BOOKLET

Decision–Making and Sustainability Assessment System: Case Studies in the MED area

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Cooperating across borders in the Mediterranean

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Sustainable MED Cities

Sustainable MED Cities - Integrated Tools and Methodologies for Sustainable Mediterranean Cities, is a capitalization project whose main objective is to enhance the capacity of public administration in delivering, implementing and monitoring efficient measures, plans and strategies to improve the sustainability of cities, neighbourhoods and buildings.

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INTRODUCTION

INTEGRATED TOOLS AND METHODOLOGIES FOR SUSTAINABLE MEDITERRANEAN CITIES

This booklet shows the results of the application of a decsion making methodology for the sustainable built environment in Mediterranean region, the cities of Sousse, Moukhtara, and Irbid are the ones which will lead this pilot. This approach, comprising seven distinct phases - initiation, preparation, diagnosis, strategic definition, retrofit scenarios, decision-making, and retrofit concept - forms the backbone of their concerted efforts to create urban and building developments facing 10 different issues .

The first phase, initiation, marks the genesis of their commitment to sustainability, setting the stage for a transformative journey. As the cities progress into the preparation phase (Phase 2), they employ context-specific tools such as the Sustainable Neighborhood Tool (SNTool) and Sustainable Building Tool (SBTool). These tools, tailored to the unique characteristics of each neighborhood or building, lay the groundwork for a meticulous examination of existing structures and infrastructure.

Integral to this methodology is the active engagement of stakeholders throughout the process. Each phase incorporates Participatory Guarantee System (PGS) online, fostering inclusivity by providing stakeholders with decision-making opportunities. This ensures that the voice of the community, encompassing residents, businesses, and local authorities, resonates in shaping the sustainable trajectory of their urban environments.

Moving forward, the diagnosis phase scrutinizes existing challenges and opportunities, paving the way for strategic definition (Phase 4). In this phase, cities outline their sustainability goals and visions, aligning them with the unique cultural and contextual nuances.

Retrofit scenarios (Phase 5) serve as a pivotal juncture, allowing cities to explore diverse pathways towards sustainability. These scenarios become the canvas upon which Sousse, Moukhtara, and Irbid envision transformative changes in areas such as energy efficiency, economic resilience, and mobility.

The decision-making phase (Phase 6) synthesizes the collective input gathered from stakeholders and the outcomes of the previous phases, steering the cities towards informed choices in pursuit of a sustainable built environment. Finally, the retrofit concept (Phase 7) crystallizes these decisions into actionable plans, providing a blueprint for the holistic transformation of urban spaces.

The outcomes of this ambitious project extend beyond theoretical frameworks. By evaluating their performance across multiple domains, including energy, economy, and mobility, these cities have not only measured their success but have also demonstrated tangible improvements. Through innovative scenarios, they envision futures where their cities are resilient, vibrant, and emblematic of sustainable urban living.

In essence, the journey undertaken by Sousse, Moukhtara, and Irbid exemplifies a paradigm shift in urban planning, showcasing how a meticulously structured methodology like Sustainable Built Environment can pave the way for cities to flourish sustainably while honoring their unique identities.

Andrea Moro

WP3 Coordinator
iiSBE Italia R&D

1. Irbid case study

A Jordan City

Phase 1: Initiation

Irbid SNTool

Selection of the urban area:

Total Study area : 0.96 km2

Residential land use prevails as the dominant land use in the study area.

There is a scarcity of green areas within the study area, represented by just a single parcel accounting for less than 1% of the total area.

The built-up area constitutes 83% of the total study area.

The study area is surrounded by four vital roads:

1. King Abdullah II street
2. Makkah Al Mukarrmah street
3. Baghdad street
4. Ratib al Batayenah street

Involvement of multiple stakeholders such as:

Ministry of Public Works and Housing (MPWH)

Ministry of Planning and International Cooperation (MOPIC)

Municipalities (including GAM and GIM)

National Building Council (NBC)

Ibird SBTool Chamber of commerce

Selection of the building:

Irbid Chamber of Commerce

Year of construction:

1998

Number of levels above earth:

4

Number of levels underground:

1

Heating system:

Inverter AC

Cooling system:

Fans+natural cooling + Inverter AC units + Free air diffuser

DHW system:

Electrical boilers + Instant electric heating water faucet and shower

Ventilation system:

Natural ventilation

Lighting System:

LED+ Fluorescent tube+ Halogen lamp

Average U value: 0.57 W/m^2 K for walls

Number of occupants: 1000 visitors + 60 Workers

Ibird SBTool Residential buildings

Selection of the building:

Level of degradation of the building

The building is recently built with average standards , limestone facades with glass façade windows

Owner

Multi family ownership

Year of construction

2010

Building method

Stone and Concrete structure

Number of levels above earth

4

Number of levels underground

1

Number of occupants

9 households

Hours of occupation per year

365

SNTool Contextualization

Issue	Priority factor	Weight
A. Use of land and biodiversity	3	7.9%
B. Energy	5	13.2%
C. Water	4	10.5%
D. Solid waste	5	13.2%
E. Environmental quality	3	7.9%
F. Transportation and mobility	4	10.5%
G. Social aspects	4	10.5%
H. Economy	5	13.2%
I. Climate change	3	7.9%
J. Governance	2	5.3%

Categories and criteria weights

Code	Category	Priority factor	Weight
B1	Energy infrastructure	5	33.3%
B2	Energy consumption	5	33.3%
B3	Renewable energy	5	33.3%
C1	Water infrastructure	4	30.8%
C2	Water consumption	5	38.5%
C3	Effluents management	4	30.8%

SBTool Contextualization for Irbid chmaber of commerce and residential Building

Issue	Priority factor	Weight
A. Site regeneration and development	5	16.1%
B. Energy and resources consumption	5	16.1%
C. Environmental loadings	3	9.7%
D. Indoor environmental quality	4	12.9%
E. Service Quality	3	9.7%
F. Social, cultural and perceptual aspects	4	12.9%
G. Costs and economic aspects	4	12.9%
H. Adaptation to climate change	3	9.7%

Categories and criteria weights

Code	Category	Priority factor	Weight
B1	Energy	5	26.3%
B2	Electrical peak demand	5	26.3%
B3	Materials	4	21.1%
B4	Use of potable water, stormwater and potable water	5	26.3%
D1	Indoor air quality and ventilation	5	33.3%
D2	Air temperature and relative humidity	5	33.3%
D3	Daylight and ilumination	5	33.3%

SNTool Benchmarks

A. Use of land and biodiversity

Indicator	Unit of measure	Benchmark	Rationale
Total area of green in the city divided by neighborhoods total population	m^2/inhabitant	0: (0.48)	Current average within Irbid Greater Municipality borders Ref: Irbid Spatial Profile 2022, UN-Habitat
		5: (11.25)	Suggested according to LEED v4.1 Cities - Plan & Design

B. Energy

Indicator	Unit of measure	Benchmark	Rationale
Total final thermal energy consumption for building operations	kWh/m^2/a	0: (100)	Ideco " Irbid Electricity Company"
		5: (30)	Questionnaire Survey

SNTool Data Sources

Criterion	Data source/ Data provider
Population density	Department of Statistics (DOS) GIS Mapping
Access to electrical service	Ministry of Energy and Miniral Resources Ideco " Irbid Electricity Company" Questionnaire Survey
Availability of a public municipal water supply	Yarmouk Water Company Questionnaire Survey
Access to solid waste and recycling collection points	GIM Questionnaire Survey Site assessment through physical visits and observation.
Particulate matter (PM10) concentration	Ministry of Environment
Permeability of land	GIM / GIS Mapping Site assessment through physical visits and observation
Greywater collection in buidings for non-pota-ble uses	GIM Questionnaire Survey

SBTool Benchmarks for Irbid chmaber of commerce and residential Building

A. Site regeneration and development

Indicator	Unit of measure	Benchmark	Rationale
vegetated landscaped area that is planted with native plants	%	0: (0)	Not all buildings accommodate land for plantation of gardens or green roofs.
		5: (100)	If a garden exists, it is best to plant it with native, or adapted plants for the total area, to en-courage water saving and lower maintenance efforts.

B. Energy and resources consumption

Indicator	Unit of measure	Benchmark	Rationale
Delivered thermal energy consumption per internal useful floor area per year	kWh/m^2/a	0: (30)	Surveys and standards
		5: (15)	Surveys and standards

SBTool Data Sources

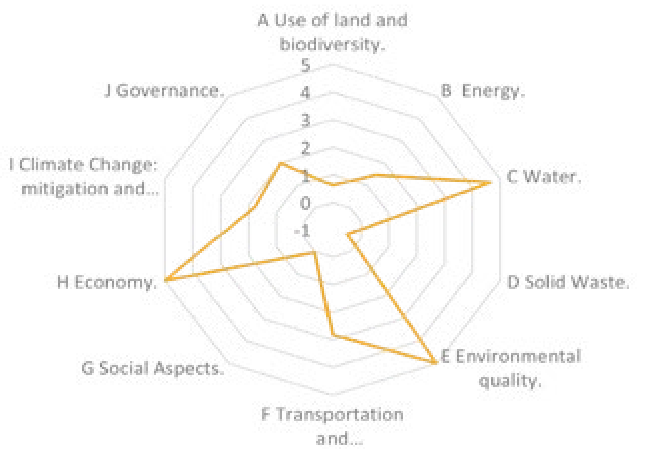
Criterion	Data source/ Data provider
Proximity of site to public transportation	GIM Transportation Department GIS Mapping Site assessment through physical visits and observation.
Potable water consumption for irrigation	Building water bills samples Site assessment through physical visits and observation
CO2 concentrations	Onsite measurements through detectors
Access to solid waste and recycling collection points	GIM Questionnaire Survey Site assessment through physical visits and observation.
Exposure to sunlight	Site assessment through physical visits and observation Buildings architectural plans and sections.
Shading of building envelope by vegetation	Site assessment through physical visits and observation

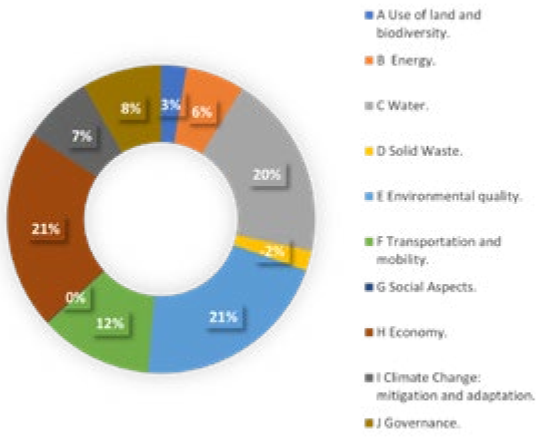
Phase 3: Diagnosis

SNTool Diagnosis Results

2.26

Over all score



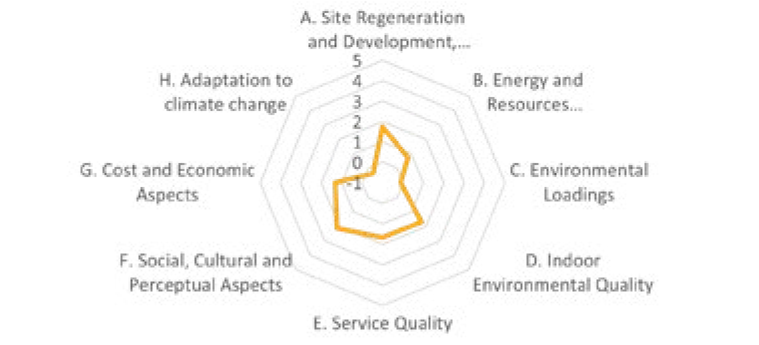


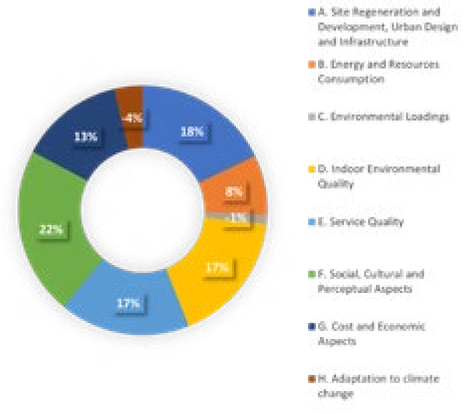
Issue	Weight	Score	Weighted Score
A. Use of land and biodiversity	8%	0.6	0.05
B. Energy	13%	1.4	0.19
C. Water	11%	4.6	0.49
D. Solid waste	13%	-0.5	-0.07
E. Environmental quality	8%	5.0	0.39
F. Transportation and mobility	11%	2.8	0.3
G. Social aspects	11%	0.02	0
H. Economy	13%	5	0.66
I. Climate change	8%	1.7	0.14
J. Governance	5%	2	0.11

SBTool Chamber of commerce Diagnosis Results

1.19

Over all score



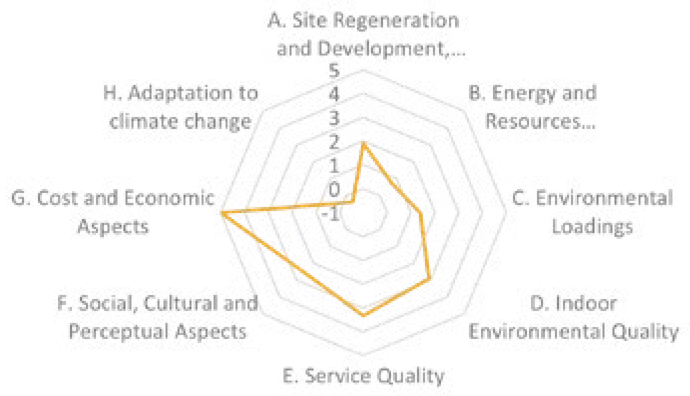


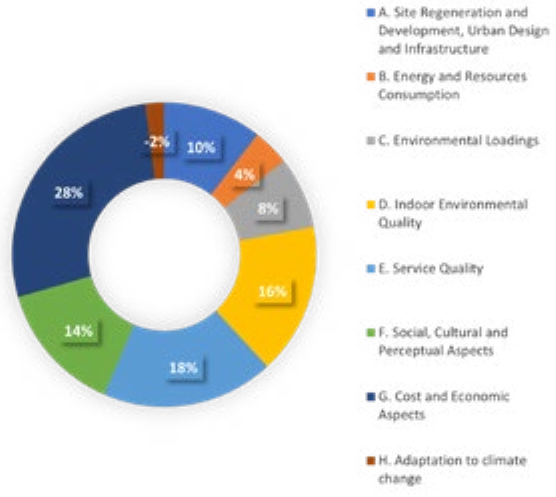
Issue	Weight	Score	Weighted Score
A. Site regeneration and development	16%	1.75	0.28
B. Energy and resources consumption	16%	0.76	0.12
C. Environmental loadings	10%	-0.11	-0.01
D. Indoor environmental quality	13%	1.69	0.22
E. Service Quality	10%	1.67	0.16
F. Social, cultural and perceptual aspects	13%	2.14	0.28
G. Costs and economic aspects	13%	1.33	0.17
H. Adaptation to climate change	10%	-0.36	-0.04

SBTool Residential Buildings Diagnosis Results

2.19

Over all score





Issue	Weight	Score	Weighted Score
A. Site regeneration and development	16%	1.95	0.31
B. Energy and resources consumption	16%	0.71	0.11
C. Environmental loadings	10%	1.39	0.13
D. Indoor environmental quality	13%	2.92	0.38
E. Service Quality	10%	3.33	0.32
F. Social, cultural and perceptual aspects	13%	2.55	0.33
G. Costs and economic aspects	13%	5	0.65
H. Adaptation to climate change	10%	-0.36	-0.04

Phase 4: Strategic Definition

SNTool Target setting

Environmental targets

To achieve environmental sustainability, a set of key targets needs to be achieved in the study area. First, incorporating nature based solutions and vegetation in green urban areas would have multiple environmental benefits, including reducing greenhouse gas emissions, especially in crucial sectors such as transportation and energy. Reducing the Urban Heat Island effect and stormwater runoff, as a result of the vegetation's cooling and infiltration capabilities. Implementing such policies would also promote creating wildlife habitats and protect biodiversity.

