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Developed within M100 HUB

METHODOLOGY FOR DATA COLLECTION, PROCESSING, VISUALISATION, INTERPRETATION & DISSEMINATION

M100 Mirror Mission Cities Hub Romania

Inspired by the EU Mission for Climate-Neutral and Smart Cities

Aligned with the NetZeroCities approach

SCOPE 3

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SCOPE

This methodology serves to enable a comprehensive and transparent, data-driven approach for monitoring the journey of cities working towards climate neutrality. It is designed for the urban authorities which are committed to reducing the local CO2 emissions within a specified timeframe (e.g., by 2030).

The methodology ensures that all of the stakeholders — the local authorities (public administration), the local ecosystem (including universities, research organisations, NGOs and businesses) and the local community (namely the citizens) — have access to clear, actionable, and reliable information regarding the city's real-time progress in transitioning to net-zero emissions.

The aim of this methodology is not only to enable the efficient monitoring of the city's headway in climate change mitigation, but also to facilitate informed decision-making and effective policy interventions at the administrative level by generating actionable insights, enhance the accountability among the major CO2-emitting entities and actively engage the public in the host city's efforts to achieve climate neutrality.

CONSIDERATIONS

- The methodology should be reviewed periodically (preferably every two years), in order remain current with the evolving developments: the updates or revisions made to the Climate City Contracts (CCC) and the growing capacity of the public administrations and the stakeholders involved in monitoring the CCC (not only in terms of personnel, but also regarding the technological innovations and the data availability). Reviewing the data methodology will also be beneficial for integrating any potential improvements or corrections into the presented processes.
- The methodology should be used in conjunction with the other documents related to the NetZero Monitoring Toolkit for the cities working towards climate neutrality, namely:
    - The set of indicators for evaluating and monitoring the impact of the climate neutrality actions and interventions;
    - The participatory monitoring process for climate neutrality initiatives;
    - The recommendations for the institutional framework required to support the monitoring and evaluation activities and inform decision-making within the public administration.

NETZEROCITIES RESOURCES / TOOLS

- **NETZEROPLANNER** (online tool based on a numerical roadmap through 2030, designed for cities to assess and enhance their Climate Neutrality Action Plans, ensuring they achieve the decarbonization goals)
- **SCENARIO-BASED ANALYSIS // MOBILITY AND ENERGY CASE STUDY** (scenario-based analysis for decision-making in urban environments)
- **VULNERABILITY AND RISK INFORMATION SYSTEMS** (data-driven methods which provide urban development project leaders with insights into the future scenarios and potential impacts of the planned developments, helping to assess risks, evaluate designs and identify possible mitigation strategies during the planning process)

STEPS

0. DATA SELECTION

- **PREPARATION:** The data selection process will take place once the CCC representatives establish the list of monitoring, evaluation and learning (MEL) indicators which will guide the evaluation and monitoring of the CCC.

SELECTING THE MEL INDICATORS

The indicator selection process will begin by identifying the MEL indicators which will be used to track the city's transition to climate neutrality (namely, the CCC implementation).

Each city will select its own indicators from the comprehensive set of MEL indicators proposed by the European Commission, particularly through the NetZeroCities platform, as part of the EU Mission for Climate-Neutral and Smart Cities. Therefore, the list of indicators should be developed based on:

- Aligning the European requirements and recommendations for monitoring the transition to climate neutrality with the national and local capacities for collecting and processing the relevant data.
- Reaching a clear consensus between the public administration and the CCC signatories (or the Local NetZero Coalition, if applicable), in order to establish the scale and complexity of the indicator list, based on the contributions which each actor can make to the monitoring process.

