


The Decarbonized and Low-emission Zone Cookbook

How to design, implement and monitor DLEZ
Guidelines for cities and experts

The ClimAct CEE Consortium

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Welcome to ClimAct CEE!

The EU's target of 40% GHG reduction by 2030 was considered soft and insufficient to achieve the ambitious policy goals for the MS; and so, the Fit for 55 package introduced a stronger target of 55% reduction of the GHG emissions. However, a major obstacle to boosting the implementation of the climate policies in the CEE still stays – the tangible results of energy and climate interventions take time and persistence to achieve and showcase. The EU's plans for a carbon neutral economy by 2050 are so far-reaching that they may not be achieved in the CEE unless there is a steady momentum of decisive and well-concerted climate policies and actions.

In the CEE, national authorities are trying to set-up policy frameworks to cut down the polluting emissions – i.e. through tax incentives for e-vehicles, grants for deep renovation and RES deployment in the residential sector. The CEE cities are also pledging their allegiance to tackling the climate challenges by participating in platforms such as the Covenant of Mayors for Energy and Climate and the Smart Cities Marketplace. Nonetheless, the expected climate uptake does not seem that vigorous.
The ClimAct CEE recognises that more nuanced policies and actions at local and regional levels are needed to tackle the climate challenges and support the CEE in achieving the long-term EU policies, especially in the light of the Fit for 55 and Green Deal packages.

The ClimAct CEE will demonstrate the strength of integrated, evidence-based climate policies through transforming pilot urban zones in Bulgaria, Croatia and Romania, into energy-wise, climate-friendly and clean air spaces for the citizens to live and enjoy. The project proposes a climate screening framework converging energy, climate and air quality policies based on the Sustainable Energy and Climate Action Plans (SECAPs) and Air Quality Inventories that will provide the cities with a guided tool to design and implement decarbonised and low-emission city zones, i.e. climate neutral zones, that will showcase and ensure that integrated policies may be a game-changer in fighting the climate challenges we all face. The application of the framework in three pilot cities in Eastern Europe will trigger their decarbonised and low-emission urban transformation. The resulting climate neutral zones will be scaled-up and replicated as flagships of the sustainable, climate-resilient and energy-independent future of all European cities.

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How the DLEZ Cookbook will help you to fight climate change

The present guidelines seeks to inspire and assist you, as a local planner, in setting up climate-neutral zones based on Sustainable Energy and Climate Action Plans (SECAPs) and Air Quality Inventories. In doing so, various methods and tools to define the scope, set targets and develop inventories for Decarbonized Low-Emission Zones (DLEZ) are proposed and outlined. The guidelines introduce planners to data collection methods for buildings, mobility, and renewable energy deployment. Local authorities can use it to diagnose and define zones aligned with national green policies, serving as test beds for energy and climate policies. The ultimate goal is to equip local planners with the necessary expertise and tools to support scaling up climate measures on a city level and implementing actions for local communities' decarbonized transition.

Air Pollution & Climate Change: A Dual Challenge

Air pollution is still one of the main environmental threats to human health causing at least 238,000 premature deaths[1] per year in Europe. Air pollution is associated with a wide range of health problems including asthma and other respiratory diseases. Central sources of particulate matter, nitrogen dioxide and ozone and other pollutions are combustion engines, wood-burning appliances and large power plants. In addition to the negative effects of air pollutants on human health, combustion processes are also a main source of carbon emissions contributing to climate change.

[1] https://www.eea.europa.eu/en/newsroom/news/premature-deaths-due-air-pollution

Towards a feasible solution

Cities are gaining in importance in the area of climate protection, and more and more are setting themselves the goal of becoming climate-neutral. If the EU and cities strive to achieve the goal of climate-neutrality, the transition to decarbonization and low-emission development will be essential. On one hand, there are initiatives such as the Covenant of Mayors for Climate and Energy that provide opportunities for the cities to pledge their allegiance to the decarbonization targets, and on the other there are EU policies that recognize air pollution as main challenge and require cities' involvement in its resolution. These initiatives define the challenge and address it through various approaches and measures, but do not do it in an integrated manner.

The aim of ClimAct CEE is to integrate the targets and limit values for both GHG emissions and air pollutants in a cohesive manner ensuring that both types of emissions are addressed through integrated policies. It proves that the integrated measures and actions target them both, effectively reducing their levels and harness even greater co-benefits.

What is a Decarbonized Low-Emission Zone?