Social targets

The adoption of inclusive urban spaces that value and accept users of different background, gender, and abilities. Which will increase social interaction, safety and acceptance. Those spaces have positive effects on residents as they reduce stress and improve mental and physical health. Creating safe living environment through efficient and engaging administration, respecting basic human rights, and increase quality of life.Public buildings must be accessible to physically and disabled people and has to be enforced by laws of government

Economic targets

To ensure the sustainability of economic growth and to achieve high levels of economic productivity for the neighborhood, several approaches should be adopted. First, some practices related to recycling and pollution reduction should be implemented, as they not only align with environmental stability but also enhance the value of materials. In addition, we should promote and increase awareness of efficient resource management to encourage inhabitants to minimize waste and optimize other resources utilization. Another important factor that should help economic growth sustainability is enhancing collaboration between public authorities and private entities, as well as fostering synergies and responsibilities

SBTool Chamber of commerce Target setting

Environmental targets

To enhance the environmental performance of public buildings within the neighborhood, several targets need to be achieved. First, more vegetated areas and native plants should be planted around the buildings. In terms of energy efficiency, several measures need to be implemented to decrease primary energy consumption and the delivered thermal and electrical energy consumption per internal useful floor area in public buildings.

Social targets

The social performance to be achieved in Public Buildings is to make sure that people with disabilities can easily access and use the building and its facilities. This means adopting the required measures while designing the building in a way that considers their needs and allows everyone to feel included and equal when using the space. Furthermore, implement additional initiatives to raise awareness about the requirements of individuals with disabilities and enhance their inclusion in the formulation of legal laws and policies.

Economic targets

To improve the economic performance of public buildings, emphasis should be placed on energy conservation, with the aim of reducing heating and electricity costs. Utilizing renewable energy sources can result in more stable energy cost management. When constructing buildings, energy-efficient building materials should be prioritized. Management of electricity consumption during peak hours is necessary to prevent costly power surges. Water conservation and efficient usage are also recommended for lowering water costs. These measures can contribute to the improvement of our neighborhood's public buildings' economic viability. In addition, more initiatives should be implemented to raise awareness of reducing electricity and water consumption. Implement energy audits and cost-effectiveness studies in order to increase awareness of feasibility.

SNTool Constraints and restrictions

Legal Constrainsts	Inadequate green legislation and enforcement that enables green growth; Specific Urban Planning legislations needed, codes and specifications : legal and specific urban planning standards are missing in the jordanian context, authorities are allowed to enforce rules when people do something illegal.
Technical Constrainsts	Lack of integrated transportation networks and land use planning resulted in reliance on private automobile, leading to traffic congestion, poor transit coverage and an increase in carbon footprint; lack of Biodiversity and ecosystems services
Financial Constrainsts	The cost of private land may limit the percentage of green urban areas due to a lack of financial resources
Environmental Constrainsts	Low annual precipitation rates may affect the growth and durability of vegetation in green urban areas and pose major stress on the water sector. lack of fossil fuels and water resources making it unusually well positioned to seize opportunities in the Jordanian governorates.
Stakeholder based restrictions	Lack of inhabitants' interest in participation in the decision-making process. Prioritization of Housing and commercial development for the use of land instead of green urban areas to obtain economic benefits.
Other relevant constraints	lack of access to health care facilities within a 5- and 15-minute walking distance lack of public spaces and pedestrian and walkable areas Lack of parking lots Social constraints regarding the bicycle network and car-free zones may prevent their planning and implementation, cultural norms would not accept using such networks within the composition of the existing road.

SBTool Chamber of commerce Constraints and restrictions

Legal Constrainsts	Land use is already defined in establish neighborhood, making it difficult to provide extra services for accessibility.
Technical Constrainsts	Some of the insulation application protocols require awareness of the importance of the complete connected insulation system for the building envelope, hence the seriousness of applying insulation to avoid thermal bridges below windows, on the corners of the walls and ceiling, etc. therefore, only basic application of the insulation is done, to save time and cost.
Financial Constrainsts	Lack of Return of Investment studies and Energy Audits, and lack of obligation to perform such studies every interval of time for maintenance
Environmental Constrainsts	The climate of Irbid in general is considered hot arid, therefore, rainwater harvesting opportunities are not highly feasible due to low precipitation values annually.
Stakeholder based restrictions	Lack of knowledge transfer and communication between the public and private sector
Other relevant constraints	Lack of smart systems: recording and reporting of data (by sector), i.e electronic government.

SBTool Target setting Residential building

Environmental targets

To enhance the environmental performance of public buildings within the neighborhood, several targets need to be achieved. First, more vegetated areas and native plants should be planted around the buildings. In terms of energy efficiency, several measures need to be implemented to decrease primary energy consumption and the delivered thermal and electrical energy consumption per internal useful floor area in public buildings.

Social targets

The social performance to be achieved in Public Buildings is to make sure that people with disabilities can easily access and use the building and its facilities. This means adopting the required measures while designing the building in a way that considers their needs and allows everyone to feel included and equal when using the space. Furthermore, implement additional initiatives to raise awareness about the requirements of individuals with disabilities and enhance their inclusion in the formulation of legal laws and policies.

Economic targets

To improve the economic performance of public buildings, emphasis should be placed on energy conservation, with the aim of reducing heating and electricity costs. Utilizing renewable energy sources can result in more stable energy cost management. When constructing buildings, energy-efficient building materials should be prioritized. Management of electricity consumption during peak hours is necessary to prevent costly power surges. Water conservation and efficient usage are also recommended for lowering water costs. These measures can contribute to the improvement of our neighborhood's public buildings' economic viability. In addition, more initiatives should be implemented to raise awareness of reducing electricity and water consumption. Implement energy audits and cost-effectiveness studies in order to increase awareness of feasibility.

SBTool Constraints and restrictions for residential buildings

Legal Constrainsts	Land use is already defined in establish neighborhood, making it difficult to provide extra services for accessibility.
Technical Constrainsts	Some of the insulation application protocols require awareness of the importance of the complete connected insulation system for the building envelope, hence the seriousness of applying insulation to avoid thermal bridges below windows, on the corners of the walls and ceiling, etc. therefore, only basic application of the insulation is done, to save time and cost.
Financial Constrainsts	Lack of Return of Investment studies and Energy Audits, and lack of obligation to perform such studies every interval of time for maintenance
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Stakeholder based restrictions	Lack of knowledge transfer and communication between the public and private sector
Other relevant constraints	Lack of smart systems: recording and reporting of data (by sector), i.e electronic government.

Phase 5: Retrofit Scenarios

SNTool Scenario 1: The Green Scenario

Green Areas, Solid waste management, social Inclusion and safety, climate change mitigation adaptation.The Green Scenario aims to create a sustainable and livable environment in Al-Nuzha neighborhood. To achieve this, the use of land and biodiversity will be optimized by increasing the green areas through the implementation of green facades, green roofs, and urban agriculture. Moreover, the micro landscape design will be enhanced by focusing on evergreen planting.

A. Use of land and biodiversity	Increase the green space per capita by changing and enforcement of urban planning legislation and codes
B. Energy	Use of renewable energy, this can be achieved by relying on a well developed equipment market related to energy sustainable systems.
C. Water	Sanitation network needs regular maintenance, Upgrade the water and sewerage networks to accommodate the increase in residents. Improve water infrastructure capability and efficiency
D. Solid waste	Introduction of recycling centers and green spots and waste banks as well as more advanced treatment through materials recycling facilities (MRFs).
E. Environmental quality	Its connected to land use strategies as increasing the green plots will enhance the air quality and decrease the noise pollution as this will play a role as noise barrier in specific areas.
F. Transportation and mobility	Development of green mobility will decrease the dependency on cars which will decrease the carbon footprint along the neighborhood
G. Social aspects	New planning strategy for green open areas at the educational institutions which will enhance the education level and social cohesion along with various physical and psychological health benefits.
H. Economy	The per capita gross domestic product (GDP) has a positive impact on the urban green space rate , thus the economic activity will increase. And the suggested urban agriculture will enhance food security.Green financing strategies will encourage the residents to be engaged in the proposed solutions.
I. Climate change	Increasing the green areas and green technology and tools are less harmful to the environment. This will push the neighborhood to a new edge of resilience and adaptation to climate change.
J. Governance	Management of green space will generate employment opportunities. Enhance participatory approach in the management of neighborhood towards more sense of belonging.

SBTool Scenario 1 : Active retrofit of public buildings

The application of active systems to improve energy efficiency and energy consumptions on most levels, including changing active mechanical and lighting systems and control devices and updating energy consuming appliances, in addition to introducing some renewable systems that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

A. Site regeneration and development	Provide electric car charging stations in the parking lot of the public building, with preferred location close to the entrance(s) of the building, in addition to the handicap car parking locations. This would encourage the use of electric cars and decrease GHG and CO_2 emissions.
B. Energy and resources consumption	Change the heating system to be operated with natural gas instead of diesel. In order to increase efficiency and lower cost. Change the artificial lighting to highly efficient LED lamps.
C. Environmental loadings	providing proper access to and from a solid waste collectable zone encourages the recycling of resources and materials.
D. Indoor environmental quality	Provide task lighting for each office and user, in order to increase controllability of lighting Provide thermostat control in each office to offset the central heating, or cooling whenever needed, this would increase comfort and wellbeing for the occupant.
E. Service Quality	Install a Building Management System (BMS) that connects all building operation systems and monitors them.
F. Social, cultural and perceptual aspects	Provide door sensors to open automatically for wheelchair users within entrance(s) and exits
G. Costs and economic aspects	By choosing optimized energy efficient systems, equipment and appliances, with high COPs and by adopting energy star ratings, energy saving will be achieved, and operational costs will be lowered
H. Adaptation to climate change	Add a local rain water reservoir on site that would collect rainwater from the non-permeable roof, and connect it with the rainwater collected by pathways around the building on site.

SNTool Scenario 2: Smart Energy Scenario towards Future

The Smart Energy Scenario towards Future Scenario depicts a future that is characterized by empowering renewable energy towards tackling the most pressing climatic issues and to reduce CO_2 emissions.

A. Use of land and biodiversity	Higher plant diversity leads to more energy stored, greater energy flow and higher energy-use efficiency in the entire network
B. Energy	Encourage the usage of energy related technology application by enhancing the use of electrolysers, Ev batteries, EV motors, solar PV and battery storage.To provide an affordable access to all energy supplies.
C. Water	Artificial intelligence (AI) and machine learning algorithms can also play a significant role in improving water efficiency. By integrating diverse data sets — from soil and weather conditions can provide sophisticated decision support tools.
D. Solid waste	Recycling: Critical minerals can be recycled from old products, which can help to reduce demand for new minerals which should be achieved through developing new technologies to reduce the demand for critical minerals in some applications.
E. Environmental quality	Smart Grid for electricity network that can intelligently integrate the actions of all users connected to it in order to efficiently deliver sustainable, economic and secure electricity supplies.
F. Transportation and mobility	Smart sensors, cameras and traffic lights can collect adjust routes of cars and public transport according to demand to help improve congestion and traffic flow. This means fewer cars are sitting with engines on in traffic and letting out huge amounts of CO_2 emissions. Streetlamps are fitted with smart LED technology which switch on and off automatically based on light data, reducing energy consumption. This reduced outdoor air pollution
G. Social aspects	Providing practical experiences, technology also enables more efficient and effective learning. Online courses, e-books, and other digital resources allow healthcare students to access information and resources from anywhere, at any time.
H. Economy	Digital Tools (e.g., mobile money and e-wallets, crowdfunding, alternative credit scoring, and cross-border remittances) have the potential to support financial inclusion of underserved persons and communities, reduce costs, and provide new livelihood and market opportunities
I. Climate change	Smart applications help in raising awareness about climate change impacts on the most vulnerable; easily including vulnerable groups in the adaptation planning and policy-making process; incorporating community-based adaptation into city plans.
J. Governance	Smart technologies can support social participation in the planning and increase the community involvement in the Nuzha neighborhood. It helps the decision makers to apply the bottom up approach and reach the largest number of residents.

SBTool Scenario 2 : Passive Retrofit of public buildings

The application of passive systems to improve energy efficiency and energy consumptions on most levels, including changing glazing systems, addition of insulation to avoid thermal bridges, and introducing shading devices.

In addition to introducing some changes in the exposed surface materials that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

A. Site regeneration and development	Provide carpool or car share parking spots in the parking lot of the public building, with preferred location close to the entrance(s) of the building, in addition to the handicap car parking location
B. Energy and resources consumption	Add thermal insulation on the corners of the walls and columns, with a U-Value of 0.57 or below, to avoid thermal bridges, and then finish the corners with proper recycled finishing plastering material.
C. Environmental loadings	providing energy efficiency measures through passive systems contributes to lowering the GHG footprint of the project.
D. Indoor environmental quality	Provide night ventilation by the operating team through the spring and summer seasons, this would increase indoor air quality, and flush-out pollutants, and help lower the temperature of the building, thus saving energy.
E. Service Quality	Provide regular awareness campaigns for occupants and visitors of the public building, through flyers, seminars, displays, and interactive exhibitions.
F. Social, cultural and perceptual aspects	Adjust outdoor ramps to be more comfortable and easier accessibility for wheelchair users. This could be done by decreasing the slope and changing the material to non-slippery.
G. Costs and economic aspects	The lowered operational cost and small sized mechanical systems optimized to the retrofitted energy saving building envelope would offset the cost of retrofit and investment needed
H. Adaptation to climate change	Provide cool roof materials as cover for non-permeable surfaces on the roof and on the pathways surrounding the footprint of the building. Cool roof materials are materials with high SRI values

SBTool Scenario 1 : Active retrofit of residential buildings

The application of active systems to improve energy efficiency and energy consumptions on most levels, including changing active mechanical and lighting systems and control devices and updating energy consuming appliances, in addition to introducing some renewable systems that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

A. Site regeneration and development	Vegetating the green space should be by native plants or adapted plants. They require low maintenance and consume less water for irrigation.
B. Energy and resources consumption	Change the hot water system used in the residential building to be connected to renewable solar thermal heating system.
C. Environmental loadings	Providing proper access to and from a solid waste collectable zone encourages the recycling of resources and materials.
D. Indoor environmental quality	Provide thermostat control in each room or household space to offset the central heating, or cooling whenever needed, this would increase comfort and wellbeing for the occupant.
E. Service Quality	Perform annual energy audits.
F. Social, cultural and perceptual aspects	Encourage the use of outdoor gathering space and include a well ventilated, view-out provided- terrace or balcony per household.
G. Costs and economic aspects	By choosing optimized energy efficient systems, equipment and appliances, with high COPs and by adopting energy star ratings, energy saving will be achieved, and operational costs will be lowered.
H. Adaptation to climate change	Utilizing the external top roof of the residential building for Photovoltaic Panels, that would insure renewable energy, lower dependence on fuel, lower CO_2 and GHG emissions, and lower the heat island effect of the residential building footprint by providing shading for the roof.

SBTool Scenario 2 : Passive Retrofit of residential buildings

The application of passive systems to improve energy efficiency and energy consumptions on most levels, including changing glazing systems, addition of insulation to avoid thermal bridges, and introducing shading devices.

