context of the local government.**

Simplified Reporting Scheme

A new, simplified reporting level has been introduced to make it easier for local governments, such as those with low available resources and low data capacity, to comply with their commitment to the GCoM.

more flexibility and ease of access	VS	consistent, more complete and comparable data at the global level

Reporting Levels

Level 1: Mandatory requirements
These provisions form the minimum set of requirements that a GCoM committed city must meet under the three pillars of the initiative.

Level 2: Recommendations
These provisions are considered good practice and therefore GCoM committed cities are strongly advised to follow these recommendations whenever possible.

Level 3: Additional options
These provisions refer to options that are acceptable under the initiative which a local government can decide to follow.

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

- The difference between the advanced and the simplified reporting levels is remarkable in relation to Emission Inventories.
- The required level of data disaggregation differs between the two levels.

Emission sources – Stationary energy

Sectors / subsectors	Advanced reporting level	Simplified reporting level
Stationary energy – TOTAL emissions	**Mandatory**	**Mandatory**
- Residential buildings	Mandatory	Recommended
- Commercial buildings and facilities	Mandatory	Recommended
- Institutional buildings and facilities	Mandatory	Recommended
- Industry	Mandatory	Optional
- Agriculture, forestry, and fisheries	Recommended	Optional
- Emissions covered by and ETS	Recommended	Optional
- Fugitive emissions	Mandatory	Optional

Emission sources – Transportation

Sectors / subsectors	Advanced reporting level	Simplified reporting level
Transportation – TOTAL emissions	**Mandatory**	**Mandatory**
- On-road	Mandatory	Recommended
- Rail	Mandatory	Recommended
- Waterborne navigation	Mandatory	Recommended
- Aviation	Mandatory	Recommended
- Off-road	Mandatory	Recommended

Local governments **should** further disaggregate road and rail travel by fleet type: municipal fleets, public, private and commercial transport. Under the simplified reporting level, local governments **may** further disaggregate road and rail travel by fleet type.

Emission sources – Waste

Sectors / subsectors	Advanced reporting level	Simplified reporting level
Waste – TOTAL emissions	**Mandatory,** disaggregated by treatment type	**Optional,** disaggregated by treatment type

Where waste is used for energy generation, GHG emissions do not need to be reported. Instead, the notation key IE **should** be used. Instead, these GHG emissions will be captured in the inventory through the use of heat or electricity generated from the treatment of waste.

Emission sources – Energy generation

Sectors / subsectors	Advanced reporting level	Simplified reporting level
Energy generation – TOTAL emissions	**Mandatory**	**Optional**
- Electricity-only	Mandatory	Optional
- Combined heat and power (CHP)	Mandatory	Optional
- Heat/cold production plants	Mandatory	Optional

To avoid double counting, These **shall** not form part of the GHG emissions inventory total, and will be reported under an “Energy Generation” sector.

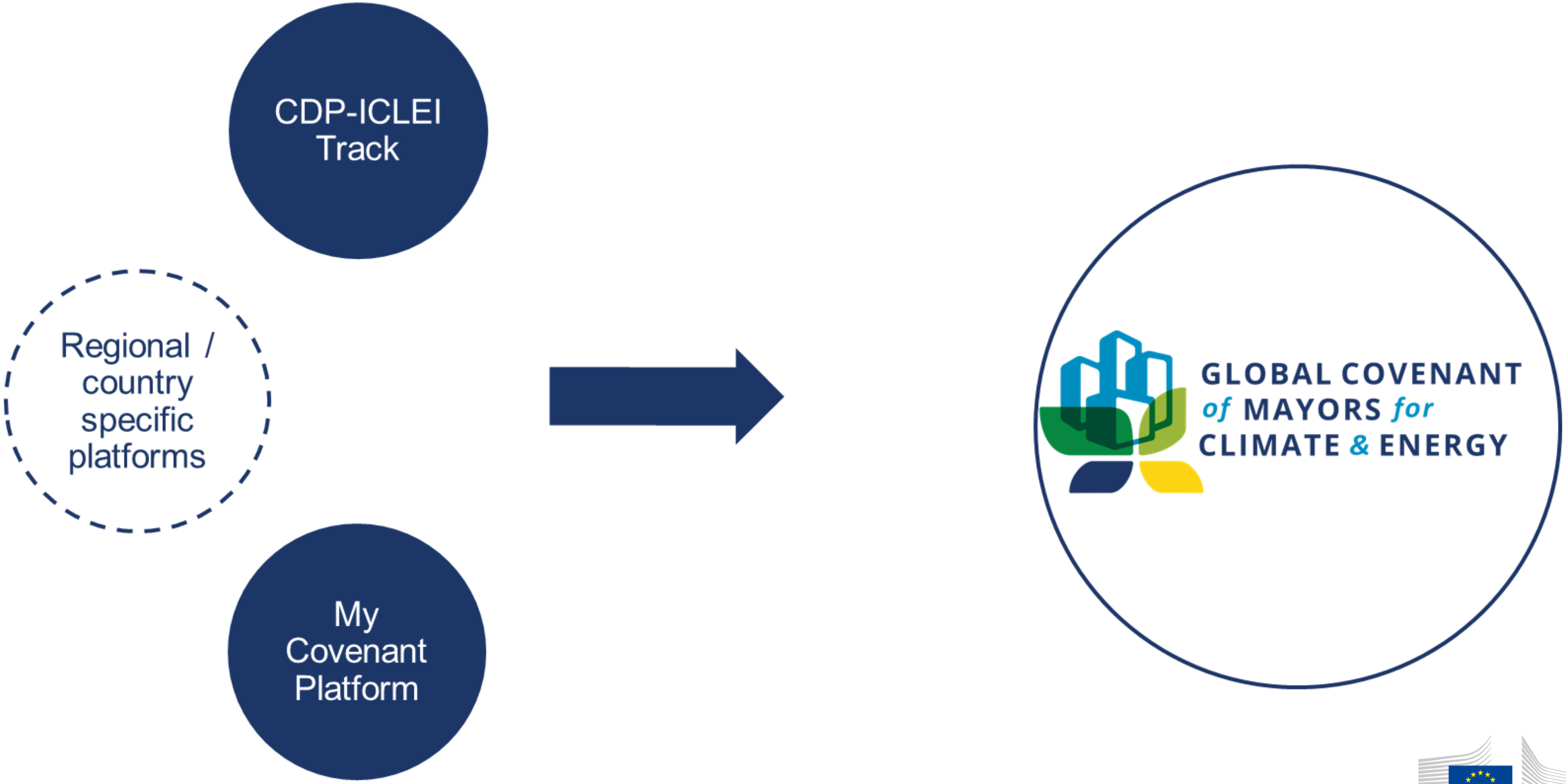
European Commission

Activity Data and Emission Factors

Data point	Advanced reporting level	Simplified reporting level
Activity data	**Mandatory**	**Optional**
Emission factors	**Mandatory**	**Optional**
CO_2 emissions	Mandatory	Mandatory
CH_4 emissions	Mandatory	Optional
N_2O emissions	Mandatory	Optional

GHG emissions **shall** be reported in metric tonnes of CO_2 equivalent (CO_2e). Where possible, local governments **should** report CO_2e emissions by individual GHG.

GCoM reporting platforms



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Reporting through MyCovenant

See also the **Covenant of Mayors for Climate & Energy Reporting Guidelines -** https://eu-mayors.ec.europa.eu/en/node/254

Covenant of Mayors Europe - commitments

Mitigation

- reduce greenhouse gas emissions on local governments' territory, with a goal to achieve **climate neutrality by 2050**

Adaptation

- increase resilience and prepare for the adverse impacts of climate change

Energy poverty

- tackle energy poverty as one key action to ensure a just transition.

NEW!

Translate their political commitment into practical measures by developing and implementing a Sustainable Energy and Climate Action Plan (**SECAP**).