The list of indicators will be organised within a digital framework (in the form of a database), which will include the following information for each selected indicator:

- Title and unique identification code
- Type (mandatory or recommended)
- Definition and calculation method/formula
- Unit of measurement
- Associated action, intervention and systemic lever
- Expected target value (for at least 2 intermediate years)
- Field of action
- Targeted domain, subdomain and sector
- Source of data collection
- Monitoring periodicity
- Responsible entity

CATEGORIES OF MEL INDICATORS

<table>
<tr><td rowspan="10">DIRECT IMPACT INDICATORS

CO2 EMISSION REDUCTION</td><td colspan="2">• To monitor the reduction of GHG emissions in each sector:</td></tr>
<tr><td>SECTOR</td><td>DATA</td></tr>
<tr><td>Energy Systems (Generation and Distribution)</td><td>GHG emission from grid supplied energy</td></tr>
<tr><td>Mobility & Transport</td><td>GHG emission from transport</td></tr>
<tr><td>Waste Management & Circular Economy</td><td>GHG emission from waste</td></tr>
<tr><td>Green Infrastructure & Nature-Based Solutions (including AFOLU)</td><td>GHG emission from AFOLU</td></tr>
<tr><td>Green Industry (IPPU)</td><td>GHG emission from IPPU</td></tr>
<tr><td>Built Environment (Stationary Energy)</td><td>GHG emission from stationary energy</td></tr>
<tr><td colspan="2">• To monitor the overall cumulative reduction achieved across all the sectors.</td></tr>
<tr><td colspan="2">• To monitor the carbon capture:
o Negative emissions through natural sinks;
o Amount of permanent sequestration of GHG within the city boundary.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>INDIRECT IMPACT INDICATORS

CO-BENEFITS AND / OR CO-RISKS</td><td colspan="2">• To monitor the co-benefits (and potential co-risks) arising from the CCC actions:
o Co-benefits (and/or co-risks) associated with each individual action;
o Co-benefits (and/or co-risks) arising from the collaborative impact of multiple actions (where applicable).</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>ECONOMIC AND FINANCIAL INDICATORS</td><td colspan="2">• To illustrate the relationship between the public and private funds invested and / or attracted to reduce the CO2 emissions and the resulting impact of the CCC actions.</td></tr>
</table>

- **DECISION:** The CCC representatives will define and establish the necessary data based on the selected indicators, specifically focusing on their definitions, calculation methods or formulas and units of measurement.

NETZEROCITIES RESOURCES / TOOLS

- **CLIMATE IMPACT INDICATORS** (overview of requirements for reporting the GHG emissions, to track the progress towards the climate neutrality goals)
- **NETZEROCITIES COMPREHENSIVE INDICATOR FRAMEWORK** (set of required and recommended indicators for monitoring the CCC impact)

1. DATA COLLECTION

- **COMPLIANCE WITH THE EUROPEAN REQUIREMENTS:** The process will start from the technical data needed to meet the European Commission's requirements:
    - **GREENHOUSE GASES:**
        - Carbon Dioxide (CO2)
        - Methane (CH4)
        - Nitrous Oxide (N20)
        - F-gases (hydrofluorocarbons and perfluorocarbons)
        - Sulphur hexafluoride (SF6)
        - Nitrogen trifluoride (NF3)
- **ALIGNMENT WITH LOCAL CAPABILITIES:** In addition to adhering to the European requirements, the national / local availability of comparable data for each targeted emission sector will also be considered. As such, the data collection will be conducted by:
    - Processing the data already owned by the local public administration and the CCC signatories;
    - Acquiring datasets from recognized official institutional sources, via official data requests submitted by the CCC representatives;
    - Collaborating with other sectors, when the public institutions are unable to provide the necessary data: academic and research (universities, RDI organisations), non-governmental (particularly environmental NGOs), private (including utility companies and private firms owning the appropriate digital solutions).
    - Engaging the local population in line with the citizen science approach (e.g., by gathering microdata from surveys conducted within the local community, by reporting the air quality via mobile apps).

SCOPE AND SECTOR COVERAGE

	DIRECT EMISSIONS (SCOPE 1)	INDIRECT EMISSIONS (SCOPE 2)	OUT-OF-BOUNDARY EMISSIONS (SCOPE 3)
BUILDINGS	Emissions from all buildings, facilities and permanent infrastructure / equipment (collectively referred to as 'stationary energy' and including public, private, residential and industrial sectors) within the city boundary (excluding EU ETS registered facilities).	Emissions from outside the city boundary due to the use of grid-supplied energy (electricity or district heating/cooling) within the city boundary	Not applicable
TRANSPORT	Emissions from on-road and rail (as a minimum) transport within the city boundary, disaggregated by municipal fleet, public transport, private and commercial transport.	Emissions from outside the city boundary due to the use of grid-supplied electricity used to charge electric vehicles	Recommended by 2030
WASTE	Emissions from waste generated and managed/sent to landfill within the city boundary.	Not applicable	Emissions from waste generated within the city boundary but managed/sent to landfill outside the city boundary.
IPPU	Emissions from GHGs used in, or as a by-product of industrial processes and products (if present / significant).	Not applicable	Not applicable
AFOLU	Changes in GHG emissions from any changes in land use giving rise to (sources) or sequestering (sinks) emissions (if significant).	Not applicable	Not applicable