In addition to introducing some changes in the exposed surface materials that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

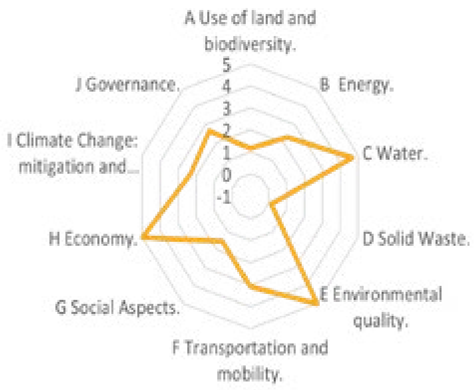
A. Site regeneration and development	Changing the tiling of the pathways leading from the outside of the residential building to the entrance(s) of the to a material with high SRI value and permeability, such as interlock tiles from light colored material
B. Energy and resources consumption	Install water saving fixtures, such as low-flow toilets, or dual flush toilets, and low-flow faucets for W.C and kitchen sinks.
C. Environmental loadings	Providing energy efficiency measures through passive systems contributes to lowering the GHG footprint of the project.
D. Indoor environmental quality	Maintenance of operable windows to be easily accessible for opening/closing by the occupant, in order to provide fresh air through ventilation when desired by the user.
E. Service Quality	Provide regular awareness campaigns for occupants through flyers, seminars, displays, and interactive exhibitions.
F. Social, cultural and perceptual aspects	Re-arrange furniture of regularly occupied rooms to remove obstacles from in front of windows, and provide more exposure to outdoor views and daylight.
G. Costs and economic aspects	The lowered operational cost and small sized heating/ cooling systems optimized to the retrofitted energy saving building envelope would offset the cost of retrofit and investment needed.
H. Adaptation to climate change	Provide greenery and plantation on the ground floor/street connecting floor. This would add shade and lower the urban heat island effect, and control stormwater runoffs.

Phase 6: Decision Making

SNTool Scenario 1: The Green Scenario

2.77

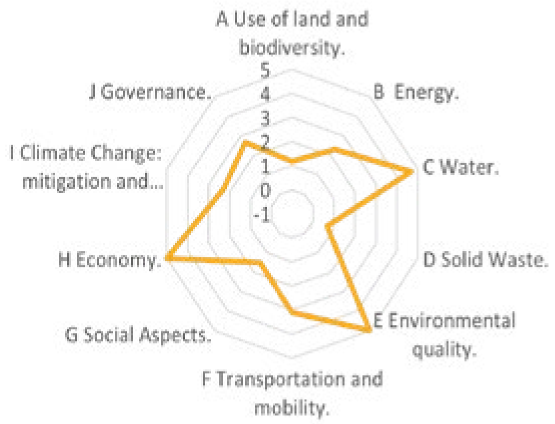
Over all score



SNTool Scenario 2: Smart Energy Scenario towards Future

2.83

Over all score



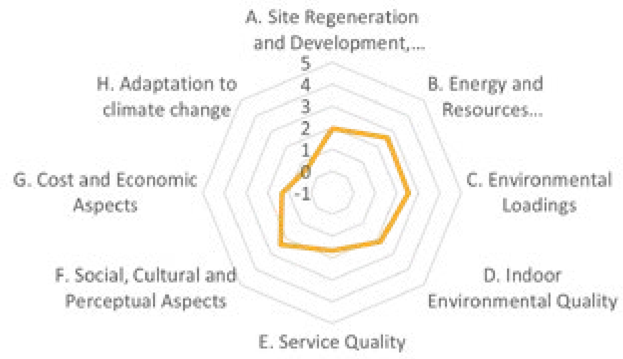
Selection of the scenario: SNTool scenario 2

The Smart Energy Scenario towards Future is a comprehensive plan that promotes renewable energy to tackle climate issues and reduce carbon emissions. The scenario outlines several initiatives, including the use of land and biodiversity to increase energy storage and efficiency. Implementing renewable energy sources such as EV batteries, EV motors, solar PV, and battery storage will provide affordable access to energy and promote clean and renewable energy sources. The efficiency of energy savings can be further improved by adopting green technology and insulation enforcement, funding energy storage projects, building a secure energy supply chain and encouraging the production of critical minerals.

SBTool Scenario 1 : Active retrofit of public buildings

1.97

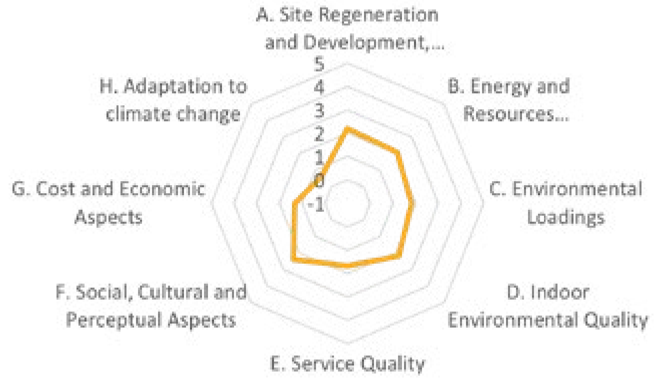
Over all score



SBTool Scenario 2 : Passive Retrofit of public buildings

1.85

Over all score



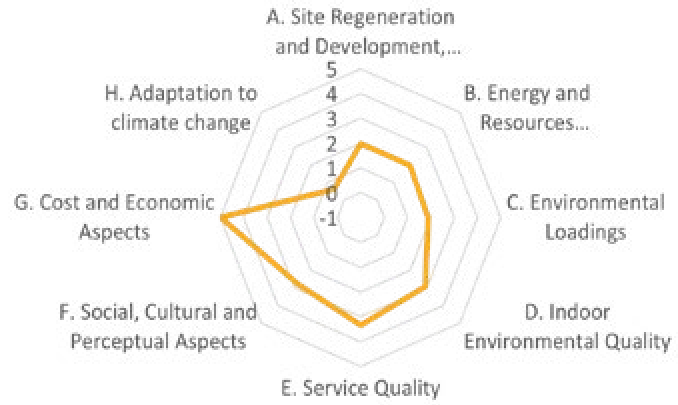
Selection of the scenario: SBTool scenario 1

The application of active systems to improve energy efficiency and energy consumptions on most levels, including changing active mechanical and lighting systems and control devices and updating energy consuming appliances, in addition to introducing some renewable systems that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

SBTool Scenario 1 : Active retrofit of Residential buildings

2.59

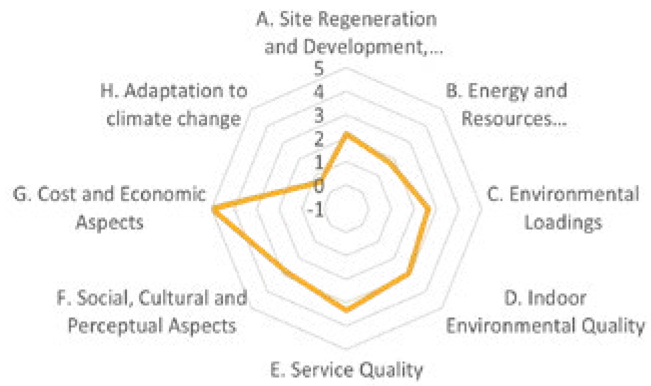
Over all score



SBTool Scenario 2 : Passive Retrofit of Residential buildings

2.66

Over all score



Selection of the scenario:

SBTool scenario 2 Passive Retrofit of Residential buildings

The application of passive systems to improve energy efficiency and energy consumptions on most levels, including changing glazing systems, addition of insulation to avoid thermal bridges, and introducing shading devices.

In addition to introducing some changes in the exposed surface materials that could contribute to lowering energy consumption and increase the building's adaptation to climate change.

Phase 7: Retrofit Concept

SNTool Description

The Smart Energy Scenario advocates for the implementation of a smart grid to promote environmental sustainability. This involves enhancing operational security, involving customers in reducing environmental impact, and enhancing overall quality of life. The plan also focuses on improving global mobility through the use of smart sensors, cameras, and traffic lights, with the goal of reducing energy consumption and outdoor air pollution. Furthermore, the scenario addresses financial inclusion by reducing costs and providing new economic opportunities through digital tools like mobile money, e-wallets, crowdfunding, and alternative credit scoring. It underscores the importance of climate technologies, such as renewable energies and drought-resistant crops, in mitigating greenhouse gas emissions, adapting to climate change, and improving environmental quality.

Expected results

1- Reduce energy demand in al-Nuzha neighborhood. 2- Enhance quality of life. 3- This energy scenario will help to establish energy systems till 2050, and help to shape a resilient energy strategy for al Nuzha neighborhood. 4- Achieve integrating artificial intelligence and sensitive energy simulation planning strategies. 5- The establishment of an energy platform through data mining, documentation of the neighborhood. 6- ensure a participatory approach in the decision making stages. 7- increase the capability to achieve sustainable development goals relevant to SDG 7 : affordable and clean energy, and SDG 11: Sustainable cities and communities

Financial scheme

Funding and grants from:
European Bank for Reconstruction and Development (EBRD)
United Nations Development Programme (UNDP)
a. International Organization for Migration.
b. Multilateral Investment Guarantee Agency.
c. The Organization for Economic Co-operation and Development (OECD).
d. United Nations.
In collaboration with the Ministry of Culture and the Ministry of Social Development, and the Ministry of Municipal Affairs (MoLA)
Local governmental funding – Greater Irbid Municipality and the Ministry of Social Development

Time scale

Short term : Up to 24 months

Medium term : 2-5 years

Long term :more than 5 years

Activities/works to implement the intervention

Develop and expand public transportation systems, including buses and Bus Rapid Transit (BRT).
- Encourage the adoption of electric vehicles by offering incentives, subsidies, and charging infrastructure including setting up EV charging stations. - Create a bike lane for scholars to promote cycling as a sustainable and eco-friendly mode of transport. - Promote carpooling and ridesharing programs to reduce the number of vehicles on the road, thereby reducing emissions and congestion.
- Implement intelligent traffic management systems that use data mining to optimize traffic flow, reducing congestion and emissions. - Design pedestrian zones, and well-maintained sidewalks to encourage walking as a means of transportation. - Incorporate green mobility concepts into urban planning, Launch public awareness campaigns to educate citizens about the benefits of green mobility and the importance of reducing their environmental impact. Enforce regulations that promote green mobility

SBTool Chamber of commerce Description

Change the Air-conditioning system to a high-performance system with energy star label above 50%, with minimum Coefficient of Performance (COP) value according to the Energy Efficient Building code of Jordan. - Choose Air Conditioning systems with refrigerants with low Ozone depletion values, and Low Global warming values.Change the boiler of the heating system to an efficient boiler according to the energy efficient building code.Change the heating system to be operated with natural gas instead of diesel. In order to increase efficiency and lower cost.Change the artificial lighting to highly efficient LED lamps.Change the hot water system used in public building to be connected to renewable solar thermal heating system. Install motion detectors and occupancy sensors to be operated after hours, to save energy, especially in corridors and non-regularly occupied spaces. Install heat pumps with minimum efficiency as required by the energy efficient building code of Jordan.

Expected results

Increase energy efficiency for equipment's.Lower energy consumption and lower energy bill.Decrease Ozone depletion, and decrease Global warming.Lower GHGs in the atmosphere.Lower the CO2 in the environment resulted from the consumption of non-renewable energy sources.Increase the dependency on renewable energy in electrical generation and thermal energy generation. Provide the highest possible performance by monitoring and verification.Conserve the environment by using less resources and less raw material.Lower the embodied energy and lower the CO2 footprint of the project. Lower potable water consumption for building operations. Encourage the purchase of locally produced products.

Financial scheme

Agence Française de Développement (AFD), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), European Investment Bank (EIB), European Union (EU), International Finance Cooperation (IFC), In collaboration with the Greater Irbid Municipality (GIM), Ministry of Energy and Mineral Resources, and the JREEEF

Time scale

Short term : Up to 24 months

Medium term : 2-5 years

Long term :more than 5 years

Activities/works to implement the intervention

Exchange the following systems into more efficient systems:
Air condition systems,Refrigerants, Boiler, Heating system to natural gas, Artificial lighting to LED
Sensor operated faucets and toilets

Install renewable systems:
Solar thermal heating for domestic hot water, Photovoltaic Cells for renewable energy

Install secondary systems:
Motion detectors. Heat pumps. BMS

Contract with a commissioning and verification agency, as a third party, to monitor and verify the new installed and exchanged systems. Contract with Energy Audit offices or programs. Plan for regular and quarterly maintenance for electricity consumption systems.Facilitating a land for wheeling and generating renewable energy to be used in the public building

SBTool Residential Building Description

Adjusting the building envelope by changing the window glazing, window frame, thermal insulation continuation and locations, shading devices, and exterior surfaces colors.Provide a well-ventilated, accessible space for the allocation of collection bins for recyclables in the residential building.Provide water saving fixtures indoors.Install water saving fixtures, such as low-flow toilets, or dual flush toilets, and low-flow faucets for W.C and kitchen sinks.Providing energy efficiency measures through passive systems. Providing proper access to and from a solid waste collectable zone. Adjust the indoor environment by controlling noise and sound efficiency, glare control and daylight admittance, provide natural and night ventilation through operable windows. Perform annual energy audits.

Expected results

Increase energy efficiency for the building envelope.Lower energy consumption and lower energy bill. Lower GHGs in the atmosphere.Lower the CO2 in the environment resulted from the consumption of non-renewable energy sources.Lower the heat absorption of the building, and lower energy consumption used for cooling.Decrease thermal bridges in the building envelope.Lower energy consumption used for cooling and increase comfortability.Lower heat absorption of the building.Encourage the recycling of materials.Potable Water consumption savingEncourage the purchase of locally produced products.