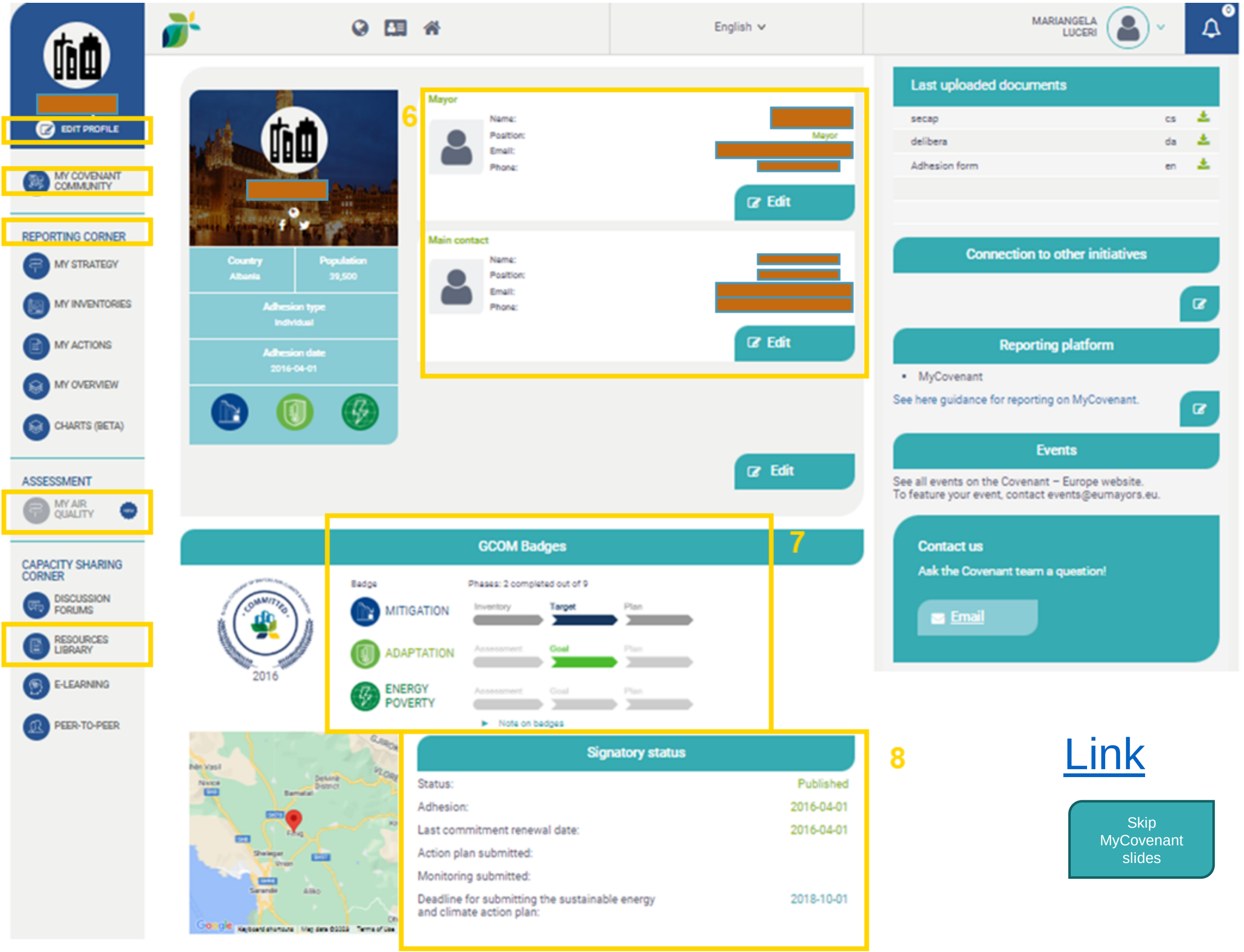
European Commission

The Covenant of Mayors process

- A SECAP shall be submitted 2 years after signing up to the initiative (extensions of the deadline may be requested)
- Every subsequent 2 years, a monitoring report shall also be submitted

MyCovenant - signatory’s view

1. Edit profile → *access to info on commitments & targets, address, reporting platform used and other EU initiatives*
2. My Covenant Community → *access to Coordinators and Supporters*
3. *Reporting Corner*
4. *My Air Quality Tool (JRC)*
5. *Resource Library → dedicated to Covenant members only*
6. *Contact information → management of contact information for both MyCovenant and CoM-Europe website*
7. *GCoM badges*
8. *Signatory’s status → upcoming deadlines, latest submitted templates / commitments*



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Skip MyCovenant slides

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My Strategy → My Action Plan Documents

- To report general information about the action plan:
  - Title
  - Approval date,
  - Approval Decision Body;
  - Indication of the year in relation to which GHG emission reduction estimates are reported (can be different to the BEI).
- To upload the action plan document(s)

European Commission

My Strategy → My Strategy

- Targets and goals in relation to the three pillars of the initiative *(N.B. reporting on the energy poverty pillar will only become mandatory as of 1 January 2025)*
- Administrative structures
- Staff capacity allocated
- Stakeholders engagement
- Budget
- Financing sources
- Monitoring process

My Inventories → Emission inventory

- Inventory year - Mandatory
- Population in the inventory year - Mandatory
- Emission factor type (IPCC, LCA, National/sub-national) - Mandatory
- Emission reporting unit (tonnes CO_2 or tonnes CO_2eq) - Mandatory
- CO2 emission factors - Mandatory
- Final energy consumption (by sector and carrier) - Mandatory
- Certified green electricity - Optional
- Local energy production - Optional
- Non-energy related sectors - Optional
- Emission inventory (by sector and carrier) – Automatically calculated

European Commission

Example - Final energy consumption table

Final energy consumption

"NO" = not occurring, "IE" = included elsewhere, "NE" = not estimated, "C" = confidential

Sector	FINAL ENERGY CONSUMPTION [MWh]																
			Fossil fuels								Renewable energies						
	Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	Biogas	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities	420823.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	420823.00
- Municipal buildings, equipment/facilities	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
- Public lighting	54948	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	54948.00
- Other	365875	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	365875.00
Tertiary (non municipal) buildings, equipment/facilities	2298505.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2298505.00
- Institutional buildings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
- Other	2298505	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	2298505.00
Residential buildings	1636322	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	1636322.00
Industry	2345350.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2345350.00
- Industry Non-ETS	2345350	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	2345350.00
- Industry-ETS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
Buildings, equipment/facilities non allocated	NE	11017432	3911061	NE	NE	NE	NE	NE	NE	1573919	NE	NE	NE	NE	NE	NE	16502412.00
Subtotal	6701000.00	11017432.00	3911061.00	0.00	0.00	0.00	0.00	0.00	0.00	1573919.00	0.00	0.00	0.00	0.00	0.00	0.00	23203412.00
TRANSPORT																	
Municipal fleet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Road	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
- Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00

My Inventories → Risks and vulnerability

- Climate hazards – Mandatory
  - Current hazards (with probability and impact) - Mandatory
  - Future hazards (with expected changes in intensity, frequency and timeframe) - Mandatory
- Vulnerable sectors in relation to each hazard – Mandatory
  - Level of vulnerability - Mandatory
  - Indicator, Indicator unit, value - Optional
- Adaptive capacity factors in relation to each sector – Optional
- Vulnerable population groups (in relation to each hazard) - Optional

My Inventories → Energy poverty assessment

To report on one or more indicators considered relevant by the city, in relation to the following macro-areas:

- Climate
- Facilities / housing
- Mobility
- Socio-economic aspects
  - The indicator “Percentage of persons / households spending up to XX% of their income on energy services” will become mandatory
- Policy and regulatory framework
- Participation / awareness-raising

My Actions – My Actions Overview

- Mitigation:
  - Number of actions included in the plan for each mitigation sector, with estimates on energy savings, renewable energy production, CO2 emission reduction by the target year mandatory
- Adaptation:
  - Number of actions by adaptation sector - Mandatory
- Energy poverty:
  - Number of actions by macro-area – Mandatory (as of 1/1/2025)