The concept of “Low-Emission-Zone” (LEZ) originated as a tool to tackle air pollution by restricting the access of polluting vehicles in designated Areas. The related concept of “zero emission zone” (ZEZ) also refers to the transport sector and is implemented by removing the traffic or banning the vehicles with internal combustion engine (petrol, diesel, gas). Both terms LEZ and ZEZ cover only specific aspects of the air pollution – i.e. most notably nitrogen oxides whose main contributor is the road transport. However, beyond the transport sector, the predominant source of health and climate damaging emissions – i.e. fine particles (PM2.5), black carbon (BC) and benzo(a)pyrene (BaP) stems from domestic heating through solid fuel burning.

Research both on GHG emissions and air pollutants show that introducing measures to mitigate either of them also contributes to the mitigation of the other. In most cases, the actions and policies introduced by the local or national authorities are related either to one or the other without accounting the multiple benefits of both.

In order to combine the scope of Air Pollution and GHG Emissions, we propose the Concept of Decarbonized Low-Emission-Zones (DLEZ). In view of the EU-Wide target of 55% of GHG Emissions by 2030, ClimAct CEE sets the following criteria for DLEZ:

A decarbonized and low-emission urban zone (DLEZ) may be considered a segregated urban area in which:

- *the total CO2 emissions are less than 55% of their levels in chosen baseline year,*
- *the limit values of the revised Ambient Air Quality Directive set for 2030 onwards are met (medium- and long-term target: compliance with WHO air quality guidelines),*
- *where DLEZ are implemented before 2030, the less stringent currently applicable limit values can serve as a starting point for a transitional regime. If this is the case, communication should focus on the temporary nature of the criteria in order to steer investment decisions and ensure plannability for all concerned parties.*

How to set up a DLEZ in Practice: A Structured Approach

ClimAct CEE proposes a step-by-step methodology to facilitate the DLEZ implementation. Following these steps will help planners to strategically pursue the development, implementation and review of DLEZ in a cost-effective manner to achieve meaningful decarbonization and improvements of air quality.

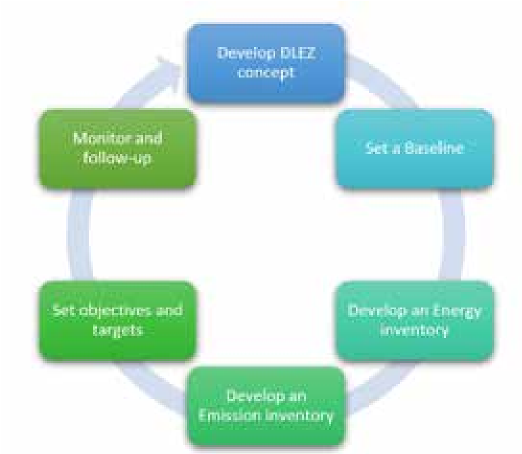


Fig. 1 The ClimAct CEE approach in DLEZ definition

The initiation phase sets out the DLEZ concept embedded in the broader urban development, which may be formulated jointly with various stakeholders. Then, a baseline needs to be defined in terms of time period, building and transport options considered, scope of energy carriers and emissions to be estimated, and monitoring mechanisms. The baseline is established through converging methodologies described in this document. The development of energy balance, emission profile and future pipeline for DLEZ transformation are also explained. Based on the baseline information and inventories, specific quantifiable targets are set for reduction of the CO2 emissions and air pollutants. Finally, monitoring mechanisms are presented to follow-up on the progress for achieving DLEZ. They are focused on reporting intermediate emission values and providing a check whether reductions are in line with the targets set.

Develop a Concept for Decarbonised Low-emission Zone

The **DLEZ concept should be defined as a 'vision'** for establishing the zone and its integration in other strategic policies and actions on city level. The definition of a potential DLEZ should be elaborated in a process consisting of consultations and expert assessments of the policy background and readiness of potential urban areas. The DLEZ is considered not just a mixture of buildings and facilities to be brought to a low-emission level, but also as a demonstration and pilot site to be embedded in the broader urban vision and strategy for decarbonization and low-emission development.

The following steps should be considered by local planners when preparing a concept for the DLEZ:

- **Consider the scope of the DLEZ.** The scope can be defined considering territorial, social, energy and climate aspects.

