Mitigation and Adaptation Indicators

D2.6

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LOCALISED

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List of Abbreviations

BEI	Baseline Emission Inventory
EUCalc	European Calculator
GW	Gigawatts
kg	Kilogram
kW	Kilowatt
LUCAS	Land Use and Cover Area frame Survey
NUTS	Nomenclature of Territorial Units for Statistics
MW	Megawatt
MWh	Megawatt hours
RVA	Risks and Vulnerability Assessment
SECAP	Sustainable Energy and Climate Action Plan
SDGs	Sustainable Development Goals
TWh	Terawatt hours

Executive Summary

The objective of LOCALISED is to downscale national decarbonisation trajectories consistent with Europe's net-zero target to the local levels and provide the results to **local administrations, citizens and businesses**, in order to speed up the uptake of mitigation and adaptation actions. To this end, the project will create tools that transform localised data from decarbonisation pathways into knowledge for action. The tools are the (1) Decarbonisation Profiler for municipalities, regions and their citizens; and (2) the Net-Zero Business Consultant tool targeted primarily at businesses. The tools will inform local administrations, and businesses on viable combinations of (sectoral) mitigation and adaptation measures; facilitate the implementation and monitoring of SECAPs; and inform citizens how climate change and EU net-zero scenarios positively and negatively affect their life and what share of mitigation can be enhanced via key behavioural change.

Defining and selecting the most appropriate and practicable indicators can be a challenge, due to factors such as data availability but also because of the degree of usability or understanding them in an easy and practical way. This deliverable aligns the wealth of information stemming from energy and climate models with the information needs of the project target groups. It connects the information needs of the targeted audiences in LOCALISED with the tools that are developed, ready to respond them. Hence, the proposed mitigation and adaptation indicators need to be defined in an early project stage in order to clearly understand the input data and the data processes (calculations) required as well as the output data provided. Additionally, they are important elements feeding into the co-creation processes. That said, the proposed list of indicators will be subject of revision as stakeholder consultation ramps up and prototypes of tools are developed.

It is crucial, to choose indicators which reflect the information needs as closely as possible and to harmonise them, providing a useful resource for the development of a decision support tool. It is also important to standardize the description of the resources used (input) the measures of the effects (output) and the contextual specifics that may facilitate or serve as barriers for the transformation of the inputs into outputs (context). In line with the above, the document is addressed to all partners involved in the identification and selection of mitigation and adaptation indicators tailored to the target groups.

1.Introduction

The overarching objective of LOCALISED is to downscale national decarbonisation trajectories consistent with Europe's net-zero target to the local levels and provide the results to local administrations, citizens and businesses, in a way that would speed up the uptake of mitigation and adaptation actions[1]. While the full set of downscaled model outputs are directly useful for scientists, for local administration, businesses and citizens, the information provision will demand a better understanding of their requirements. Local actors need and deserve to know why they might have to take different decisions or call on different or additional resources in conducting their livelihoods. Thus, they need to know about the changing risk context, how it may affect them, and what they can do to prepare and protect themselves. This can range from simple re-wording of model outputs to make them more intelligible to a target group, to the formulation of a new indicator tailored to the user needs. Accordingly, in the overall process of LOCALISED (see Figure 1) there needs to exist an alignment between data provision, target group needs and tool functionality.

Hence, this report will present a first set of proposed mitigation and adaptation indicators needed for each target group within the project as well as select them to be simple to understand. Those indicators must be defined early at the project in order to clearly understand the input data required, the data processes (calculations) required and the output data provided; serving as input for models and impact evaluation, setting baseline values or used with different scenarios climate change. **The methodological approach and detailed description of indicators, including feedback from the engagement process with stakeholders, will be part of respective deliverables to come in the project.** The identification, selection and implementation of indicators is an ongoing activity, this report an undertaking to harmonise them and to check the availability of data.

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[1] Firus, K., et al. (2022). Dissemination and communication strategy (LOCALISED Deliverable 9.1) https://www.localised-project.eu/wp-content/uploads/2022/09/LOCALISED_Dissemination-and-communication-strategy_D9.1.pdf

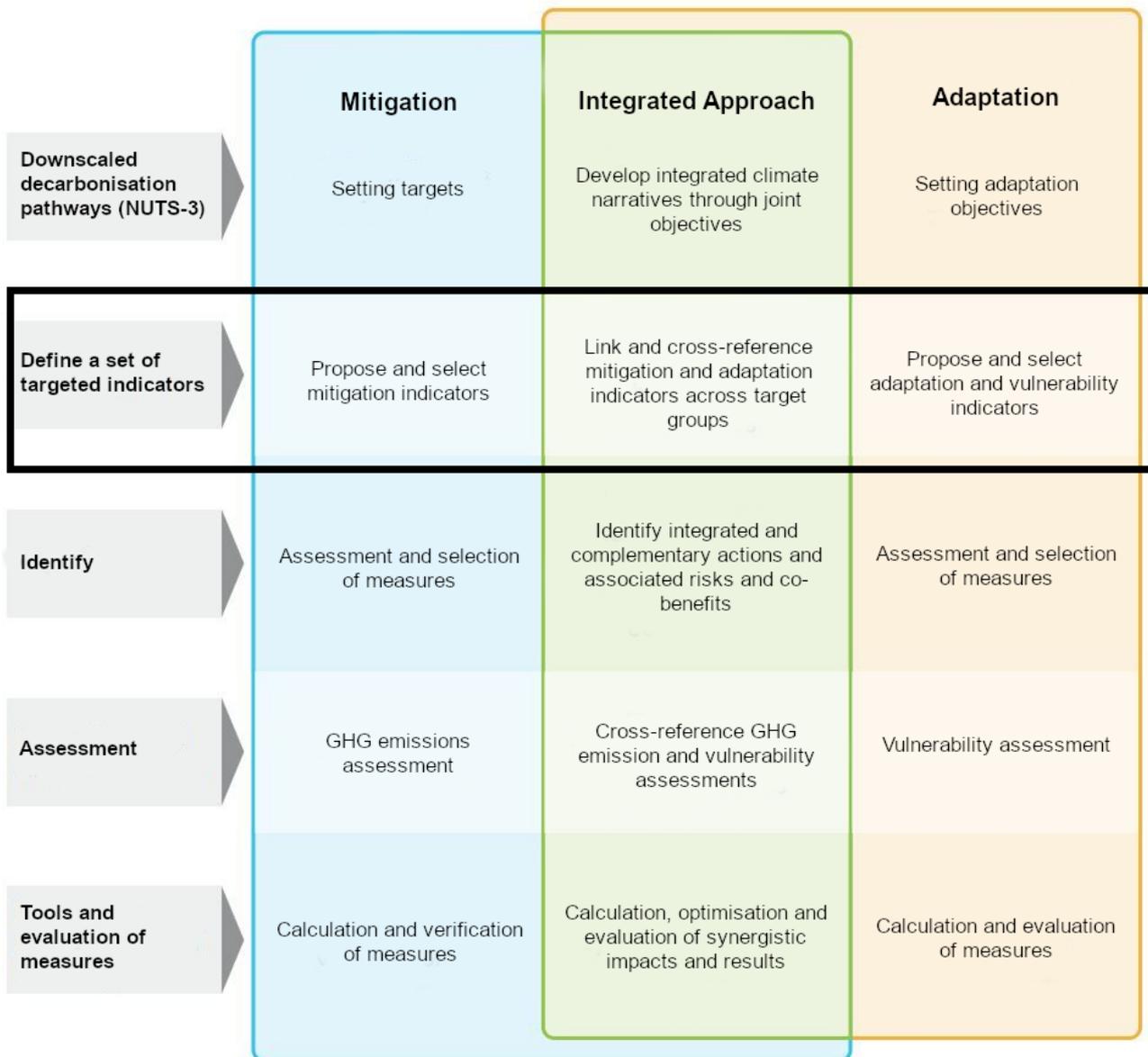|	Mitigation	Integrated Approach	Adaptation
Downscaled decarbonisation pathways (NUTS-3)	Setting targets	Develop integrated climate narratives through joint objectives	Setting adaptation objectives
Define a set of targeted indicators	Propose and select mitigation indicators	Link and cross-reference mitigation and adaptation indicators across target groups	Propose and select adaptation and vulnerability indicators
Identify	Assessment and selection of measures	Identify integrated and complementary actions and associated risks and co-benefits	Assessment and selection of measures
Assessment	GHG emissions assessment	Cross-reference GHG emission and vulnerability assessments	Vulnerability assessment
Tools and evaluation of measures	Calculation and verification of measures	Calculation, optimisation and evaluation of synergistic impacts and results	Calculation and evaluation of measures

Figure 1: LOCALISED's integrated approach of mitigation and adaptation actions

In this report, we present a first step towards the identification and selection of a coherent framework of mitigation and adaptation indicators, intended to stimulate discussion among the communities of target groups and practitioners. It is the aim, to open the silos and to harmonise solutions with the same objectives and scales. Hence, they should be made easier to upscale and replicate in a systematic mode to achieve the much-needed impact in timely addressing climate change and building resilience. Feedback to the indicators will be gathered in multiple stakeholder interactions for the tool's co-design to understand the questions and needs of the end users of the project's results and services. The integrated approach proposed here also addresses the capacity of target groups to undertake effective climate actions and that it is matched to the impacts of interventions of vulnerability, as shown in Figure 1.

