Co-funded by the Erasmus+ Programme of the European Union

CITY MINDED
City Monitoring and Integrated Design for Decarbonisation

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OUTPUT 3

Decarbonisation Roadmaps

Leading Organisation	UPO - Universidad Pablo de Olavide
Participating Organisations	IRENA - Istarska Regionalna Energetska Agencija Za Energetske Djelatnosti Doo MIEMA - Malta Intelligent Energy Management Agency UNISI - Università Degli Studi di Siena UNIROMA3 - Universita' degli Studi Roma Tre
Language	English

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1.- Introduction to the Decarbonisation Roadmaps.

The City Minded Decarbonisation Roadmaps consist of a collection of urban decarbonisation agendas (O3) produced during the three City Decarbonisation Itinerant Workshops, that have been implemented in an online format due to Covid-19 restrictions, and Intensive course and workshop in Valletta, Malta.

After each workshop, hosting partners have collected, selected and systematised all the resulting materials - according to the standard methodology agreed upon at the beginning of the project – and have delivered them to UPO which has checked these materials, further harmonised them, and reorganised them. They will be uploaded to the project web platform in collaboration with MIEMA.

The City Minded decarbonisation roadmaps have not been conceived as traditional text documents, but rather as a structured repository of data and solutions for decarbonisation in different urban contexts that could be updated, upgraded and exploited during future educational experiences inspired by the City Minded project.

This output includes the Carbon footprints produced during the city decarbonisation workshops, as well as the analyses and studies of real urban contexts and environmental sustainability conducted in each target area.

2.- City Decarbonistation Itinerant Workshops

2.1.- Introduction

The structure of all the City Decarbonisation Workshops and of the Intensive Course in Malta was very similar: a first half-day dedicated to the presentation of the hosting city and of the target neighbourhood, followed by the training and co-working sessions conducted by the hosting organization; three half-days dedicated to the training and co-working sessions conducted by the other partners; and a final half-day devoted to a wrap-up of the results achieved and of the problems incurred, which involved stakeholders, partners and participating students. The Intensive Course included an additional preparatory week, during which the participants received the training on urban decarbonisation topics, going more in-depth on each topic in comparison to the previous workshops.

A similar procedure was also applied to each 'block' of training and co-working session (that is, to each Module): first, a series of presentations on the 'topic of the day' (reflecting each partner's expertise) delivered during a plenary and ending with a Q&A moment; afterwards, students were divided into groups and each group worked in a different virtual room (or table in the case of the intensive course in Malta), assisted by one/two delegates from the partner in charge of the session and (if needed) by one delegate of hosting organisation. Once the group work finished, students and partners' delegates returned to the main room (or plenary) and a spokesperson for each group presented the results achieved in a plenary, triggering further discussion and allowing for an evaluation of the group work.

The respective thematic areas, based on each of the partners' expertise and presented in each "block" of training and co-working session have been vulnerability associated with climate change, carbon accounting, place-making framework and energy efficiency and renewable energy technologies.

The objective of the workshops was to put together project partners (teachers, researchers, or trainers), students, and local stakeholders in order to address common onsite challenges and define collaborative urban decarbonisation roadmaps for the Ravacciano (Siena), Torrino-Mezzocammino (Rome), Seville's north district and Valletta's neighbourhoods through a 'learning-by-doing' method.

2.2.- Siena's Decarbonisation Workshop.

The 1st City Decarbonisation Itinerant Workshop, from the 23rd to the 27th of November 2020, consisted of a virtual workshop carried out on the Cisco Webex platform and organised by the University of Siena (UNISI), Italy.

The Involved students (around 20) attend the Master Course in Ecotoxicology and Environmental Sustainability of the Department of Physical Sciences, Earth and Environment at the University of Siena. UNISI also involved some stakeholders from the Municipality of Siena to present the URBiNAT project and some virtuous experiences that are taking place in the municipality: Dr. Iuri Bruni talked about the Horizon2020 URBiNAT project (Urban Innovative & Inclusive Nature) that involve 28 partners, 7 cities (including Siena) and 15 countries; Dr. Mariapiera Forgione talked about the Horizon2020 URBiNAT project more in detail about communication aspects and how this is a success factor for participation processes; and Arch. Pietro Romano talked about the experience connected to the creation of urban vegetable gardens in the San Miniato neighbourhood in Siena and the project "100Orti in Toscana" of the Tuscan Region.

2.3.- Rome's Decarbonisation Workshop.

The 2nd City Decarbonisation Itinerant Workshop, from the 1st to the 5th of March 2021, consisted of a virtual workshop carried out on the Teams platform and organised by the University of Roma Tre (UNIROMA3), Italy.

On the first day, in order to better understand the target area, some relevant stakeholders were involved: the Torrino-Mezzocammino Consortium (that, having carried out the construction works of the target neighbourhood, was able to provide valuable insights on the transformations in the area) and the local neighbours' association. The results of a survey aimed at assessing the inhabitants' perception of their neighbourhood completed the presentation of the target neighbourhood. Other presentations served to frame it into the overall dynamics and issues of the city of Rome, providing an overview of the transformations of the urban area between the city centre and the littoral, and of the vulnerability to climate change of the city.

Regarding the participants, UNIROMA3 succeeded in involving 24 students, of which nine PhD students, eleven students from the Bachelor's degree in architecture, three from the Master's degree in architectural design, and one from the Master's degree in engineering.

2.4.- Seville's Decarbonisation Workshop.

The 3rd City Decarbonisation Itinerant Workshop, from the 7th to the 11th of March 2022, consisted of a virtual workshop carried out on the Bb Collaborate platform and organised by the University of Pablo de Olavide (UPO), Seville, Spain.

On the first day, to better understand the target area, some relevant stakeholders were involved: Antonio García (UPO) held a presentation about Seville's recent development and main socio-environmental issues. This was followed by Ángela Lara García (ResCities Project), who tackled how current experiences of urban resilience are shaped by civil society in the context of climate change.

And lastly, Raúl Puente (Plataforma Parque Miraflores) put his focus on the northern district of the city, where an initiative to build urban gardens has served as a multifunctional nature-based solution to tackle the degradation of the area.

Regarding the participants, UPO succeeded in involving 7 students, from UPO's Social and Environmental PhD programme.

2.5.- Malta's Intensive Course.

Malta Intensive Course hold in an online format for one week and face-to-face from the 11th to the 22nd of July 2022 in Valletta, Malta, was organised by Malta Intelligent Energy Management Agency (MIEMA) and Istrian Regional Energy Agency (IRENA).

The first week of the course was held online via Zoom and aimed to give an overview of the City Minded project and the partnership, and to allow partners to give in-depth presentations of their respective thematic areas.

The second week of the course was organised in Valletta, Malta. This was the first opportunity to have a face-to-face project activity and brought together the project partners (teachers and researchers), students and local stakeholders from the city of Valletta. Collaborative roadmaps for urban decarbonisation of Valletta were elaborated during the course by taking into consideration the different thematic areas addressed.

The first day of the second week was primarily dedicated to presentations by local stakeholders which covered different aspects and perspectives concerning to the city of Valletta. Topics included green communities coordinated by the Valletta Cultural Agency, background to the city's history and evolution and the rehabilitation of the historic building where the course was hosted (the Valletta Design Cluster). The stakeholders' presentation served to give a holistic representation of Valletta and allowed the students to better understand the context of the city, its peculiarities and possible challenges which need to be overcome as part of an urban decarbonisation strategy.

An on-site visit of the target area was carried out during the morning of the second day, during which the host from MIEMA explained and showed different characteristics of the city and the students had the opportunity to ask questions and take notes/photos. The following part of the workshop was dedicated to co-working sessions for the different thematic areas, moderated by the respective teachers. The students were divided into two groups for all the co-working sessions, which enabled them to interact with each other and work on the different exercises prepared by the teachers. The groups made use of different resources such as maps of Valletta and of the neighbouring port region and Google Maps and can walk around the building and surrounding area.

After each co-working session both groups presented the results of their collaborative work. After the completion of all the exercises the groups worked on the preparation of a site-specific urban decarbonisation roadmap on the afternoon of the fourth day, integrating the results from the different co-working sessions. The roadmaps were presented by the groups on the last day of the course.

Regarding the participants, the project succeeded to involved 7 students (2 from UNIROMA3, 2 from UNISI and 3 from UPO) and 8 teachers (2 from UNIROMA3, 2 from UNISI, 2 from IRENA, 1 from UPO and 1 from MIEMA).

3.- Description of the pilot areas in Siena and Rome (Italy), Seville (Spain) and Valletta (Malta).

3.1.- Ravacciano neighbourhood, Siena, Italy.