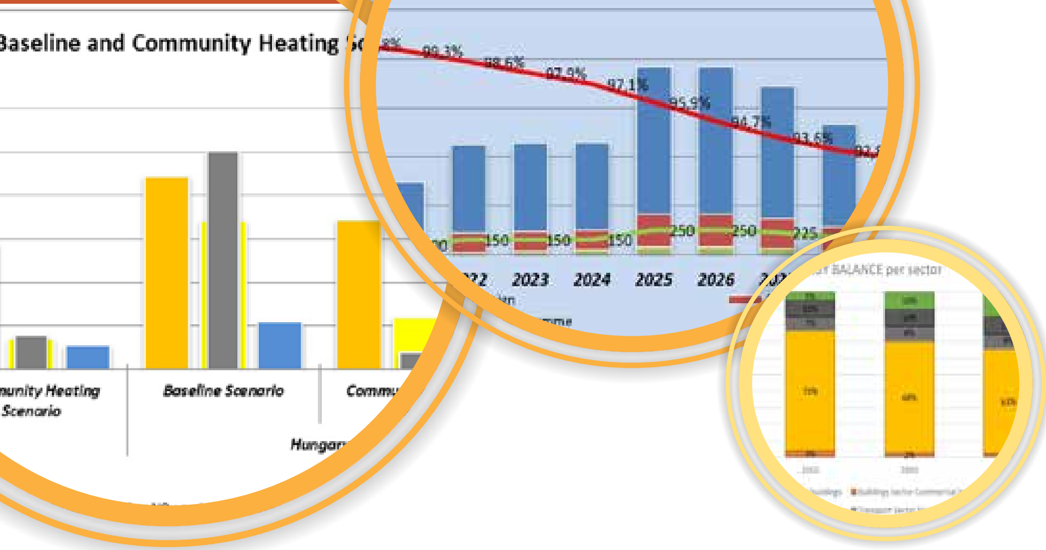
- **Gather information and data.** Common barriers such as insufficient data, market-sensitive or protected data etc. should be considered from the onset to avoid pitfalls.

- When gathering information and data, **combine bottom-up** (e.g. questionnaires, focus groups with targeted audience) **as well as top-down approaches** (e.g. national or regional statistics). Both quantitative and qualitative data should be gathered to inform the decision-making process.

- Assess how a DLEZ would be positioned within **broader strategic planning processes**.

- Arrange **meetings with experts and citizens.** Engage stakeholders and the community in the planning process.

Once the concept has been set up, a baseline needs to be identified and the corresponding inventories developed.



Define
Energy and Emission Baselines

The **DLEZ baseline is a fixed point back in time that serves as a reference value** through which the change is defined. Setting up a baseline for the current status is an important step of the process that will support the future monitoring of the progress. Choosing a baseline year is more or less a subjective process that is based on one's own demands for future energy and climate planning. However, it is good to note that aligning the baseline year with other significant baselines may be extremely beneficial to applying integrated policies.

The ClimAct CEE methodology for calculation of the baseline inventories considers public and private buildings and all transport options and their energy flows in a single baseline year. For the purpose, a dedicated set of tools is available which can be employed to establish a DLEZ baseline inventory. It covers the buildings and facilities and transport modes in the concerned area and all energy carriers associated with the energy consumption as well as energy production that may be attributed directly to them.

To set up emission profiles in the DLEZ, the inventory should be calculated based on specific CO2 and air pollution emission factors from the EU guidelines and national legislation. There are no specific values on the energy consumption or production for the DLEZ to achieve, but only specific targets for the emission limits. However, given that the emissions are a derivative of the energy consumption and production, the two are inextricably linked. So, the replacement of energy carriers that are potentially polluting with RES alternatives will support both the energy independence and low-emission impact on the surrounding community.

The general DLEZ concept suggests that all energy sources are converted to renewable generation that may be self-consumed or prosumed. This concept faces a challenge when a centralised energy source is in place – as the DLEZ geographical scope only covers a part of the city, its supporting energy infrastructure cannot be left unaccounted for. However, its energy source can only be converted on a central basis which requires significant efforts for the local authorities and may affect other stakeholders. There are cases when it is possible and reasonable to convert from centralised to decentralised heating source.

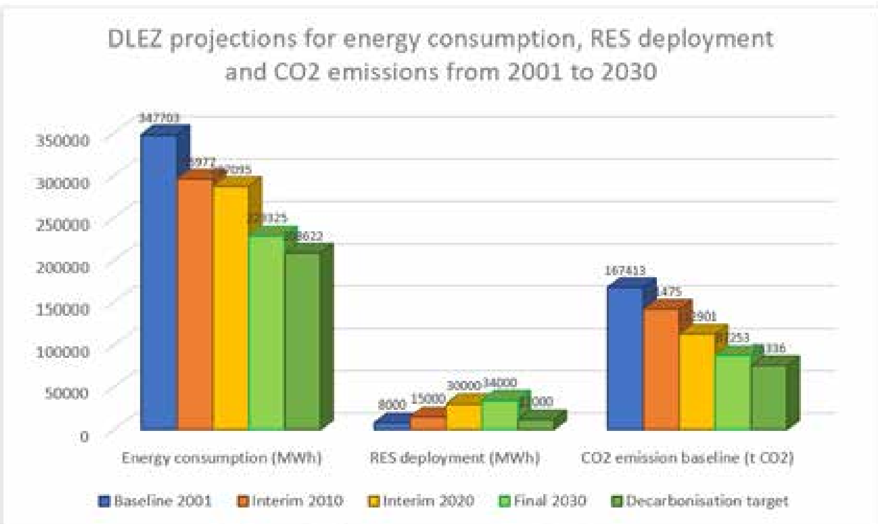


Fig. 2 An example of DLEZ Implementation pipeline

Develop an Energy Inventory

The **development of an energy inventory** is a two-fold process:

- Define the scope and boundaries of the DLEZ
- Define a top-down or bottom-up approach to the inventory

The boundaries of the DLEZ are the geographical limits to which the zone extends along with all buildings, urban and road infrastructure that need to be taken into consideration when preparing the inventory. The zone may be defined based on the pollution levels detected through measurements, for example – crossroads with heavy traffics or residential areas with fossil fuel burning – or based on other strategic targets of the local authorities – for example, major building renovation plans, revitalization actions, etc. Overall, the definition of the DLEZ should be a pragmatic process that is well-integrated in other plans of the local authorities for urban development and revitalisation.

The approach towards the development of the inventory for the zone depends highly on the quality and quantity of the data needed. Top-down or bottom-up approaches as well as a mix of the two may be considered.

A top-down approach is suitable when general statistics for the zone are available and may be considered reliable. The bottom-up approach is preferred when it comes to specific territories and facilities to be addressed, so the data will come from each and every building and facility in the zone. The data gathering may be conducted as live or online surveys and interviews with the building owners and/or managers involved or it may be acquired through the energy providers for each point of interest. It is more difficult to apply this approach to the transport sector where the mobility flows are not static to the zone but dynamic and may change rapidly throughout the day.

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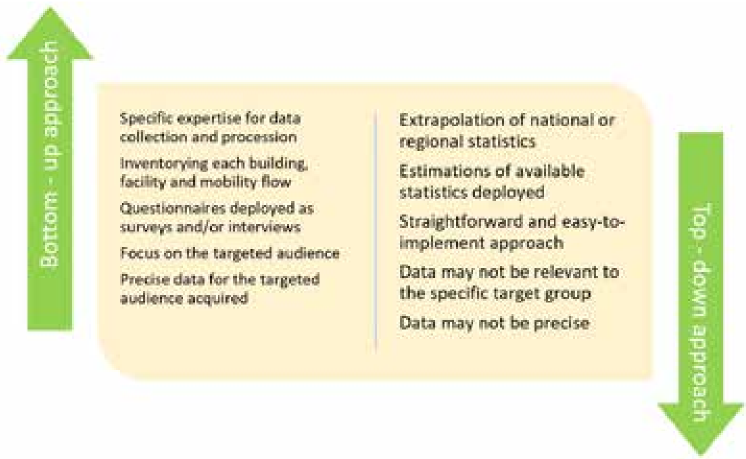

Fig. 3 Top-down vs bottom up approach

Energy Inventory for Public and Private Buildings

As a first step in making an inventory of the building sector, one needs to identify the buildings to be covered, i.e. some of the buildings on site may not be in the scope of the study and thus will be left out of the inventory. Second, there needs to be identification of the energy sources and carriers and their delivery points - i.e. electricity, district heating, natural gas, heating oil, firewood, coal, etc. Third, for each building and its energy carriers, one needs to identify the quantities of fuels used. Usually, they are recorded through metering and invoices/bills – a conversion from their natural units to energy units is thus neccessary. Fourth, there needs to be an inventory calculation sheet - the ClimAct CEE project suggests such. Based on the inventory, the energy balance of the energy sector may be established.

Energy Inventory for Transport and Mobility sector

The transport sector is a key one when it comes to determining the levels of emissions within a city. The main challenge related to its inventory is that unlike other sectors, its sources are not stationary but mobile ones, i.e. move in and around the area. Figuring out these patters often requires detailed traffic studies. Also, the data and statistics on the fuel used, the kilometers travelled, occupancy levels, etc. are not directly accessible in the public domain, but require additional estimations and calculations.

Data sources and data collection methodologies

Data collection related to transport sector depends on the type of transport infrastructure in place. The most direct data sources are traffic studies often used in Sustainable Urban Mobility Plans (SUMPs) and various means for counting traffic- i.e. traffic cameras, public surveillance, speed cameras, road tolling infrastructure.

Energy sources and carriers

Most energy sources considered for the transport sector are currently fossil fuels and electricity. The fossil fuels are mostly used in commercial and private transport with diesel being the main fuel used for trains, cargo trucks/boats and commercial road transport, followed by gasoline for private transport of individuals and electricity being used for railways and its private road transport.

