2.2. Energy use savings due to green infrastructure implementation

Project Name: URBAN GreenUP (Grant Agreement no. 730426)

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Savings in energy use due to improved green infrastructure	**Climate Resilience**
Description and justification	The energy sector is the largest single source of global greenhouse gas emissions, and is responsible for over a quarter of all EU greenhouse gas emissions (European Commission). Green Infrastructure can play a role in reducing the negative impacts of the energy sector, by: (1) reducing energy consumption; (2) providing bioenergy; and (3) providing carbon uptake and storage. The KPI presented aims at quantifying both the energy savings and the bioenergy generated by all the NBS implemented in Valladolid. This KPI will be calculated converting into energy savings the benefits already considered by means of other KPIs. Therefore, in this KPI, all the NBS that provide an ecosystem service which has a direct link to an energy saving or the ones that generate electricity themselves will be considered.
Definition	This KPI is calculated from measured data using a methodology defined by URBAN GreenUP Project. Energy savings due to improved Green Infrastructure (ESGI) will be calculated by converting other KPIs (BASE KPIs, with other units of measurement) into its associated energy saving. Accordingly, from the complete list of KPIs measured at Valladolid DEMOSITE, the ones that imply an energy saving will be considered.
Strengths and weaknesses	- This KPI gives an overview of the direct and indirect energy savings - This KPI requires the management of large amounts of data. - The accuracy of the output will depend on the baseline data and the conversion factors
Measurement procedure and tool	The initial step is the selection of the KPIs that either directly or indirectly generate energy savings (BASE KPI). As an example, at one particular site in the URBAN GreenUP project the following KPIs were selected: tons of carbon

removed or stored per unit area per unit time, energy savings from reduced building energy consumption, temperature reduction in urban areas, intercepted rainfall, water for irrigations purposes or water removed from water treatment system. Once these KPIs are identified, they can be converted into their corresponding energy savings. Initially, units have to be harmonized to the same timescale (referred to the same period of time; daily, monthly, annually).This harmonization will be conducted considering constant values along the time (either if the time should be extended or reduced) as indicated in the table.

	BASE KPI	CONVERSION	TIMESCALE CONVERTED KPI
EXTENSION	m^3/month	BASE KPI x 12 months	m^3/year
REDUCTION	m^3/5 years	BASE KPI/5	m^3/year

Once all the BASE KPIs have the same timescale, their corresponding energy savings will be calculated. Each one of the BASE KPIs considered for this calculation is given in different primary units. Therefore, for the calculation of their associated energy savings, when required, they will be converted into energy units by means of specific conversion factors.

Accordingly, the factors required to convert the primary units into energy units are the ones stablished in the table.

CONVERSION FACTOR	CF_i	Units CF_i
Conversion factor from CO_2 to energy	CF_{CO2}	$kWh/kgCO_2$
Energy consumption per cubic meter of wastewater transported and treated by the municipal wastewater treatment plant	CF_{WW}	KWh/m^3
Energy consumption per cubic meter of potable water (including transport)	CF_{PW}	KWh/m^3
Energy consumption per cubic meter of irrigation water (including transport)	CF_{IW}	KWh/m^3
Energy consumption per cubic meter of wastewater transported and treated by the municipal wastewater treatment plant	CF_{WW}	KWh/m^3

These conversion factors will be provided by the different stakeholders. Once the conversion factors are stablished, energy savings due to improved green infrastructure for each

	specific BASE KPI (KPI_i) will be calculated following the expression: $$ESGI_{KPIi} = BASE\_KPI_i \cdot CF_i$$ **RESULTS** To calculate the final value of the ESGI KPI ($ESGI_{tot}$), and only once all the BASE KPIs are converted into their associated energy savings per period of time ($ESGI_{KPIi}$), all the energy savings will be summed up according to the following expression: $$ESGI_{tot} = \sum_i ESGI_i$$
Scale of measurement	City / neighbourhood
Data source	
Required data	It is measured at the level of the related Demo Sites.
Data input type	See tables above.
Data collection frequency	Annually.
Level of expertise required	Technical / Expert
Synergies with other indicators	<table><tr><th>Key performance indicator</th><th>Primary units</th></tr><tr><td>Tons of carbon removed or stored per unit area per unit time</td><td>$tCO_2/m^2 \cdot y$</td></tr><tr><td>Energy savings from reduced building energy consumption</td><td>kWh/y</td></tr><tr><td>Temperature reduction in urban areas</td><td>% energy reduction</td></tr><tr><td>Intercepted rainfall per period of time</td><td>m^3/y</td></tr><tr><td>Water for irrigations purposes</td><td>$m^3/ha/y$</td></tr><tr><td>Volume of water removed from water treatment system</td><td>m^3/y</td></tr></table>
Connection with SDGs	SDG3 / SDG4 / SDG8 / SDG10 / **SDG11**
Opportunities for participatory data collection	--
Additional information	
References	URBAN GreenUP Deliverable D2.4 - Monitoring program to Valladolid.

	https://www.urbangreenup.eu/insights/deliverables/d2-4---monitoring-program-to-valladolid.kl URBAN GreenUP Deliverable D3.4 - Monitoring program to Liverpool https://www.urbangreenup.eu/insights/deliverables/d3-4---monitoring-program-to-liverpool.kl URBAN GreenUP Deliverable D4.4 – Monitoring program to Izmir https://www.urbangreenup.eu/insights/deliverables/d4-4--monitoring-program-to-izmir.kl URBAN GreenUP Deliverable D5.3: City Diagnosis and Monitoring Procedures https://www.urbangreenup.eu/insights/deliverables/d5-3-city-diagnosis-and-monitoring-procedures.kl European Commission. Green infrastructure in the Energy sector.

2.3. Estimated carbon emissions reduction from building energy saving - cooling

Project Name: URBAN GreenUP (Grant Agreement no. 730426)

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Reduction in carbon emissions from building energy saving - cooling	**Climate Resilience**
Description and justification	GI-Val is The Mersey Forest's green infrastructure valuation toolkit. The current prototype is free and open source, and can be downloaded under a Creative Commons License from: https://www.merseyforest.org.uk/services/gi-val/. It takes the form of a spreadsheet calculator and a user manual. GI-Val Tool 1.6 can estimate reduced carbon emissions from building energy saving due to the cooling impact of nature-based solutions. It uses data from the US and UK to estimate energy, fuel cost and CO_2 savings as a result of having trees around buildings. An independent assessment of GI Val by the Ecosystems Knowledge Network is available from this link, along with