EXAMPLES OF DATA NEEDED TO CALCULATE THE MEL INDICATORS ACROSS THE MAIN EMISSION SECTORS, ALONG WITH RELEVANT DATA SOURCES (ROMANIA CASE)

EMISSION SECTOR	NECESSARY DATA	DATA COLLECTION SOURCES
ENERGY SYSTEMS (GENERATION AND DISTRIBUTION)	Energy consumption GHG emissions (from the grid-supplied electricity, heat, steam and/or cooling systems) Quantity of local renewable energy production Quantity of locally available energy	Local public administration City-level energy operators (producers, providers, transporters) National Regulatory Energy Agency Energy Manager CNAP experts SECAP experts
MOBILITY & TRANSPORT	GHG emissions (from the operations of vehicles) Mobility behaviours	Local public administration National Environmental Protection Agency City-level transport operators Academia (universities) CNAP experts SUMP experts
WASTE MANAGEMENT & CIRCULAR ECONOMY	GHG emissions (from waste treatment, waste incineration and landfills) Quantity of recycled municipal waste Quantity of urban wastewater meeting the UWWTD requirements	Local public administration City-level waste operators City-level wastewater operators Waste Management Intercommunity Development Association Water and Wastewater Intercommunity Development Association National Administration for Romanian Waters National Environmental Protection Agency CNAP experts
GREEN INFRASTRUCTURE & NATURE-BASED SOLUTIONS	Surface of green spaces Surface of tree canopy cover	Local public administration Environmental Protection Agency

EMISSION SECTOR	NECESSARY DATA	DATA COLLECTION SOURCES
(INCLUDING AFOLU)	Surface of protected natural areas Quantity of GHG emissions absorbed by natural sinks Surface of newly urbanised land Surface of redeveloped brownfield areas	National Agency for Protected Natural Areas National Cadastre and Property Advertising Agency Academia (universities) GIS tools CNAP experts
GREEN INDUSTRY (IPPU)	GHG emissions (from industrial processes)	National Environmental Agency National Institute of Statistics Operators of industrial facilities Industry Associations CNAP experts SECAP experts
BUILT ENVIRONMENT (STATIONARY ENERGY)	No. of total municipal buildings No. of municipal buildings equipped with building energy management systems Quantity of fuel consumption (per fuel type) GHG emission (per fuel type)	Local public administration Energy Manager National Regulatory Energy Agency

- **MIX OF COLLECTION TOOLS:**
  - **SURVEYS AND SELF-REPORTING TOOLS**: Gathering the necessary data from the residents and the private stakeholders through periodic surveys (which can also be requested digitally, if feasible). The surveys are particularly recommended for assessing the co-benefits and /or co-risks resulting from the implementation of the CCC actions, as they help verify how the population perceives the effects of the measures adopted at the local level to achieve climate neutrality.
  - **PARTNERSHIPS:** Engaging with research institutions and private companies, in order to obtain specialised datasets, forecasting tools and satellite imagery.
  - **TECHNICAL SOLUTIONS:** If feasible, in line with the principles of the EU Mission for Climate-Neutral and Smart Cities, the public administration will deploy smart city technologies (e.g., air quality sensors, energy consumption metres), in order to gather real-time data. If the required digital solutions are available only within other sectors (e.g., the

academia, the private industry), the CCC representatives will request the necessary data from their counterparts.