Energy Inventory for Renewables sector

Renewable energy sources (RES) are sources of energy that are replenished naturally and continuously, such as solar, wind, hydro, geothermal, biomass, and biogas. Unlike fossil fuels, which are finite and non-renewable, RES are sustainable and have minimal impact on the environment. RES can be used for various applications, including electricity generation, heating and cooling, transportation, and industrial processes.

Data sources and data collection approaches

Some of proposed data sources and data collection methodologies for RES may include: individual metering of installations, estimated production through modelling and simulations, reported production to utilities, market operators, Transmission or Distribution System Operators, energy certificates of buildings, surveys and interviews with building or facility owners. By using a combination of these approaches, a more accurate account of the RES deployed can be obtained.

Develop an Emissions Inventory

When making an inventory of the building, transport or RES sector to replace old facilities or technologies with alternatives, we need to consider the emission factors of the old and new technologies for all types of emissions. This section explains how to choose an approach and summarises the necessary activity data and emission factors needed for assessing the GHG emissions and air pollution emissions.

GHG Emissions

The most common and reliable approach to inventorise the GHG emissions is based on the principles of the Intergovernmental Panel on Climate Change (IPCC) or the Life-Cycle Analysis (LCA) approach. In general, emissions of each greenhouse gas from various sources are calculated by multiplying fuel consumption by the corresponding emission factor. Good practice is to use the most disaggregated, technology-specific and country-specific emission factors available, particularly those derived from direct measurements at the different stationary combustion sources.

Stationary sources / Building sector

The activity data for the stationary sources in the public and residential sectors for all tiers are the amounts and types of fuel combusted. Most fuels consumers (enterprises, small commercial consumers, or households) normally pay for the solid, liquid and gaseous fuels they consume. Therefore, the masses or volumes of fuels they consume are measured or metered.

Methods

The IPCC guidelines provide methods and data necessary for sectorial approach to estimate the emissions. The activity data for stationary sources in the public and residential sectors across all tiers are the amounts and types of fuel combusted. There are three tiers: the Tier 1 requires the least data and so presents the most straightforward calculation method; however, it also remains the least accurate one. The Tier 2 and Tier 3 approaches require more detailed data and resources (time, expertise and country-specific data) to produce an estimate of emissions. Due to the detailed data invested in the estimation, they are far more accurate than that in Tier 1.

Choice of emission factors

The CO2 emission factors for all Tiers reflect the full carbon content of the fuel less any non-oxidised fraction of carbon retained in the ash, particulates or soot. Since this fraction is usually small, the Tier 1 default emission factors neglect this effect by assuming a complete oxidation of the carbon contained in the fuel (carbon oxidation factor equal to 1).

The Tier 1 approach is preferred and embedded in the ClimAct tools for most energy carriers. However, it is also possible to apply Tier 2 approach which will make the estimations more accurate.

Mobile sources / Transport sector

Mobile sources refer to vehicles in the transport sector, i.e. road, off-road, air, railways, and water-borne navigation. They produce direct greenhouse gas emissions of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) from the combustion of various fuel types, as well as several other pollutants such as carbon monoxide (CO), Non-methane Volatile Organic Compounds (NMVOCs), sulphur dioxide (SO2), particulate matter (PM) and oxides of nitrate (NOx), which also cause or contribute to local or regional air pollution.

The CO2 emissions are best calculated on the basis of the amount and type of fuel combusted by the vehicles and their carbon content. The amount is based on the vehicle kilometres which are notoriously difficult to capture for private transport. In the cases of DLEZ, this task becomes even more difficult due to the fact that the DLEZ covers only a limited area through which the vehicles pass and it is usually not the case that they are counted or their movement monitored.

Methods

The Tier 1 method calculates CO2 emissions by multiplying estimated fuel sold with a default CO2 emission factor. The CO2 emission factor takes account of all the carbon in the fuel including that emitted as CO2, CH4, CO, NMVOC and particulate matter. The Tier 2 approach is the same as Tier 1 except that country-specific carbon contents of the fuel sold in road transport are used.

Choice of emission factors

The CO_2 emission factors are based on the carbon content of the fuel and should represent 100 percent oxidation of the fuel carbon. It is good practice to follow this approach using country-specific net-calorific values and CO_2 emission factor data, if possible.

In Tier 1 approach, the emission factors should assume that 100 percent of the carbon present in fuel is oxidized during or immediately following the combustion process (for all fuel types in all vehicles) irrespective of whether the CO_2 has been emitted as CO_2, CH_4, CO or NMVOC or as particulate matter. At higher tiers, the CO_2 emission factors may be adjusted to take account of un-oxidised carbon or carbon emitted as a non-CO_2 gas.