My Actions – My Action details

- Mitigation:
  - At least 3 key actions - Mandatory
- Adaptation:
  - At least 3 key actions - Mandatory
- Energy poverty:
  - At least 1 key action – Mandatory (as of 1/1/2025)

Action	Type	Key action	Origin of the action	Implementation timeframe		Status of Implementation
	All			Start	End	
AOS1.1: Establishing the necessary tools, mechanisms and management structure for the effective implementation of climate change adaptation strategies	Adaptation	☆	Local authority	2021	2025	Ongoing
AOS1.3: Develop an administrative organisational structure for the implementation and monitoring of GCAP and SECAP actions	Adaptation	☆	Local authority	2020	2021	Ongoing
B1.11: Explore ways to support residential retrofits being undertaken to a higher and greener energy performance standard	Mitigation	☆	Local authority	2020	2030	Not started
B1.3: Review and update the local-level policies, planning regulations and guidelines for future and new municipality development around energy efficiency	Mitigation	☆	Local authority	2022	2030	Ongoing

My Actions – Key action form

- Type of action (Mitigation/Adaptation/Energy poverty)
- Title of the action
- Key action?
- Key Action Title
- Origin of the action
- Responsible body
- Short description of the action
- Implementation timeframe and status
- Action stakeholders
- Total cost
- Source of funding

- Mitigation action details:
  - Sector / area of intervention / policy instrument/
  - Estimated impacts (energy savings, energy production, emission reduction)
- Adaptation action details:
  - Climate hazard(s) addressed
  - Sector(s)
  - Outcome(s) reached (description)
  - Vulnerable population group(s) targeted
- Energy poverty action details:
  - Macro area(s)
  - Outcome(s) reached (description)
  - Vulnerable population group(s) targeted

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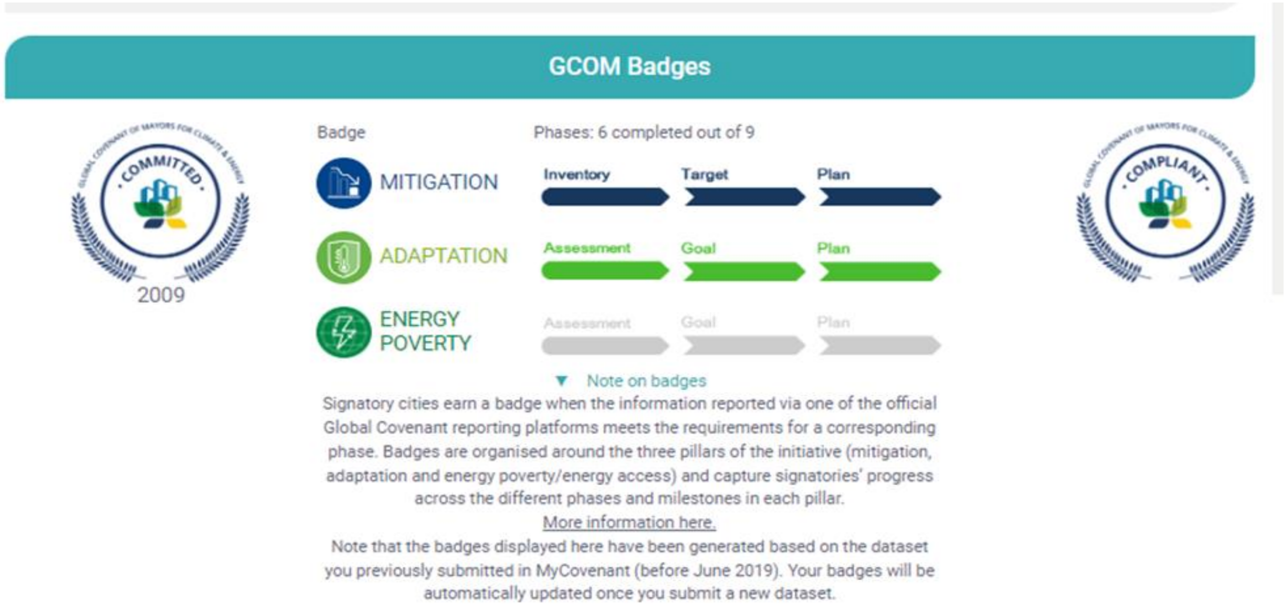
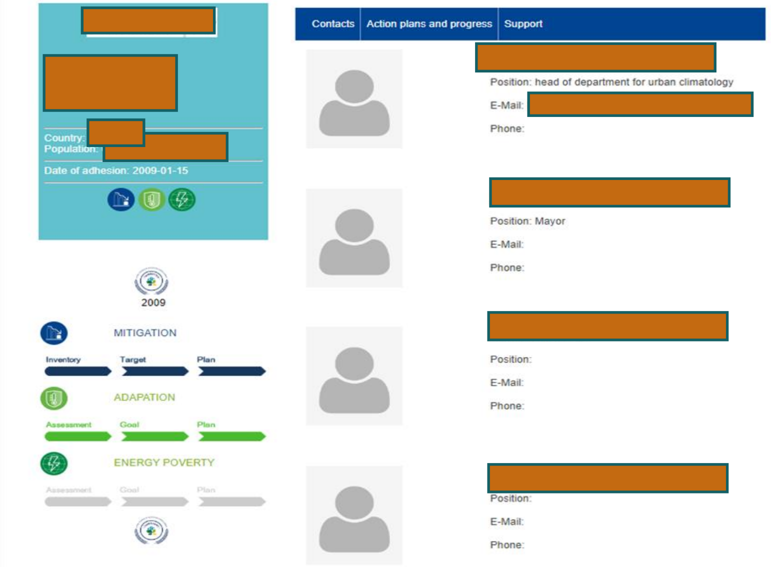
GCoM badges