Financial scheme

Time scale

Short term : Up to 24 months

Medium term : 2-5 years

Long term :more than 5 years

Activities/works to implement the intervention

The glazing of the windows into double glazing with G-value lower than 2.4, Change the frames of the windows for well-sealed frame and insulted cross-section with U-Value of lower than 2:00, Add thermal insulation on the corners of the walls and columns, with a U-Value of 0.57 or below, to avoid thermal bridges, and then finish the corners with proper recycled finishing plastering material.Add a thermal insulation layer above and below windows, with a U-Value of 0.57 or below. Add continuous thermal insulation on the roof of the building, to achieve U-value of 0.55 or lower. in addition to proper water and vapor insulation. This could also be integrated with a cool roof system as tiling to protect the insulation layer. Add internal shading devices to control solar radiation. Add external movable shading devices to control the admittance of solar radiation whenever needed or unwanted.Install operable windows to Encourage the use of natural ventilation

SMC Passports

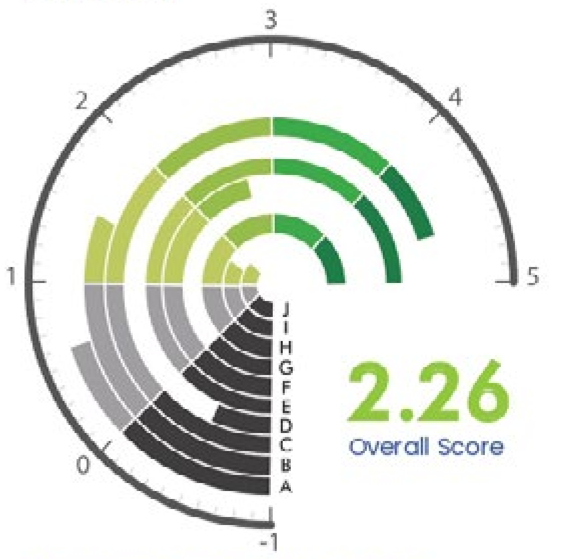
Assessment Results Irbid

at the neighbourhood scale

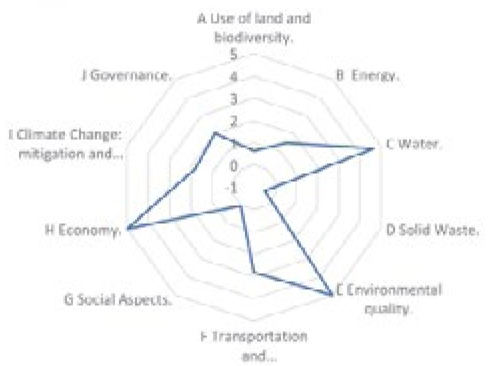
Sustainable MED Cities

Al Nozah Urban Area

Final Score



Spider Chart

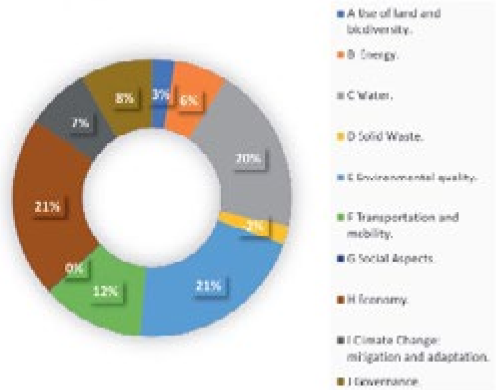


Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (including KPIs) in the assessment

# of available criteria	92	# of active criteria	73

Pie Chart



Description of the KPIs

	KPIs at neighbourhood scale	Value	Unit of measure
B2.1	Total final thermal energy consumption for building operations.	100,00	kWh/m²/yr
B2.4	Total final electrical energy consumption for building operations.	32,04	kWh/m²/yr
B2.7	Total primary energy demand for building operations.	85,00	kWh/m²/yr
B3.1	Share of renewable energy generated on-site, relative to final thermal energy consumption for building operations.	0,00	%
B3.4	Share of renewable energy generated on-site, relative to final electric energy consumption for building operations.	8,00	%
B3.7	Share of renewable energy generated on-site, relative to the total primary energy consumption for building operations.	3,00	%
C2.3	Consumption of potable water in residential buildings.	70,00	L/occupant/yr
D2.2	Access to solid waste and recycling collection points.	0,00	%
E1.2	Particulate matter (PM_x) concentration	0,00	days/yr
F1.1	Performance of the public transport system	93,30	%
F2.3	Bicycle network	0,00	m/inhabitant
G3.1	Availability and proximity of key services.	100,00	%
I1.1	Greenhouse Gas emissions.	2,80	t CO_2eq./ inhabitant /yr
I3.1	Permeability of land.	37,40	%

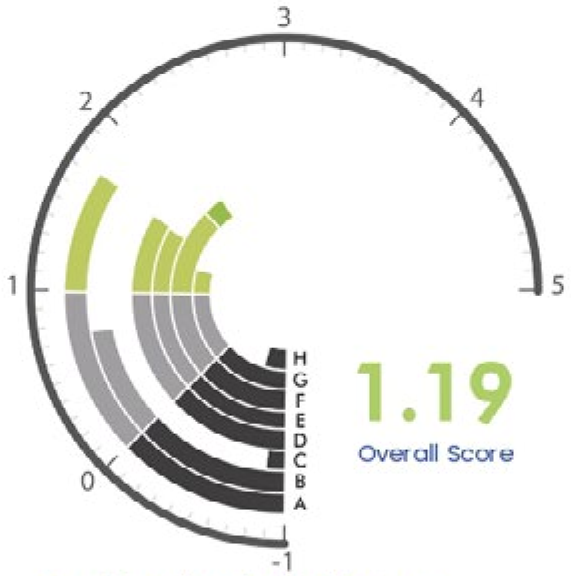
Assessment Results Irbid

at the Building Scale

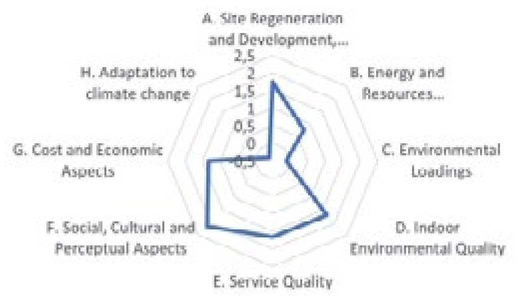
Sustainable MED Cities

Irbid's Chamber of Commerce

Final Score



Spider Chart

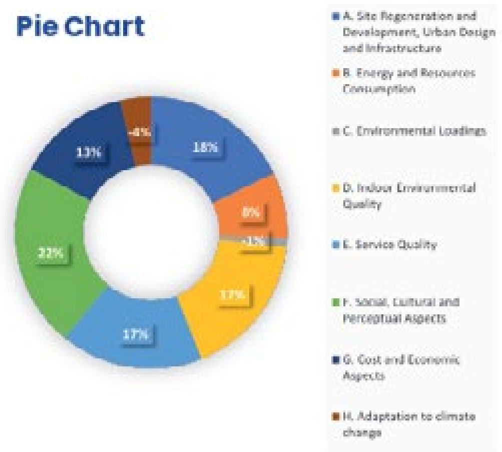


Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (including KPIs) in the assessment.

# of available criteria	92	# of active criteria	33

Pie Chart



Description of the KPIs

	KPIs at neighbourhood scale	Value	Unit of measure
B1.1	Primary energy consumption	289,00	kWh/m²/yr
B1.2	Thermal energy consumption	70,00	kWh/m²/yr
B1.3	Electrical energy consumption	201,00	kWh/m²/yr
B1.4	Energy from renewable sources in total thermal energy consumption	12,00	%
B1.5	Energy from reneable sources in total electrical energy consumption	27,00	%
B1.6	Embodied non-renewable primary energy	903,00	MJ/m²
B3.4	Recycled materials	0,00	%
B4.3	Potable water consumption for indoor uses	2,00	m³/occupant/yr
C1.1	Embodied carbon	3,00	$KgCO_2eq/m^2$
C1.2	GHG gas emissions during operations	74,00	$KgCO_2eq/m^2$ yr
D1.2	TVOC concentration	0,30	µg/m³
D1.7	Mechanical ventilation	0,70	l/s/m²
D2.3	Thermal comfort index	17,00	%
D3.1	Daylight	3,00	%
E1.2	Smart readiness indicator	60,00	%
G1.4	Energy cost	16,00	€/M²/yr
H1.2	Heat island effect	35,00	SRI

Assessment Results Irbid

at the Building Scale

Sustainable MED Cities

Residential Building

Final Score

Spider Chart

Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (including KPIs) in the assessment.

# of available criteria	92	# of active criteria	33

Pie Chart

Description of the KPIs

KPIs at neighbourhood scale		Value	unit of measure
B1.1	Primary energy consumption	48,00	kWh/m²/yr
B1.2	Thermal energy consumption	26,00	kWh/m²/yr
B1.3	Electrical energy consumption	33,00	kWh/m²/yr
B1.4	Energy from renewable sources in total thermal energy consumption	25,00	%
B1.5	Energy from reneable sources in total electrical energy consumption	27,00	%
B1.6	Embodied non - renewable primary energy	903,00	MJ/m²
B3.4	Recycled materials	0,00	%
B4.3	Potable water consumption for indoor uses	90,00	m³/occupant/yr
C1.1	Embodied carbon	3,00	$KgCO_2eq/m^2$
C1.2	GHG gas emissions during operations	12,00	$KgCO_2eq/m^2$ yr
D1.2	TVOC concentration	0,30	µg/m³
D1.7	Mechanical ventilation	0,70	l/s/m²
D2.3	Thermal comfort index	12,00	%
D3.1	Daylight	3,00	%
E1.2	Smart readiness indicator	80,00	%
G1.4	Energy cost	5,00	€/M²/yr
H1.2	Heat island effect	35,00	SRI

2. Sousse case study

A Tunisia City

Phase 1: Initiation

Sousse SNTool

Sahloul 3 is a residential area of 60.91 Ha

1715 housing units (1396 in 2014)

5809 inhabitants (4619 in 2014)

The urban development index is 731% between 1998 and 2020.

14.3 km of roads. Around 8 out of 10 authorized constructions are of the individual type, and 1/10 concerns a rehabilitation or redevelopment project.

Collective type projects are very few in number, but significant in size.

Sahloul 3 neighborhood is a subdivision of the Tunisian land and housing agency (AFH). The first building permits were granted at the beginning of 2000, so it can be considered as a new urban area. It includes quite diverse urban components (individual, collective housing, administrations, green spaces, etc.)

It is surrounded by similar urbanism areas (Sahloul 1, 2 and 4) all belonging to the same developer and which have the same characteristics. The results of this particular neighborhood can be used for many other urban areas in the city.

In the city of Sousse, AFH created large undeveloped areas, and so we considered the experience acquired through the study of this district can be considered as a demonstration project which will allow this public developer to better address sustainability aspects in future projects, not only in the city, but also in many other places in the hole country.

Relevant Stakeholders:

Tunisian Electricity and Gas Company

National agency for energy management

Tunisian Land and Housing Agency

Regional director of the Foncière Habitation agency

Order of Tunisian Engineers

Sousse SBTool

Address : Boulevard Yasser Arafat Sahloul 3

Actual building use : Sahloul District Building

Level of degradation of the building : New building

Owner : Municipalité of Sousse

Year of construction :2022

Building method :Reinforced concrete structure, exterior walls made of double hollow brick partitions. The slabs are 16+5 slabs. The interior partitioning is made of plastered bricks. The joinery is in single-glazed aluminum

Number of levels above earth :1

Number of levels underground :0

Heating system : Natural gas central heating

Cooling system :Split system air conditioners

DHW system : Null

Ventilation system :Natural

Lighting system : LED

Average U value: 1.1081

Number of occupants : 20

Hours of occupation per year :3000

Relevant Stakeholders:

Order of Tunisian Architects

University Of Sousse

Regional Directorate for Equipment and Housing

National Environmental Protection Agency

Regional Department of the Environment

National Waste Management Agency

SNTool Sahloul 3 Contextualization

Issue	Priority factor	Weight
A. Use of land and biodiversity	4	12.5%
B. Energy	4	12.5%
C. Water	4	12.5%
D. Solid waste	4	12.5%
E. Environmental quality	3	9.4%
F. Transportation and mobility	3	9.4%
G. Social aspects	3	9.4%
H. Economy	0	0%
I. Climate change	4	12.5%
J. Governance	3	9.4%

Categories weights

Code	Category	Priority factor	Weight
B1	Energy infrastructure	3	27.3%
B2	Energy consumption	4	36.4%
B3	Renewable energy	4	36.4%
C1	Water infrastructure	4	36.4%
C2	Water consumption	4	36.4%
C3	Effluents management	3	27.3%

SBTool Sahloul building Contextualization

Issue	Priority factor	Weight
A. Site regeneration and development	5	16.1%
B. Energy and resources consumption	5	16.1%
C. Environmental loadings	5	9.7%
D. Indoor environmental quality	4	12.9%
E. Service Quality	3	9.7%
F. Social, cultural and perceptual aspects	4	12.9%
G. Costs and economic aspects	5	12.9%
H. Adaptation to climate change	5	9.7%

Categories weights

Code	Category	Priority factor	Weight
B1	Energy	5	31.3%
B2	Electrical peak demand	3	18.8%
B3	Materials	3	18.8%
B4	Use of potable water, stormwater and potable water	5	31.3%
D1	Indoor air quality and ventilation	4	22.2%
D2	Air temperature and relative humidity	4	22.2%
D3	Daylight and ilumination	4	22.2%

SNTool Sahloul 3 Benchmarks

A. Use of land and biodiversity

Indicator	Unit of measure	Benchmark	Rationale
Human Density	Inhabitants/Ha	0: (60)	This is the density average value of the city in 2020
		5: (200)	The highest density is 218 Inh/Ha in the city

B. Energy

Indicator	Unit of measure	Benchmark	Rationale
Energy consumption of public lighting	KWH/Km/Year	0: (15000)	Study on the average consumption of public lighting in the city
		5: (8000)	Aim to have consumption by using low-energy consumption lamps

SNTool Data Sources

Criterion	Data source/ Data provider
Human Density	National Institute of Statistics (INS),Atlas of neighbourhoods (http://pduisousse.tn/documents/)
Availability of public water supply	Société Nationale d'Exploitation et de Distribution des Eaux (SONEDE),Atlas of neighbourhoods (http://pduisousse.tn/documents/)
Availability of solid waste collection	Municipality of Sousse,Geoportal of the city of Sousse,National Waste Management Agency (ANGED)
Sidewalk Availability	Local Urban Plan (PLU) of the city of Sousse Atlas of neighbourhoods (http://pduisousse.tn/documents/),Tour of the neighbourhood Aerial photo (Ministry of Equipment)
Risk of flooding	Atlas of neighbourhoods (http://pduisousse.tn/documents/), Qgis
Energy consumption of public buildings	Tunisian Electricity and Gas Corporation (STEG) Municipality of Sousse, Regional Directorates of Public Departments and Agencies,Atlas of neighbourhoods (http://pduisousse.tn/documents/)

SBTool Sahloul building Benchmarks

B. Energy and resources consumption

Indicator	Unit of measure	Benchmark	Rationale
Primary energy consumption per internal useful area per year	kWh/m²/a	0: (312)	Modified repository taking into account local climatic conditions and energy conversion factors
		5: (200)	Modified repository taking into account local climatic conditions and energy conversion factors

B. Energy and resources consumption

Indicator	Unit of measure	Benchmark	Rationale
Shading of the building envelope by vegetation	%	0: (30)	modified reference system taking into account local climatic conditions
		5: (70)	modified reference system taking into account local climatic conditions

SBTool Data Sources

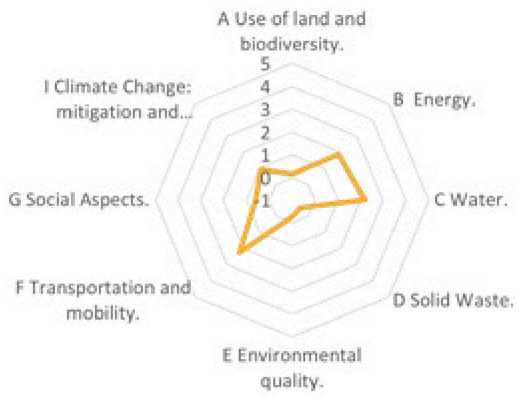
Criterion	Data source/ Data provider
Proximity to main services	Atlas of neighbourhoods (http://pduisousse.tn/documents/),Google map - Open Street Map PLU of the municipality of Sousse
Construction waste	Environmental Service Municipality of Sousse National Waste Management Agency ANGED
Total water consumption	Municipality : SONEDE Invoice
Daylight Supply	Building Tour
Ongoing monitoring and verification of performance.	Municipality : Audit Department
Envelope Fire Resistance	Municipality : SPA Records - DPA - Project Delivery Building Permit Plan
Use of vegetation to improve the microclimate and cooling during summe	Building Tour