DATA COLLECTION PRINCIPLES

- **COLLECTORS:** The data collectors will uphold transparent and consistent relationships with the data providers, the experts responsible for processing and interpreting the data and the final beneficiaries of the disseminated information.
- **DECISIONS:** The decisions concerning the data sources' selection will be impartial and objective.
- **PROCESS:** The data collection process will be:
    - Designed to produce relevant, high-quality and timely statistics related to the MEL indicators;
    - Cost-effective in terms of resource use;
    - Whenever possible, based on a bottom-up approach, in order to obtain detailed and accurate data; when not feasible, a combination of bottom-up and top-down approaches should be used, in order to fill any potential gaps.
    - Aimed at fostering trust among the information beneficiaries.

NETZEROCITIES RESOURCES / TOOLS

- **CITIZEN SCIENCE** (approach which engages people in research and monitoring through the voluntary collection, tracking and interpretation of data)
- **IOT SENSOR & EDGE COMPUTING FOR ENVIRONMENTAL MONITORING** (digital solutions which assist cities in collecting real-time data on various parameters from multiple locations, enabling informed resource management decisions)

2. DATA CENTRALIZATION

- **DATA STORAGE:** The public administration will implement and manage a centralised digital repository, aimed at consolidating all the collected data, ideally categorised by each emission sector.
    - Particular attention will be given to ensuring that the employed digital solutions provide adequate storage capacity and a secure environment for the data storage and retrieval processes (including, if applicable, all the scanned documents and questionnaires used for the data collection). Consequently, a comprehensive digital document management system should be implemented within the public administration, in order to streamline the document handling, especially for the extensive datasets sourced from multiple origins.
- **DATA GOVERNANCE:** A comprehensive governance protocol will be developed within the public administration, particularly for the personnel engaged in the CCC implementation and monitoring, in order to ensure data consistency, standardisation and security.
    - The governance model will also incorporate a data quality assurance component, aimed at implementing quality checks and validation processes, in order to address any potential inaccuracies, discrepancies or missing data.
- **DATA STANDARDIZATION:** In order to guarantee data cleaning and harmonisation, dedicated procedures will be developed (by collaborating with external experts, if the internal resources are inadequate), in order to standardise the data from various sources, thereby ensuring its consistency and comparability.

NETZEROCITIES RESOURCES / TOOLS

- **DATA OWNERSHIP** (ownership and accountability of information)

DATA CENTRALIZATION PRINCIPLES

- **ANONYMISATION:** The personal data (e.g., household energy or water usage information) will be anonymized, in compliance with all the applicable national and European data protection regulations (e.g., GDPR). Consequently, the individual information will not be published or disseminated in a way which allows for the identification of any specific individual, household, organisation or related private information, except for the technical data which is needed for calculating the MEL indicators.
- **SECURITY:** Solid encryption techniques will be employed, in order to safeguard the sensitive data throughout the processes of collection, transmission, storage etc.
- **ACCOUNTABILITY:** Role-based access controls will be established, in order to limit the data access exclusively to the authorised personnel. Moreover, audit logs will be maintained, in order to monitor who accessed or modified the data.

3. DATA PROCESSING

- **DATA ANALYSIS:** For each of the proposed indicators, the corresponding data will be used for its computation, according to the formulas and standard calculation methods recommended by the European Commission. This approach will ensure that the data processing adheres to the European Commission's framework (concepts, definitions, methodologies, standards and scopes), thereby enabling the comparability with the data from other cities engaged in similar initiatives. Additionally, the Emission Accounting Frameworks recommended by the European Commission will be employed, in order to standardise the processing of emissions data.
    - The data analysis for monitoring the MEL indicators should encompass three components: an assessment of the current situation (already conducted with the development of the Climate City Contract), an analysis of the changes over time (during the CCC implementation and monitoring phases) and a referential analysis (periodic comparisons with the established targets for the final year).
    - A critical process in estimating the environmental and climate impacts of the CCC actions will involve the thorough examination of the technical specifications of the projects associated with these actions.
- **DATA MODELLING:** In collaboration with external experts (particularly those engaged in the Local NetZero Coalition, other CCC signatories, or outsourced specialists), algorithms and models will be developed to track the GHG emissions, calculate the MEL indicators, quantify the effects of the implemented CCC actions and, where possible, predict future trends.
    - Where applicable, machine learning models or other predictive analytics tools may also be used, in order to forecast the future trends in emissions, energy consumption, environmental impact etc.
- **CCC CORRELATION:** The monitored data will be aligned with the targets set in the CCC: not only the MEL indicators, but also the early changes and the long-term outcomes outlined in the CCC's Impact Pathways. This approach will enhance the objectivity in assessing the progress towards the climate neutrality goals, thereby reinforcing the CCC representatives' accountability.
    - Regular reviews and evaluations of the interim results and final reports should be conducted, in order to facilitate a continuous improvement in the data processing. These assessments should be performed routinely and used internally, in order to optimise the processes.