The municipality of Siena, covering an area of 118.71 km^2, is home to a population of 53,937 people. The urban system includes the historic center within the ancient walls and a set of new settlements: an initial urban expansion to the north closer to the city and, after the 1956 master plan, several satellite neighborhoods. The study area consists of the southeastern Ravacciano neighborhood. The Ravacciano area hosts 1631 inhabitants, with an average density of 35.6 people/hectare. The first settlement has been built during the 1930s to House the population of Salicotto - removed from their homes in order to sanitize and restore the original downtown district - and an area occupied by a green valley that is included within the Good Government Agricultural Park.Then the built area has grown until the ‘70s and ‘80s. The valleys of Follonica and Ravacciano, separated by the ancient wall, connect the old city to the Ravacciano neighbourhood and the productive and commercial district down the hill. These valleys are partially accessible to people and are fractioned into several private properties, besides a few public owned areas. The neighborhood lacks connections to the city with only one main entrance to the west. The inhabitants of Ravacciano have started mobilising, and organising themselves with local stakeholders, regarding the co-planning of a Healthy Corridor which will provide an improved pedestrian access to the historic centre of Siena, as well as the creation and/or restoration of ecological services, some of which data back to the medieval origins of the city.

Data on the age and gender of the population in the Ravacciano neighbourhood show that females are almost 56% of residents. Moreover, almost 15% are under 18 years old (248), 38% are over 18 and under 50 (636), 26% are over 50 and under 70 (430) and the over 70 are almost 22% (362). The average age in the district in 2019 is 48 years.

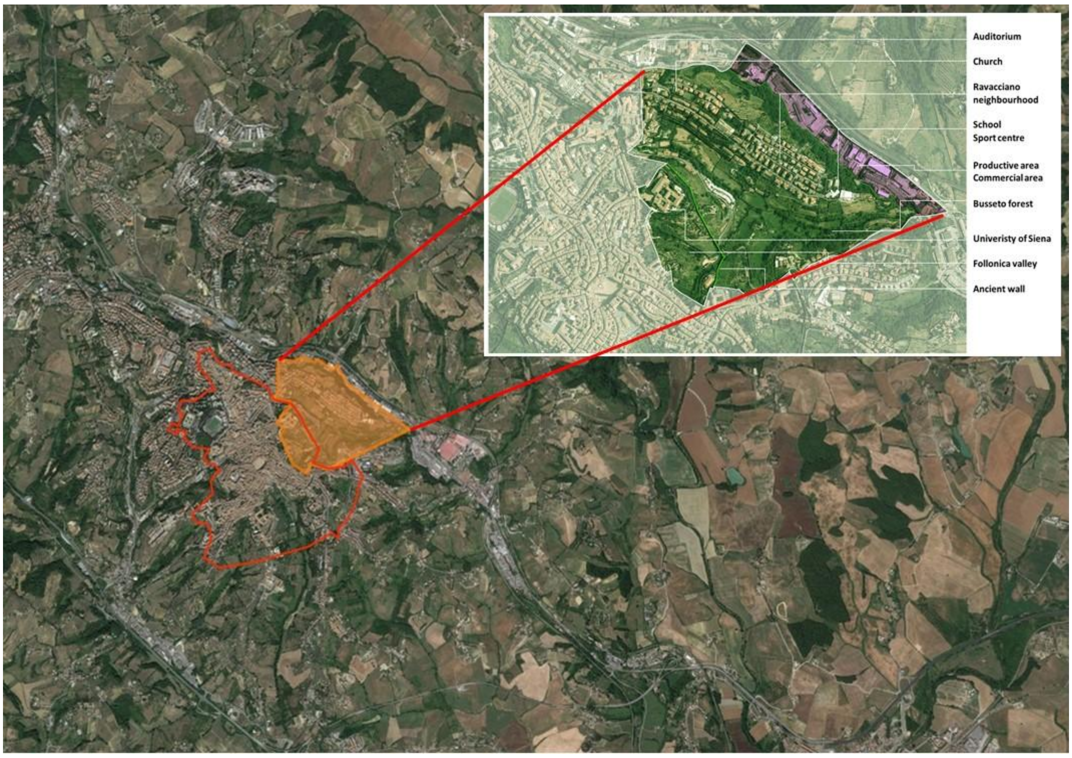


Figure 1. Case study area: Ravacciano neighbourhood and valleys.

3.2.- The Torrino-Mezzocammino neighbourhood, Rome, Italy.

The Torrino-Mezzocammino neighbourhood lies in the south-western part of the city of Rome, just outside Rome's ring road, known as Grande Raccordo Anulare (GRA). Torrino ('small tower' in Italian) is a historical place name originating from a nearby neighbourhood, while Mezzocammino literally means halfway, because the area is in in the middle of the route between the city centre and the port of Ostia. A small pier for the overnight stop of commercial boats was located on the river in the vicinities of the neighbourhood.

Ever since the 1930s the area was supposed to be developed as a residential area, but it was not until the late 1990s that a consortium of landowners was established, allowing the preparation of a development plan for the area. The first inhabitants moved in in 2008, with most works still ongoing, both on the amenities and on the houses. The neighbourhood covers around 190 ha. As of March 2021, some areas are still being developed.

The neighbourhood features a rectangle of roads at its centre, enclosing a large open space, still awaiting to be developed into an urban park. Other parks are already open and feature benches, open-air gym equipment, playgrounds, and even the remnants of an ancient Roman road. One of the corners of the rectangle features a roundabout below the ground level. The walls of the roundabout are painted with the pictures of famous Italian comic book characters, as reflected by the street names, honouring comic book writers and designers. On top of the roundabout is a cluster of supermarkets, shops and restaurants. Other shops and amenities are located on the main roads.

Torrino Mezzocammino is well connected to the surrounding road system: apart from the ring road, via Ostiense/del Mare and via Cristoforo Colombo connect it to the city centre and to the seaside. What lacks is the public transport connection: despite being bordered by the metro- like the Roma-Lido railway, the neighbourhood has no station, nor it is expected to be built soon. Bicycle paths cross all parks and footpaths are large and well maintained, so the inhabitants can easily move around the neighbourhood sustainably. The only setbacks are the long distances and the lack of a connection to the Tiber and to the cycle path that runs along it. Nevertheless, the area is full of promises: good maintenance of the parks and amenities, and better public transport and cycle connections can make it a good standard for future neighbourhoods.

Figure 2. Aerial view of the Torrino-Mezzocammino neighbourhood

Figure 3. Location of the Torrino-Mezzocammino neighbourhood

3.3.- The North District neighbourhood, Seville, Spain.

The North Municipal District is strongly characterised by the development of the infrastructures that surround it and that have crossed it during its history. The SE-30 Ring Road to the south, the Super North Ring Road and the railway network to the north, the Guadalquivir's Dock and, formerly, the railway to the west, and the Miraflores Park to the east. Large industrial areas and storage buildings, as well as the huge plot of the cemetery occupy the heart of the area, sharply separating the two large inhabited areas. This separation is increased by the high-speed traffic access roads to the city, leaving the neighbourhoods of San Jeronimo and La Bachillera isolated, as well as the settlement of El Vacie, which separates the North Ring Road from the rest of the neighbourhood at which it belongs.

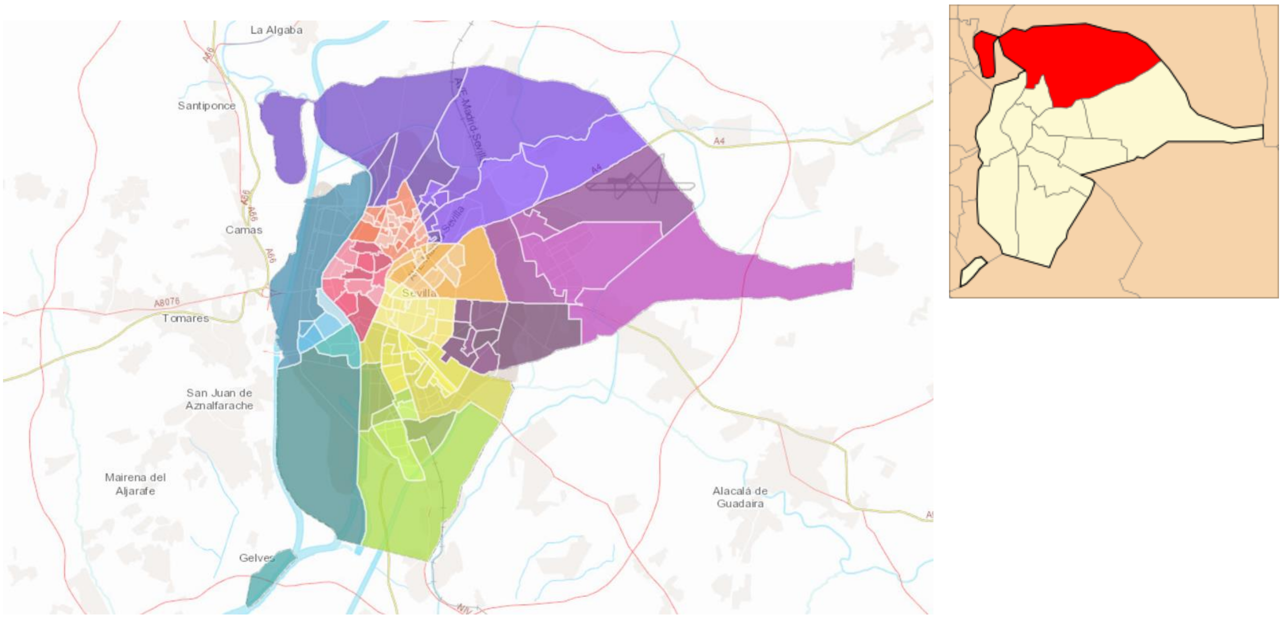


Figure 4. Seville's Neighbourhoods (North District in red). Source: Seville City Council

The SE-30 and Super North Ring Roads have greatly changed the neighbourhood's connections while at the same time establishing real physical barriers that are difficult to cross on foot or through means of non-mechanised transport.