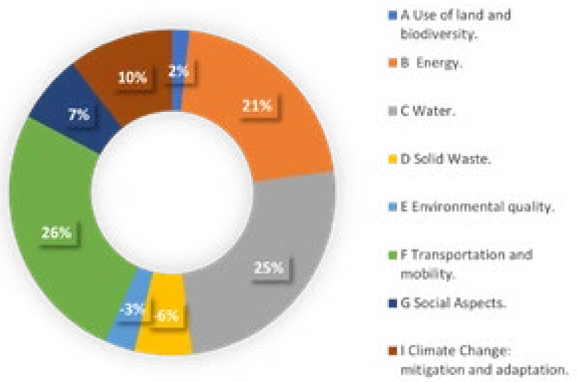
Phase 3: Diagnosis

SNTool Sahloul 3 Results

0.82

Over all score



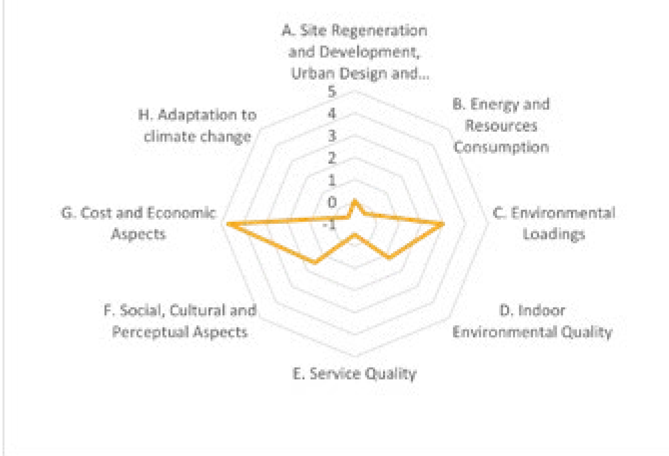


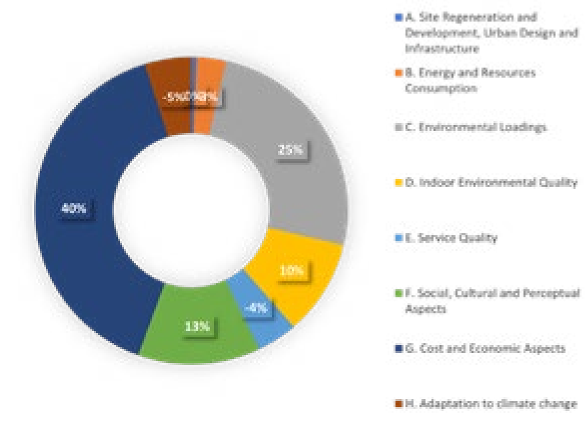
Issue	Weight	Score	Weighted Score
A. Use of land and biodiversity	13%	0.15	0.02
B. Energy	13%	1.85	0.23
C. Water	13%	2.20	0.28
D. Solid waste	13%	-0.50	-0.06
E. Environmental quality	9%	-0.27	-0.03
F. Transportation and mobility	9%	2.27	0.21
G. Social aspects	9 %	0.59	0.06
H. Economy	0%	0	0
I. Climate change	13%	0.92	0.12
J. Governance	9%	0.00	0.00

SBTool Sahloul building Results

1.2

Over all score





Issue	Weight	Score	Weighted Score
A. Site regeneration and development	14%	0.06	0.01
B. Energy and resources consumption	14%	0.36	-0.05
C. Environmental loadings	14%	2.97	0.41
D. Indoor environmental quality	11%	1.19	0.13
E. Service Quality	8%	-0.50	-0.04
F. Social, cultural and perceptual aspects	11%	1.50	0.17
G. Costs and economic aspects	14%	4.70	0.65
H. Adaptation to climate change	14%	-0.57	-0.08

Phase 4: Strategic Definition

SNTool Target setting

Environmental targets

Increase green spaces, permeable areas and vegetation in the neighborhood

The creation of the necessary facilities for gentle modes of travel : pedestrians and cyclists.

The control or even reduction of the consumption of thermal and electrical energy as well as water consumption.

Renewable energies (mainly solar and photovoltaic) are needed, especially as the potential is real.

The implementation of the system for the selective sorting of household waste in the district.

The use of regulations that help improve air quality in the neighborhood.

Social targets

Accessibility for people with disabilities of all buildings and communal areas, as well as the adequate fitting-out of pedestrian infrastructure (sidewalks and roadways.

The creation of as much essential service equipment as possible in close proximity to the inhabitants must be a priority for the city of Sousse, in order to reduce commuting by motorized vehicles, which are sources of energy waste and air pollution.

Moreover, in the context of the revision of its urban development plan, the city of Sousse, which claims to be the "quarter-hour city", has already taken certain measures and provisions in line with this objective.

Economic targets

Regarding the theme (H) relating to the economy and its various aspects, it should be noted that no criteria of this theme have been selected by the partners to carry out the diagnosis and evaluation of sustainability in the Sahloul 3 neighborhood.

This can be explained by the high social level of the inhabitants, as well as by the economic dynamics (trade and services) that this neighborhood experiences within the city of Sousse.

SBTool Target setting

Environmental targets

Reducing the specific consumption of the building for the different forms of energy (electricity and natural gas) will lead to a reduction in CO_2 emissions and consequently to better air quality and a better feeling of comfort.

Air filtration will help maintain the health of the building occupants.

The addition of the plantation will provide better shade and protection against prevailing winds that affect the thermal balance of heating and cooling.

The use of renewable energy will reduce GHG emissions.

Social targets

The only category of the Social, Cultural and Perceptual Aspects (F) theme is F1.1:

Universal access on site and in the building" which is represented by a single indicator active in the simulation, namely: "The scope and quality of the design measures planned to facilitate access and use of the building facilities by disabled people".

The latter has a score of 3 so it represents a fairly good performance that will be maintained.

Economic targets

For Theme (G) costs and economic aspects, both categories and related indicators also have acceptable performance ratings:

G1.4 Economic costs: for this category, the indicator "Annual energy cost per indoor useful area" has a score of 4.4

G1.5 Water costs: the indicator "Annual water cost per internal useful area" scores 4.64 per simulation.

The goal is to preserve these scores.

SNTool Sahloul 3 Constraints and restrictions

Legal Constrainsts	The Rigid urban regulation is not aligned with the objectives of sustainable urban renewal, which may require efforts to update or modify them.
Technical Constrainsts	Land Reserve Almost Nil (Almost entirely urbanized area) is 5%
Financial Constrainsts	Public funding: The low availability of public funding is a major factor.
Environmental Constrainsts	Management of construction waste Water management: Urban renewal must take into account storm water management to avoid flooding. The district is crossed by developed watercourses whose dedicated infrastructure remains undersized compared to the high frequency of precipitation due to climate change.
Stakeholder based restrictions	Resistance to change: Some stakeholders may be reluctant to adopt sustainable urban renewal practices due to lack of awareness, resistance to change or perceived additional costs.
Other relevant constraints	Periodicalization of investments in sustainability.

SBTool Sahloul building Constraints and restrictions

Legal Constrainsts	No legal constraints
Technical Constrainsts	Small areas on the roof for RE No room for rainwater collection No room for more vegetation
Financial Constrainsts	High investments with long payback period
Environmental Constrainsts	Possible problem of shading of solar installations due to the height of the surrounding buildings
Stakeholder based restrictions	No stakeholders restrictions
Other relevant constraints	Lack of technical staff in the municipality Periodicalization of investments in sustainability

Phase 5: Retrofit Scenarios

SNTool Scenario 1: THE ECOQUARTIER SAHLOUL 3

The scenario plans to make Sahloul 3 an eco-responsible neighborhood through the implementation of the following objectives: Development of green areas and vegetation, Introducing energy sobriety and promoting renewable energy, Encouragement of eco-construction, Optimization of water resource management, Introduction of selective sorting and intelligent management of solid waste, Reduction of air pollution, Promotion of soft mobility, Encouragement of new green urban governance.

A. Use of land and biodiversity	To encourage green architecture (green roofs, green facades, etc.), which will have a positive impact not only on the well-being and quality of life of the inhabitants, but also on mitigating the effects of climate change such as combating urban heat islands, reducing the carbon footprint, etc.
B. Energy	The scenario will seek to introduce energy efficiency into smart city management: Implement a solar photovoltaic self-generation system on the roofs of buildings .Encourage the installation of electric vehicle charging stations, and facilitate parking for electric vehicles.
C. Water	The installation of storm water recovery devices to supply water points used for watering. Encourage the use of water-efficient appliances.
D. Solid waste	Implementation of a system for the selective sorting of household waste. Installation of connected waste bins. Adoption of a communication and awareness-raising policy for inhabitants on this issue. Encouraging the installation of relays for collecting recyclable waste
E. Environmental quality	Install air quality sensors in the neighborhood and implement a communication and awareness policy .Modulate the displacement and speed of motor vehicles to account for peaks in air pollution if necessary.
F. Transportation and mobility	Limit the movement of motor vehicles in space and time (e.g. alternating traffic). Pedestrianizing targeted streets and avenues .Develop continuous and safe bike lanes.Encouraging the use of biofuels in public transport.Helping to increase the density of transit stops.
G. Social aspects	Equipping green and recreational spaces with play and entertainment facilities for children. Provide all public spaces that receive the public with access facilties and amenities for people with physical disabilities.Facilitate travel for the visually impaired through the widespread use of Braille on public spaces.

SBTool Scenario 1 : INTEGRATION OF GREEN TECHNOLOGIES

The scenario foresees interventions to replace different energy-intensive equipment, mainly air conditioning, heat generation, lighting, with others with better energy performance. The integration of renewable energy will reduce the building's carbon footprint. Other actions related to water consumption and air quality will lead to a more sustainable building.

A. Site regeneration and development	Set up bicycle parking spaces to activate soft mobility. Redevelop and equip outdoor recreational spaces near the building. Planting trees in the rear garden to shade the south facade of the building, which is highly exposed to the sun, resulting in a reduction in cooling requirements in summer.
B. Energy and resources consumption	The implementation of a SAS at the building entrance will improve the tightness of the reception hall and minimize thermal losses. The municipality may also consider the installation of an air curtain at the entrance door, which will improve the waterproofing but have less impact on durability. Replace the split air conditioning system individual systems at the large service room with central air conditioning using variable volume ventilation (VAV) or variable refrigerant volume (VRV) or variable flow refrigerant (RDV) techniques which all have high energy performance coefficient (EER>3.5) At the office level the existing air conditioners will be replaced by new units of INVERTER type with better energy performance.
C. Environmental loadings	Set up a selective sorting system inside the building in coordination with the system that will be upgraded to neighborhood level. The carbon footprint of the building is significantly reduced through planned energy performance measurements . Implementation of recycling and waste management programs to minimize the amount of waste sent to landfills.
D. Indoor environmental quality	Placing sunshine on windows will reduce heat input from direct sunlight while maintaining diffuse radiation to allow for natural lighting. The installation of selective stop-ground reflective film will reduce the risk of direct exposure to solar radiation in the reception hall with a glazed facade on the North-West side. The installation of SAS at the entrance will also reduce the noise coming from the main track in front of the building characterized by a strong road traffic, resulting in better sound insulation.
E. Service Quality	The use of the Energy Management Dashboard will optimize the operating costs of the building by means of the system for generating performance indicators, a project monitoring and planning tool and finally the warning device enabling preventive maintenance operations to be started on time and also reducing corrective maintenance delays, thus improving the quality of the service provided.

I. Climate change	The carbon footprint of buildings is greatly reduced thanks to planned energy performance measures. Encourage or require the use of certifications such as ECOBAT. Increase soil permeability ratios (and thus rainwater catchment and vegetation).
J. Governance	Communication and awareness-raising campaign among residents on the importance of sustainability issues. Systematic use of eco-construction standards, existing certifications, optimization of the energy consumption of all buildings, spaces and areas under public authority in the neighborhood.

	Centralized Technical Management (GTC) makes use of the best control, regulation and monitoring technologies leading to better energy performance combined with better quality of service
F. Social, cultural and perceptual aspects	Take back the entrance ramp for the disabled and make it more adapted to people with reduced mobility. Develop a more accessible service counter for disabled persons. Put in place a mechanism to give them priority in the service provided. Obtain certifications such as ECOBAT to attest the building's compliance with strict environmental standards and serve as a model of energy efficiency for occupants and visitors.
G. Costs and economic aspects	The energy management dashboard that will be put in place is a powerful tool to monitor both energy and water spending. It makes it possible to monitor and monitor expenditure relating to the consumption and maintenance of energy-intensive equipment. The TBGE also has a project simulator for estimating the costs and calculating the economic profitability of the actions to be implemented.
H. Adaptation to climate change	The tree planting on the SOUTH side improves the shade of the Façades exposed to direct solar radiation. The main façade side tree plantation protects the building from prevailing winds from the north. The installation of a storm water recovery system will reduce water consumption and reduce the amount of runoff that can lead to flooding in the event of heavy rains.

SNTool Scenario 2: AN INNOVATIVE AND ATTRACTIVE NEIGHBORHOOD

A complete, diverse, connected and inclusive living environment that provides a supportive lifestyle for the neighborhood's residents. A policy of active and collective mobility, based on a neighborhood open to the city. A network of integrated green and public spaces, at the basis of the spatial organization of the neighborhood. An urban identity of the place renovated.

A. Use of land and biodiversity	Functional diversity: Integrate a variety of land uses, including residential, commercial, industrial and recreational, to create a vibrant neighborhood. This can reduce the need for long-distance travel and encourage social interaction. This requires a change in urban regulation. Vertical construction: Opt for higher buildings to maximize the use of floor space. This can be particularly beneficial in the urban areas of Sahloul 3 by allowing an additional level (3rd floor) for individual constructions. Community gardens and green spaces: Develop community gardens and green spaces that serve as places of relaxation and food production (urban agriculture), with the aim of promoting urban biodiversity
B. Energy	Development of an energy plan: Develop a plan that identifies targets for reducing energy consumption, using renewable energy and improving energy efficiency. Smart Grids: Implement intelligent street lighting, which adapts as needed, uses energy-efficient LED bulbs, and incorporates sensors to detect human presence. Monitoring and evaluation: Put in place monitoring tools and equipment (collective and individual) to measure progress on energy efficiency and clean energy use, to make adjustments if needed.
C. Water	Green infrastructure: Integrate green spaces and landscaping in the neighborhood to promote rainwater infiltration and improve water quality. Artificial wetlands can also contribute to water purification. Example (partial development of the green zone east of the neighborhood) Reduction of losses in the water system: Improve the efficiency of the water distribution system by repairing leaks and upgrading infrastructure. Use advanced technologies to monitor and control the network. Protection of water resources: Encourage the preservation of groundwater, limiting polluting activities and raising awareness in the community of the importance of protecting these resources. Water reuse: Explore ways to collect and treat gray water (water from showers, washbasins, etc.) for reuse in irrigation of green spaces. Convert the pumping station located in the neighborhood into a mini STEP (Sewage Treatment Plant).
D. Solid waste	Technology and tracking: Use smart technologies to monitor waste levels, plan collection more efficiently and proactively report problems. Waste reduction at source: Work with local businesses and businesses to reduce unnecessary packaging and promote online sales. Efficient collection and transport: Optimize waste collection routes to reduce costs and carbon footprint. Use of cleaner and more energy efficient vehicles (100% electric household waste trucks)

SBTool Scenario 2 : ECO-RESPONSIBLE RENOVATION

This scenario prioritizes the intervention on the building envelope mainly the actions of insulation of walls and roofs, the choice of adequate carpentry for exterior openings, the increase of green spaces, the use of renewable energies, the adoption of intelligent building management, the replacement of equipment and furniture by others made of recyclable materials and with low incorporated energy.