SPATIAL AND TEMPORAL BOUNDARIES OF THE CLIMATE NEUTRALITY DATA TRACKING SYSTEM

- **GEOGRAPHIC SCOPE:** The tracking process should cover the entire city, with the exception of specific locations which are explicitly excluded from the CCC (e.g., certain neighbourhoods or emission sources - a factory).
    - Whenever possible, granularity should be defined at the neighbourhood or district level, in order to facilitate targeted interventions.
    - The geographic scope may extend to the surrounding metropolitan area, if it falls within the CCC's coverage.
- **TEMPORAL SCOPE:** The time frame for the data collection and analysis should include:
    - **HISTORICAL BASELINE PERIOD:** This period (e.g., the baseline year specified in the CCC) will be used to measure the progress.
    - **CURRENT PERIOD:** The ongoing data collection will focus on assessing the present-day emissions and impacts.
    - **FUTURE OUTLOOK:** The projections should be modelled for the target year outlined in the vision for achieving climate neutrality (e.g., 2030), as well as for 1-2 intermediate years (e.g., in line with the early changes and late outcomes covered by the CCC's Impact Pathways), in order to monitor the anticipated climate neutrality milestones.

NETZEROCITIES RESOURCES / TOOLS

- **PREDICTIVE MODELLING** (process for real-time management and long-term planning within cities)
- **PREDICTIVE MAINTENANCE SUPPORTING TOOLS** (tools enabling the predictive maintenance for large energy systems in buildings)
- **SATELLITE AND GEOSPATIAL DATA** (technologies which provide urban planners and authorities with the opportunity to make informed decisions through quantitative analysis and predictive modelling)

4. DATA INTERPRETATION

- **MEL INDICATOR MONITORING:** The data interpretation process will enable the tracking of the city's progress against the defined MEL indicators (e.g., emission reductions, renewable energy adoption) and implicitly the climate neutrality targets set in the CCC.
    - The MEL indicator data will be analysed within the context of the current local policies, programs and investments. This approach will help identify any potential gaps and areas for improvement, guiding the potential optimisations or adjustments needed in order to maximise the impact of the CCC actions. It will also support the iterative process of periodically updating the CCC.
- **REGULAR REPORTING:** Based on the interpreted data, periodic reports will be issued, in line with the monitoring schedule established for the MEL indicators. These reports will summarise the key insights and trends related to the evolution of the monitored indicators.
- **EXPERT ANALYSIS:** Beyond the technical staff involved in the data processing, experts such as researchers, economists, urban planners and environmental specialists (e.g., from specialised NGOs and firms) will contribute to the analysis and interpretation of the complex datasets.

5. DATA VISUALIZATION

- **DATA PRESENTATION - DIGITAL DASHBOARD:** A digital dashboard will be developed, in order to transparently communicate the processed data and track the progress toward climate neutrality, by calculating the MEL indicators.
    - The dashboard will provide the real-time visualisation of the key climate neutrality metrics, along with the evolution of the monitored indicators over time.
    - The dashboard will be designed to incorporate both the territorial perspective and the temporal scope in the data visualisation, addressing three key aspects: 1) monitoring the current situation, 2) tracking the changes over time and 3) conducting the referential analysis of the current state and its progression over time.