The shape of urbanisation in the case of San Jeronimo has been conditioned by the radial position of the main roads that have articulated it. It represents a very heterogeneous set of buildings, where the public space is constituted as residual, although the area has one of the city's great urban parks, such as San Jeronimo Norte and, on the other side of the Dock, the Alamillo Park. There are therefore four types of housing in this area: a) Pseudo-rural typology, b) The expansion in a closed block (San Jeronimo in the 1950s), c) Isolated high-rise housing (La Papachina), and d) New developments in San Jeronimo in the 1990s with a single-family semi-detached house, an isolated and a closed block.

To the southwest of San Jeronimo there is the neighbourhood of La Bachillera that organises its growth between two of the historic roads leading out of the city towards La Vega (agricultural land). Emerging from a colonising process (occupation of disparate portions of agricultural land), it is surrounded to the north by an orchard and an electrical substation. It is a self-built neighbourhood with substandard housing characteristics and poor urban habitability conditions, which has generated a certain marginality among its inhabitants.

El Vacie is a slum settlement, the oldest in Europe, where around a hundred families live and which occupies the east side of the cemetery within the neighbourhood, on land planned for the expansion of the cemetery and part of the Soledad Becerril Park, which has prevented the execution and use of the road that borders it, extension of the street, and its maintenance and use.

3.4.- Valletta, capital city of Malta.

Valletta is the capital city of Malta, located on a peninsula between two natural harbours, Marsamxett and the Grand Harbour. It is the southernmost capital of Europe and the European Union's smallest capital city with an area of 0.61 km^2.

Valletta was designed by engineer Francesco Laparelli da Cortona, appointed by Pope Pius V and the foundation stone of the city was laid by Grand Master Fra Jean de Valette of the Hospitaller Order of St John the Baptist on 28 March 1566.

The city is characterised by its fortifications and presently has a population of around 5,800. The city is Baroque in character, with elements of Mannerist, Neo-Classical and Modern architecture. Valletta's 16th-century buildings were constructed by the Knights Hospitaller. In spite of some rebuilding projects during the 19th century and severe damage during World War II, a high proportion of the original monuments and the surrounding urban fabric has been preserved intact or carefully restored. The city was officially recognised as a World Heritage Site by UNESCO in 1980 and was the European Capital of Culture in 2018. Valletta was designated as an Urban Conservation Area in 1995 and all properties therein are considered to be of historical value and conserved.

Valletta is built on a narrow peninsula surrounded by water. As a result, the perimeter of the city has remained largely unchanged since the departure of the Knights of St John, unencumbered by more recent development. Despite the succession of eventful interludes that Valletta has witnessed since the departure of the Knights, resulting in frequent changes of use of many of the buildings they left behind, Valletta has remained the administrative and commercial hub of the island. A significant number of residential buildings which were left vacant during the past decades have been converted into office spaces of rental accommodation / boutique hotels. The original grid of the street plan has been respected and the most important public squares have been retained, although some key monuments were lost to 19th and 20th century re-development. Rebuilding and restoration necessitated by later war damage has respected the materials and proportions of the historic city

Figure 5. Valleta City. Source: Aerial view.

4.- Methodologies and materials used during the Student Workshops and the Intensive Course.

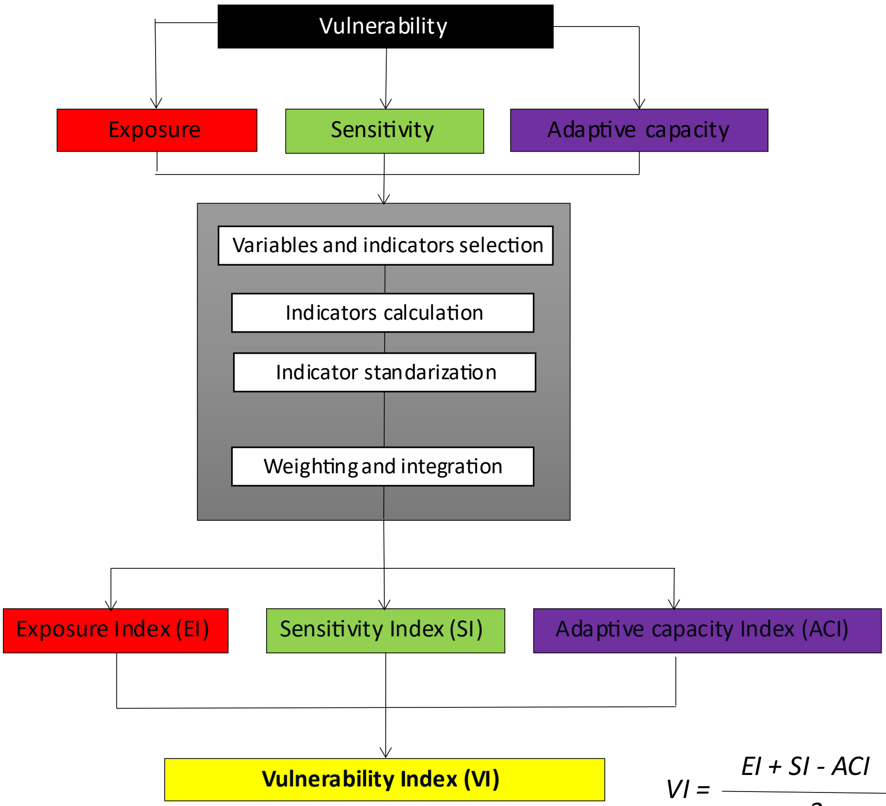
4.1.- Introduction to methodologies and materials.

4.1.1.- Vulnerability Assessment method and materials by UPO.

A specific learning methodology has been developed for the vulnerability assessment. Given the different backgrounds of the students, methodology and tools have been designed in a transversal and general way so that they can be approached by any student profile. A methodology and learning tools have been developed and adapted to the different case studies (Rome, Siena, Seville and Malta).

Each learning session in the different case studies has followed the same three-parts structure: 1) Brief theoretical introduction on the usefulness of addressing vulnerability analysis in the framework of adaptation and disaster risk reduction; 2) Students work with the tools provided by the teacher to assess vulnerability (Groups of 5-6 students where each group analyzes a case study), and 3); Presentation of results obtained and discussion on the usefulness of the methodology and tools used for group work.

The starting point of the learning methodology was the risk equation (Risk = hazard * Vulnerability). To assess vulnerability, we adopted the methodological framework proposed by Intergovernmental Panel on Climate Change which defines vulnerability based on three main components: Exposure, Sensitivity, and Adaptive capacity. Figure 6 shows the methodological proposal to assess vulnerability.



$$VI = \frac{EI + SI - ACI}{3}$$

Figure 6. Vulnerability Index Calculation Steps

The variables and indicators selected to characterize each of the three components have been adapted to the work scales used in each case and to the availability of data. A set of variables and indicators were previously selected based on two criteria: 1) availability of data; 2) that were diverse enough to capture the multidimensional nature of vulnerability (social, natural, economic, institutional, and technological) and allow students to train different tools and research techniques and data. To facilitate the process of calculating the indicators and the final assessment of vulnerability, each group was provided with two different tools.

1. A step-by-step document providing the variables and indicators selected, the justification for their use, their relationship with vulnerability, the sources from which to obtain the data and the necessary formulation for the calculation and standardization of the results obtained.
2. A result Excel sheet where students could enter the indicator results obtained and the composite indicators of exposure, sensitivity, adaptive capacity, and the final vulnerability index were automatically calculated.

Once the indicators of each component were calculated we used the triangle structure of vulnerability to analyse the contribution of each component to the final vulnerability value.

4.1.2.- The Carbon Accounting method and materials by UNISI.

This Carbon Accounting Methodology works as a mediating model that offers the opportunity to quickly discern an integrated vision of the city of the future, combining technologies with other measures at the scales of the neighbourhood, household, and citizen. It provides the opportunity to systemically evaluate the effects of different solutions and the actions planned. Furthermore, the visual expedients developed are useful communication tools for a wide audience including, students, citizens, policymakers, but also companies, administrations, and many other local stakeholders. In our opinion, this methodology is probably the most appropriated for the outputs and results we want to achieve because this approach is generally replicable elsewhere being highly visual, impactful, transferable, and multi-stakeholder friendly.