MyCovenant

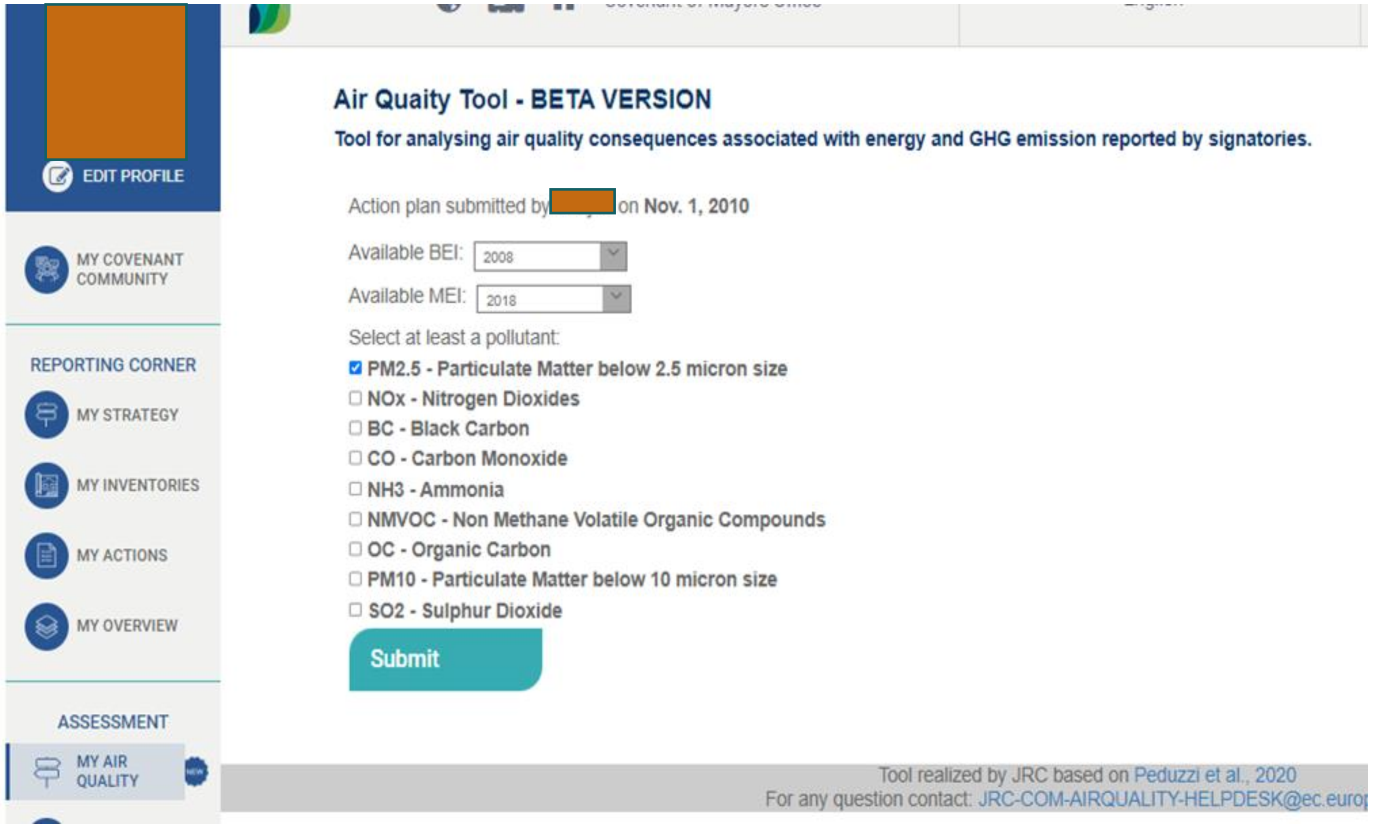


Covenant Europe website



- Showed both on the signatory's public profile and on the MyCovenant dashboard
- Automatically assigned

Air Quality Tool Assessment



- Developed by JRC
- Particularly relevant for small and medium size municipalities
- Available if the signatory has reported a BEI and at least a MEI
- After running the tool, the signatories is provided with a full explanation of the indicators, the table and the plots proposed

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SECAP Evaluation

JRC Analysis Mitigation

Analysis date	Analysis status	Internal created date	User	Internal Comment	Document
18.01.2023	accepted	2023-01-18 14:41:15.620285+00			feedback report +

New analysis status: Please select
Analysis date: 2023-01-18
Internal comment:
Save new analysis status

If you have questions about the analysis, please email to JRC-COM-TECHNICAL-HELPDESK@ec.europa.eu

JRC Analysis Adaptation

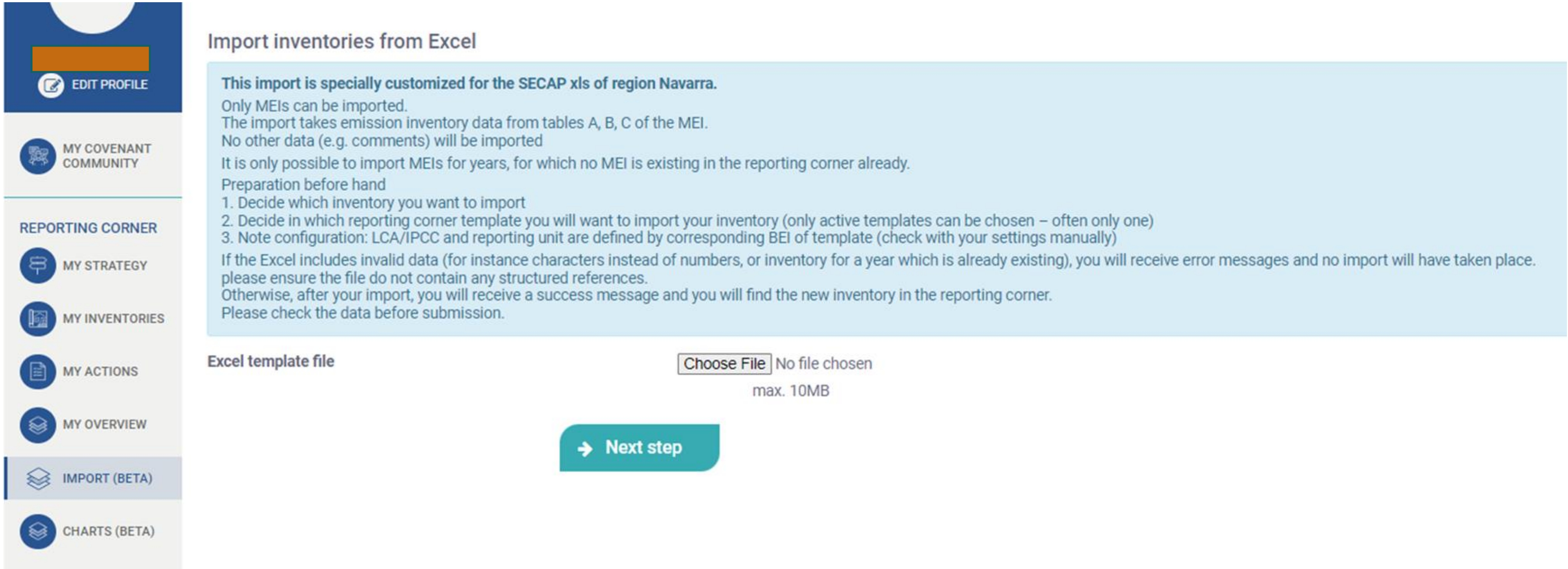
Analysis date	Analysis status	Internal created date	User	Internal Comment	Document
18.01.2023	under_evaluation	2023-01-18 14:41:40.96533+00			+

New analysis status: Please select
Analysis date: 2023-01-18
Internal comment:
Save new analysis status

If you have questions about the analysis, please email to JRC-COM-TECHNICAL-HELPDESK@ec.europa.eu

- Analysis carried out by JRC
- Available in the signatories reporting corner
- Easy to check the status of the evaluation of the action plan
- Feedback report provided when action plan accepted / rejected.

Import of emission inventories



- Successfully tested!
- Standard template provided by CoM Europe
- Next: import of whole action plan’s templates / monitoring reports from xls files.

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New features | Charts

Possibilities for small-sized municipalities

Joint SECAPs

Support from Covenant Territorial Coordinators

Cooperation among cities and towns

Challenges in relation to climate planning:

- Limited capacity to develop a plan
- Limited possibility to leverage action from the private sector
- Limited financial resources available to implement actions
- Reporting requirements perceived as too burdensome

Existing **opportunities** for:

- Creating economies of scale for the development of the action plan
- Implementing collective actions (e.g. supra-municipal public transport)

Joint SECAP approach

“Standard” vs. “joint” action plan

	“Standard” Action Plan	Joint Action Plan - Option 1	Joint Action Plan - Option 2
Emission reduction target	Individual	Individual	Shared
Emission inventory development	Individual	Individual	Shared
Action plan development	Individual	Shared	Shared
Action plan approval	The Municipal Council approves the plan	Each Municipal Council approves the joint plan	Each Municipal Council approves the joint plan
Action plan submission	Individual reporting	Individual reporting	Shared reporting

See also *Covenant of Mayors Office, 2023 . [Quick Reference Guide - Joint Sustainable Energy & Climate Action Plan](#) Guidebook Part 1 (2018).*

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External support: Covenant Territorial Coordinators

Raising awareness	Technical Support	Cooperative Mechanisms	Financial Support
• of politicians • of technical staff at municipal level • of citizens • of stakeholders in private sector	• Technical guidelines/tools • Data collection at local level (for mitigation) or spatial data at regional or local level (for adaptation) • Methodologies • Establishing dedicated offices/helpdesk/working groups	• Regular consultation • Stakeholders meeting • Cooperation agreements • Establishing steering committees or working groups • Promotion of collaborative platforms	• Incentives/subsidies/grants • Public-private partnerships • Crowdfunding • Others

In addition, coordinators may provide support to **tackle specific issues** such as energy poverty and/or to **monitor signatories' progress** towards their climate objectives.