KEY FEATURES OF THE CLIMATE NEUTRALITY DIGITAL DASHBOARD

- **PUBLIC:** It will make the data publicly accessible.
- **COMPREHENSIVE:** It will display all the monitored MEL indicators, in a complete and detailed manner.
- **CUSTOMIZABLE:** The users will be able to customise the views, by filtering the data based on various criteria (e.g., time periods, emission sectors / scopes / types).
- **INTERACTIVE:** It will be engaging and user-friendly for all the target groups – public institutions (e.g., environmental agencies and other public entities), universities and research organisations, private sector entities (utility providers, companies), local NGOs, citizens (including the children and the elderly).
- **INCLUSIVE:** It will present the information in a clear and accessible format, being suitable for both the technical and non-technical audiences, and will be adapted for the individuals with disabilities, such as those with vision impairments.
- **RESPONSIVE:** It will be designed to allow any stakeholder (particularly the local NGOs and the citizens) to contribute their observations on the city's progress, functioning as a mechanism for citizen feedback.
- **ADAPTIVE:** The dashboard and its data will be optimised for both PCs and mobile devices, ensuring the accessibility via smartphones and other mobile platforms. Over time, a dedicated mobile application may also be developed.

- **GRAPHICAL REPRESENTATION:** The data will be presented in a highly intuitive manner, by using maps, charts, infographics and other visual tools.
    - Where feasible, geospatial analytics will also be employed, incorporating GIS tools in order to create interactive maps (e.g., by neighbourhood) for tracking the emissions. As such, the GIS solutions could enable the

spatial visualisation of the emissions data, highlighting the high-impact areas or the ones in need of urgent actions.

- The dashboard's numerical, tabular and graphical data will be periodically (e.g., annually) used to generate local climate neutrality profiles. These profiles could even serve as benchmarking tools, allowing the city's performance to be compared against the national and European climate neutrality targets.

NETZEROCITIES RESOURCES / TOOLS

- **CITY DASHBOARDS** (city dashboard model for use by municipalities and urban planning organisations)
- **INTEGRATED ENERGY AND GHG SCENARIO MAPPING TOOLS** (integrated energy and GHG scenario mapping tools used by cities to implement energy-saving strategies)

6. DATA DISSEMINATION

- **PUBLIC AVAILABILITY:** In addition to the digital climate neutrality dashboard, various other methods will be employed, in order to ensure that the generated statistics are publicly available and widely accessible.
    - A broad range of dissemination channels and engagement tools will be used, in order to effectively reach multiple specific target groups, e.g.:
        - Local stakeholders: distribution of publications and documents (e.g., through email newsletters), organisation of hybrid (both in-person and online) workshops (to present the data and gather input and feedback from various stakeholders);
        - Community: Press releases, communication campaigns (including local events, posters, street art and social media), interactive digital solutions, public forums;
        - General public: The City Hall's website, along with the web pages and social media accounts of the CCC signatories.
- **TRANSPARENT COMMUNICATION:** The public administration will prioritise transparency in the dissemination of data to the public, fostering trust and accountability in the local journey towards climate neutrality.
    - User support services will be established, in order to address any questions, clarifications or requests regarding the data; the assistance will be provided promptly by knowledgeable staff members involved in the CCC monitoring process.

DATA DISSEMINATION PRINCIPLES

- **INDEPENDENCE:** The dissemination process will be conducted in an independent, impartial and objective manner.
- **PRIVACY:** Privacy and confidentiality will be upheld in all the published data.
- **ACCESSIBILITY:** The statistics will be made readily accessible through a variety of media channels.
- **CLARITY:** Simplified, jargon-free reports and visualisations will be developed, in order to make the complex data understandable for the general public (e.g., data summaries for non-experts).
- **TRANSPARENCY:** Regular updates will be provided on the city's progress toward climate neutrality, highlighting both the successes and challenges, in order to ensure that the local stakeholders are informed not only of the positive outcomes but also of the obstacles faced and overcome.
- **ENGAGEMENT:** The data producers will engage with the end users whenever possible (e.g., through dedicated events, such as public consultations).

NETZEROCITIES RESOURCES / TOOLS

- **DATA AND SOLUTION CATALOGUES** (data management and sharing ecosystems that offer functionalities for publishing and searching various data service offerings)
- **OPEN DATA MODELS & ONTOLOGIES** (how to share data in a freely accessible format to enhance transparency, collaboration and information reuse (open data) and how to foster a shared understanding of the meanings and relationships between concepts within a specific domain (ontologies)