2. Mitigation and adaptation indicators in LOCALISED

The increasing recognition of the necessity to integrate adaptation and mitigation measures in our society's response to the climate crisis has led to an understanding of the need for making targeted, justified, and effective policy decisions. As it is known, data and information alone have limited power to driving action. On top of that, stakeholder interactions have shown that this information is on the one hand patchy and scattered and on the other hand it is provided in a very complex way or only national data are available which are not easily usable without being an expert.

Because it is impossible to claim knowledge on all the information and knowledge requirements of our broader focus groups, the project will engage - both as partners or associates - representatives of local administrations, businesses and groups of citizens in order to conduct co-creation sessions to define, refine and test the project tools. Not all variables or indicators are meaningful for the range of user groups targeted by LOCALISED. In this sense, the starting point is to identify relevant mitigation and adaptation indicators for citizens, regions and businesses.

In order to succeed in this endeavour, it is necessary to understand very well the specific needs of the users of these services, as key stakeholders of the value-chain, differentiated along dimensions like group, experience, country and size of the administration or company. The understanding we gain (cf. D8.1[2]) needs to be taken into account and integrated in the tools to be developed.

Table 1 is the result from initial stakeholder interaction carried out in LOCALISED, putting the information needs and expectations of target groups on the table. In dedicated meetings at the projects meetings with the city partners involved in the project, the outreach to associated partners of business associations and desk research on mitigation and adaptation actions lead to the following. In respond, LOCALISED will take into consideration their specific needs and individual starting points in developing the tools and services. In addition to that, continuous stakeholder interaction will ensure that the feedback and suggestions on the design and usability are implemented in a meaningful and proper way.

Table 1: Target groups, information needs and LOCALISED's solutions

Target group…	…their information needs	…and what LOCALISED delivers
Local administrations	Easy access to sectoral energy demand in the same granularity as the Sustainable Energy and Climate Action Plans (SECAPs) template.	Downscaled material, energy demand and emissions that are consistent with nationally-defined decarbonisation pathways.

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[2] Hezel, B., Broschkowski, E., Lamberty, R., Firus, K., Shayegh, S. (2022), Stakeholder interaction methodology and schedule (LOCALISED Deliverable 8.1) https://www.localised-project.eu/wp-content/uploads/2022/09/LOCALISED_Stakeholder-interaction-methodology_D8.1.pdf

	Mapping climate risk indicators to NUTS3 level. Prioritising occurring impacts, especially the ones that are projected to become severe in the future. Evaluate the likelihood and severity of impacts over the near, the medium and the long term. Matching the goals and objectives as laid down in SECAPs with concrete mitigation and adaptation measures and actions, needed to reach a specific target.	Regional assessment of SECAP-oriented climate hazards and vulnerable sectors/groups. Combinations of adequate adaptation and mitigation options. With the LOCALISED tools, interregional collaboration in mitigation and adaptation should receive a boost to ensure the broad implementation of solutions at reduced (shared) risk. LOCALISED aims to translate and disaggregate highest-level European climate targets and ambitions to the regional level, where they are actually being operationalized a firm commitment is needed.
Citizens and local communities	Break down the effects and impacts of climate change not only on average, but also how vulnerable groups and genders are affected by climate change and the energy transition. There is a potential bottleneck of data that cannot be directly delivered, e.g. the EUCalc cannot provide energy cost data. If this is an important indicator for citizens, we need to find another way of assessing this.	Use pathways to evaluate how diverse groups of citizens are affected by both climate change and climate policies. This includes the impact on living standards, the transformation of the labour market, the pass-through of carbon costs in energy bills, the health benefits, etc. Supporting decisions and activities by translating knowledge into action is most visibly undertaken at the local level, and usually by individuals, households and other communities. Provide quantified impacts of measures. Achieving regionally representative samples of case study regions, citizens' perceptions and attitudes towards potential decarbonising behaviour changes are surveyed, with focus on vulnerable groups.
Businesses	Businesses, and particularly SMEs, which make up the backbone of the EU economy, have a hard time obtaining relevant information when it comes to mitigation and adaptation pathways. Also in the case of businesses, relevant adaptation and mitigation indicators need to be explored. Support in evaluating businesses core activities vulnerability to climate impacts, of the impacts that decarbonisation pathways will have on them and of possible ways to overcome negative impacts, including emerging mitigation and adaptation technologies and access to financing.	To calculate the vulnerability index, information is needed on exposure, vulnerability and response/resilience. Data on exposure will comprise both climate change indicators and regional decarbonisation pathways. Vulnerability will comprise supply chain, energy input or emissions. Adaptive capacity is assessed via technologies. Industries will be selected in terms of share of economic output/ employment. LOCALISED provides information on emerging technologies in manufacturing, transportation and agriculture sectors as a response to changes in the natural, social, and business environment. This

	Provide context-specific information on environmental, social and economic co-benefits.	will increase the number of successful scale-up and uptake of innovation and climate-friendly best practice solutions across Europe.

This deliverable supports the need for a growing climate resilience and adaptation by offering a flexible and integrated approach through which planners, policy makers and anyone interested in running an initiative for climate mitigation and adaptation can clarify their own priorities for adapting to and/or mitigating climate change and implement responsive strategies, policies and actions. As it is the main objective of this deliverable, a number of indicators are proposed by the consortium (see Chapter 3) for evaluating mitigation and adaptation, many of which will need to be operationalised in the course of LOCALISED by translation them into context-specific indicators relevant to particular situations and target groups. The indicators take into account the differing preferences and solutions in how to achieve climate mitigation and adaptation in European regions, businesses and on an individual citizen level. In order to bring the anticipated benefit, mitigation and adaptation measures must be integrated across specific key communities (target groups) and must be better coordinated among them. Without addressing the challenges in tandem, the underlying linkages between the climate, economic, social, technological and organisational issues go unaddressed and unresolved. It is the aim of this deliverable, to harmonise a set of global indicators, providing a useful resource for the development of a decision support tool. It is also important to standardize the description of the resources used (input) the measures of the effects (output) and the contextual specifics that may facilitate or serve as barriers for the transformation of the inputs into outputs (context).

Adaptation and mitigation indicators serve a range of purposes, including tracking progress in the implementation of an strategy or plan, monitoring the spending of adaptation funds, mainstreaming measures in different sectors and communicating information to policy-makers, to mention a few. Evidently, climate change and climate change adaptation are rather complex issues, and hence different types of indicators have been developed and used for different purposes. Unlike climate change mitigation, the success of which ultimately may be measured in terms of a single metric such as greenhouse gas emissions avoided or atmospheric greenhouse gas concentrations, there is no single metric for adaptation, because functions and goals of adaptation will be different in different contexts and target groups. For example, adaptation interventions might seek to reduce mortality from climate-related disasters, improve agricultural productivity and nutrition, make infrastructure more robust in the face of climate-related stresses, improve water use efficiency in the face of reduced water availability, preserve natural resources and ecosystems, and so on.

Where adaptation outcomes cannot be measured directly because of timescale issues, one approach is to assess the impact of adaptation interventions on vulnerability. Vulnerability in LOCALISED is defined in terms of the factors that make individuals (e.g.

citizens), populations and businesses more or less likely to experience adverse outcomes when exposed to an external stress, in this case a climate-related risk. Vulnerability may therefore be seen as comprising societal and other (e.g. local environmental) factor that mediate the outcomes of climate-related hazards and risks.

For the purpose of LOCALISED, finding a common understanding about which indicators are useful and which data best underpin them to measure the progress towards policy objectives and business strategies against dynamic business risks is part of the respective deliverable. Vulnerability indicators are selected carefully, and will vary according to context and the climate (change) hazard(s) with which adaptation is concerned. However, there is no one size-fits-all indicator, which is why it is essential to understand the assumptions and limitations of the indicators, the uncertainties and possible risks in using them and their data availability.