Source: Covenant of Mayors Office, 2020 – "COVENANT COORDINATORS - Crucial contributors to the Covenant of Mayors success"

Thank you

Giulia.MELICA@ec.europa.eu

SECAP Monitoring Actions.
SECAP validation.

EU4ETTR - CAPACITY BUILDING FOR OBSERVER MUNICIPALITIES
SECAP REPORTING AND MONITORING ACTIONS
8 November 2023

Giulia Melica, Joint Research Centre

Outline

- Why is monitoring important?
- What should be monitored?
- When should monitoring happen?
- How should a SECAP be monitored?
- Second level validation of action plans

Why is monitoring important?

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10 key elements of a successful SECAP

1. Formal adoption of the plan by the municipal council	2. Definition of clear mitigation and adaptation target(s) / goal	3. Sound assessment of the local situation (based on the BEI and the RVA)	4. Comprehensive measures addressing the key sectors of activity
5. Strategies and actions until 2030 (or until the target year)	6. Mobilization of all municipal departments involved	7. Engagement of citizens and stakeholders	8. Identification of the key financing resources
	9. Monitoring and reporting	10. SECAP submission and filling the template	

Why is monitoring important?

To track progress towards the target(s)	• Assess the progress made in actions' implementation • Quantify the progress made in terms of GHG emission reduction
To inform citizens and stakeholders	• Keep them engaged and motivated • Engage new partners
To adjust planning	• Take advantage of new opportunities / **Re-set priorities** • Learn from experience / **What did not work?**
To showcase city's contribution to global initiatives	• Report on SECAP implementation in the context of GCoM, RtZ, RtR, etc.

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What should be monitored?

Pillar-specific indicators:

- Performance indicators
- Progress indicators

Budget spent

Possible changes to the general context

Mitigation pillar

Performance indicators (in relation to headline targets)	Progress indicators (some examples in relation to individual actions)
• GHG emissions (absolute or per capita) • Energy consumption (absolute or per capita) • Energy production from renewables • Quantity of waste generated and how/where it is treated	• m^2 of public buildings renovated • m^2 of residential buildings renovated • no. of refueling / recharging stations for alternative fuels • km of bicycle lanes • kW of PV installed • …

Other indicators are listed in ISO 37120:2018

European Commission

Adaptation pillar

Performance indicators (in relation to adaptation goals)	Progress indicators (some examples in relation to individual actions)
• Number of vulnerable population to climate hazards • Number of buildings damaged by climate hazards (i.e. river flooding, storms) • Economic loss of a sector due to the impact of climate hazards (i.e. to droughts, extreme heat) • Number of forest fires / hectares land burned	• Number of extra trees planted • m^2 of extra green roofs or façade gardens per citizen • m^2 softened surface for water infiltration • m^3 additional rainwater recuperation per citizen

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General context

Political context	Regulatory context	Financial opportunities
Technological opportunities	Level of support from the ground	Level of support from other governance levels

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Budget spent

Budget

Overall budget foreseen for plan implementation			Budget spent so far		
Total (€)	Mitigation (%)		Total (€)	Mitigation (%)	
0	Adaptation (%)		0	Adaptation (%)	

Budget period 2020 2030 10 year

It is also recommended to monitor the budget spent for individual actions.

My Actions Overview

Mitigation sectors	Number of actions included in the plan	Action plan implementation status				Estimates in 2020		
		Completed	On-going	Postponed	Not-started	Energy savings (MWh/a)	Renewable energy production (MWh/a)	CO2 reduction (t CO2/a)
		%	%	%	%	MWh/a	MWh/a	t CO2/a
Municipal buildings	6	50	33	0	17	27751	0	5660
Tertiary (non municipal) buildings, equipment/factilities	3	0	67	0	33	0	0	0
Residential buildings	8	50	25	0	25	369252	15	73613
Industry	0	0	0	0	0	0	0	0
Transport	28	43	25	0	32	206553	0	52786
Local Electricity Production	26	54	23	8	15	0	34283	16546
Local Heat/Cold Production	3	100	0	0	0	0	0	37725
Waste	0	0	0	0	0	0	0	0
Others	20	50	20	0	30	2530	0	19398
Total	94.00					606086.00	34298.00	205728.00

When should monitoring happen?

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Monitoring and reporting to GCoM

Monitoring element	Reporting to GCoM
GHG emissions inventory	Every four years a recent monitoring emission inventory shall be submitted
Progress toward commitments in the climate action plan(s)	Every two years
Status of the implementation of each action/action area/sector in the climate action plan(s)	Every two years
Cost of each action/action area/sector	Every two years
Required revisions of the climate action plan(s)	At the next reporting cycle

Monitoring and reporting to CoM Europe

- The SECAP process is a cycle
- Reporting on the implementation is required every 2 years from submission
- The SECAP can be adjusted based on the results of monitoring

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Monitoring process

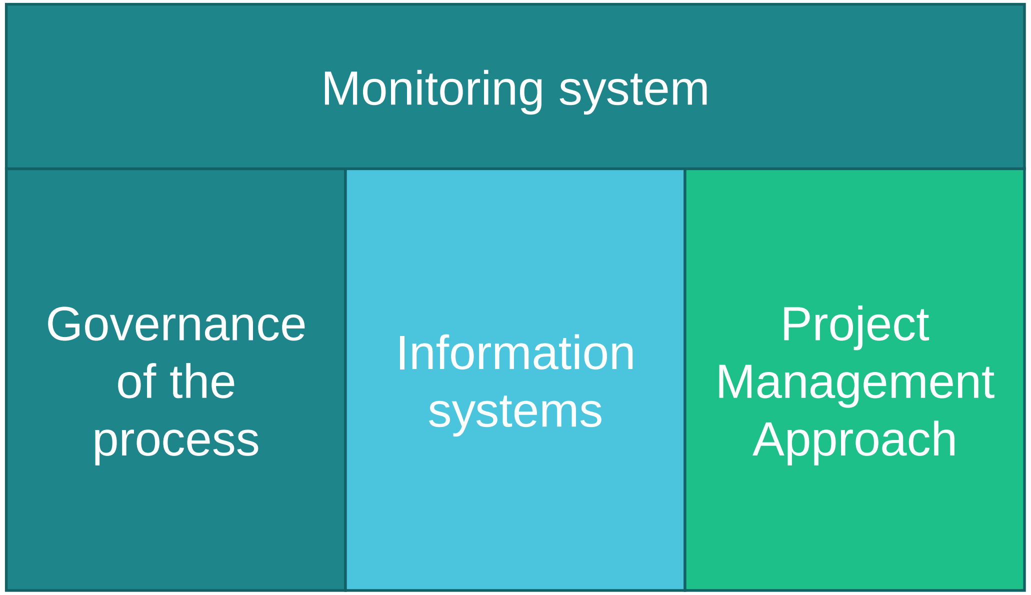
- Should be **designed** already **when developing the AP**.
- Should be intended as a **continuous process**, going hand-in-hand with the implementation of the SECAP.
- Should foresee some **milestones** (e.g. yearly progress reports).

Although the CoM requires reporting on SECAP implementation every two years, some cities have decided to report annually.

How should a SECAP be monitored?