The Carbon Accounting Methodology is inspired by the IPCC Standard Methodology for Greenhous Gases (GHG) Emissions Inventory of Nations and has a dual role: to both assess the Carbon Footprint of urban neighbourhoods and to estimate the effects of action plans addressed to carbon neutrality in terms of Carbon Footprint mitigation.

The Carbon Accounting Methodology shown to the students is based on the one developed as part of the EU FP7 City-Zen Project and improved and implemented for the City Minded workshops. The method aimed to establish a general approach for urban neighbourhood retrofitting in European cities for decarbonisation including the monitoring of carbon emissions and the estimate of the effects of mitigation measures.

The first step of this procedure is to provide a clear picture of the state of the art of urban districts in terms of GHG emissions as the initial condition to start from and plan integrated measures for neighbourhood retrofitting towards carbon neutrality. This work starts with the data collection to obtain the current Carbon Footprint of the area. The data are usually obtained from local or national databases and reports and then scaled down for the study area.

Usually, the sectors considered in this type of analysis are households, tertiary sector, and other city energy consumption (i.e., public lighting), but also productive activities, transport, and agriculture. Each sector considers appropriate emission sources. Once collected, activity data are properly elaborated and aggregated representing different urban activities as main emissions sources. The emission sources considered in this study are energy use (usually we account for electricity, natural gas, and other fuels used for lighting, appliances, cooling, heating, domestic water heating, and cooking are accounted for), mobility (concerning all the fuel used for all public and private vehicles), waste management (that considers the total waste production and how it is managed), water consumption (quantity of tap water per capita per day), and food consumption (in this case, three diets are taken into account: diet with medium-high consumption of animal protein; balanced diet; a balanced diet with purchase of local food). All the activity data emissions are then converted in tons of carbon dioxide equivalent (CO_2eq) using specific emission factors (expressed in kg CO_2eq/unit activity) for the three main greenhouse gases released into the atmosphere, i.e., carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), multiplied by the respective 100-year Global Warming Potential (GWP).

The next step of the methodology is aimed at better understanding the intensity and size of the impacts of the study area. To do this, the Carbon Footprint of the urban area is represented and visualized in terms of virtual forestland equivalent, i.e., the equivalent surface covered by a relatively young forest that would be needed to absorb an equivalent amount of carbon emissions generated within the area. In the end, a dynamic representation of the decarbonisation plan for city neighbourhoods by 'crunching' the virtual forestland was carried out. A sequence of mitigation actions and policies are applied to show how they could progressively reduce the Carbon Footprint of the urban area potentially bringing impacts to zero.

4.1.3.- The Placemaking method and materials by UNIROMA3.

For the workshops, UNIROMA3 used a mixed qualitative method to analyse the neighbourhood and subsequently define strategies for improving its urban quality and environmental performance. This method, called 'Placemaking', is composed of participatory context analysis comparable to Community mapping, critical analysis such as the SWOT, and definition of objectives and actions that take into account the analyses outcomes.

Community mapping can be defined as a way to make citizens express their views on the development of their neighbourhood. It is a set of approaches and techniques that combines the tools of modern cartography with participatory methods to record and represent the spatial knowledge of local communities. The team adopted a wide perspective on decarbonisation, by including those aspects that highlight its connections to other topics:

- Town planning, because the structure of a city can influence decarbonisation;
- Climate change, because the reduction of greenhouse gas emissions mitigates its effects;
- Green infrastructure, as their implementation plays a major role in carbon sequestration in the built environment.

In the workshops and intensive course, students were divided into groups, where they worked together on two qualitative exercises:

1. The first one had a more graphical aspect. To set an urban scenario for the neighbourhood, students were asked to highlight three main features on a map: barriers (natural and artificial), connections (ecological, mobility and visual) and key elements (criticalities and values), and to devise possible solutions to the problems they highlighted in the previous analysis.

2. The second one was a more critical thinking exercise: we asked students to develop a SWOT analysis in terms of landscape perception and interpretation. This being a qualitative exercise, its added value is not easy to quantify: even solutions or project proposals are not the end result of the exercise. Rather, the exercise aims to provide students with the tools that help them analyse a neighbourhood. Together with the tools they should also gain the knowledge to look at cities from a different point of view.

The data provided to students were maps and aerial views of the pilot area that they could use to define their own maps, as well as the graphical symbols (arrows, lines and dots) that they could use to highlight important features. The lectures presented in the training session also provided them with pictures of the neighbourhood and with some knowledge of the area, notably on the structure, morphology and history of the neighbourhood.

The approach adopted in workshops and intensive course was useful, because it allowed students with little or no background in the field of architecture and town planning to engage with issues connected with cities. Both exercises made it possible for students not familiar with maps and graphical tools to read and analyse a neighbourhood.

The first exercise gave the students some simple tools to highlight basic urban features, such as arrows, lines and dots. They also had maps and aerial views that could help them understand the potential issues and values of the neighbourhood they were studying.

The second exercise used a common tool, the SWOT analysis, that allowed students to brainstorm ideas on strengths, weaknesses, opportunities and threats. Through the SWOT analysis participants can critically reflect on positive and negative assets of an area and must make the effort of distinguishing between external and internal factors.

Summing up, the use of basic tools is a good way to engage students that do not have a background in architectural or urban studies and can produce interesting results even though the tools employed could be seen as too generic.

4.1.4.- The Energy Efficiency and Renewable Energy Technology method and materials by MIEMA-IRENA.

This method consists of solving exercises and finding energy efficiency and renewable energy technologies solutions to achieve a greener and carbon-neutral target district.

During the co-working session, the students were presented with the importance of energy efficiency and renewable energy technologies and their correlation with the project aim of developing urban decarbonisation scenarios for the target neighbourhood and they also engaged in solving exercises and finding solutions to achieve a greener and carbon-neutral target district.

The practical part of the exercise with the students was divided into seven tasks, each following and complementing the previous one. Students were divided into three groups with five members each. The first task was to select a target building or a target zone.

- Each group was asked to select a different building type or a group of buildings within the neighbourhood. The first group had to select a school building, the second group an office building or commercial premises and the third group had to select a residential area (a block of apartments or a group of houses in a street).
- The second task was the identification of main energy consumers within the building/s chosen and to list the three highest energy consumers according to their opinion and to explain why they have chosen them. The third task was related to the proposal of energy efficiency or renewable energy interventions.
- Based on the highest energy consumers identified as part of the second task, each group was asked to propose what energy efficiency measures may be implemented in the building/set of buildings to reduce the consumed energy and improve the energy performance of the buildings.
- The fourth task was focused on detecting possible challenges that will make the energy improvement difficult both for the energy efficiency measures and renewable energy sources (financial, social, legal or technical barriers to energy renovation).
- In the fifth task, based on the challenges and barriers identified, students had to propose solutions to overcome the challenges. A more practical task was the sixth one which was related to the estimation of CO_2 reduction through the installation of photovoltaic (PV) panels on the selected building.
- The final task was the presentation of the results by a group member.

The described methods and procedures were chosen to bring the subject of energy efficiency and renewable energy technologies closer to the group of students with a various level of knowledge on the presented topics and to raise awareness about the importance of conducting selected energy efficiency measures on the targeted buildings together with the use of renewable technologies, both aiming to the achievement of targets set in the local/regional/ national energy plans, but also to provide a healthier, greener and sustainable environment.

The part related to energy efficiency was focused on the building stock of the target neighbourhoods and their energy-efficient improvement by sharing the knowledge about energy efficiency, detecting potential problems and identifying solutions during the co-working session. The focus of the exercise was on how to achieve energy-efficient buildings in the target neighbourhood. Among different energy consumers in the urban areas, buildings were chosen since the building stock is responsible for approximately 40% of EU energy consumption and 36% of the greenhouse gas emissions. Buildings are the single largest energy consumer in Europe and about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. Unfortunately, only about 1% of the building stock is renovated each year and these numbers in the following years will have to change rapidly if the targets set in the EU Green Deal are to be achieved.

The used methodology was designed particularly for the project City Minded and it aims to be easily replicable on different scales after the project ends. The project City Minded will be a testbed for the methodology which can easily be updated according to the single workshop needs.

4.2.- Different Scales applied by the City Minded methodologies in the study areas.

4.2.1.- Methodologies adapted to different scales of work.

- **The Vulnerability Assessment Methodology.**

The Vulnerability Assessment associated with Climate Change Methodology has been well **adapted to the different scales of work** (**province in the Italian cases and municipalities in the Spanish and Maltese case**) and could be adapted to other territorial realities. The main difficulty encountered is related to the availability of data in the appropriate form, updating and scales. The methodology has been applied in several case studies through different workshops with students (Siena, Rome, Seville, and Malta). Results show the feasibility of this methodology to be applied, although in a flexible way in the different case studies. It is concluded that the most accurate vulnerability analyses should be done at the local scale, however the availability of information sources at this scale is not sufficient.