2.1. Local administrations

Two main instruments are being considered to establish a set of oriented indicators for local administrations, the Sustainable Development Goals (SDG), supported by the United Nations, and the **Sustainable Energy and Climate Actions Plans (SECAP)**, created under the umbrella of the Covenant of mayors. Both instruments have a predefined set of indicators which are used to verify the achievement of specific goals and are frequently used to oversee the implementation of mitigation and adaptation actions at local and other levels. Nevertheless, even though there is a wide range of indicators available, there is a lack of coordination between the initiatives, and indicators are sometimes conceptualized considering a different scale, such a national implementation. In addition, some of them are not clearly established, such as the ones related to adaptation strategies, therefore relying on the hands of public administrations. As a consequence, the lack of harmonization entails an extra effort to align the objectives established in both instruments and hinders the implementation and benchmarking.

Moreover, even so nowadays more than 9,000 towns and cities have joined the Covenant of Mayors framework, and the achievement of SDG is already considered by some advanced local administration, the lack of resources and the difficulty of obtaining the necessary data is a clear barrier to assess the current situation and establish appropriate measures. The main objective of the project is to provide downscaled and completed real, adapted to case, and local data, that allows the concretion, implementation and monitoring of SECAPs and the Sustainable Development Goals (SDGs) at Municipality and NUTS3 levels. Thus, the platform will offer reliable data to establish the **Baseline Emission Inventory (BEI)** and the **Risks and Vulnerabilities Assessment (RVA)** on the territory, and provide feasible adaptation and mitigation options to municipalities.

The BEI and the RVA will be defined using consistent geo-located public information with the aim of providing reliable data to establish and, above all, identify the crucial aspects to be assessed in long-term plans to achieve decarbonisation. Adaptation and mitigation capabilities and feasibilities will be introduced as available layers for SECAPs. Special emphasis will be given to key pillars for decarbonisation, such as large-scale building retrofit actions, and local energy communities. As regards to adaptation, the project will define relevant and feasible remaining adaptation measures on the regional level. Consequently, local authorities will gain knowledge on their remaining risk profiles and be provided with knowledge on feasible solutions. Moreover, since currently SECAP plans are often based on static administrative documents, which difficult the monitoring of the objectives over the years, the project will introduce a dynamic model that will allow an active control of the targets for assessment and dynamic adaptation.

Additionally, and based on the analysis of the targets and available indicators, the platform will gather a set of oriented specific indicators to help local authorities define the steps and measures to successfully implement both SECAPs and the 2030 Agenda. The alignment between SECAP plans and SDG targets and indicators will provide a clear robust framework to define the necessary measures and effectively allocate resources, leading to comprehensible, feasible, and effective long-term strategies.

2.2.   Citizens and local communities

Citizens are not only a target group of the project, as governments and local administrations should also act in their best interest. Thus, their wellbeing and attitudes provide guidelines for policies. From this perspective, 3 dimensions are vital for the evaluation of adaption or mitigation measures: Firstly and obviously, it is necessary to know how citizens are affected by climate change and transformation of the energy system. We label this **(1) Climate Change Effects (CCE)**. In addition, the effects on certain vulnerable groups like elderly, children, women, transgender persons, people in poor health, people on low incomes, tenants, illiterate groups, groups with limited knowledge of the official language or isolated people, who are less likely to receive information - need to be differenced. Second, adverse or positive consequences of measures or policies for citizens need to be to be taken into account. We can summarize this as **(2) Effects Of Measures (EOM).** This dimension will, among others, encompass economic indicators (e.g. unemployment rate, income), but also social aspects like gender justice (e.g. gender pay gap, gender pension gap) or different education levels and health issues. The third dimension is **(3) the Acceptance Of adaptation/mitigation Measures and Policies (AOM)**. This is a crucial aspect, when the most promising options of similar effective scenarios are to be singled out. Indicators for each of the three dimensions need to be defined, whereby the complexity increases from 1 to 3.

A local community refers to one or several groups of people, usually with shared economic and cultural interests, living in close proximity at the local scale. Communities are themselves aggregates of individuals, households, and other local institutions. As such, they are complex and dynamic, with identifying factors such as geography, culture, economic status, livelihood activities, language and/or religion creating divisions or linkages between people living in the same area.

At the same time, citizens are not just a source of data, but play an important role in the co-decision and co-creation of mitigation measures. As a result of citizen engagement activities, information needs of citizens will ultimately feed into both the design of the online tools and measures. Again, different prospects on mitigation policies and different consequences (vulnerable) groups have to be taken into consideration.

Through the planned activities, the exploitable results of LOCALISED will be rooted in the reality of life of citizens. It will be more tailored to prevailing needs and prospects. For local administrations and decision makers, LOCALISED will deliver not just deliver a tool that calculates emission pathways, but integrates the viewpoints of citizens to some degree. Citizens as a target group will benefit from a fine-grained and intersectional analysis along different groups and (dis)advantages. This allows the research for *more just* and *more accepted* options amongst the calculated pathways. Furthermore, the possibility to evaluate different lifestyle choices for individual citizens will be provided by the online tools.

2.3.   Businesses

The EU industrial strategy supports the transformation of EU energy-intensive industries to enable a climate-neutral, circular economy by 2050, promotes advanced technologies, and supports the move to a climate-neutral economy. In light of such transition, EU businesses and industries will be subject to an array of environmental, technological, economic, social, and institutional changes which challenge their status quo by threatening their bottom line and affecting their workforce but also by providing new business opportunities for innovation and mitigation/adaptation solutions. In order to help businesses at the regional level to prepare for the outcome of such developments, their vulnerability (or resilience) to decarbonisation pathways should be quantified and measured in a transparent and harmonised fashion.

Vulnerability index is a composite indicator of business vulnerability, developed for three main sectors of agriculture, manufacturing, and transportation. The main components of the vulnerability index are identified through an interactive co-design and co-creation process with the engagement of key business stakeholders. Furthermore, mitigation and adaptation measures which aim to reduce business vulnerability and increase its resilience and competitiveness will be identified and quantified through the **development of a business adaptive index**.

The combination of these two indicators (i.e., vulnerability and adaptive indices) and exposure indicators resulting from downscaling EU decarbonisation pathways at the regional level, provides businesses with first-hand insight into risks and opportunities that such decarbonisation pathways would present. This allows businesses and local authorities to quantify and compare business vulnerability under different pathways and across sectoral, geographical, and temporal dimensions.

3. Proposed mitigation and adaptation indicators

The following tables include the first set of proposed mitigation and adaptation indicators used within LOCALISED. They include the indicator name, as short description of the indicator, the metric, and some categorisation to cross-link and group them.

Contextual information, aiming to support the understanding and interpretation vulnerability, identifying adaptation needs and evaluation strategies. Set of indicators in the context of a given category, are as follows:

- Geophysical (**Geo**)
- Environmental (**Env**)
- Economic (**Econ**)
- Technological (**Tech**)
- Social (**Soc**)
- Institutional (**Inst**)

To facilitate the implementation in the LOCALISED framework, all indicators are classified into three tiers based on their level of methodological development (also new indicators can be proposed), and the known availability of data, either the downscaling procedure is already clear or has to be defined yet:

- **Tier 1**: Indicator conceptually clear, data for calculation available and downscaling procedure clear.
- **Tier 2**: Indicator conceptually clear, data for calculation to be sourced from external sources; downscaling procedure clear.
- **Tier 3**: New indicator, data needs to be generated and downscaling procedure defined.