A. Site regeneration and development	Installation of bicycle parking with charging stations for electric bicycles powered by photovoltaic panels installed on the roof of the shelter (to be built). Redevelop and equip outdoor recreational areas near the building. Rehabilitation of the exterior sun coating with a high permeability coating to retain the maximum amount of rainwater by infiltration.
B. Energy and resources consumption	Add a special layer of white paint to the roof to ensure tightness and reflect direct sunlight while lowering its temperature and improving its thermal insulation performance. Re-insulate the walls of the building envelope with a suitable coating (plaster and additive mixture) applied from the outside and painted in white. Install sunshades over the sun-exposed SOUTH and West openings and install selective interior curtains. Implement openings at the outer walls allowing natural circulation of fresh air by chimney effect. Install economizers on water points mainly washbasins. Modification of flushing by a network of pipes with pressurized water and controlled by pushers.
C. Environmental loadings	Set up a selective sorting system inside the building in coordination with the system that will be upgraded to neighborhood level. The carbon footprint of the building is significantly reduced through planned energy performance measures.
D. Indoor environmental quality	Mounting of an ambient air filtration device on air conditioners. The installation of selective stop-ground reflective film will reduce the risk of direct exposure to solar radiation in the reception hall with a glazed facade on the North-West side. The installation of SAS at the entrance will also reduce the noise coming from the main track in front of the building characterized by a strong road traffic, resulting in better sound insulation. Addition of humidity controlled fragrant steam diffuser for a better feeling of comfort and lower energy consumption.
E. Service Quality	The scheduling of training sessions for permanent occupants of the building on the subject of energy efficiency, the display of instructions for optimal operation of equipment, the dissemination of awareness spots and information on comfort conditions inside and outside the building increases the sensitivity of space users and promotes good energy efficiency practices. The addition of extractor with a heat recuperator on the reception receiving a large number of visitors allowing a standardized air renewal with a minimum of heat loss.

	Recycling and recovery of waste: Establish partnerships with recycling companies to treat recyclable waste. Encourage the recovery of organic waste through composting and Create a protocol and make agreements with ANGED.
E. Environmental quality	Reducing industrial emissions: Implement strict regulations on industrial emissions near Sahloul 3 and compel them to adopt cleaner technologies. Traffic restrictions: Limit restricted traffic areas (RCAs) where only clean vehicles (hybrid, 100% electric) are allowed to operate. Pedestrian areas and green areas: Transform areas into pedestrian spaces and create more recreational spaces to reduce pollution, improve air quality and provide quality spaces.
F. Transportation and mobility	Soft mobility: Promote gentle modes of transportation, such as walking and cycling, by creating user-friendly sidewalks, safe bike lanes and reducing reliance on the car. Open data and mobile applications: Provide real-time transportation data and encourage the development of mobile apps to facilitate trip planning. Shared mobility: Promoting carpooling, car sharing services and on-demand transportation to reduce the number of vehicles on the road. A partnership with development startups to create a local platform for neighborhood car sharing.
G. Social aspects	Strengthen security in the neighborhood in cooperation with law enforcement and by establishing smart surveillance systems. Increasing use of urban cameras in public spaces, parks and gardens. Make the built environment accessible to all, by ensuring that existing public infrastructure, buildings and public spaces are adapted to people with reduced mobility. Encourage the creation of artificial intelligence startups led by recent graduates from universities in the immediate area.
I. Climate change	Use GIS to monitor and map water levels in real time, facilitating a rapid response to flooding. Use advanced mapping technologies to identify at-risk areas and plan safe evacuation routes in the event of flooding. Promote development practices that reduce impermeable surfaces, such as the installation of permeable pavers and bitumen, to combat flooding and promote groundwater recharge. Use artificial intelligence to analyze weather data, monitor water levels and predict floods.
J. Governance	Actively include the community in the planning and design process to ensure that local needs are taken into account Establish flexible urban regulations that promote innovation while ensuring high standards of sustainability. Organize awareness campaigns to encourage residents to adopt energy-efficient behaviors and invest in energy-efficient technologies.

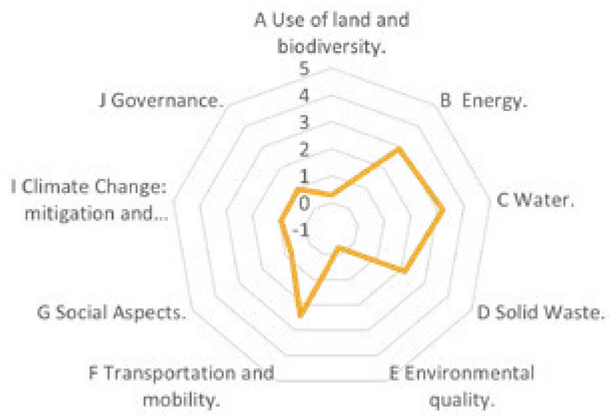
F. Social, cultural and perceptual aspects	Take back the entrance ramp for the disabled and make it more adapted to people with reduced mobility. Develop a more accessible service counter for PRMs.Put in place a mechanism to give them priority in the service provided. Obtain certifications such as ECOBAT to attest the building's compliance with strict environmental standards and serve as a model of energy efficiency for occupants and visitors.
G. Costs and economic aspects	Implementation of sustainable systems, such as energy-efficient lighting and efficient HVAC equipment, reduces ongoing operating costs. Take advantage of tax incentives or subsidies for sustainable construction projects provided by the state, which can help offset the initial costs. The sustainable building will have increased real estate value due to their energy efficiency and reduced environmental impact. Durable materials often have a longer lifespan and require less maintenance, which can reduce maintenance costs over time.
H. Adaptation to climate change	Environmentally responsible buildings are designed to be more energy efficient, reducing emissions from the consumption of electricity and fuels for heating, cooling and lighting. Rainwater harvesting systems and water saving schemes help reduce water consumption, which is crucial in regions facing water stress such as Tunisia.

Phase 6: Decision Making

SNTool Scenario 1: THE ECOQUARTIER SAHLOUL 3

153

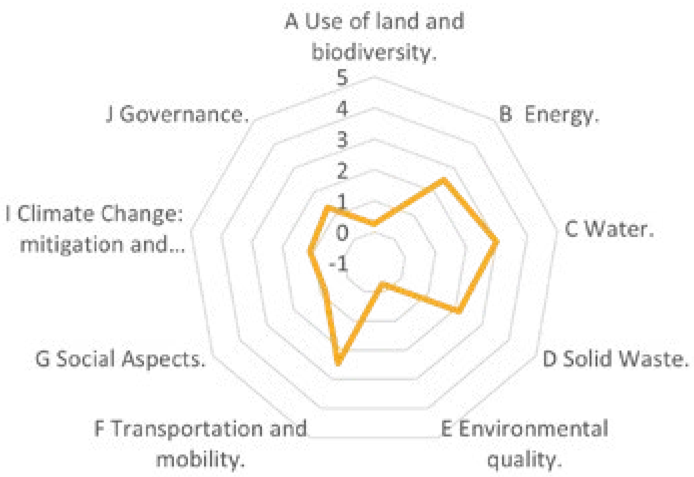
Over all score



SNTool Scenario 2: AN INNOVATIVE AND ATTRACTIVE NEIGHBORHOOD

155

Over all score



Selection of the scenario 1: THE ECOQUARTIER SAHLOUL 3

An in-depth discussion was held with the stakeholders to choose the retrofitting scenario, by vote, after the validation of the different scores and weights.

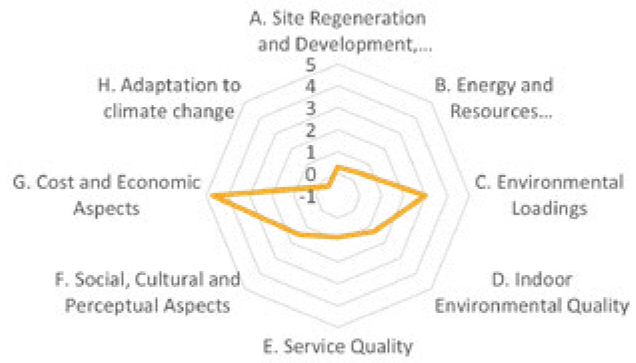
The choice was made unanimously, especially after minor adjustments made to the initial version.

We are convinced that this unanimous vote, in addition to legitimizing the selected scenario, will ensure that each stakeholders will do their best to make what was decided together a reality.

SBTool Scenario 1 : INTEGRATION OF GREEN TECHNOLOGIES

1.5

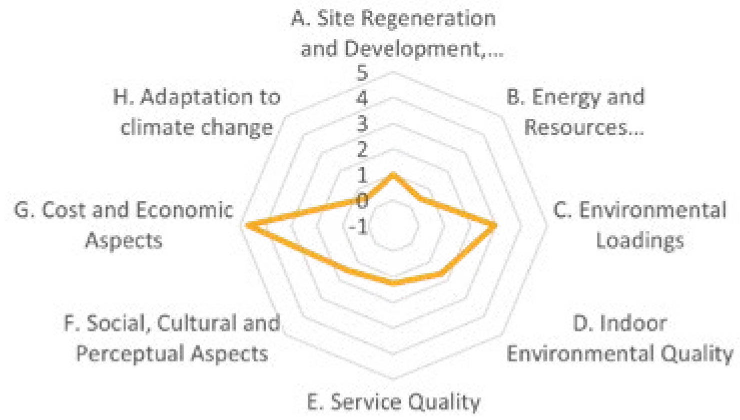
Over all score



SBTool Scenario 2 : ECO-RESPONSIBLE RENOVATION

1.79

Over all score



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Phase 7: Retrofit Concept

SNTool Description

The scenario plans to make Sahloul 3 an eco-responsible neighborhood through the implementation of the following objectives:

Development of green areas and vegetation, Introducing energy sobriety and promoting renewable energy, Encouragement of eco-construction, Optimization of water resource management, Introduction of selective sorting and intelligent management of solid waste,Reduction of air pollution, Promotion of soft mobility, Encouragement of new green urban governance.

The scenario aims to improve landscaping by expanding the use of evergreen plantations:

Along the 14.3 km of streets and avenues of the neighborhood

Of the 4.22 Hectares of dedicated green areas according to the urban planning regulations

On all parts of permeable non-buildable parcels (withdrawal areas for individual residences)

Expected results

The density of green spaces in the area is expected to increase from 7.45% to 10.7%. This will have a positive impact not only on the well-being and quality of life of the inhabitants, but also on mitigating the effects of climate change such as combating urban heat islands, reducing the carbon footprint etc.

Improving the aesthetics of the urban area and strengthening environmental resilience

Financial scheme	Time scale
Usually the municipal budget or more rarely the Ministry of the Environment	Period 2024-2040

Activities/works to implement the intervention

Planting evergreen trees on streets and avenues in the neighborhood

Trees in the green areas not yet planted in the district

Implement an efficient irrigation system for the trees during their first year of growth, to ensure they are rooted.

Provide regular maintenance for the trees planted, including pruning, watering, fertilization and disease control.

SBTool Description

Throughout the themes we have built synergies: mostly easy, energy transition and ecological transition. Then, synergy with the circular economy, comfort, health, well-being, and then with biodiversity.

The dynamics of responsible building and increased building are possible but not achieved: they require special political and societal attention.

Beyond addressing global warming, the environmental transition includes the non-depletion of the planet’s resources and the intelligent use of scarce non-renewable resources. The circular economy applied to buildings and cities will be the answer

There are synergies between efficient building (energy, carbon, resource) and health and comfort, as well as a dynamic of connected buildings, new possibilities of authorized services at the scale of the building and the city thanks to digital and artificial intelligence

The augmented building makes the building a great platform of services that complement and flourish at the neighborhood and city level. Some services give us opportunities for more responsible lifestyles on energy, environmental, health and biodiversity issues.

Expected results

Reduced fuel consumption for building users.

Increasing infrastructure for soft mobility

Improving outdoor air quality

Improve energy consumption balances by reducing direct exposure of building walls to direct solar radiation.

Financial scheme	Time scale
Municipal budget	Court terme (2024)

Activities/works to implement the intervention

Redevelop and equip outdoor recreational spaces near the building.

Planting trees in the back garden to shade the building’s south side with high sun exposure reduces cooling requirements in summer.

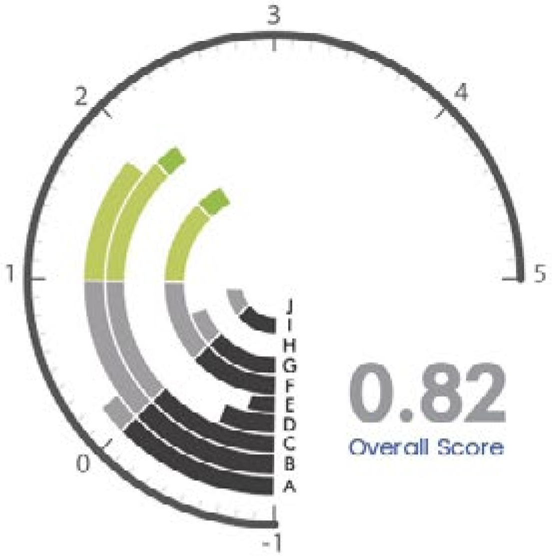
SMC Passports

Assessment Results Sousse
at the neighbourhood scale

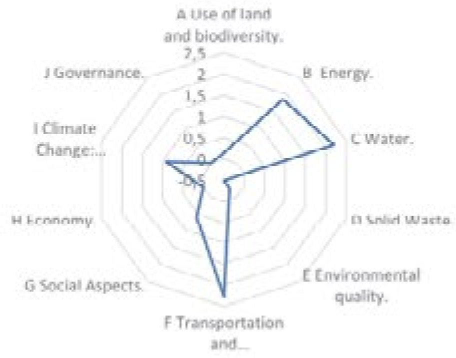
Sustainable MED Cities

Sahloul 3 Urban Area

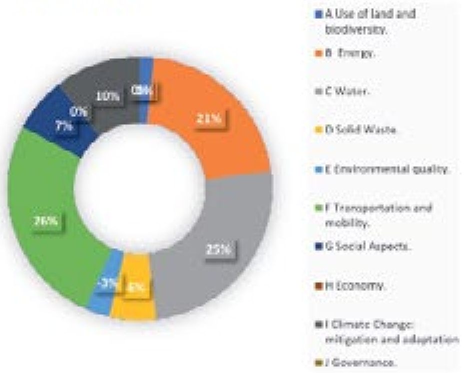
Final Score



Spider Chart



Pie Chart



Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (including KPIs) in the assessment.