- **The Carbon Accounting Methodology.**

The Carbon Accounting Methodology is typically designed for the national scale, using data collected by government agencies whose aggregation is unlikely to go into local detail. Applications of carbon offsetting solutions, however, often need to consider finer details of communities, households, or even individuals. The framework assessed and tested during the project workshop has been performed in reference to different spatial scales, from the municipality level to the single-family household (to the individual citizen), taking into account several activity sectors and emission sources. It aims to provide a comprehensive assessment of the current state in terms of greenhouse gas emissions, analyse the impact of different emission sources and finally figure out possible scenarios for the decarbonisation of the study area. The scale of the study at the neighbourhood level requires an additional effort in data collection that involves the interlocution with local public administrations, sometimes reluctant to give information, hovering between privacy and transparency. For this reason, data collection is a step that is performed upstream of the exercise, as it is the phase that requires more time, authorizations or permits and a fair amount of experience to assemble the information in a way that is appropriate and conforms with the conversion factors available to us in the subsequent phases.

The methodology proposed is extremely versatile and allows for the study and evaluation of study areas that can range **from the national scale to the local and punctual scale of a single house**. In this case, the choice of the study area fell on the urban area of the cities affected by the project, focusing on specific neighbourhoods. The application of the Carbon Footprint at a neighbourhood level or a small scale is a perfect example of the practical application of the philosophical principle of Glocal as addressing global issues (such as climate change and the increase of CO_2 emissions into the atmosphere) at a local level. By addressing the consumption and waste of energy and resources daily, solutions and best practices are applied down to the individual level. These, when added together by the effort of all, achieve national and international results.

Although it is often the large-scale solutions that make the difference, the change of mindset that is triggered in individual citizens who apply solutions at the local level, can be the right engine for the acceptance of those infrastructures necessary to achieve the result.

4.2.2.- Methodologies that work at the local scale.

- **The Placemaking Methodology.**

The Placemaking Methodology is **local as it looks at a neighbourhood within a city or town** and aims to analyse it both looking separately at its components and as a whole. The neighbourhood as a unit within the city is the most appropriate scale for the exercises, since it is large enough to contain basic functions, yet not too extensive to be analysed over the course of a training session. The dimensions of the neighbourhoods have been appropriate: students, both with and without previous knowledge, were able to analyse it during the allotted time. In terms of the results, that is, transferring some critical knowledge of an area to students, the chosen scale was important. As explained above, the dimension of the neighbourhood is ideal, as it allows students to analyse it properly over the course of the exercise.

- **The Energy Efficiency and Renewable Energy Technologies Methodology.**

The Energy Efficiency and Renewable Energy Technologies Methodology was adapted and prepared for a **local scale** according to the project aim of targeting one city district or neighbourhood and its transformation into a carbon-neutral zone. As the main target of the exercise was the existing building stock and its energy efficiency improvement by conducting energy efficiency measures and boosting the use of renewables, the action in the building sector has to happen at the local level although the challenge of climate change is global.

All the proposed measures are applicable on a local scale together with the proposed and presented renewable energy technologies, photovoltaic technologies (conventional panels and BIPV), micro-wind and combined heat and power systems, the potential of energy storage solutions and smart micro-grids aiming to further maximise self-consumption of energy produced through renewable energy technologies within the buildings.

The idea of the exercise and particularly the co-working session with the focus of each group of students on different building types (public or commercial building, school, residential area) has allowed the students to express their way of thinking on how to improve and transform the area on a smaller scale, which can then be replicated and extrapolated also on a wider regional or national scale with the proposed measures. The achieved results have proved that the students mastered the subject well taking into account the online environment (for the Siena, Rome and Seville workshops) and the limited time for conducting the exercises.

4.3.- Qualitative and Quantitative Approaches of City Minded Methodologies and Tools.

4.3.1- Quantitative Approaches of City Minded Methods and Tools.

- **The Vulnerability Assessment Methodology**

The Vulnerability Assessment exercise makes possible to analyse and assess in a **quantitative** way the vulnerability value of a given case study. To assess vulnerability, the methodology adopts the methodological framework proposed by Intergovernmental Panel on Climate Change (IPCC), which defines vulnerability based on three main components: Exposure, Sensitivity, and Adaptive capacity. The variables and indicators selected to characterize each of the three components have been adapted to the work scales used in each case and to the availability of data. A set of variables and indicators were previously selected based on two criteria: 1) availability of data; 2) that were diverse enough to capture the multidimensional nature of vulnerability (social, natural, economic, institutional, and technological) and allow students to train different tools and research techniques and data. Once the indicators of each component are calculated, the triangle structure of vulnerability is elaborated to analyse the contribution of each component to the final vulnerability value.

The Carbon Accounting Methodology

The Carbon Accounting procedure, developed to be easily and quickly communicated, implemented, and replicated, provides a reliable ex-ante evaluation of urban design measures. This framework provides **quantitative information and visual representations**, to support creative and innovative design, and, more significantly, to raise awareness of the carbon challenges ahead and the solutions available to meet them. Therefore, this methodology makes it possible to quantify, in terms of reduction of tons of CO_2 emitted into the atmosphere, the contribution of virtuous individual behaviour or policies aimed at increasing the use of renewable resources or reducing energy waste by improving the efficiency of systems. Using equations and emissions factors, taken from the 2006 IPCC guidelines, students are able to convert values obtained from data collection into kg CO_2eq. If used in the correct way, students put through the exercise will all get the same end results.

Once the greenhouse gas emissions are quantified from an individual citizen perspective, that climatic impact can be extended to the city scale and beyond. From this vantage point, the idea of a zero-carbon city is seen by stakeholders as a vital and realisable goal.

The type of exercise does not leave much room for imagination and variability of results, but it is useful to understand the methodology and the use of conversion factors to transform activity data into emissions expressed in CO_2 equivalent (CO_2eq). This accounting approach allows to convert the impacts of several greenhouse gases (different from CO_2), under a single denominator (CO_2eq), applying characteristic Global Warming Potentials (GWPs).

The following conversion from a quantity of greenhouse gas emission to a surface of forestland necessary for its absorption can give a less abstract evaluation and that in itself is the only solution to neutralize the negative climate effects.

4.3.2- Qualitative Approach in City Minded Methods and Tools.

- **The Placemaking Methodology.**

The approach of the Placemaking exercise is a **qualitative** one: we provided students with maps, aerial photos, symbols and information on the neighbourhood. With these tools, they were asked to highlight features and criticalities of the neighbourhood.

This being an exercise with a qualitative approach, its results were not quantifiable. The results are represented by the students' improved understanding of the neighbourhood, testified by their maps and SWOT analyses. In Siena, as explained above, students did not have the time or previous knowledge to come up with solutions for the issues they highlighted during the exercise. In Rome, however, students were able to imagine solutions and showed pictures of case studies where similar solutions were put in place.

- **The Energy Efficiency and Renewable Energy Technologies.**

A quantitative approach in relation to improving the energy efficiency of the building stock is usually chosen, however due to the time limitations for the online co-working session and exercises with the students, a **qualitative approach** was chosen for the MIEMA-IRENA exercise. The approach focused on the identification of different types of buildings within the neighbourhood which need energy renovation. The buildings were selected through the use of online maps and could be visually inspected through 3D street views. The students were asked to present a set of assumptions in relation to the energy use within the building in order to propose the highest energy consumers in particular buildings depending on the specific use. Assumptions included building occupancy levels, hours of use of the building and activities carried out which would require a certain amount of energy for a particular system (e.g. HVAC systems in a shopping centre; domestic hot water in a residential block etc). A set of energy efficiency interventions and / or renewable energy sources were then proposed with the aim of addressing the system which were consuming the most energy within the chosen building, based on the opinion of the students. A qualitative approach to the identification of challenges and barriers which make the implementation of energy improvement measures and the integration of renewable energy sources difficult was also taken, whereby the students presented and discussed different types of barriers such as social acceptance, lack of trained people to carry out the interventions and availability of funding for such improvements. The final task of the exercise had a more quantitative approach since the students were asked to take measurements from the map to calculate the roof space available for the installation of a PV system and calculate the possible yearly energy generation from such a system and the related reduction in CO_2 emissions.

The chosen qualitative approach enabled the students to think about the energy needs of different types of buildings and what systems would be the highest energy consumers, taking into consideration both the power of the systems and the hours of use. The qualitative approach helped to trigger very interesting discussions and ideas between the students within the groups about what challenges may be encountered when carrying out energy renovation of buildings as well as proposing different ways in which such challenges may be overcome. The presentation of the different tasks carried out by each group to the teachers and other students also highlighted the approach taken by each group and any assumptions considered when identifying major energy consumers and proposed energy conservation measures. Each group showed a very good level of understanding of energy within the buildings and the importance of improving the energy performance of the building stock within the neighbourhood as a key element of the urban decarbonisation strategy.

4.4.- Comparative Review of Itinerant Workshops Methodologies.

- **Vulnerability Analysis and Carbon Accounting Methodology.**

UPO's Vulnerability Analysis is an analytical tool that integrates the carbon footprint with other environmental aspects at a broader scale but that is reflected in both causes and effects on a local scale even in neighbourhoods. Consequently, the UPO work is very useful and complementary to that performed by UNISI because it also allows for an evaluation of the context in which the neighbourhood is located; this makes it possible, for example, to understand whether the neighbourhood or urban area is virtuous with respect to the territorial context.