3.1. Local Administrations

Table 2: Proposed mitigation and adaptation indicators for local administrations

Indicator name	Category	Indicator short description	Metric	Tier level	Covered in SDG	Indicator type
Mitigation and adaptation indicators relevant for public administrations						
CO2 emissions of the city	Env	This indicator estimates the tonnes of CO2 equivalents yearly emitted by a city. It is also a main indicator used to monitor Sustainable Energy and Climate Action Plans at local level (SECAP)	Tonnes CO2eq/year	1	11.6 13.2 13.3	Mitigation
CO2 emissions per capita	Env	This indicator estimates the tonnes of CO2 equivalents yearly emitted by a city weighted by the average population of the reference year (per capita).	Tonnes CO2eq/year / citizen	1	13.2 13.3	Mitigation
Greenhouse gas emissions from households, tertiary and industry (non-ETS industry)	Env	This indicator estimates CO2 Yearly emitted by households, tertiary and industry buildings.	Tonnes CO2eq/year	1	3.9 7.2 9.2 9.4 13.3	Mitigation
Greenhouse gas emissions generated by the commerce sector	Env	This indicator estimates CO2 Yearly emitted by commercial buildings.	Tonnes CO2eq/year	1	8.4	Mitigation
Greenhouse gas emissions per capita for buildings, equipment/Facilities, and Industry	Env	This indicator estimates CO2 yearly emitted by buildings and industry weighted by the average population of the reference year (per capita).	Tonnes CO2eq/year / citizen	1	13.2 13.3	Mitigation
CO2 emissions (tonnes) (per MWh or gigawatt) electricity consumed, Carbon content in electricity	Env	This indicator estimates the CO2 emission per MWh of electricity generated to cover energy consumption.	Tonnes CO2eq/MWh	1	13.1 13.3	Mitigation

CO2 emissions per capita transport	Env	This indicator estimates the CO2 emission generated by the transport sector. It is a relevant sector addressed in Sustainable Energy and Climate Action Plans at local level	Tonnes CO2eq/year	1	13.2 13.3	Mitigation
Final energy consumption by sector and fuel	Env	This indicator covers the final energy consumed by end users, such as industry, transport, households, services, and agriculture; it excludes energy consumption of the energy sector itself and losses occurring during transformation and distribution of energy. It is the main information requested in SECAP mitigation pillar to calculate the emissions of the different sectors	Millions of tonnes of oil equivalent (TOE) / year	1	7.2 7.3	Mitigation
Total electricity consumption in the city	Env	This indicator covers the final electricity consumption of the city; it excludes energy consumption of the energy sector itself and losses occurring during transformation and distribution of energy. The final energy consumption of the different fuels is one of the main indicators used in SECAP to calculate emissions of the different sectors.	Millions of tonnes of oil equivalent/ year	1	7.3	Mitigation
Electricity consumption per capita	Env	This indicator covers the final electricity consumption of the city weighted by the average population of the reference year. The final energy consumption of the different fuels is one of the main indicators used in SECAP to calculate emissions of the different sectors.	kWh/ year / citizen	1	7.3	Mitigation
Transport energy consumption	Env	This indicator covers the final energy consumption of the transport sector. Transport is one of the key sectors included in the SECAP mitigation pillar and one of the main areas of intervention for municipalities.	TOE or MWh	1	11.2	Mitigation
Final energy consumption of public buildings per year	Env/ Inst	This indicator covers the final energy consumption of public buildings. Public buildings are one of the key sectors included in the SECAP mitigation pillar and one of the main areas of intervention for municipalities.	TOE, GJ or MWh, sometimes by m2	1	7.3	Mitigation
Final energy consumption in homes including all types of energy	Env	This indicator covers the final energy consumption of households by citizen. Public buildings are one of the key sectors included in the SECAP mitigation pillar and one of the main areas of intervention for municipalities.	MWh/inhabitant	1	7.3	Mitigation
Energy consumption of households for heating	Env	This indicator covers the final energy consumption in households dedicated to heating. It is the main information requested in SECAP mitigation pillar to calculate the emissions of the different sectors	MWh/inhabitant	1	7.3 13.3	Mitigation
Proportion of the electricity consumed	Env	The indicator provides information about the proportion of energy consumed in the city that comes from renewable sources.	%		7.2 12.2	Mitigation

in the city that comes from renewable sources		Renewable generation is an indicator reported in SECAP mitigation pillar and is used to calculate the final emissions.				
Energy consumed in the city locally generated using renewable resources	Env	The indicator provides information about the proportion of energy consumed in the city that is covered exclusively using locally generated renewable sources, it includes thermal and photovoltaic production and other renewable sources available in the site. Local Renewable generation is an indicator reported in SECAP mitigation pillar and is used to calculate the final emissions.	%	1	7.2	Mitigation
Renewable energy on the total energy consumed in households and the tertiary sector	Env	The indicator provides information about the proportion of energy consumed in households and tertiary buildings that is covered by renewable sources. Final energy consumption disaggregated by fuel is one of the main indicators of the SECAP mitigation pillar.	%	1	7.2	Mitigation
Vehicle energy consumption of the different transport modes	Tech	The indicators measure the fuel required to travel a unit of distance (L/100km). This metric is calculated for each vehicle model through standardised testing procedures and drive cycles. Including passengers automotive, passengers 2-wheel, passengers aviation, passengers' marine, regional public transport, commercial, freight automotive, commercial freight aviation, commercial freight marine, commercial freight rail. Technologies that improve vehicle fuel efficiency are important for CO2 emission reductions.	(litre per gasoline equivalent (LGE)/100 km	1	7.3	Mitigation
Energy production with fossil fuels: Hard coal, Brown coal (Lignite), Oil, Natural Gas, Liquid Gas, Heating Oil	Env	The indicator provides information about the gross electricity production from fossil fuels. Primary energy supply is defined as energy production plus energy imports, minus energy exports.	TWh/year GWh/year or KTOE/year	1	7.2	Mitigation
Energy generated locally from renewable resources	Env	The indicator provides information about the gross electricity production from renewable sources. Renewables can include hydro, geothermal, solar, wind, tide and wave sources, biofuels, and energy recovered from municipal waste present in the site. The production of renewable electricity is part of the SECAP mitigation template and is used to calculate the final emissions of the city.	TWh/year GWh/year or KTOE/year		7.2	Mitigation
Percentage of total electricity production that comes from fossil	Env	The indicator provides information about the percentage of gross electricity production coming from fossil fuels. Primary energy	%	1	7.2	Mitigation

fuels (natural gas and oil, excluding coal)		supply is defined as energy production plus energy imports, minus energy exports.				
Percentage of renewable energy production Energy generated locally from renewable resources	Env	The indicator provides information about the percentage of gross electricity production coming from renewable sources. Renewables can include hydro, geothermal, solar, wind, tide and wave sources, biofuels, and energy recovered from municipal waste present in the site. The production of renewable electricity is part of the SECAP mitigation template and is used to calculate the final emissions of the city.	%	1	7.2	Mitigation
Energy recovery from solid municipal waste	Env	The energy recovery indicator reflects the amount of energy recovered from municipal waste generated. The production of renewable electricity is part of the SECAP mitigation template and is used to calculate the final emissions of the city.	kWh/ton of waste	1	7.3 9.4 12.5	Mitigation
Energy demand of the different industries: Iron & Steel, Cement, Chemicals & Plastics, Paper & Pulp, Ceramics, Oil Refinement	Env/ Tech	The indictor provides information about the energy demand of the following energy-intensive industries are considered to: food, pulp and paper, basic chemicals, refining, iron and steel, nonferrous metals (primarily aluminium), and non-metallic minerals (primarily cement). Together, they account for about half of all industrial sector delivered energy use. The indicator is relevant to monitor Tech development and efficiency in the plants to reduce CO_2 emission.	TWh/year	1	7.3	Mitigation
Energy demand of agriculture	Env/ Tech	The indictor provides information about the energy demand of the agricultural sector. Agricultural energy demand can be divided into direct and indirect energy needs. The direct energy needs include energy required for land preparation, cultivation, irrigation, harvesting, post-harvest processing, food production, storage and the transport of agricultural inputs and outputs. Agricultural energy demand can be divided into direct and indirect energy needs. The direct energy needs include energy required for land preparation, cultivation, irrigation, harvesting, post-harvest processing, food production, storage and the transport of agricultural inputs and outputs. The indicator is relevant to monitor Tech development and efficiency to reduce CO_2 emission.	TWh/year	1	7.3	Mitigation
Energy demand of buildings	Env/ Tech	The indictor provides information about building energy demand. The indicator is relevant to monitor Tech development and efficiency of the systems and retrofitting actions to reduce CO_2 emission.	TWh/year	1	7.3	Mitigation