# of available criteria	92	# of active criteria	33

Description of the KPIs

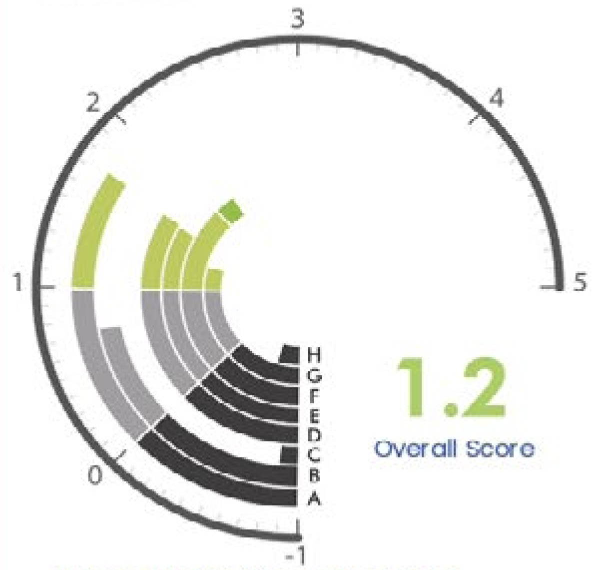
	KPIs at neighbourhood scale	value	Unit of measure
B2.1	Total final thermal energy consumption for building operations	19,42	kWh/m²/yr
B2.4	Total final electrical energy consumption for building operations	13,86	kWh/m²/yr
B2.7	Total primary energy demand for building operations.	53,24	kWh/m²/yr
B3.1	Share of renewable energy generated on-site, relative to final thermal energy consumption for building operations	4,30	%
B3.4	Share of renewable energy generated on-site, relative to final electric energy consumption for building operations	6,90	%
B3.7	Share of renewable energy generated on site, relative to the total primary energy consumption for building operations.	0,00	%
C2.3	Consumption of potable water in residential buildings	169,84	L/occupant/yr
D2.2	Access to solid waste and recycling collection points	0,00	%
E1.2	Particulate matter (PM) concentration.	42,00	days/yr
F1.1	Performance of the public transport system	80,00	%
F2.3	Bycicle network.	0,02	m/inhabitant
G3.1	Availability and Proximity of Key Services	25,00	%
I1.1	Greenhouse Gas emissions.	1,06	t CO_2eq./ inhabitant /yr
I3.1	Permeability of land.	7,86	%

Assessment Results Sousse
at the Building Scale

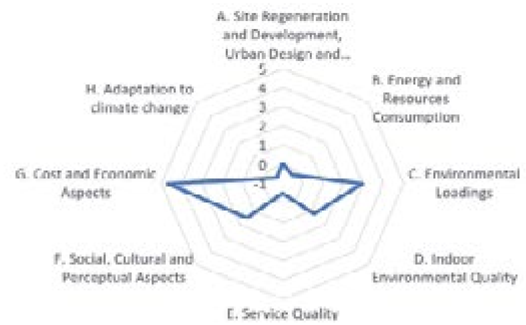
Sustainable MED Cities

Municipality's Building

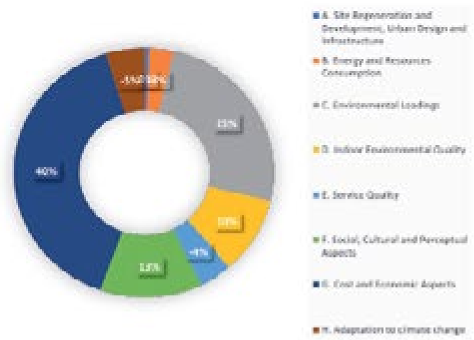
Final Score



Spider Chart



Pie Chart



Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (including KPIs) in the assessment.

# of available criteria	92	# of active criteria	32

Description of the KPIs

	KPIs at neighbourhood scale	Value	Unit of measure
B1.1	Primary energy consumption	226,23	kWh/m²/yr
B1.2	Thermal energy consumption	30,60	kWh/m²/yr
B1.3	Electrical energy consumption	00,25	kWh/m²/yr
B1.4	Energy from renewable sources in total thermal energy consumption	0,00	%
B1.5	Energy from reneable sources in total electrical energy consumption	0,00	%
B1.6	Embodied non-renewable primary energy	814,43	MJ/m²
B3.4	Recycled materials	8,00	%
B4.3	Potable water consumption for indoor uses	175,00	m³/occupant/yr
C1.1	Embodied carbon	2,61	$KgCO_2eq/m^2$
C1.2	GHG gas emissions during operations	35,62	$KgCO_2eq/m^2$ yr
D1.2	TVOC concentration	0,60	µg/m³
D1.7	Mechanical ventilation	0,76	l/s/m²
D2.3	Thermal comfort index	35,00	%
D3.1	Daylight	4,70	%
E1.2	Smart readiness indicator	23,06	%
G1.4	Energy cost	26,97	€/M²/yr
H1.2	Heat island effect	27,80	SRI

3. Moukhtara case study

A Lebanon City

Phase 1: Initiation

Moukhtara SNTool

Moukhtara is an old village that was firstly named and built up in the late 16 century on the remains of the roman ruins, Moukhtara means "The Chosen" and it named so because it was chosen by the Joumblat's Prince.

Moukhtara is considered the central village of the federation of Higher Shouf's municipalities, and it has many services and infrastructure that serves the nearby areas.

Moukhtara is a rural area with an integrated social context constructed by family units that are very interactive with the stakeholders in the area. People in the area depend on agriculture and tourism as the main economic activities.

Moukhtara village is surrounded by the Shouf Biosphere Reserve recognised by UNESCO in 2005, Ain w Zein grotto, the garden of Kamal Jumblat in Boqaata and the historical villages of Beiteddine, Deir el Qamar, Baaqline, Maasser el Shouf and Ain Zhalta.

Olive terraces are located at the foot of the village with a well-preserved natural environment all around the village.

Water falls at Nabee Mershed and the pond of Berket el Arous and Bire el Blat add to the Moukhtara a natural heritage.

The data collection process was based on the municipal data available through questionnaire, observation, participatory approach during meetings and available statistics and studies.

There are no archiving and documentation system related to the subject of the piloting study available.

There is no Supervisory Control and Data Acquisition (SCADA) System for data monitoring and analysing

Moukhtara SBTool

The municipality building was firstly constructed in 1999, and it is now the official seat of the federation of municipalities of the Higher Shouf and the municipality of Moukhtara.

The municipality building is a Lebanese traditional building with a brick roof.

The municipality building is a hybrid construction entity (old design- new construction), it is a stone construction (Iwan Building) with concrete column and stone cladding

Relevant Stakeholders:

Category of the stakeholder: Tourism
Organisation: Ain Merched
Activity of the organisation: Restaurant
Role in the decision-making process: Advisory

Category of the stakeholder: Commercial
Organisation: Moukhtara Cooperative
Activity of the organisation: Grocery + Butchery + Bakery
Role in the decision-making process: Advisory

Category of the stakeholder: Small Industries
Organisation: Saleem
Activity of the organisation: Dairy Production
Role in the decision-making process: Advisory

Category of the stakeholder: Public school
Organisation: Moukhtara Public School
Activity of the organisation :Teaching
Role in the decision-making process: Participatory

Category of the stakeholder: Tourism
Organisation: Shouf Biosphere Reserve
Activity of the organisation: Tourism and Natural park
Role in the decision-making process: advisory

Phase 2: Preparation

SNTool Contextualization

Issue	Priority factor	Weight
A. Use of land and biodiversity	2	11.8%
B. Energy	4	23.5%
C. Water	3	17.6%
D. Solid waste	3	17.6%
E. Environmental quality	2	11.8%
F. Transportation and mobility	1	5.9%
G. Social aspects	1	5.9%
H. Economy	0	0%
I. Climate change	1	5.9%
J. Governance	0	0%

Categories weights

Code	Category	Priority factor	Weight
B1	Energy infrastructure	1	16.7%
B2	Energy consumption	3	50%
B3	Renewable energy	2	33.3%
C1	Water infrastructure	3	50%
C2	Water consumption	1	16.7%
C3	Effluents management	2	33.3%

SBTool Contextualization

Issue	Priority factor	Weight
A. Site regeneration and development	0	0%
B. Energy and resources consumption	4	23.5%
C. Environmental loadings	3	17.6%
D. Indoor environmental quality	2	11.8%
E. Service Quality	2	11.8%
F. Social, cultural and perceptual aspects	2	11.8%
G. Costs and economic aspects	3	17.6%
H. Adaptation to climate change	1	5.9%

Categories weights

Code	Category	Priority factor	Weight
B1	Energy	3	33.3%
B2	Electrical peak demand	0	0%
B3	Materials	2	22.2%
B4	Use of potable water, stormwater and potable water	4	44.4%
C1	Green house gas emissions	1	100%
C2	Other atmospheric emissions	0	0%
C3	Solid wastes	0	0%

SNTool Benchmarks

B. Energy

Indicator	Unit of measure	Benchmark	Rationale
Aggregated annual total primary energy consumption per aggregated indoor useful floor area	kWh/m2/year	0: (170) 5: (100)	These Benchmarks were adopted taking into consideration the factors adopted to set the benchmarks for the thermal energy and electrical energy.

C. Water

Indicator	Unit of measure	Benchmark	Rationale
Annual potable water consumption per occupant	Liters/day/ person	0: (250) 5: (60)	These benchmarks were adopted taking into consideration an overall assumption for Lebanon in general and then contextualized for the Moukhtara context based on data from the Beirut and Mount Lebanon water Establishment online platform

SNTool Data Sources

Criterion	Data source/ Data provider
Green areas in relation to the neighborhood population	Moukhtara Municipality Engineering team listed under the SMC team members, led by the SMC team Coordinator conducted the data collection. Data verification and analysis was conducted by the SMC Team Lead and Quality Management consultants.
Total final thermal energy consumption for building operations	Data verification and analysis was conducted by the SMC Team Lead and Quality Management consultants. Calculation of the targets and values were based on assumptions and local standards (Libnor). Final values were confirmed through coordination between all the members of the SMC team listed under template 1.4
Greenhouse gas emissions	Calculation of the targets and values were based on assumptions and local standards (Libnor). Final values were confirmed through coordination between all the members of the SMC team listed under template 1.4. Calculations based on the data collected for category B and available studies for assumptions of coefficient factor

SBTool Benchmarks

B. Energy and resources consumption

Indicator	Unit of measure	Benchmark	Rationale
Primary energy demand per internal useful floor area per year	kWh/m2/yr	0: (155) 5: (50)	These benchmarks were adopted taking into consideration the electrical and thermal energies benchmarks contextualized for Moukhtara municipality building

E. Service quality

Indicator	Unit of measure	Benchmark	Rationale
The availability of a comprehensive and long-term plan at the end of Design phase, and evidence of its implementation during Operations phase	Score	0: (0) 5: (5)	These benchmarks were adopted since the indicator was divided into 5 points: availability of the plan, is it comprehensive, is it for long terms, is there evidence for implementation and does it cover all the aspects of the building

SBTool Data Sources

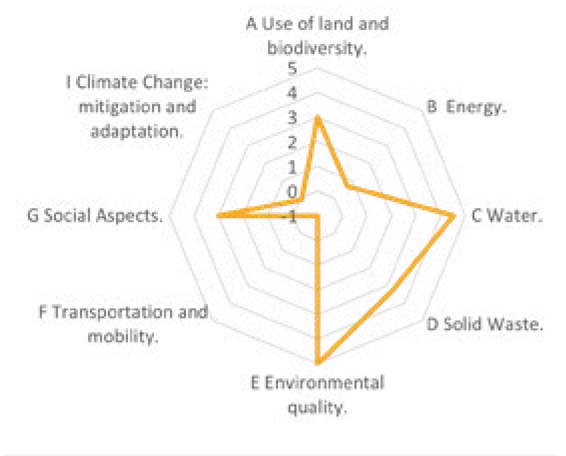
Criterion	Data source/ Data provider
Energy from renewable sources in total electrical energy consumption	Moukhtara Municipality Engineering team listed under the SMC team members, led by the SMC team Coordinator conducted the data collection. Data verification and analysis was conducted by the SMC Team Lead and Quality Management consultants. Calculation of the targets and values were based on assumptions and local standards (Libnor). Final values were confirmed through coordination between all the members of the SMC team listed under template 1.4
Universal access on site and within the building.	Moukhtara Municipality Engineering team listed under the SMC team members, led by the SMC team Coordinator conducted the data collection.

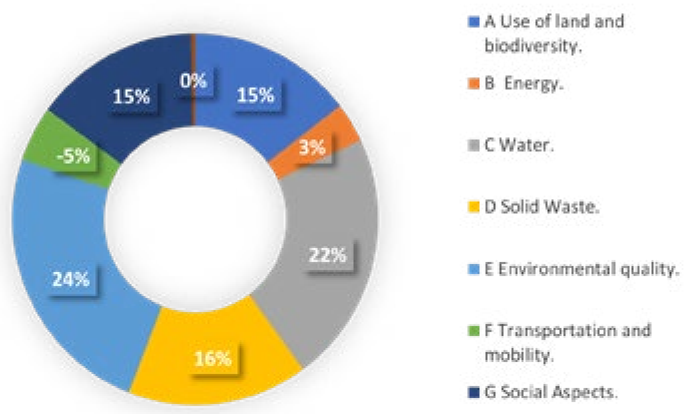
Phase 3: Diagnosis

SNTool Results

2.6

Over all score



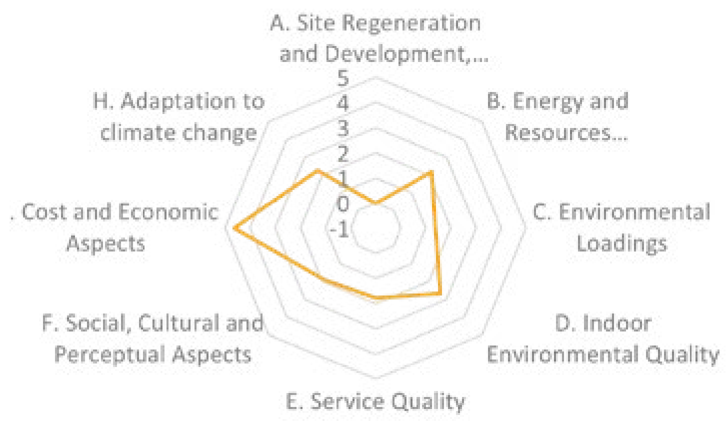


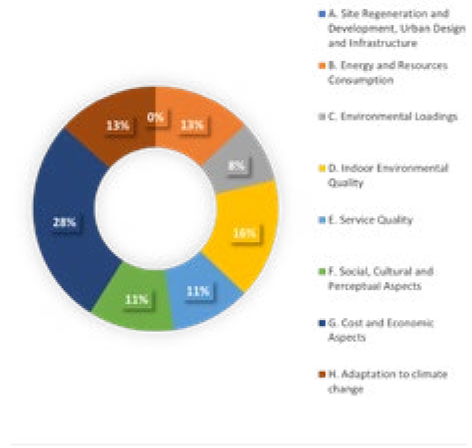
Issue	Weight	Score	Weighted Score
A. Use of land and biodiversity	12%	3	0.35
B. Energy	24%	0.71	0.17
C. Water	18%	4.52	0.80
D. Solid waste	18%	3.29	0.58
E. Environmental quality	12%	5	0.59
F. Transportation and mobility	6%	-1	-0.06
G. Social aspects	6 %	3	0.18
H. Economy	0%	0	0
I. Climate change	6%	-0.08	0
J. Governance	0%	0	0

SBTool Municipality Building Results

2.45

Over all score





Issue	Weight	Score	Weighted Score
A. Site regeneration and development	0%	0	0
B. Energy and resources consumption	24%	2.18	0.51
C. Environmental loadings	18%	1.38	0.24
D. Indoor environmental quality	12%	2.66	0.31
E. Service Quality	12%	1.77	0.21
F. Social, cultural and perceptual aspects	12%	1.90	0.22
G. Costs and economic aspects	18%	4.62	0.81
H. Adaptation to climate change	6%	2.26	0.13

Phase 4: Strategic Definition

SNTool Target setting

Environmental targets

The Environmental targets entail the targets under the category B - Energy and category I – Climate change mitigation and adaptation

The target for the Energy is based on the scenario of installing solar systems to generate electricity at household level, installing solar water heaters and solar street-lights.

This will increase the target of the electricity generated from Renewable energy for residential buildings in Moukhtara to 90% and will reduce the thermal energy used for household heating and water heating by 15%.

Social targets

The scenario forecasted for Moukhtara area and municipality will not affect directly the value under the social indicator.

Economic targets

There is no economic target forecasted for Moukhtara urban area.

SBTool Target setting

Environmental targets

The environmental targets set under this section are mainly related to shifting the electricity demand related to the municipality building from fuel-based power.

The proposed scenario is to install solar PV system to benefit the municipality and the social club and to install solar water heaters to reduce the dependance of the building on thermal fuel-based energy to heat water.

Social targets

There are no social targets forecasted for the Moukhtara municipality building since there are no social indicators ranked as low performance.

Economic targets

There are no economic targets forecasted for the Moukhtara municipality building since there are no economic indicators ranked as low performance.