Design the monitoring process

- Assign clear responsibilities (for overall coordination of the SECAP and for individual actions)
- Ensure good communication (internal and external)
- Network with other CoM signatories, to exchange experiences and best practices.
- Liaise with other levels of government who could provide support to the city



Main elements of the monitoring system – adapted from the SECAP of Genoa

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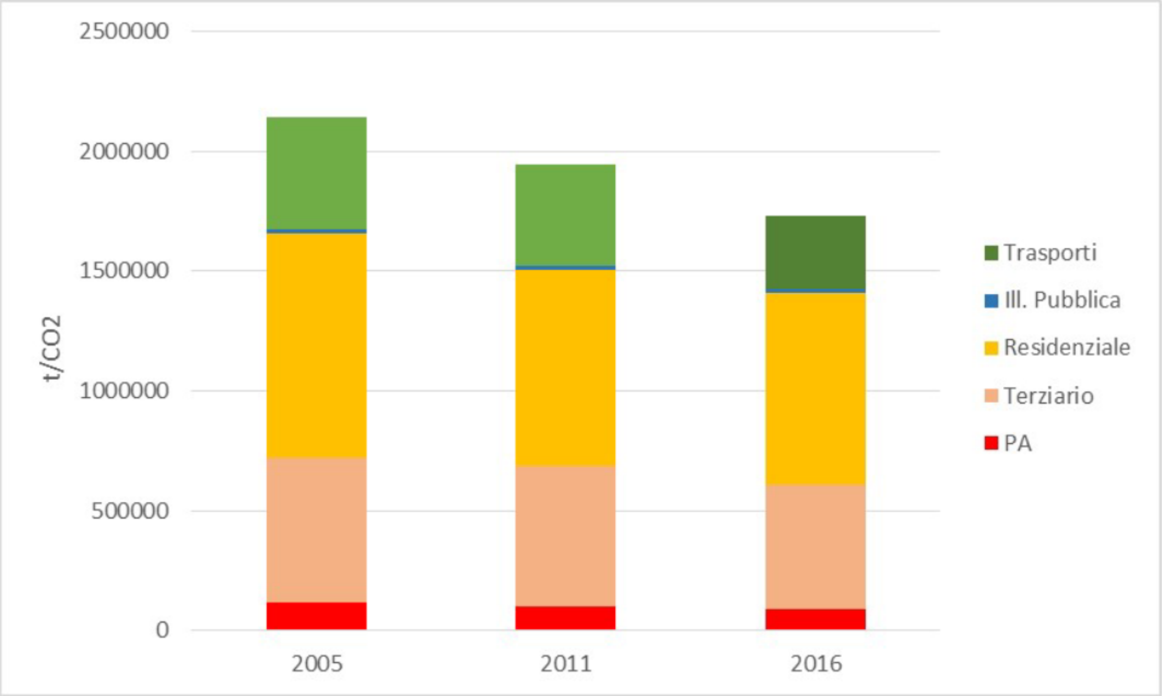
Communicating the results

Monitoring report

The local authority is encouraged to draft also a monitoring report (in national language) and have it approved by the Municipal Council to ensure transparency and accountability. This monitoring report could be used to reinforce communication towards citizens and stakeholders, keeping them informed on progress achieved, barriers encountered, opportunities, possible need for corrective measures, etc.



Emissions by sector - from the SECAP of Genoa

Second level validation of action plans

Why is CAP validation important?

- To **ensure the credibility** of the initiative:
  - Involving an independent body and experts on climate and energy planning
  - Ensuring the consistency of the methodology
  - Ensuring the quality of reported data
- To **improve the quality** of CAPs:
  - providing signatories with a set of suggestions / recommendations regarding potential improvements, hints and links to relevant information / best practices

CoM Europe | **CoM East** | **CoM MED** | **CoM SSA***

not mandatory

+ Indonesia, Malaysia, Vietnam, Thailand (via CDP-ICLEI track)
& cities from other countries (e.g. Türkiye) reporting through MyCovenant

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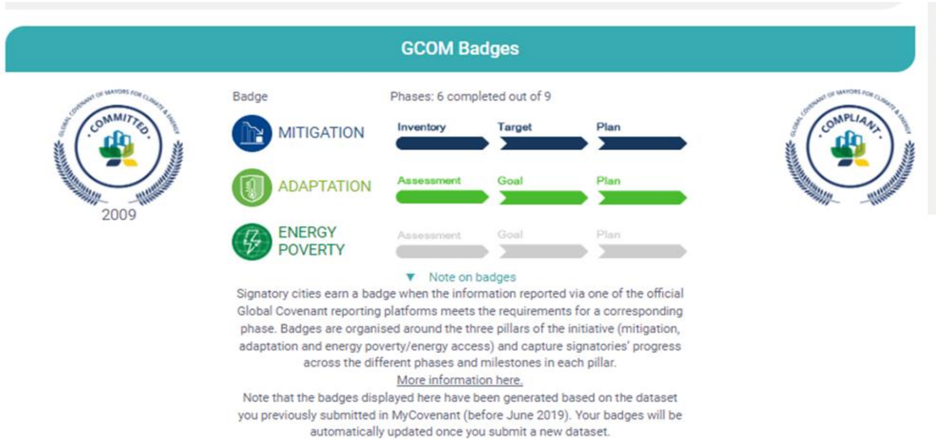
What is a 2^{nd} level validation step?

- A check on the compliance of action plans with some essential criteria based on the (regional) Covenant of Mayors formal commitments.
- An analysis in greater details of the content of the submitted template (i.e. data in MyCovenant) and documents (i.e. pdf of the action plans) on the basis of specific criteria

Two levels of validation:

- **1^{st} level validation:** validation conducted automatically by the platform checking mandatory information potentially awarding “badges” for data completeness
- **2nd level validation:** ‘manual’ or ‘semi-automated’ validation conducted by experts, checking mandatory and optional information, providing also recommendations for improving the action plans



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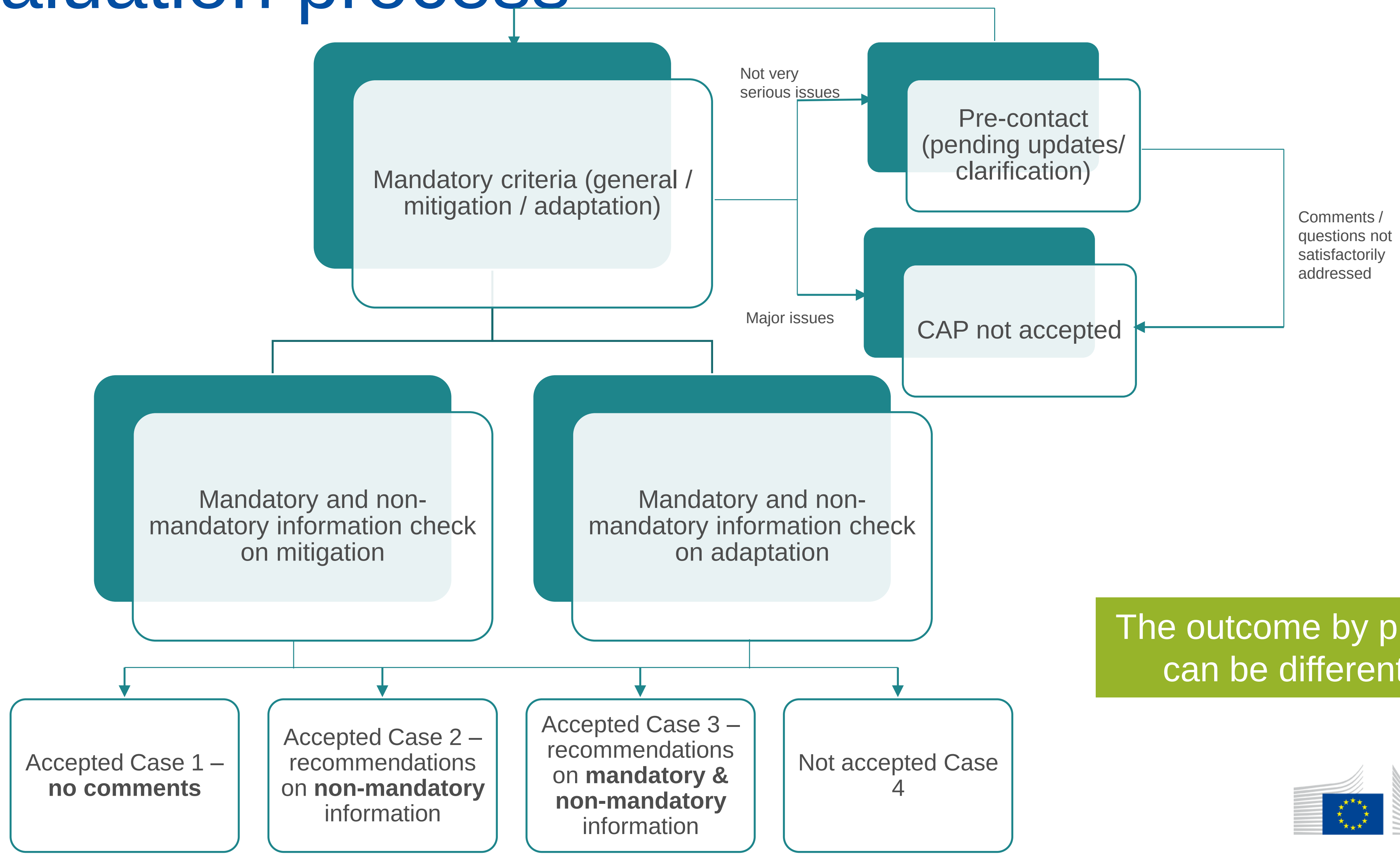
Evaluation process