Energy demand of residencies	Env/ Tech	The indictor provides information about energy demand by dwelling.	TWh/year	1	7.3	Mitigation
Energy demand of households for the different uses: appliances, lighting, air conditioning/ heating demand.	Env/ Tech	The indictor provides information about the energy demand if the main household uses.	TWh/year	1	7.3	Mitigation
Energy demand of transport.	Env/ Tech	The indictor provides information about the energy demand of the transport sector including passenger automotive, passenger 2-wheel, passenger aviation, passenger marine, commercial freight automotive, commercial freight aviation, commercial freight marine and commercial freight rail. The indicator is relevant to monitor Tech development and efficiency and to reduce CO2 emission.	TWh/year	1	7.3	Mitigation
Traffic modal split	Env	Modal split of passenger transport is defined as the percentage share of each mode of transport in total inland transport, expressed in passenger-kilometres (pkm). It is based on transport by passenger cars, buses and coaches, and trains.	%	1	11.2	Mitigation
Occupancy rate by modal split	Env	The indicator provides information about the average number of passengers in a vehicle (cars, buses, trains, and aircraft). Including: automotive, passenger 2-wheel, passenger aviation, passenger marine, commercial freight, commercial freight aviation, commercial freight marine, commercial freight rail. For commercial uses load factor is another relevant metric. Utilisation efficiency is one of the main parameters that determine energy and emission efficiency. Favouring high occupancy rates is usually evaluated as to reduce emissions.	Passengers per car, % of passenger seats occupied	1	11.2	Mitigation
Renewable sources installed capacity	Tech	The indicator estimates the maximum net amount of energy that a certain region can produce. Including: solar PV, onshore wind, offshore wind, nuclear, hydroelectric, geothermal, marine, CSP, biomass & biogas and district heating. The indicator is relevant to monitor Tech development, increase the renewable share and reduce CO2 emission.	GW or MW	1	7.2	Mitigation
Installed power (kW) per technology eligible for green certificates	Tech	The indicator provides information of the renewable energy produced that can be eligible for green certificates. A renewable energy certificate, or REC, is a market-based instrument that	kW or MW	1	7.2	Mitigation

		represents the property rights to the environmental, social, and other non-power attributes of renewable electricity generation.				
Total municipal (solid) waste generated (domestic and commercial)	Env	The indicator estimates the amount of municipal waste generated including households, commerce, offices, and public institutions weighted by the average population of the reference year. Municipal waste from industry and agriculture are not included. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system.	Thousand Tonnes	1	11.6 12.5	Mitigation
Kg of residual waste compared to number of citizens	Env	The indicator estimates the amount of municipal waste generated including households, commerce, offices, and public institutions weighted by the average population of the reference year. Municipal waste from industry and agriculture are not included. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system.	Kg per capita	1	11.6 12.5	Mitigation
Production of residual waste, PMC, paper, organic waste by the municipality	Env	The indicator estimates the amount of municipal waste generated including residual waste, PMC, paper, and organic waste, weighted by the average population of the reference year. Municipal waste from industry and agriculture are not included. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system.	Kg per capita	1	8.4 11.6	Mitigation
Hazardous waste generated per capita	Env	The indicator estimates the amount of hazardous municipal waste generated weighted by the average population of the reference year. Municipal waste from industry and agriculture are not included. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system.	Kg per capita	1	12.4	Mitigation
Proportion of urban solid waste with adequate final discharge out of total urban solid waste generated by cities	Env	The indicator estimates the percentage of urban solid municipal waste that is adequately discharged.	%	2	12.4 11.6	Mitigation

Number of kg selectively collected waste	Env	The indicator provides information about the selective collection, recycling and final processing of household and similar commercial waste, the value is weighted by the average population.	Kg/citizen	1	11.6 12.5	Mitigation
The percentage of solid waste dealt with in the following ways should be reported on: a) disposed to sanitary landfills; b) burnt in an open area; c) incinerated; d) disposed in an open dump; e) recycled; f) composted; g) digested; h) other (with regard to total amount of solid waste produced).	Env	The indicator breaks down waste disposal according to the different management operations. The percentage of solid waste dealt with in the following ways should be reported on: a) disposed to sanitary landfills; b) burnt in an open area; c) incinerated; d) disposed in an open dump; e) recycled; f) composted; g) digested; h) other (with regard to total amount of solid waste produced).	%	1	12.5	Mitigation
Proportion of hazardous waste treated, by type of treatment	Env	The indicator provides information about the disposal of hazardous waste according to the different management operations.	%	1	12.4	Mitigation
Number of deaths, missing, directly affected persons attr. to disasters	Env	This indicator measures the number of people who died, went missing or were directly affected by disasters per 100,000 population.	Rate, Nº deaths/ 100.000 inhabitants	2	1.5 11.5 13.1	Adaptation
Proportion of people who have to migrate to another region due to climate/natural hazards	Env	This indicator provides information about the percentage of people that due to environment hazards that adversely affected their living conditions or places, are forced to leave their habitual residence, and move to another region.	%	3	1.5 11.5	Adaptation
Mortality rate attributed to unintentional poisoning	Env	The indicator provides information on mortality patterns due to unintentional poisoning. It describes mortality in relation to the total population. Expressed in deaths per 100 000 inhabitants.	Rate: Nº of death/100.000 inhabitants	1	3.9	Adaptation

Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene	Env	The indicator provides information on mortality patterns attributed to unsafe water, unsafe sanitation and lack of hygiene. It describes mortality in relation to the total population. Expressed in deaths per 100 000 inhabitants.	Rate: Nº of death/100.000 inhabitants	2	3.9	Adaptation
Annual number of deaths attributed to excessive atmospheric pollution	Env	The indicator estimates the number of deaths that can be attributed to air pollution. It is calculated by first combining information on the increased (or relative) risk of a disease resulting from exposure, with information on how widespread the exposure is in the population (the annual mean concentration of particulate matter to which the population is exposed). This allows calculation of the 'population attributable fraction' (PAF), which is the fraction of disease seen in a given population that can be attributed to the exposure.	Number of deaths	2	3.9	Adaptation
Deaths from infectious diseases of the respiratory system	Env	The indicator estimates the number of deaths due to respiratory system. It describes mortality in relation to the total population in a given period.	Rate	2	3.9	Adaptation
Red List Index	Env	The Red List Index measures change in aggregate extinction risk across groups of species. It is based on genuine changes in the number of species in each category of extinction risk on The IUCN Red List of Threatened Species (IUCN 2015) is expressed as changes in an index ranging from 0 to 1.	Index ranging from 0 to 1.	2	15.5	Adaptation
Biodiversity index for native birds	Env	The indicator expresses the evolution of the populations of native and wild species (exotic and semi-domestic pigeons) of birds.	Index ranging from 0 to 1.	3	15.5	Adaptation
Population exposed to flood risk, flood prone population	Env	The indicator shows the number of people who are directly exposed to floods in a 1-in-100-year flood event, thus posing significant risk to lives and livelihoods.	Number of people	3	1.5 6.4 11.5	Adaptation
Urban Flood Risk or areas exposed to flooding	Env	The indicator shows the areas potentially exposed to flooding or in floodplains.	Area	3	11.5 13.1	Adaptation
Percentage of people exposed to more than 10 μg/m³ of PM2.5	Env	The indicator refers to population exposure to more than 10 micrograms/m3 and are expressed as annual averages.	%	1	11.6	Adaptation
Population exposed to NO2 concentration	Env	The indicator refers to population exposure to NO2 concentration.	%	2	11.6	Adaptation

Exposure of vulnerable people to Heat waves	Env	This indicator tracks the change in the number of heatwave exposure events (with one exposure event being one heatwave experienced by one person aged over 65 or child from birth to 1 year old) and days of heatwave exposure in these populations compared with the average number of events in the reference period (1986–2005).	Change in exposure events (million persons-day)	2	1.5 11.5	Adaptation
Soil sealing or artificial coverage		The indicator estimates the increase in sealed soil surfaces with impervious materials due to urban development and construction (e.g., buildings, constructions and laying of completely or partially impermeable artificial material, such as asphalt, metal, glass, plastic or concrete). This provides an indication of the rate of soil sealing when areas change land use towards artificial and urban land use.	Index	2	11.3 15.1 15.3	Adaptation
Implementation of Resilience Plan or disaster risk reduction strategy Sendai Framework for Disaster Risk Reduction	Inst/ Env	The indicator provides information of the implementation of risk and vulnerability assessments, financial (capital and operating) plans and technical systems for disaster mitigation addressing natural and human induced disasters and hazards in the cities or regions.	Qualitative (e.g. yes/no)	2	1.5 11.5 11.b 13.1 13.2	Adaptation
Whether or not the city has adopted and implemented local disaster risk reduction strategies	Inst/ Env	The indicator provides information of the implementation of risk and vulnerability assessments in line with national strategies.	Qualitative (e.g. yes/no)	2	1.5 11.5 11.b 13.1 13.2	Adaptation
Presence of regulations supporting biodiversity, soil and ecosystem health and/or regulating use of chemical inputs/sustainable farming practices	Inst/ Env	The indicator shows information related to the implementation of biodiversity regulation and the protection of soil and ecosystem health.	Qualitative (e.g. yes/no)	2	2.4 15.5	Adaptation
Is the city part of national, European, or international climate adaptation initiatives	Inst/ Env	The indicator shows information regarding the Signatory to the Covenant of Mayors initiative.	Qualitative (e.g. yes/no)	2	7.a 13.1 13.2	Adaptation