- **Vulnerability Analysis and Placemaking Methodology.**

Vulnerability analysis methodology develops a theorical, and operational assessment and analysis of vulnerability associated with climate change, that underlies the importance of not only measuring vulnerability but also to analyse it. In this regard, placemaking provide qualitative and bottom-up insights on a neighbourhood's adaptive capacity that complete a given area vulnerability analysis regarding the hybrid nature of risks, in which the interaction between natural events and social processes are related to generate risk situations.

- **Carbon Accounting Methodology and Energy efficiency and renewable energy technologies solutions.**

UNISI's Carbon Accounting Methodology has a strong connection with the module held by IRENA and MIEMA since the energy efficiency in buildings and the use of renewable energy technologies are two of the most important aspects to mitigate the greenhouse effect in the urban context. For IRENA and MIEMA it was very interesting to follow the co-working session held by UNISI and to see the practical examples of how conducted mitigation actions and policies can progressively reduce the carbon footprint of the urban area and potentially reach the carbon neutrality of the target zone.

The work developed by IRENA and MIEMA is highly interlinked with the methodology developed by UNISI. Energy efficiency in housing and the implementation of Renewable Energy System (RES) production facilities are two of the most important aspects to mitigate the greenhouse effect in the urban context. Particularly interesting was the co-working session that allowed the students to imagine and hypothesize solutions for a single house or building; this approach is fully in line with the methodology developed by UNISI, which allows students to observe the contribution of the single house and suggest specific mitigation solutions.

- **Placemaking Methodology and Carbon Accounting Methodology.**

UNIROMA3's exercise connects with the exercises of both UNISI and IRENA/MIEMA, as they also work at the neighbourhood scale, even though their exercises focus on the buildings.

In particular, the Modules of UNIROMA3and UNISI complete each other, since they look at the neighbourhood from a quantitative (UNISI) and qualitative (UNIROMA3) point of view. Moreover, both modules take into consideration multiple facets of decarbonisation, including mobility aspects, the amount of green areas for carbon offset, etc. Finally, both modules embed a reflection on the spatial relationship between the RES installations and the current land use. It can be affirmed that the UNISI module provides the necessary tools to quantify the results of the place-making by UNIROMA3; at the same time, place-making provides the spatial framework for contextualizing carbon footprint calculations by UNISI.

The UNIROMA3module interfaces as a preliminary study to the application of mitigation actions and carbon offsetting, as the identification of artificial and natural barriers, ecological connections to be enhanced or visual connections to be hidden at the landscape level, help to avoid situations both of social unacceptability for ethical, historical and landscape reasons, and of structural hindrance especially in the case of installations of energy solutions (photovoltaic panels, wind turbines). Furthermore, the Nature Based Solutions (NBS) identified and studied by the UNIROMA3team are also part of the mitigation solutions developed in the UNISI methodology. The shading effect of vegetation or sunscreens and passive ventilation help to ensure the cooling energy saving in household and businesses; an increase of vegetation, trees, and solar reflective surfaces at the street level, thus mitigating the Urban Heat Island Effect (UHIE).

- **Energy efficiency and renewable energy technologies solutions and Placemaking Methodology.**

The IRENA/MIEMA module provides an even closer look, focusing mainly on buildings and installations, and can therefore looks at the issues highlighted in the UNIROMA3place-making module in more detail.

The negative impacts of the energy sector, the largest single source of global greenhouse gas emissions, and responsible for over a quarter of all EU greenhouse gas emissions, can be mitigated by creating or restoring green infrastructure and through proper town planning, as presented by UNIROMA3. Urban green areas such as urban parks and tree-lined streets can play a role in reducing an area's overall energy demand (i.e. for cooling) and thus contribute to the moderation of the 'urban heat island' effect. Trees, green roofs, and other green infrastructure elements can cool urban areas by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere. Buildings are responsible for 40% of energy consumption and 36% of CO_2 emissions in the EU. A large proportion of this energy is used to maintain internal building temperatures through heating and cooling systems. Green infrastructure elements such as green roofs can contribute to reducing primary energy consumption and therefore the CO_2 emissions associated with buildings.

The exercise presented and held by IRENA and MIEMA consisted of topics dealing with energy efficiency and renewable energy technologies has strong connections with all the other modules and complement each other in many ways, particularly with the modules developed by UNIROMA3 and UNISI.

5.- Workshops and Intensive Course results.

5.1.- Validation of the methodology based on the workshops and intensive course results.

- **Vulnerability Assessment Methodology.**

After the application of the methodology in the different learning cases it can be concluded that this methodology has proved to be very useful and interesting to introduce students, with different background and interest, to the **theoretical and practical approaches of risk assessment, and to the methodologies of vulnerability analysis and assessment.** The exercise has been well adapted to the different scales of work (province in the Italian cases and municipalities in the Spanish case) and could be adapted to other territorial realities. The main difficulty encountered is related to the availability of data in the appropriate form, updating and scales.

Regarding the results obtained, the exercise has been useful to demonstrate and discuss with students the hybrid nature of risk and the need to approach vulnerability studies from its multifaceted nature (social, environmental, institutional, economic, physical).

- **Carbon Accounting Methodology.**

The methodology developed and tested during the project workshops proved to be extremely versatile and useful for the project purpose. The original framework was conceived to be developed in presence, through the organisation of real co-working sessions in which students could sit around a table and discuss, **bringing together different skills acquired in their studies to produce innovative solutions to make the study area carbon neutral**. The workshops that have been developed during the City Minded project have presented limitations caused by the health situation connected to the Covid-19 pandemic and the restrictions that followed. Despite this, the methodology, revised and adapted for remote application, has also provided good results. The students, in both the Siena and Rome workshops, demonstrated to be interested in the subject matter presented in the framework and in the exercises that they carried out. They have had a critical and proactive approach that allowed them to carry out the exercise correctly and to identify useful solutions to reduce the emissions of the neighbourhood.

The involvement and contribution of the students in the workshops and the intensive course went well beyond expectations. The students were protagonists in a process of study, evaluation, and planning that really aimed at obtaining neighbourhood that could become smart, people-friendly, and greener.

Various policy proposals, after the examples provided by the module, were made by students assuming various degrees of involvement and incidence of the resident population. To do this, we asked them not to set limits for themselves and thus avoid being constrained by the actual feasibility of implementing the policy. Some assumptions were added to the default planned intervention policies.

- **Placemaking Methodology.**

The results of the different workshops' exercises surely validate the methods used in the workshops and intensive course and confirm that the chosen approach is a good one and can be used in future workshop and lectures. This being a qualitative exercise, its added value is not easy to quantify: even solutions or project proposals are not the end result of the exercise. Rather, the exercise aims to **provide students with the tools that help them analyse a neighbourhood**. Together with the tools they should also gain the knowledge **to look at cities from a different point of view**. At the end of the first exercise, students proposed, along with the analysis of the neighbourhood, some solutions for the issues they highlighted and pictures relating to case studies that they looked up.

- **Energy efficiency and renewable energy technologies solutions to achieve a greener and carbon-neutral target district.**

The results of the conducted exercises with the students have proved that the methodology was well balanced and tailored to the student knowledge about the topics and that the theoretical presentations were easily understandable and useful for solving the exercises during the co-working session. The students within the group engaged in interesting discussions about the energy requirements of different buildings types and what measures can be proposed to improve the energy performance of the building and reduce the CO_2 emissions, including interventions to the building envelope, upgrading of building systems such as heating, cooling, domestic hot water and lighting as well as the generation of on-site energy through renewable energy technologies. Each group was asked to prepare a short presentation with the results of each task undertaken and to present the results to the teachers and other students at the end of the co-working session. The presented results of the exercises of all three groups showed that the students obtained a good understanding of energy efficiency and renewable energy within the urban context and how to identify the correct solutions for different building categories. A particularly important point that was highlighted by the students themselves is the importance of focusing on buildings located in the urban areas, both in terms of energy efficiency improvement as well as for the installation of renewable energy technologies in the buildings to minimise the use of green areas for energy production.

The general added value (in addition to the very good results of the exercises) of the co-working session is the raised awareness among the students about the **importance of improving the energy performance of the building stock and understanding different methods** on how buildings can help to achieve carbon neutral neighbourhoods by conducting energy renovation of the existing building stock, by creating new buildings that are energy self-sufficient and how to choose and integrate the most suitable renewable energy technologies in the building stock to generate clean energy within the neighbourhood that can partially offset carbon emissions.

5.2.- Proposed solutions contributing to Decarbonisation.

5.2.1.- Identified solutions contributing to Decarbonisation.