The outcome by pillar can be different

Mandatory evaluation criteria

General criteria
- **1.**CAP approved by the city council
- **2.** Mandatory data and information on MyCovenant are complete and correctly filled-in

Mitigation criteria
- **3.**The CAP clearly states a GHG emission reduction target (in line with regional targets)
- **4.** The results of the Baseline Emission Inventory (BEI) are provided and cover the key sectors of activity
- **5.** The CAP lists a set of actions aimed at reaching the identified mitigation target in the mitigation key sectors, including at least 3 Key mitigation actions

Adaptation criteria
- **6.** The CAP includes at least one adaptation goal.
- **7.** The CAP includes a complete local Climate Risk & Vulnerability Assessment (RVA)
- **8.** The CAP lists a set of actions aimed at reaching the identified adaptation goal(s), including at least 3 Key adaptation actions

Only for CoM-SSA until 2022 - before the activation of EAPP

Energy access criteria
- **9.** Electricity: at least one indicator per each category, along with the general one
- **10.** Clean cooking: at least one indicator per each category, along with the general one
- **11.** Actions provided- key sectors covered- indicators affected indicated

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Criteria leading to recommendations – mitigation [1]

Item/principle checked	Potential problem
GHG reduction target	• The objective stated in the template is <> than the one in the document • The objective is mentioned, but not as a firm commitment
Baseline Emission Inventory: completeness	• No sectoral data (only sub-totals) • More than one sector missing or poorly covered • Partial data is given (e.g. only electricity in residential buildings) • Order of magnitude of energy consumption (and/or CO_2 emissions) per capita is within reasonable limits • Values exactly match the national averages (risk that they did not carry out a local inventory)
Baseline Emission Inventory: consistency with reference values	• Emission factors deviate from recommended values
Baseline Emission Inventory: methodology	• 20 MW limit check in local electricity production not applied • Biomass sustainability not considered • Local emission factors for electricity not calculated according to formula

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Criteria leading to recommendations – mitigation [2]

Item/principle checked	Potential problem
Comprehensive measures targeting main sectors	• One or more key mitigation sectors not covered by measures • Some measures target sectors not included in BEI • Some sectors are covered by non-relevant measures, poor (insufficient) measures or measures whose impact is doubtful • No estimated impacts (GHG emission reduction, energy saving/production) are reported • Measures are poorly described, information missing on responsible people, stakeholders involved, costs, financing sources • Measures are consistent with the guidebook (e.g. industry delocalization not used as a way to reduce emissions) • The sum of GHG emission reduction per sector does not match the target • One measure responsible for a very large share of emission reduction
Strategies and actions until 2030 or beyond	• Only short-term measures reported in the CAP

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Criteria leading to recommendations – adaptation [1]

Item/principle checked	Potential problem
Risk and vulnerability assessment	• No real RVA in the document, or it is based on national/regional info, without analysing local vulnerabilities or adding quantitative information • RVA confuses hazards with risks and/or impacts • RVA identify hazards that are not climate hazards (i.e. green loss, air pollution)
Adaptation goal	• Goal is generic/non-quantitative, it does not allow to track progress toward target • Goal is not linked to a climate hazard and/or a vulnerable sector or addressed hazards and sectors not identified in RVA. • Adaptation goal is the deployment of adaptation actions (only tracks the implementation of the actions)

Adaptation actions	• Actions are not coherent with RVA:
	    • they address hazards not identified in RVA while leaving high risk hazards unaddressed
	    • they cover sectors not identified as vulnerable in RVA while leaving high vulnerable sectors uncovered
	• Actions are not coherent with the adaptation goal (they are not designed to reach the goal and progress toward the target identified)
	• Actions are mainly mitigation actions with only a benefit for adaptation

Criteria leading to recommendations – adaptation [2]

Item/principle checked	Potential problem
Adaptation key actions	• Actions not coherent with RVA or goals • Actions are mainly mitigation actions, marginally tackling adaptation • Actions do not include information on the vulnerable population groups targeted by the action • Or they address vulnerable population groups not identified in RVA (while leaving vulnerable groups unaddressed) • Actions do not identify positive synergies with mitigation actions and/or energy poverty actions • Actions provide information internally not coherent (title, climate hazards addressed, sectors covered, origin and responsible body, short description, expected outcome, costs, etc.)

Additional “horizontal” criteria (not checked systematically)

Item/principle checked	Potential problem
Consistency between doc and reporting platform	• The data in the reporting platform do not reflect the content of the approved documents
Adaptation of city structures	• Not described • Poorly described • No adaptation or poor adaptation of city structures
Mobilisation of the civil society	• Not described • Poorly described • No involvement or poor involvement of the civil society
Financing	• Not described • Poorly described • No or insufficient financing sources
Monitoring and reporting	• Not described • Poor description of the monitoring provisions • No or poor monitoring provisions

Feedback to cities

The results of the 2^{nd}-level validation are compiled in a document, including:

- The final decision on the action plan acceptance/rejection (only in CoMs Europe, South and East)
- If relevant - an explanation of the reasons for rejection
- Very often – suggestions/recommendations for further improvement for accepted action plans

Grouped approach for SECAP validation (only CoM EU)

- It can be applied to plans developed with the support of a **'Covenant Territorial Coordinator' or a 'Covenant Supporter'**, in accordance with a common methodology and data sources.

- It consists of an **in-depth analysis of the common methodology and some representative plans**.

- Once the methodology and reference plans are analysed and accepted, all other plans <50,000 ab. under the same Covenant coordinator or supporter are accepted without further analysis by the JRC – provided they meet the mandatory criteria verified by the coordinator or supporter.