like the 'Covenant of Mayors for Climate and Energy'?						
The concept of 'corridors' or connected spaces for wildlife across the city is included in the action plans	Inst/ Env	The indicator provides information about the fragmentation of natural areas. It considers all the areas, which are not fragmented by artificial infrastructure.	Index	2	11.a 15.9	Adaptation
Expenditure on culture and nature by municipal administration per capita (preservation, protection, and conservation)	Inst/ Env	The indicator is calculated by dividing total public funding in heritage (i.e. including transfers paid but excluding transfers received) from government (central, regional, local) and the total of private funding from households, other private sources such as donations, sponsorships or international sources in a given year by the number of inhabitants and by the PPP$ conversion factor.	US Dollars constant PPP$ 2017 in unit	1	11.4	Adaptation
Proportion of agricultural area under productive and sustainable agriculture (or Share of agricultural land farmed organically / Share of eco-certified agricultural companies in the urban area or organic farming)	Env	This indicator measures progress in achieving more productive and sustainable agriculture. It is made up of relevant sub-indicators that will provide governments with strategic information for evidence-based policies.	%	2	2.4	Adaptation
Built-up Areas per Inhabitant or per capita (Residential, Industrial and Commercial areas)	Geo	The indicator provides information about the Built-up areas (roofed structures) per inhabitants.	Square meters per capita	1	11.3	Adaptation
Percentage of city area protected as natural sites	Env	The indicator provides information about the percentage of protected natural areas in the city.	%	2	11.4 15.5	Adaptation

Natural Areas in the City or urban green spaces	Env	The indicator provides information about the percentage of natural areas in the city.	%	1	11.4 11.7 15.1 15.2	Adaptation
Forest area	Env	The indicator measures the proportion of forest ecosystems in comparison to the total land area. Data used for this indicator is derived from the Land Use and Cover Area frame Survey (LUCAS). It is connected to SDG target 15.1 and 15.2	%	1	15.1 15.2	Adaptation
Exposure of people to climate hazards (cold waves, heavy precipitation, droughts, storms, mass movement, forest fires, heat island effect)	Env	New indicator with the aim of establishing the vulnerability of population to climate hazards in a certain region. The methodology must be defined, there are similar indicators such as population living in hazard prone areas or mortality risk associated to hazards.	To be defined	3		Adaptation
Hazards current probability (heat and cold waves, floods, droughts, precipitation, storms, mass movement, wildfires, chemical change, and biological hazards)	Env	New indicator with the aim of assessing and evaluating climatic hazards in the regions and adaptation measures needed, the methodology to establish the values must be defined.	Four values: Low, moderate, high, not known	3	13.1	Adaptation
Hazards impact (heat and cold waves, floods, droughts, precipitation, storms, mass movement, wildfires, chemical change, and biological hazards)	Env	New indicator with the aim of assessing and evaluating climatic hazards in the regions and adaptation measures needed, the methodology to establish the values must be defined.	Four values: Low, moderate, high, not known	3	13.1	Adaptation
Hazards expected change in intensity (heat and cold waves, floods, droughts,	Env	New indicator with the aim of assessing and evaluating climatic hazards in the regions and adaptation measures needed, the methodology to establish the values must be defined.	Four values: Low, moderate,	3	13.1	Adaptation

precipitation, storms, mass movement, wildfires, chemical change, and biological hazards)			high, not known			
Hazards expected change in frequency (heat and cold waves, floods, droughts, precipitation, storms, mass movement, wildfires, chemical change, and biological hazards)	Env	New indicator with the aim of assessing and evaluating climatic hazards in the regions and adaptation measures needed, the methodology to establish the values must be defined.	Four values: increase, decrease, no change, not known	3	13.1	Adaptation
Hazards timeframe (heat and cold waves, floods, droughts, precipitation, storms, mass movement, wildfires, chemical change, and biological hazards)	Env	New indicator with the aim of assessing and evaluating climatic hazards in the regions and adaptation measures needed, the methodology to establish the values must be defined.	Four values: current, short-term, medium-term, long-term, not known	3	13.1	Adaptation

3.2. Citizens and local communities

Table 3: Proposed mitigation and adaptation indicators for citizens

Indicator name	Category	Indicator short description	Metric	Tier level	Covered in SDG	Indicator type
Mitigation and adaptation indicators relevant for citizens						
1) Climate Change Effects (CCE)						
Number of deaths, missing persons and persons affected by disaster per 100,000 people	Soc	This indicator measures the number of people who died, went missing or were directly affected by disasters per 100,000 population. Focus on poor and vulnerable groups needed. The ideal disaggregation level: by sex, age, class, (dis)ability, health and pregnancy);	Rate, Nº deaths/ 100.000 inhabitants	2	1.5 11.5 13.1	Exposure & Vulnerability
Heating degree-days needed to maintain an average building indoor temperature of 15.5 degree Celsius	Soc	This indicator measures the total effort needed to keep a decent indoor temperature / exposure to cold temperatures.	Degrees times days	1	13.2	Exposure & Vulnerability
Cooling degree-days needed to maintain an average building indoor temperature of 22 degree Celsius	Soc	This indicator measures the total effort needed to keep and decent indoor temperature / the exposure to hot temperatures	Degrees times days	1	13.2	Exposure & Vulnerability
Current hazard risk level of cool waves	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Current hazard risk level of heat waves	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Current hazard risk level of floods and sea level rise	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure

Current hazard risk level of heavy precipitation	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Current hazard risk level of droughts and water scarcity	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Current hazard risk level of mass movement	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Current hazard risk level of forest fire	Soc	Exposure to a risk of a certain hazard leads to higher vulnerability.	Low/ mod/ high/	2	13.2	Exposure
Share of imports of staple food	Econ	Measures the dependency on other economies. Scarcity (and price) of staple food poses risk.	%	2	2.4	Vulnerability
Share of people who have/had to migrate to another region due to natural hazards	Soc	New indicator; available indicators on forced migration focus on international migration. High hazard risk areas might force people to move to other regions too.	%	3	11.1 11b	Vulnerability
Percentage of population with access to at least 1 hectare of green urban areas (parks) and forests within 15 minutes of walking	Soc	Indicator measures the access to basic goods and the chance to satisfy basic needs.	%	2	11.7	Adaptation
2) Effects Of Measures and Policies (EOM)						
Gender pay gap	Soc	This indicator is defined as the difference between the average gross hourly earnings of men and women expressed as a percentage of the average gross hourly earnings of men. Disaggregation needed by age, highest education and income (class).	% (share of male gross earning)	2	5.1	Vulnerability

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Gender Pension Gap	Soc	This indicator the percentage by which women's average pension income is higher or lower compared with men. Pension income includes old age benefits, survivors' benefits as well as regular pensions from individual private plans. Disaggregation needed by age, highest education and income (class).	%	2	5.1	Vulnerability
Tenancy	Soc	Distribution of population by tenure status, type of household and income group	%	2	11.1	Vulnerability
Health situation	Soc	How many days of sick leave, or share of disabled people.	Days/%	2	3.8	Vulnerability
Migration index	Soc	Share of people with mother tongue other than official administrative language. Language skills (host country language) by migration status and citizenship	%	2	10.2, 10.3	Exposure & Vulnerability
Crime level	Soc	Percentage of people who declared they had faced the problem of crime, violence or vandalism in the local area	%	2	16.1, 16.2, 16.3	Exposure
Access to internet	Tech	Internet access is defined as the percentage of households who have access to the Internet. It might be via smartphones or personal computer, using a dial-up or cable broadband access.	Index (0-1)	2	9.c	Vulnerability
Gini-Index	Soc	This indicator measures the (in)equality of income in society.	Index (0-1)	2	5.a	Vulnerability
Age groups	Soc	Distribution of age groups, Demographic change in Europe.	%	3	-	Demography
Unemployment rate	Soc	Measures the share of people without formal income. Unemployment poses risk. Disaggregation needed by sex, age, disabilities, education.	%	1	8.3 8.6	Vulnerability
Percentage of single households	Soc	This indicators shows, how many people are living alone. Data on households by type is available.	%	2	-	Demography
Percentage of population satisfied with the quality of public transportation	Soc	Indicator measures the access to basic goods and the chance to satisfy basic needs.	%	2	11.2	Satisfaction & Quality of Life
Access to public transport	Soc	Indicator measures the access to basic goods and the chance to satisfy basic needs.			11.2	Mitigation