- **Carbon Accounting Methodology**

The output of the activity presented by UNISI is precisely the study of the urban area to find the **best political, technological, and behavioural solutions for reducing CO_2 emissions.** This methodology allows the contribution of each action and policy to be quantified and graphically visualised in terms of its contribution to reducing the greenhouse effect. The solutions highlighted in this process, if applied, could enable the urban area to become carbon neutral in the medium to long term. The proposed mitigation measures relate to different urban contexts; for example, the area of available flat roofs for PV installation, the energy potentials (e.g., wind speed, geothermal heat), the existing infrastructural facilities and services are site-specific conditions that affect the plan and provide the real parameters to be processed in the equation's framework. This hypothetical scenario demonstrates that urban systems in Europe can be radically transformed through setting proper action plans applying to different sectors and relating to different spatial and time scales. Moreover, results deal with daily life aspects that citizens know well and therefore contribute to raising awareness about their behaviour and the opportunity to change for the Planet. Besides others, measures such as greening and shading facades, optimizing the use of lights and appliances, walking/cycling to school/work, car-pooling, using public transport, could be immediately applied at no costs, just by inducing citizens to change their lifestyle. The role of communication for the awareness of citizens is therefore crucial.

Our approach demonstrated that the Carbon Accounting methodology can be a powerful tool for showcasing the effects of ambitious but reliable action plans for the decarbonisation of neighbourhoods in different European cities.

- **Energy efficiency and renewable energy technologies solutions to achieve a greener and carbon-neutral target district.**

The results of the student's work and the contribution to the reduction of CO_2 emissions can be presented through the proposed solutions of each group for the selected building types. Each group had to detect the highest energy consumers and suggest proposals for the reduction of energy consumption and a consequent decrease in CO_2.

For the exercises that selected a school, students identified heating, lighting, electrical equipment and water as the highest energy consumers. Proposals for energy efficiency improvement/RES included heating controls, double glazed windows, wall insulation, LED lighting, use of electronics equipment with a high energy class, water-saving taps and the installation of PV on the roof as well as PV shading devices in the playground of the school, PV panels on the roof and parking lots, rainwater collecting systems, electric vehicles (EV) charging stations, vegetation and green areas as external shading systems, and the use of nature-based solutions as a waterproofing system (rain gardens).

For the exercises that selected a shopping centre, the main energy consumers identified included escalators, HVAC systems, water, automatic doors, refrigeration, lighting and gas. Proposed solutions included roof-mounted PV system, LED lighting, solar thermal panels on the outdoor parking and a new heat pump, automatic doors on refrigerators, using waste to production of biogas, heat pumps and rainwater collection.

For the exercises that selected a set of houses, the highest energy consumers identified were electrical equipment and heating and domestic hot water. Proposed measures included PV panels, LED lighting, micro-wind technologies, solar water heaters, roof insulation and infiltration control, PV and solar thermal panels, LED lighting and afforestation. The setting up of a community micro-grid was also proposed.

All the proposed measures are crucial to help reducing CO_2 emissions in the target area whilst decreasing the energy demand of the selected buildings through the generation of clean energy through renewable technologies.

5.2.2.- Methodologies contributing to Decarbonisation by assessments and mapping.

- **Placemaking Methodology**

During the exercise the students came up with some solutions, such as the installation of solar panels, the extension of green areas, innovative public spaces and mobility solutions. All these solutions can surely contribute to decarbonisation, since they reduce the use of fossil fuels and increase the quantity of CO_2 absorbed by plants. However, the quantification of the decarbonisation input of such solutions was outside of the scope of the placemaking exercise.

- **Vulnerability Assessment Methodology**

For the nature of the vulnerability assessment exercise the quantification of the decarbonisation input was outside of the scope.

5.3.- Proposed solutions impact on Climate Change effects.

5.3.1.- Proposed Solutions in line with Adaptation and Mitigation.

- **Vulnerability Assessment.**

In the face of the current climate emergency, mitigation actions must be combined with adaptation strategies to address the risks and impacts already being experienced. The risks arising from climate change differ from one place to another, as do the elements exposed and the capacities to cope with them.

Vulnerability assessment and analysis exercise results **address the need to also consider knowledge on methodologies aimed at strengthening adaptation to the effects of climate change that complement the knowledge acquired on mitigation**. In this way, students acquire a global and more complete vision of the possible strategies for action in the face of climate change. The exercise results have assessed the effects of climate change through the calculation of a synthetic vulnerability index (VI) based on exposure, sensitivity, and adaptive capacity. These results are a first approach to the multifaceted nature of risks.

- **Placemaking Methodology.**

The proposals resulting for the exercise **tackle climate change both in terms of mitigation and adaptation**. The installation solar panels in suitable buildings contributes mainly in terms of mitigation, as it will reduce the use of fossil fuels for the production of energy for the buildings where they will be located, either partially or entirely. This can also be brought about through sustainable mobility solutions, such as bicycle lanes and improved public transport. The extension of green areas and the planting of trees and shrubs represent a no-regret kind of solution, where both mitigation and adaptation can be achieved. An increase in plants represents both that they will absorb more CO_2 and that water will be absorbed in the ground and through the leaves. A re-organisation of public spaces that allows rainwater to create small lakes and fountains could reduce the quantity of water that reaches the drainage system, thus delaying its blockage.

5.3.2.- Proposed Solutions in line with Mitigation.

- **Carbon Accounting Methodology.**

In Europe, the level of demographic urbanization is approximating 74% and this is a major contributor to the greenhouse effect and the resulting climate change. City refurbishment and better spatial planning, including that of green spaces, can be major drivers to pursue the aim of net-zero greenhouse gas emissions by 2050. The **calculation of the carbon footprint and the consequent mitigation actions are exactly the way to positively impact the prevention of the causes of climate change itself**: **the reduction of climate-altering gas emissions into the atmosphere**. Given the final goal of carbon neutrality, the selected measures concern short-term initiatives for energy-saving and renewable energy generation as well as long-term plans of the energy transition to fully electric systems for both the residential and mobility sectors. The scope of our approach is also to help the students to imagine how our cities would appear, operate, and contribute to healthier lifestyles by 2050; this methodology does not just imagine or hypothesise future solutions but also quantifies what the real contribution of each action is to reducing climate change by reducing greenhouse gas emissions.

- **Energy efficiency and renewable energy technologies solutions.**

Renewable energy, together with energy efficiency, has particular importance in the global mitigation strategy. They represent a safe, reliable, affordable, and immediately deployable pathway to a low-carbon future that can achieve over 90%of the energy-related CO_2 emission reductions needed to meet climate goals. Avoiding the worst effects of global warming will require us to source at least 85% of global power from renewables, with a minimum of two-thirds of total energy from renewable sources – wind, solar, geothermal, and hydropower, by 2050.

The results of the students work and the proposed solutions for the selected areas are in line with **mitigation strategies and can play a significant role in achieving a cleaner and healthier environment on the local scale**. Moreover, the students emphasised the importance of good behaviour as an instant and free of charge way to reduce energy consumption. Mitigation strategies to address barriers identified for the energy renovation of specific building types are a very important consideration. Proposed mitigation measures to facilitate the energy improvement of buildings included funding for new technologies, the installation of EV charging stations, increase of environmental awareness and the need for more specialized and qualified workers.

6.- Pilot areas' delivered solutions in the City Decarbonisation Itinerant Workshops.

6.1.- The 1st City Decarbonisation Itinerant Workshop, Siena, Italy (online format).

6.1.1.- Vulnerability Assessment of Ravacciano neighbourhood.

This exercise was divided into three complementary parts: vulnerability assessment, vulnerability analysis and results' debate.

Regarding results on the vulnerability assessment, figure 7 shows the vulnerability assessment results for each study case (exposure index, sensitivity index, adaptive capacity index and the final vulnerability compound index). As shown, exposure presents low results in three study cases, however sensitivity index presents higher results in all cases. Adaptive capacity presents high differences between the three study cases. This component introduces those important social and institutional variables which are more difficult to measure (risk perception, institutional trust, climate change adaptation).