The Tier 1 approach is preferred and embedded in the ClimAct tools for the fuels used in transport. The full guidance on the calculation of the GHG emissions may be found in the "IPCC Guidelines for National Greenhouse Gas Inventories".

Air Pollution Emissions

The air pollution emissions and the approaches to their estimation are best defined in the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA) air pollutant emission inventory guidebook (ed. 2019). It provides procedures on how to compile emission inventories that meet quality criteria for transparency, consistency, completeness, comparability and accuracy, and also estimation methods and emission factors at various levels of sophistication.

Stationary sources / Building sector

The pollutants that are of particular interest when it comes to the building sector, because of their impact on health and environment, are particulate matter (PM10, PM2.5, ultrafine particles), black carbon (BC), nitrogen oxides (NOx), sulphur oxides (SOx), Non-methane Volatile Organic Compounds (NMVOC) and often Polycyclic aromatic Hydrocarbon (PaH) and carbon monoxide (CO). They come from fuels such as natural gas, heating/liquid oil, biomass, burned in small combustion installations. For solid fuels, generally the emissions due to incomplete combustion are many times greater in small appliances than in bigger plants.

Methods

Usually, the Tier 1 approach is applied in the absence of the data and information needed for Tier 2. Also, it is unlikely that a facility-specific approach (Tier 3) could be adopted because detailed information on individual installations may not be available. However, if possible, the Tier 2 approach is encouraged to be used - it uses more detailed information on the fuel, technology and country-specific features.

The inventory considers the number and type of installations in operation rather than the cumulative energy consumption. The calculation of air pollutants for the buildings relies on information for the volumes of natural gas, liquid gas, biomass (firewood, pellets, etc.) burned in each specific device; in the cases of the same type of devices, their aggregate consumption may be used. For some energy carriers such as wood, estimations may be difficult as this consumption data is difficult to capture – the best way possible is through survey among the households.

Mobile sources / Transport sector

Exhaust emissions from road transport arise from the combustion of fuels such as petrol, diesel, liquefied petroleum gas (LPG), and natural gas in internal combustion engines. The air pollutants emitted from the vehicles are ozone precursors (CO, NOx, NMVOCs), greenhouse gases (CO2, CH4, N2O), acidifying substances (NH3, SO2), particulate matter mass (PM) including black carbon (BC) and organic carbon (OC), carcinogenic species (PAHs and POPs), toxic substances (dioxins and furans), and heavy metals. Most important of these are the nitrogen oxides for which breaches of the value limits are often observed.

Methods

The Tier 1 uses fuel as the activity indicator in combination with average fuel-specific emission factors. As the road transport is a key category, the Tier 1 method should only be used in the absence of any detailed information. Tier 2 considers the fuel used by different vehicle categories and their emission standards. In Tier 3, exhaust emissions are calculated using a combination of technical data and activity data and the emission factors vary (driving situations, climatic conditions).

The full guidance on the calculation of the air pollutants may be found in the "EMEP/EEA air pollution inventory guidebook (2019)".

Set Objectives & Targets

Based on the investigation of the initial baseline inventories in the DLEZ and its supporting vision for city development, targets are to be set for emission reduction, energy consumption reduction and increase in the RES deployment. These could vary based on the intentions of the local authorities to develop, replicate and up-scale the DLEZ across the city.

The joint investigation of GHG and air pollution emissions requires two different targets to be set – reduction of the GHG emissions and reduction in the air pollution imissions. The targets may be articulated through the EU-wide requirements for decarbonisation and clean air, i.e. at least 55% reduction of the CO_2 emissions by 2030 and reducing the concentration and number of annual exceedances of the air pollutants to the limit values. In the case of air pollution, air pollution modelling is needed; however, if there is no possibility of doing it, then it may be assumed that the percentage reduction of imissions will be the same as of the one for emissions.

When defining the objectives, one can deploy SMART objective approach to better illustrate the intended changes:

- **Specific**: concise and detailed, narrowed down to a concrete topics,
- **Measurable:** providing units to quantify the progress,
- **Attainable**: achievable and feasible actions,
- **Realistic**: aligned with the available resources,
- **Time-bound**: specific time frame for achieving the desires results.

Monitor and Follow-Up

The implementation of the DLEZ may become a success if the process is properly monitored with suitable monitoring schemes and key performance indicators.

An effective monitoring scheme includes a variety of tools to follow-up on the activities implemented in the DLEZ. It utilises both qualitative and quantitative data gathered based on the inventories prepared. For the GHG emissions, calculation methodologies may again be applied, but for the air pollution real-life measurements are better suited for monitoring. It requires careful planning of the type and format of the data needed – it should be the same as the baseline data so that compatility and comparability is ensured. Usually, specific permissions need to be obtained from the data gathering institutions.