Percentage of population satisfied with quality of air	Soc	This indicator measures perceived air quality. Decarbonisation policies must not worsen living circumstances for the population or certain groups. Disaggregation is needed by: sex, age, income, disabilities.	%	2	11.6	Satisfaction & Quality of Life
Social housing availability: Social housing share compared to total housing stock of main residencies	Soc	This indicator measures affordable housing. Decarbonisation policies must not worsen living circumstances for the population or certain groups. Disaggregation is needed by: sex, age, income, disabilities.	%	2	1.4, 11.1	Satisfaction & Quality of Life
Whether or not the city has adopted and implemented local disaster risk reduction strategies in line with national disaster risk reduction strategies	Inst/ Env	The indicator provides information of the implementation of risk and vulnerability assessments in line with national strategies.	Qualitative (e.g. yes/no)	2	1.5 11.5 11.b 13.1 13.2	Adaptation
Share of the total green area of the city/municipality	Soc	Measures the chance for citizens to use green and public spaces. Needs to be broken down to: accessible for all/people with disabilities, safe for women and children	%	3	11.7, 15.2	Adaptation
Air quality index (AQI) based on reported value for: Particulate matter (PM10, and PM2.5), NO2 (nitrogen dioxide), SO2 (sulphur dioxide), O3 (ozone)	Soc	This indicator measures air quality. Decarbonisation policies must not worsen living circumstances for the population or certain groups. Disaggregation is needed by: sex, age, income, disabilities.	Index	2	1.6	Exposure
Share of jobs in environmental industries	Soc	Measures the positive outlook for jobs, if environmentally friendly policies are implemented.	%	1	8.3	Vulnerability

Performance of public transport network, ratio between accessibility and proximity to people	Soc	This indicator provides information on the quality of the public transport network.	Index	2	11.2	Mitigation
Performance of car transport network, ratio between accessibility and proximity to people	Soc	This indicator provides information on the quality of the public transport network.	Index	2	11.2	Mitigation
Proportion of population with access to electricity	Soc	Indicator measures the access to basic goods and the chance to satisfy basic needs.	%	2	7.1	Vulnerability
Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed	Soc	New indicator; proxy measure for the level of knowledge and awareness on environment and global justice issues.	Index	3	4.7, 13.3.1	Vulnerability
3) Acceptance of Adaption/Mitigation Measures and Policies (AOM)						
Education Index	Soc	This index, as part of the Human Development Index, measures the educational attainment. Disaggregated by gender	Index	2	4.3 4.5. 13.3	Vulnerability
Income	Soc	This indicator measures the wealth and is a proxy measure for well-being. Disaggregation needed by gender, age, disabilities, education level	Euro (or categories)	1	10.1	Demography
Age (median)	Soc	This indicator provides information on who "old" or "young" the citizens of the respective region are.	Years	1	-	Demography
Political left-right self-placement	Soc	This indicator provides information on the political values held in the public. Disaggregation needed by age and gender.	Index (0-100) (EVS)	2	4.7	Political/ Attitudes

Political trust: confidence in government / parties / parliament	Soc	Political trust is a fundamental component of civic culture. It is crucial to the functioning of democratic systems and linked to compliance. Disaggregation needed by age and gender.	Index (0-100) (EVS)	2	4.7	Political/ Attitudes
Opinion: Impact of climate change will be very bad on people across the world	Soc	This index provides information on how climate change is considered. Disaggregation needed by age and gender.	Index (0-100) (EVALVE)	2	13.3	Political/ Attitudes
Attitudes towards (sexual) minorities	Soc	Tolerance towards minorities; Percentage of people who claimed that they live in a good place for minorities from other countries / European Social Progress Index	-	-	10.2	Political/ Attitudes
Post-materialist index	Soc	This constructed variable provides information on respondents' political attitudes towards political freedom, participation, care for the environment a.o. Disaggregation needed by age and gender.	Qualitative (dis/agreement to statements)	2	-	Political/ Attitudes
Political action	Soc	Provides information on whether respondents have participated in political actions other than voting, for instances: signing a petition, joining in boycotts, attending lawful/ peaceful demonstrations, or joining unofficial strikes.	Qualitative (have done/ might do/ would never do)	2	-	Political/ Attitudes
Membership in voluntary organizations	Soc	This variable describes membership in voluntary organizations belonging to the sectors of conservation, the environment, ecology, animal rights/ environmental organizations.	Qualitative (active/ non active/ not member) EVS	2	-	Political/ Attitudes

3.3.   Businesses

Table 4: Proposed mitigation and adaptation indicators for businesses

Indicator name	Cate gory	Indicator short description	Metric	Tier level	Covered in SDG	Indicator type
Mitigation and adaptation indicators relevant for businesses						
Manufacturing						
Energy						
Energy demand of the different industries: Iron & Steel, Cement, Chemicals & Plastics, Paper & Pulp, Ceramics, Oil Refinement	Tech	The indictor provides information about the energy demand of the following energy-intensive industries are considered to: food, pulp and paper, basic chemicals, refining, iron and steel, nonferrous metals (primarily aluminium), and non-metallic minerals (primarily cement). Together, they account for about half of all industrial sector delivered energy use.	MWh/unit of output	1	7.3	Exposure
Imported energy dependency in manufacturing	Tech	This indicator shows the portion of energy demand in manufacturing which comes from imported sources such as Russian natural gas	Level (High-Medium-Low)	3	7.3	Vulnerability
Energy saving measures in manufacturing	Tech	This indicator shows the relative reduction in energy demand due to the introduction of energy saving measures during the manufacturing process including the adoption of new technologies, alternating working hours or manufacturing procedures	Level (High-Medium-Low)	3	7.3	Response/Re silience
Energy input diversification in manufacturing	Tech	This indicator shows the portion of energy demand in manufacturing which comes from renewable sources including wind, solar, hydro	Level (High-Medium-Low)	3	7.2	Response/Re silience
Labour						

Size of workforce in manufacturing	Inst	The indictor provides information about the number of employees in manufacturing	Person/unit of output	1	8.5	Exposure
Share of low-skilled labour	Inst	The indictor provides information about the portion of low-skilled employees in manufacturing	Level (High-Medium-Low)	3	8.5	Vulnerability
Automation measures in manufacturing	Tech	This indicator shows the relative reduction in labour force due to the introduction of automation measures during the manufacturing process including the adoption of new technologies, digitalization initiatives, and other automation procedures	Level (High-Medium-Low)	3	8.5	Response/Resilience
Input/Output						
Total manufacturing output	Tech	The indictor provides information about the amount of manufactured goods	unit of output	1	12.1	Exposure
Imported key raw material used in manufacturing	Tech	The indictor provides information about the key raw material used in manufacturing	Kg/unit of output	3	12.2	Vulnerability
Material input diversification in manufacturing	Tech	This indicator shows the portion of key raw material in manufacturing which can be procured from domestic/local sources	Level (High-Medium-Low)	3	12.2	Response/Resilience
Emissions						
Emissions from manufacturing	Geo	The indictor provides information about the total CO_2 emissions from manufacturing	Kg CO_2/unit of output	2	9.4	Exposure
Fossil fuel energy demand in manufacturing	Tech	This indicator shows the portion of energy demand in manufacturing which comes fossil fuel sources	Level (High-Medium-Low)	2	9.4	Vulnerability
Technology diversification in manufacturing	Tech	This indicator shows the portion of emissions from manufacturing which can be avoided using cleaner technologies	Level (High-Medium-Low)	3	9.4	Response/Resilience
Location						