- More info: **Reference Guide on Group SECAPs Analysis** , CoM Europe - 2023

For more information

https://academy.europa.eu/courses/global-covenant-of-mayors-cities-taking-action-against-climate-change

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Thank you

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Adaptation goal and target: monitoring

- **RVA** High-Risk Hazard: ***Floods*** *(i.e. 5 impactful events in the last 5 years)*
- **RVA** High-Vulnerable Sector: ***Buildings*** *(i.e. 50 damaged buildings per year, 5 year average, 2022)*
- **Goal**: *"By 2030, limit to zero the impact of flood events on buildings"*
  => *monitor n. of damage buildings per year*

Goal	Target value	Target year	Base Year value	Base Year	Progress towards the target (% of progress at 1st monitoring)	Progress towards the target (2nd monitoring)
By 2030, reduce by 50% the impact of flood events on buildings (compared to 2022)	0	2030	50	2022	20%	50%

- *i.e. At first monitoring in 2024, the 5-year average of damaged buildings is 40 (20% progress), At second monitoring, in 2026, is 25 (50% progress)*

ACTIONS TO BE MONITORED

- **Action1**: *Climate-proofing exposed buildings (valves, pumps, ..) in area X*
  => *monitor n. of improved buildings*
- **Action2**: *Developing nature-based solutions on public space in area X*
  => *monitor square meters improved*
- **Action2**: *Developing campaigns on climate awareness and preparedness*
  => *monitor n. of citizens reached*

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Examples and good practices on SECAP reporting and monitoring

EU4ETTR - CAPACITY BUILDING FOR OBSERVER MUNICIPALITIES
SECAP REPORTING AND MONITORING ACTIONS
8 November 2023

Giulia Melica, Joint Research Centre

Common mistakes

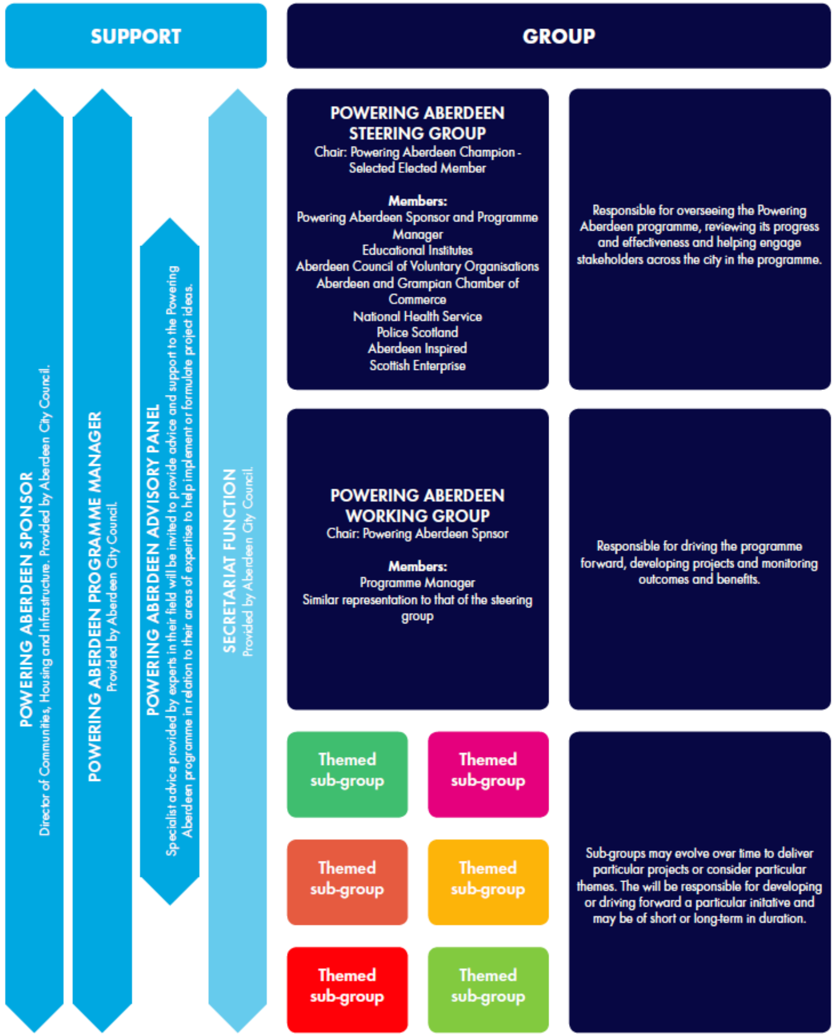
- Information populated in national language (required in English)
- Overall GHG emission reduction estimation by the target year insufficient to reach the declared target
- <3 key actions on adaptation
- Mandatory fields not properly filled in the key action form
- Incoherence between online template and officially approved document (e.g. emission inventory or RVA results, targets)
- No renewable energy production estimates, although relevant actions are reported
- Plan submitted as monitoring report

Good practices

- Template duly filled-in, including optional info
- Template does not list just 3 key actions on mitigation and adaptation, but includes all the actions of the SECAP
- The title of the action contains an alpha-numerical code, allowing us to easily verify the coherence between the template and the document.

PU08C "Cleaning of road drains and checking their proper sizing"	Adattamento	★	Ente locale	2020	2030	In corso
PU09C "rainwater recovery"	Adattamento	★	Ente locale	2020	2030	Non iniziata
PU10C "NON-structural mitigation intervention of hydrogeological risk"	Adattamento	★	Ente locale	2021	2030	Non iniziata
PU11C "structural mitigation interventions of hydrogeological risk"	Adattamento	☆	Ente locale	2020	2030	Non iniziata
RE02B - Promote New Buildings And Interventions With High Energy And Environmental Performance	Mitigazione	☆	Ente locale	2021	2024	In corso
RE03C Renewable energy purchasing groups	Mitigazione	☆	Ente locale	2022	2030	Non iniziata
SA01B "Creation of a municipal and territorial computerized database"	Mitigazione	☆	Ente locale	2022	2024	Non iniziata
SA02B "Energy training of municipal technicians	Mitigazione	☆	Ente locale	2021	2022	Non iniziata

Example from the SEAP of Aberdeen



"*Powering Aberdeen* will harness local knowledge to develop the action plan. Co-operative and community led projects will be supported to ensure that citizens have a greater role in their own environment, finances, health and wellbeing."

- Steering group (oversee the plan, review progress, engage stakeholders)
- Working group (drive the programme forward, monitor outcomes & benefits)
- Themed sub-groups
- Sponsor
- Programme manager
- Advisory panel
- Secretariat

("Powering Aberdeen", 2016)

European Commission

Monitoring individual actions: examples

<table>
<tr><td>
</td><td colspan="3">Acción 1: Adquisición de vehículos híbridos y eléctricos en el parque móvil municipal bajo criterios de viabilidad y rentabilidad.</td></tr>
<tr><td>DESCRIPCIÓN</td><td colspan="3">Se pretende la incorporación paulatina de motocicletas de policía por motocicletas eléctricas, y vehículos municipales por vehículos eléctricos/híbridos. Inicialmente se estimó la incorporación de 6 vehículos híbridos y 9 eléctricos. En una segunda fase se supone la introducción de 22 vehículos, 10 híbridos y 12 eléctricos puros.

En 2020, se dispone de 3 vehículos eléctricos, 6 vehículos híbridos, 2 vehículos eficientes GNC y 7 motocicletas eléctricas, formando, parte de la flota municipal:
• 2 vehículos eléctricos (Commarth , Cros Rider) – MA y vivienda
• 1 vehículo eléctrico (Sanyou) - Policía Local
• 6 vehículos híbridos (Toyota Prius) - Protocolo
• 2 vehículos GNC (Fiat Punto) - Transportes
• 6 motos eléctricas compartir funcionarios (V-MOTO/E-MAX - 120S)
• 1 moto eléctrica (Bultaco, Brinco RE) – Policía Local

En total para 2020: 10 vehículos eléctricos, 6 híbridos y 2 a GNC frente a los 10 vehículos híbridos y 12 eléctricos estimados, por lo que no se alcanza el objetivo.</td></tr>
<tr><td>GRADO DE EJECUCIÓN</td><td colspan="3">GRADO EJECUCIÓN (82%)
ESTA MEDIDA SE RETOMA EN EL HORIZONTE 2030</td></tr>
<tr><td>COSTE DE EJECUCIÓN</td><td colspan="3">880.000 €</td></tr>
<tr><td>FUENTES INFORMACIÓN</td><td colspan="3">Ayuntamiento de Murcia, Servicios Generales</td></tr>
<tr><td>Producción de energía renovable (MWh/a)</td><td>162</td><td>Reducción de CO_2
t CO_2/a</td><td>63</td></tr>
</table>

- Expected implementation timeframe
- Target to be reached
- Description of the state of play
- Progress made towards the target
- Allocated budget
- Proposal for corrective actions (if any)

What are the main challenges you encountered in SECAP reporting / monitoring?

Is there any good practice you would like to share?

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Thank you

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