SNTool Constraints and restrictions

Legal Constrainsts	There is no specific legal constraint related to the installation of solar water heaters or solar systems at household levels since it falls under the law 462.
Technical Constrainsts	The technical constraints is related to the available space to install the panels on the roofs either for electricity generation or solar water heaters.
Financial Constrainsts	Taking into consideration the current fuel cost, KWh cost by the public utility and KWh cost by the back up generator, and the cost of Kwh of solar energy, the return on investment will be achieved after 4.5 years assuming the system installed include 6 solar panels with 4 LED acid batteries.
Environmental Constrainsts	Lebanon benefit from 300 days of solar, while the remaining 60 days can vary from full raining days to cloudy days, making Lebanon a good environment for solar energy.
Stakeholder based restrictions	The citizens of Moukhtara are cooperative and willing to participate in the project
Other relevant constraints	Not applicable

SBTool Constraints and restrictions

Legal Constrainsts	The municipality and social club building is a public building managed by the municipality. There is no law or legal legislation that limit the installation of solar systems at a municipality building less than 1.5 MW.
Technical Constrainsts	The roof of the municipality is a tiled roof. The contractor will need to conduct a design study to decide on the orientation and best engineering practices to install the solar panels.
Financial Constrainsts	The cost of the scenario is around 28,000 USD for solar system and solar water heater to benefit the municipality and club building. The Return on investment will be reached in approx. 10 years.
Environmental Constrainsts	Lebanon benefit from 300 days of solar, while the remaining 60 days can vary from full raining days to cloudy days, making Lebanon a good environment for solar energy.
Stakeholder based restrictions	All the municipality members are cooperative and aware of the benefits of the scenario.
Other relevant constraints	Not applicable

Phase 5: Retrofit Scenarios

SNTool Scenario 1: Renewable Energy for All (REFA)

Switching the dependance of Moukhtara village on electricity produced by the thermal energy plants and back up diesel generators to green renewable energy produced by solar photovoltaic panels and storing it in lead acid batteries to overcome the power shortage and long black out hours.

Providing access to heated water by installing solar water heaters at household level to reduce the dependance of households on expensive diesel fuel oil.

Switching the traditional high-pressure sodium streetlights to clean energy solar streetlights to increase the safety and visibility of the roads.

The REFA scenario will entail the following activities:
Installation of solar PV panels for 116 houses consisting of 6 solar panels, 4 lead acid batteries with required inverter and steel structures, cables, panels and accessories.
Installation of 200 Liters solar water heaters for 39 houses with required booster pump and water tank
Installation of 185 solar streetlights on existing poles.

B. Energy	The execution of the REFA scenario will increase the renewable energy share from the total electrical energy to 90%. The installation of solar PV for each household in Moukhtara will increase the level of responsibility of the benefiting families and help them become energy efficient consumer.
E. Environmental quality	The scenario will indirectly affect the environmental quality in Moukhtara by reducing noise, emissions, and pollution due to shorten in the hours of running of the back-up generators and due to reduction in the power needed to serve the households
G. Social aspects	The REFA scenario will indirectly affect the food security since residents will be able to conserve their food and eliminate losses. The challenge of throwing food during the peak of the crisis in 2000 and 2001 affected gravely the Lebanese population.
H. Economy	The REFA scenario will directly affect the economy of the Moukhtara residents by lowering the public energy bill and minimizing/cancelling the back-up generators bill
I. Climate change	The REFA scenario will positively impact the climate change mitigation measures by reducing the green houses gas emissions and the reliance on fossil fuel

SBTool Scenario 1 : Moukhtara Municipality Greener (MMG)

The Moukhtara Municipality Green scenario have one specific purpose to provide access to clean electricity and heated water to the municipality and club buildings.

The scenario aim to install the followings:
24 PV solar panels of minimum 550 W each with steel structures.
4 LifePO4 storage batteries of 10 KWh each
2 inverters 8 KW each
Cables, panel, and accessories
3 solar water heaters of 250 Liters each with booster pump, cold water tanks, piping and required accessories.

Replacing the electrical devices and the municipality and club building to class A to manage electricity consumption and being in compliance with the solar system installed

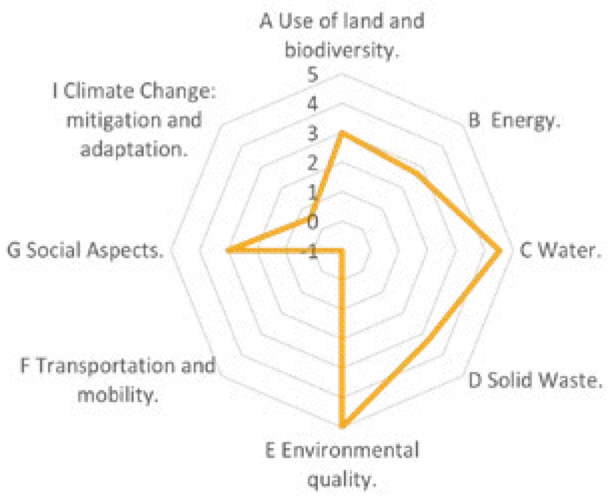
B. Energy and resources consumption	The MMG scenario will increase the dependance of the municipality and club building on the clean renewable energy and will minimize the reliance on the fossil fuel energy. The scenario will result in reducing the overall primary energy demand by 54% from 19,070 KWh/year to 10,371 KWh/year.
C. Environmental loadings	The scenario will result in reducing the green houses gas emissions by avoiding 7,260 KgCO2 equivalent per year.
D. Indoor environmental quality	The reduction of burning fossil fuel will enhance the indoor environmental quality by enhancing the quality of the air and reducing the CO2 emissions.
E. Service Quality	The replacement of the electrical and electronic devices to class A will enhance the service quality of the equipment in the building.
F. Social, cultural and perceptual aspects	The availability of power source at the municipality building will help the municipality to be reachable by the residents easily and to enhance the quality of social services.
G. Costs and economic aspects	The shifting of the energy resources to renewable energy will reduce the cost of electricity bills paid by the municipality to the public utility and back-up generator up to 90% resulting in a saving up to 2,460$ per year.
H. Adaptation to climate change	Being 90% independent of the public electricity grid, the municipality is considered as an adaptive building to harsh environment.

Phase 6: Decision Making

SNTool Scenario 1: Renewable Energy for All (REFA)

3.11

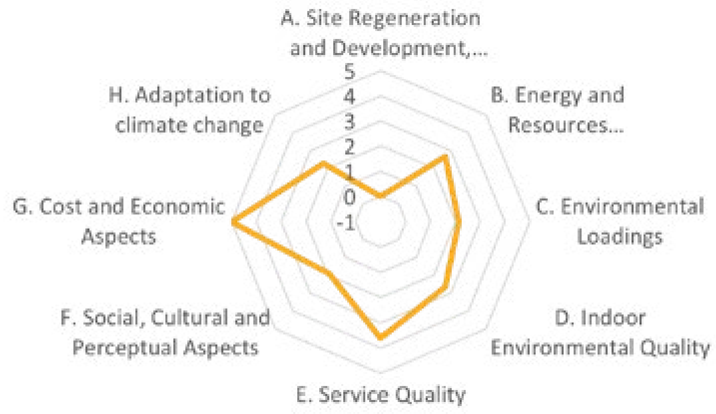
Over all score



SBTool Scenario 1 : Moukhtara Municipality Greener (MMG)

2.98

Over all score



Selection of the scenario 1:Renewable Energy for Moukhtara village

Note: One scenario for the Moukhtra urban area was identified and One scenario for the Moukhtara Municipality building was identifed. No second scenario was identified for the Moukhtara urban area and municipality building and no scenario was identified for the public school building.

Therefore, there is one global sustainibility score equal to 3.097

Justification of the scenario 1:Renewable Energy for Moukhtara village

The installation of residential solar PV system and solar water heater at households' level in Moukhtara urban area and the equipping of Moukhtara municipality and club building with solar system and solar water heaters, while replacing the traditional streetlamps with solar lamps will have a tremendous positive effect on the Moukhtara residents since most of them are cash-strapped population and not being able to be released from the dependency on back-up generators.

The most surprising aspect of Lebanon's decentralized adoption of solar energy is that it is being led by individual households rather than state policy, and therefore the support of a secured fund for solar installation at a household and building level is a matter of life and human dignity since basic daily needs cannot be accomplished without the availability of electricity.

Phase 7: Retrofit Concept

SNTool Description

This intervention aim to provide all the households in Moukhtara currently relying on standby generators to support their needs in electricity with renewable and sustainable energy sources to eliminate their dependance on fuel-based power which is very expensive, intermittent and pollutant

Expected results

Access to 21 hours of electricity generated by clean energy

Access to 24 hours of continuous electricity, this will be possible for the first time since 2019.

Being able to store food since refrigerators will be able to run and hold their working temperature as per design requirements.

Being able to drive safely due to the lighted streets

Eliminate the dependance on back-up generators.

Reduce the public electricity bills.

Financial scheme

The Renewable Energy for All (REFA) retrofit scenario will need to be totally funded by the Sustainable MED Cities

Budget estimation

The overall budget of the retrofit concept is equal to 313,000 Euros.

Time scale

The overall timeline is 5 months assuming the project will be executed during wet season

Activities/works to implement the intervention

Conducting a site visit to prepare an assessment to evaluate the conditions of the household roofs, Preparation of a design for 3.3 KWp of solar PV system, Installation of solar system for 116 houses, installation of solar water heaters for 39 houses. Installation of 185 solar streetlamps on existing poles of 200 watt each.Training for the households' owners

SBTool Description

The Moukhtara Municipality Green intervention have one specific purpose to provide access to clean electricity and heated water to the municipality and club buildings.

Expected results

Meeting the energy demand of the municipality and the club building

Increasing the electricity generated from Renewable energy for the municipality and club building in Moukhtara to 90%.

Reducing by 25% the dependance on fuel associated with the building thermal energy.

Financial scheme

The possible financing of this retrofitting intervention is through a grant funding to the municipality of Moukhtara.

Budget estimation

The overall budget of the retrofit scenario is equal to 28,500 Euros.

Time scale

The overall timeline is 7 weeks

Activities/works to implement the intervention

Conducting a site visit, Preparation of a design for a minimum of 13 KWp of solar PV system, Installation of solar system for the municipality building, Installation of solar water heaters, Training for the municipality members.

SMC Passports

Assessment Results Moukhtara

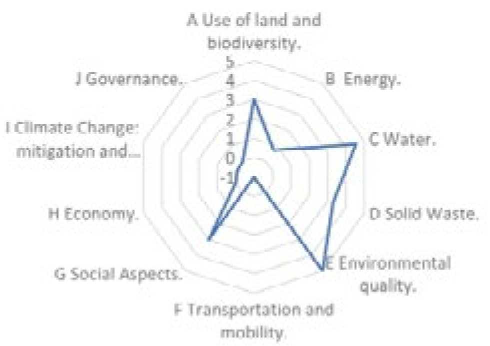
at the neighbourhood scale

Sustainable MED Cities

Moukhtara's Central District

Final Score

Spider Chart

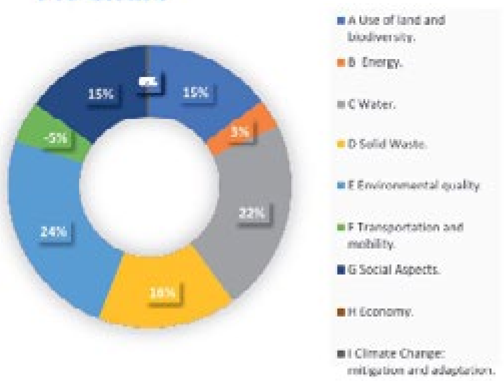


Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (Including KPIs) in the assessment.

# of available criteria	92	# of active criteria	35

Pie Chart



Description of the KPIs

KPIs at neighbourhood scale		Value	Unit of measure
B2.1	Total final thermal energy consumption for building operations.	197,00	KWh/m²/yr
B2.4	Total final electrical energy consumption for building operations.	20,64	KWh/m²/yr
B2.7	Total primary energy demand for building operations.	217,64	KWh/m²/yr
B3.1	Share of renewable energy generated on-site, relative to final thermal energy consumption for building operations.	29,00	%
B3.4	Share of renewable energy generated on-site, relative to final electric energy consumption for building operations.	36,00	%
B3.7	Share of renewable energy generated on-site, relative to the total primary energy consumption for building operations.	79,00	%
C2.3	Consumption of potable water in residential buildings.	180,00	l/occupant/yr
D2.2	Access to solid waste and recycling collection points.	22,00	%
E1.2	Particulate matter (PM_{10}) concentration.	1,00	days/yr
F1.1	Performance of the public transport system.	0,00	%
F2.3	Bycicle network.	1,00	m/inhabitant
G3.1	Availability and Proximity of Key Services.	80,00	%
I1.1	Greenhouse gas emissions.	2,49	t CO_2eq / inhabitant / yr
I3.1	Permeability of land.	63,00	%

Assessment Results Moukhtara

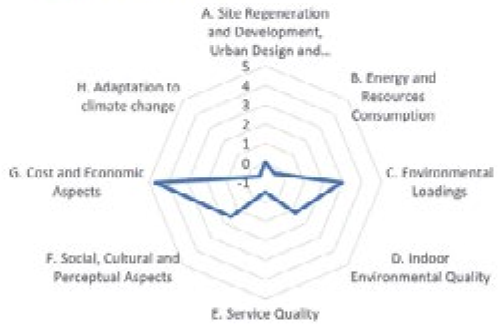
at the Building Scale

Sustainable MED Cities

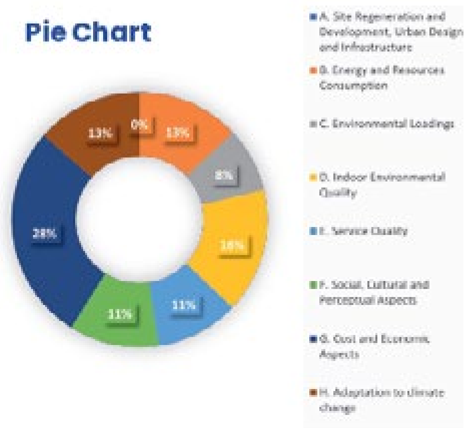
Municipality's Building

Final Score

Spider Chart



Pie Chart



Number of Active Indicators:

Total number of indicators available in the SNTool and number of indicators selected (Including KPIs) in the assessment.

# of available criteria	92	# of active criteria	32

Description of the KPIs

KPIs at neighbourhood scale		Value	Unit of measure
B1.1	Primary energy consumption	52,97	kWh/m²/yr
B1.2	Thermal energy consumption	36,17	kWh/m²/yr
B1.3	Electrical energy consumption	16,80	kWh/m²/yr
B1.4	Energy from renewable sources in total thermal energy consumption	0,00	%
B1.5	Energy from reneable sources in total electrical energy consumption	0,00	%
B1.6	Embodied non-renewable primary energy	3.000,0	MJ/m²
B3.4	Recycled materials	10,00	%
B4.3	Potable water consumption for indoor uses	0,05	m³/occupant/yr
C1.1	Embodied carbon	495,00	KgCO_2eq/m²
C1.2	GHG gas emissions during operations	37,00	KgCO_2eq/m² yr
D1.2	TVOC concentration	0,30	µg/m³
D1.7	Mechanical ventilation	0,80	l/s/m²
D2.3	Thermal comfort index	16,60	%
D3.1	Daylight	3,00	%
E1.2	Smart readiness indicator	60,00	%
G1.4	Energy cost	7,30	€/M²/yr
H1.2	Heat island effect	27,00	SRI

Decision–Making and Sustainability Assessment System: Case Studies in the MED area

https://www.enicbcmed.eu/projects/sustainable-med-cities