Flooding probability of manufacturing activities	Env	This indicator shows the relative change in the probability of manufacturing activities being flooded due to climate change	Level (High-Medium-Low)	3	13.1	Exposure
Proximity of manufacturing activities to rivers	Env	The indictor provides information about the location of manufacturing activities in relation to bodies of water	Level (High-Medium-Low)	2	13.1	Vulnerability
Protective measures in manufacturing against flood and rain	Tech	This indicator shows the relative change in manufacturing activities to provide protection against flood	Level (High-Medium-Low)	3	13.1	Response/Resilience
Transportation						
Energy						
Energy demand in transportation	Tech	The indictor provides information about the energy demand of transportation sector	MJ/Km	1	7.3	Exposure
Imported energy dependency in transportation	Tech	This indicator shows the portion of energy demand in transportation which comes from imported sources such as Middle Eastern oil	Level (High-Medium-Low)	3	7.3	Vulnerability
Energy saving measures in transportation	Tech	This indicator shows the relative reduction in energy demand due to the introduction of energy saving measures in transportation including the adoption of more energy efficient technologies	Level (High-Medium-Low)	3	7.3	Response/Resilience
Energy input diversification in transportation	Tech	This indicator shows the portion of energy demand in transportation which comes from renewable sources including wind, solar, hydro	Level (High-Medium-Low)	3	7.2	Response/Resilience
Labour						
Size of workforce in public transportation	Inst	The indictor provides information about the number of employees in public transportation	Person/Km	1	8.5	Exposure
Share of low-skilled labour	Inst	The indictor provides information about the portion of low-skilled employees in public transportation	Level (High-Medium-Low)	3	8.5	Vulnerability

Automation measures in transportation	Tech	This indicator shows the relative reduction in labour force due to the introduction of automation measures in transportation including the adoption of autonomous vehicles, car sharing, and other mobility initiatives.	Level (High-Medium-Low)	3	8.5	Response/Resilience
Emissions						
Total transportation output	Tech	The indictor provides information about the output of transportation	Km travelled	1	11.2	Exposure
Emissions from transportation	Geo	The indictor provides information about the total CO2 emissions from transportation	Kg CO2/Km	2	9.4	Exposure
Fossil fuel energy demand in public transportation	Tech	This indicator shows the portion of energy demand in public transportation which comes fossil fuel sources	Level (High-Medium-Low)	2	9.4	Vulnerability
Technology diversification in transportation	Tech	This indicator shows the portion of emissions from transportation which can be avoided using cleaner technologies	Level (High-Medium-Low)	3	9.4	Response/Resilience
Location						
Flooding probability of transportation routes	Env	This indicator shows the relative change in the probability of transportation routes being flooded due to climate change	Level (High-Medium-Low)	3	13.1	Exposure
Proximity of transportation routes to rivers or seas	Env	The indictor provides information about the location of transportation routes in relation to bodies of water	Level (Close-Far)	2	13.1	Vulnerability
Protective measures in transportation against flood and rain	Tech	This indicator shows the relative change in transportation activities to provide protection against flood	Level (High-Medium-Low)	3	13.1	Response/Resilience
Agriculture						
Energy						

Energy demand of agriculture	Tech	The indictor provides information about the energy demand of the agricultural sector. Agricultural energy demand can be divided into direct and indirect energy needs. The direct energy needs include energy required for land preparation, cultivation, irrigation, harvesting, post-harvest processing, food production, storage and the transport of agricultural inputs & outputs. Agricultural energy demand can be divided into direct and indirect energy needs. The direct energy needs include energy required for land preparation, cultivation, irrigation, harvesting, post-harvest processing, food production, storage and the transport of agricultural inputs/ outputs.	MWh/unit of output	1	7.3	Exposure
Imported energy dependency in agriculture	Tech	This indicator shows the portion of energy demand in agriculture which comes from imported sources such as Middle Eastern oil	Level (High-Medium-Low)	3	7.3	Vulnerability
Energy saving measures in agriculture	Tech	This indicator shows the relative reduction in energy demand due to the introduction of energy saving measures during the agricultural process including the adoption of new technologies and practices	Level (High-Medium-Low)	3	7.3	Response/Resilience
Energy input diversification in agriculture	Tech	This indicator shows the portion of energy demand in agriculture which comes from renewable sources including wind, solar, hydro	Level (High-Medium-Low)	3	7.2	Response/Resilience
Labour						
Size of workforce in agriculture	Inst	The indictor provides information about the number of employees in agriculture	Person/unit of output	1	8.5	Exposure
Share of low-skilled labour	Inst	The indictor provides information about the portion of low-skilled employees in agriculture	Level (High-Medium-Low)	3	8.5	Vulnerability
Automation measures in agriculture	Tech	This indicator shows the relative reduction in labour force due to the introduction of automation measures during the agricultural	Level (High-Medium-Low)	3	8.5	Response/Resilience

		process including the adoption of new technologies, digitalization initiatives, and other automation procedures				
Water						
Water demand in agriculture	Tech	This indicator shows the amount of water needed for producing a unit of output in agriculture	m3/unit of output	2	6.4	Exposure
Dependence of agricultural products to water	Tech	This indicator shows the amount of water needed for producing a unit of output in agriculture	Level (High-Medium-Low)	3	6.4	Vulnerability
Water saving measures in agriculture	Tech	This indicator shows the relative reduction in water demand due to the introduction of water saving measures during the agricultural process including the adoption of new technologies and practices	Level (High-Medium-Low)	3	6.4	Response/Resilience
Production						
Suitable temperature for agriculture	Tech	The indictor provides information about the best range of temperature for agricultural production	range (degree C)	3	2.4	Exposure
Imported fertilizers used in agriculture	Tech	The indictor provides information about fertilizers used in agriculture	Kg/unit of output	3	2.4	Vulnerability
Crop diversification in agriculture	Tech	This indicator shows the portion of crops in agriculture which can be changed due to climate change	Level (High-Medium-Low)	3	2.4	Response/Resilience
Emissions						
Total agriculture output	Tech	The indictor provides information about the amount of agricultural goods	unit of output	1	2.4	Exposure
Emissions from agriculture/land use change	Geo	The indictor provides information about the total CO2 emissions from agriculture	Kg CO2/unit of output	2	9.4	Exposure

Agricultural land demand	Env	The indictor provides information about the amount of land needed for agriculture	m2/unit of output	2	2.4	Vulnerability
Technology diversification in agriculture	Tech	This indicator shows the portion of emissions from agriculture which can be avoided using cleaner technologies	Level (High-Medium-Low)	3	9.4	Response/Resilience
Location						
Flooding probability of agricultural activities	Env	This indicator shows the relative change in the probability of agricultural activities being flooded due to climate change	Level (High-Medium-Low)	3	13.1	Exposure
Proximity of agriculture activities to rivers or seas	Env	The indictor provides information about the location of agricultural activities in relation to bodies of water	Level (Close-Far)	2	13.1	Vulnerability
Protective measures in agriculture against flood and rain	Tech	This indicator shows the relative change in agricultural activities to provide protection against flood	Level (High-Medium-Low)	3	13.1	Response/Resilience

4. Conclusions

Effective climate policy aimed at reducing the risks of climate change to natural and human systems involves a portfolio of diverse adaptation and mitigation actions. To strengthen the important role of regions in climate actions, and stimulate wide stakeholders' engagement including citizens and businesses, we propose an integrated approach in mitigation and adaptation actions.

In this deliverable we presented a first set of proposed mitigation and adaptation indicators needed for each target group within the project. In order to succeed, it is both necessary to understand the specific user information needs of final LOCALISED tools and services, as well as their expectations. In dedicated meetings at projects meetings with city partners involved in the project, the early outreach to associated partners of business associations and desk research on mitigation and adaptation actions lead to the proposed mitigation and adaptation indicators (see chapter 3).

At this time of the project, the set of indicators may be too broad and exhaustive, however it represents a well justified and formulated "wish list" of indicators to be used in the project. The categorisation into tier levels already showed limitations, both on the methodological approach and the potential data availability, further research will aim finding solutions and suggest new (combined) indicators to be investigated.

The methodological approach and detailed description of indicators, including feedback from the engagement process with stakeholders, will be part of respective deliverables to come in the project. The identification, selection and implementation of indicators is an ongoing activity, this report an undertaking to harmonise them and to check the availability of data.

By submitting this deliverable, the work on the identification, selection and justification on mitigation and adaptation indicators will not come to an end. It may be updated for internal use and to deepen the work on interconnections between various tasks and work packages. It also provides the basis for "matching" key performance indicators derived from the European Calculator and the measures and actions coming from stakeholders.

5. References

Firus, K., et al. (2022). Dissemination and communication strategy (LOCALISED Deliverable 9.1).

Landauer, M., Juhola, S. & Söderholm, M. Inter-relationships between adaptation and mitigation: a systematic literature review. Climatic Change 131, 505–517 (2015). https://doi.org/10.1007/s10584-015-1395-1.

Hezel, B., Broschkowski, E., Lamberty, R., Firus, K., Shayegh, S. (2022), Stakeholder interaction methodology and schedule (LOCALISED Deliverable 8.1).

Taylor, A., J. Downing, B. Hassan, F. Denton and T.E. Downing, 2007: Supplementary material to chapter 18: Inter-relationships between adaptation and mitigation. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

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