To acquire measurable and comparable results, it may be neccessary to set key performance indicators and milestones. The indicators are the measurable aspect of the monitoring scheme. For each measure and action implemented in the DLEZ, indicators need to be allocated. The indicators need to be quantifiable – they need to be expressed in numbers or percentages so that objective data on the progress can be monitored. All of them may be placed at various time-points during the DLEZ implementation so that various aspects of it are monitored. Data needs to be precisely collected and placed in the inventory records for further investigation and procession. The milestones are important "stops" in the design of the DLEZ as they mark the critical points of the overall implementation, especially when it is needed to manage numerous activities.

Decarbonised and Low-emission Zones in Action

Inspiration from the pilots

DLEZ in Plovdiv (Bulgaria)

The City of Plovdiv is the second largest city in Bulgaria, with over 150 000 dwellings in 19 000 residential buildings. Plovdiv developed as an industrial centre, but today it is a three-sector city - a business, cultural and historical site. Its economy is growing an average GDP growth of over 13%. It enjoys a constant flow of investments and intensive stakeholder interest.

The demonstration pilot in the city of Plovdiv – the residential neighbourhood Trakia - focuses on a designated urban area with a high demand for energy renovation actions in the public and private sector. It is one of the largest neighbourhoods in the city designed in 1968 and built mostly between 1973-1976 making its building stock old and inefficient. Its 60 000 inhabitants live in approximately 260 large multi-family panel-built residential buildings.

Photo 1 Trakia Neighbourhood (Source: https://trakia-plovdiv.bg)

The residential neighbourhood of Trakia faces major challenges in the residential sector – the old multi-family panel buildings are in need of renovation and heating refurbishment. It is comprised privately-owned multi-family residential buildings – the older buildings being panel-based and the new ones brick-based. The high percentage of co-ownership, their vast surface area, as well as legal, administrative and technical barriers have hindered their energy renovation throughout the years and so the aging residential building stock has become a major contributor to the high final energy consumption and CO2 and air pollutant emissions in the neighbourhood.

The pilot has been chosen as a potential DLEZ as it is a densely populated and primarily residential area. The residential renovation will contribute to improving its energy efficiency status; also, potential for community-based RES capacity may be explored further. These will significantly affect its decarbonisation and will contribute to reducing the air pollution.

The investigation of DLEZ establishment contributes to the overall plans for revitalisation of the neighbourhood. It also gives evidence for the impacts of energy efficiency and RES actions on the pilot development which may further provide rationale for prioritising funding for renovation in this area.

The proposed pilot actions on renovating the residential building stock, refurbishment of the heating systems, increased RES deployment through the available state funding programmes along with the suggested set of policies on improved local governance and leadership will:

- Mitigate fully air pollution emissions related to PM10;
- Reduce the NOx emissions by 10%;
- Increase the energy efficiency by 15%;
- Increase the RES share twice;
- Achieve reduction of the CO_2 emissions by 32%.

Challenges & Potential pitfalls

Developing a climate neutral framework that is applicable across diverse zones and urban scapes is a challenge due to their specificities. So, it is difficult to find a common approach for the energy and emission inventory and to collect segregated data for them. It requires in-depth knowledge and research over the datasets and their specific features when needed for various applications.

Lessons learned

It is difficult to design and implement policies for a segregated urban area. In many cases, this may lead to public disagreement especially when banning specific energy sources or vehicles is considered or piloted. The introduction of DLEZ may not be widely supported by the public and so it requires strong political will and a balanced approach.

DLEZ in Alba Iulia (Romania)

Alba Iulia, having a high historical significance, is a mixed profile but predominantly touristic city with a population of 74.490 on an area of 103,65 km2. It is situated in the Central part of Alba County which lies also in the middle of Romania, in the Transylvanian Region.

Photo 2 GIS planning of the DLEZ in Alba Iulia

The selected area for DLEZ aims to encompass multiple sectors, including municipal, residential, and tertiary, fostering trans-sectoral approaches and sector coupling for efficient decarbonization strategies. It intersects at least one transit road that is a main source of traffic emissions. Additionally, the area has already some RES installations on the buildings. The municipality is engaged in at least one major infrastructure project intersecting the area reflecting broader urban developments within the municipality.

The selected area demonstrates potential for improvement in decarbonization efforts, particularly in enhancing the ratio of fossil to green energy consumption, especially within the building sector. The DLEZ approach ensures that the chosen location aligns with the overarching goals of sustainable urban development and emissions reduction in the city.

The residential buildings sector in the area is comprised of 13 housing blocks and 5 standalone houses. Although two of the building blocks have office spaces on the ground floors, they are considered part of the residential sector due to their primarily residential nature. The estimated population in the area constitutes 3.1% of the municipal population. This figure includes temporary users from municipal buildings, such as elementary school, high school and dormitory facilities. The area encompasses a total of 7 municipal buildings and 3 tertiary buildings, primarily hosting office spaces. The area includes a range of essential facilities, including waste collection, water and wastewater collection, public lighting along all public roads and municipal building spaces. Moreover, there are a total of 286 parking spaces.

The DLEZ area features dedicated bike lanes and bus lanes integrated into the DN1 transit road, enhancing accessibility and promoting eco-friendly modes of transportation. There is no district heating grid in operation and no public charging stations for electric vehicles in the area.

Challenges & Potential pitfalls

- Lack of available energy related data: traffic related consumptions, energy consumptions in the residential sector, etc.
- Lack of air quality monitoring: there is no reliable data as there are few functioning monitoring stations in the city,
- Local authorities or even regional authorities have no responsibility in air quality monitoring,
- Lack of best practice cases in Romania.

Lessons learned

- It is difficult to design and implement policies for a small urban area.
- Citizens' opposition to restrictive measures related to traffic or residential consumption is hard to counteract and this needs long-term and consistent communication and awareness raising activities.
- The introduction of DLEZ may not be widely supported by the public and so it needs strong political will.
- Currently, the DLEZ is only viewed as having connection to the traffic pollution and the building sector is not well-accounted for.

DLEZ in Karlovac (Croatia)

Zvijezda, a 16th-century Renaissance fortification in Karlovac, holds vital historical and urban significance, presenting challenges in the vision for its development. Addressing issues such as cultural preservation, space multifunctionality, and symbolic representation, the site faces complexities in harmonising diverse demands. Located in the city's historical core, Zvijezda has undergone demographic changes, with a declining population of 1 142 residents, mainly elderly people.

The area includes 252 buildings, with notable cultural heritage. Legally protected, Zvijezda falls under immovable cultural heritage, covering 33.83 hectares in the Spatial Plan, safeguarding nine immovable and seven movable cultural properties within the UPU area.

Photo 3 Map of Zvijezda (Source: Spatial Plan, Zvijezda', Karlovac)

DLEZ Objectives and targets

The decarbonisation targets are established at 55% to align with European goals, reflecting a commitment to reduce energy consumption, deploy renewable energy sources, and cut CO_2 emissions. These targets aim to contribute to broader European efforts in achieving sustainability and addressing climate change concerns.

Key stakeholders

The key stakeholders who actively participated in the stakeholder consultation process and significantly contributed to the policy development discussions for the DLEZ include the Heads of the Administrative Boards for Spatial Planning and Construction, representatives from the City Heating Company Karlovac (GRADSKA TOPLANA Karlovac), the UPU Luščić-center Developer, and the Awarded Authors Group for the EUROPAN Competition Luščić-center. Additionally, the Director of GEOTERMIKA company, REGEA (North-West Croatia Regional Energy and Climate Agency), the City of Karlovac, the Energy Institute Hrvoje Požar, the Croatian Chamber of Architects and Urban Planners, and Greenika played integral roles in shaping the policy discourse.

Challenges & Potential pitfalls

Zvijezda remains a sensitive area for the City of Karlovac, balancing its profound historical significance with challenges such as population outflow. Local authorities are actively working to revitalise it and attract younger population.

Currently, the area is predominantly inhabited by elderly people, often reliant on social assistance, posing an additional challenge in Zvijezda's energy transition. The awareness of these residents regarding contemporary climate and energy challenges may need to be improved, thus further complicating the transition process.

Additionally, interventions in the historic core and the intricate procedures required to restore cultural heritage contribute to the complexities. Despite these challenges, Zvijezda is undergoing a renewal process, presenting an opportunity to delve into energy and climate-related issues while revitalising this significant area.

References

- Bertoldi P. (editor), Guidebook ,How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 1 - The SECAP process, step-by-step towards low carbon and climate resilient cities by 2030, EUR 29412 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79- 96847-1.
- Bertoldi P. (editor), Guidebook ,How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 2 - Baseline Emission Inventory (BEI) and Risk and Vulnerability Assessment (RVA), EUR 29412 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96929-4.
- Bertoldi P. (editor), Guidebook ,How to develop a Sustainable Energy and Climate Action Plan (SECAP) – PART 3 – Policies, key actions, good practices for mitigation and adaptation to climate change and Financing SECAP(s), EUR 29412 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96927-0.
- EMEP/EEA air pollutant emission inventory guidebook 2019, 1.A.3.b.i-iv Exhaust emissions from road transport
- EMEP/EEA air pollutant emission inventory guidebook 2019, 1.A.4 Small combustion
- IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Energy