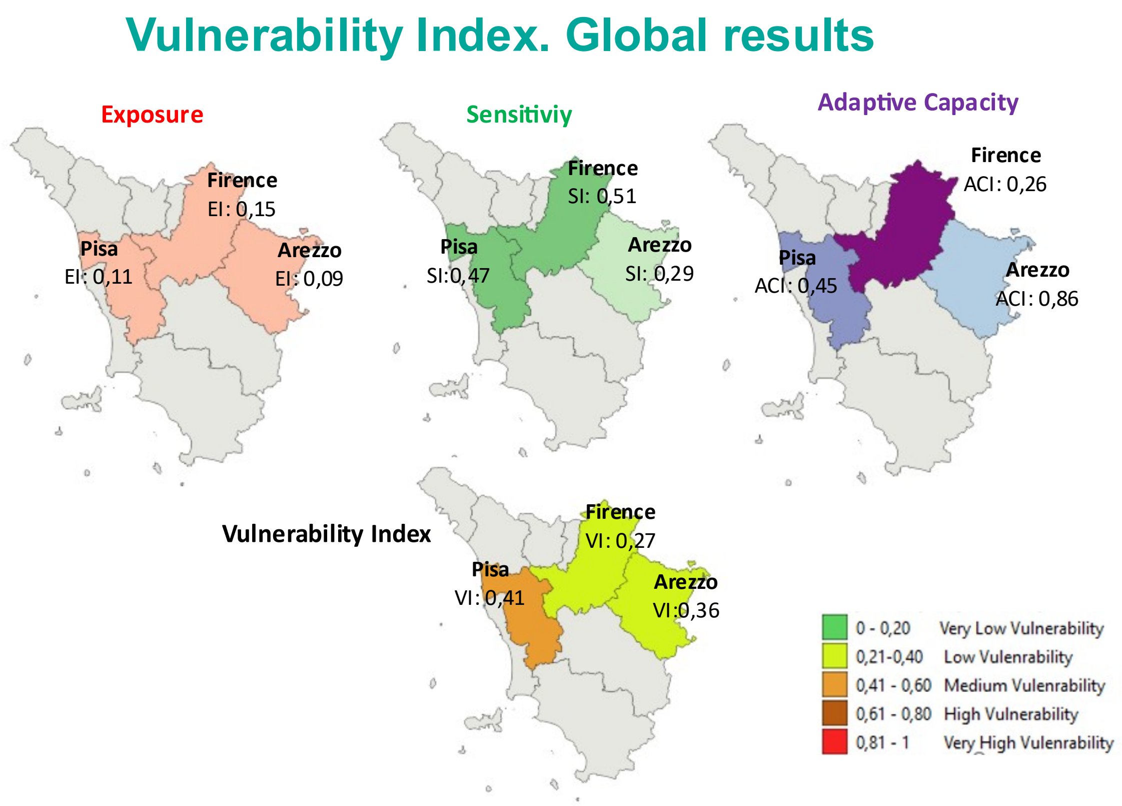


Figure 7. Vulnerability Index results

Figure 8 shows the vulnerability structure triangle results. Arezzo's study case presents a low adaptive capacity and so, the contribution of this component to the final value of vulnerability is the highest (adaptive capacity is inversely related to vulnerability). Pisa and Firenze results show that sensitivity is the component which contributes the most to the final value of vulnerability.

Vulnerability Structure Triangle. Global results

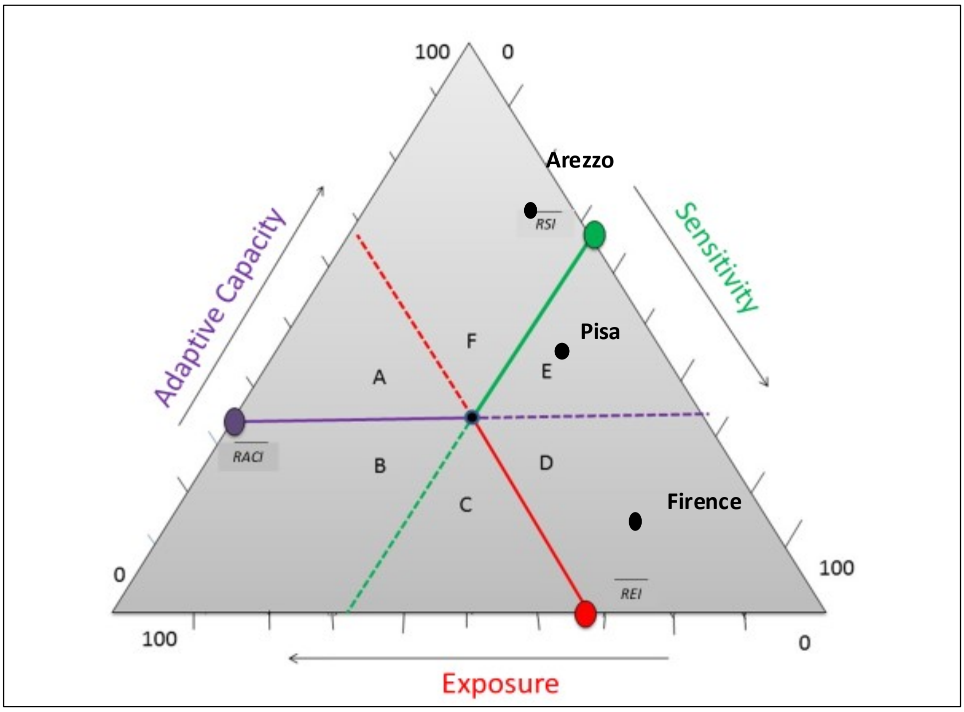


Figure 8. Vulnerability structure triangle global results.

6.1.2.- Carbon Footprint solutions for Ravacciano neighbourhood.

For the decarbonization of the Ravacciano neighbourhood, a series of mitigation measures have been assumed to be applied over a period of about 30 years, with the ultimate goal of achieving neighbourhood Carbon Neutrality. The following is the sequence of the hypothesized measures:

1. Reduction of energy consumption (led lamps and more efficient appliances);
2. Life Cycle Assessment and circular economy in industrial sector;
3. Increased use of bicycles and less waste production and water consumtion;
4. Balanced diet;
5. Nature-based solutions and thermal insulation;
6. Smart working and car pooling;

7. Less water supply losses;
8. Local food;
9. PV panels (South exposed roofs);
10. Increase in waste recycling and increase in anaerobic digestion of organic fraction;
11. Wind turbines;
12. Public transport;
13. Heat pumps and electric mobility;
14. Other PV panels and wind turbines;

Uptake, through the planting of trees.

6.1.3.- Placemaking solutions for Ravacciano neighbourhood.

During the co-working session, the students started from a satellite map of the neighbourhood and highlighted therein three main features: barriers (natural and artificial), connections (ecological, mobility and visual) and key elements (criticalities and values). The result (Figure 9) was meant to be the basis to set an urban scenario for the area.

Figure 9. Community mapping of Ravacciano neighbourhood

The second exercise (Figure 10) was a more critical thinking one: we asked students to develop a SWOT analysis in terms of landscape perception and interpretation.

Figure 10. SWOT analysis of Ravacciano neighbourhood

The overall result was positive: the students gained critical knowledge of the area; they improved their skill in recognising the urban environment they live in. Without prior knowledge of the area they were able to interpret maps and read the urban space and its features.

6.1.4.- Energy efficiency and renewable energy technologies for Ravacciano neighbourhood.

The exercise with the students was divided into seven tasks, each following and complementing the previous one. Students were divided into three groups. Each group consisted of five members. The first task was to select a target building or a target zone. Each group was asked to select a different building type or a group of buildings within the neighbourhood of Ravacciano or Siena area. The first group had to select a school building, the second group an office building or commercial premises and the third group had to select a residential area (a block of apartments or a group of houses in a street). The first group selected a primary school located at the centre of the Ravacciano neighbourhood and identified the heating system, lighting and electrical equipment and water as the highest energy consumers within the building. Proposals for energy efficiency improvement / RES included heating controls, double glazed windows, wall insulation, LED lighting, use of electronics equipment with a high energy class, water saving taps and the installation of PV on the roof as well as PV shading devices in the playground of the school. The main barriers identified were lack of funds, technical problems with the installation of new systems, disruption related to works and the aesthetic impact of PV installations. Proposed solutions included the use of funds or grants, carrying out a structural assessment of the building prior to the start of works, carry out works during holidays and carrying out a campaign to educate the residents on the benefits of PV systems.

The second group focused on a shopping centre and the main energy consumers identified included escalators, HVAC systems, water, automatic doors, refrigeration, lighting and gas. Proposed solutions included roof mounted PV system, automatic doors on refrigerators, using waste for the production of biogas, heat pumps and rainwater collection. Barriers to energy renovation included lack of energy awareness, lack of funds and the fact that a good part of the building envelope area is glass. Awareness campaigns, incentives and crowdfunding and the replace of glass with alternative building materials were presented as possible solutions to overcome the barriers.

The third group studies a set of 5 adjacent houses. The highest energy consumers in this case were electrical equipment and heating and domestic hot water. Proposed energy conservation measures included PV panels, LED lighting, micro-wind technologies, solar water heaters, roof insulation and infiltration control. The setting up of a community micro-grid was also proposed. Identified barriers were related to lack of awareness among the residents, investment cost and the visual impact. Similarly, to the previous groups, proposed solutions included awareness campaigns, government assistance/tax credits and the use of technologies with a low visual impact.

The presentations of all three groups showed that the students obtained a good understanding of energy efficiency and renewable energy within the urban context and how to identify the correct solutions for different building categories. A particularly important point that was highlighted is the importance of focusing on buildings located in the urban areas, both in terms of energy efficiency improvement as well as for the installation of renewable energy technologies in the buildings to minimise the use of green areas for energy production**.**

6.2.- The 2nd City Decarbonisation Itinerant Workshop in Rome, Italy (online format).

6.2.1.- Vulnerability Assessment of Torrino-Mezzocammino neighbourhood.

This exercise was divided into three complementary parts: vulnerability assessment, vulnerability analysis and results' debate.

Figure 11 shows the vulnerability assessment results for each study case (exposure index, sensitivity index, adaptive capacity index and the final vulnerability compound index). We include also results from 1st and 2nd Decarbonisation meeting obtained in Siena and Rome (Italy) where we used the same methodology, so we can have an overview of the work yield in the whole project.

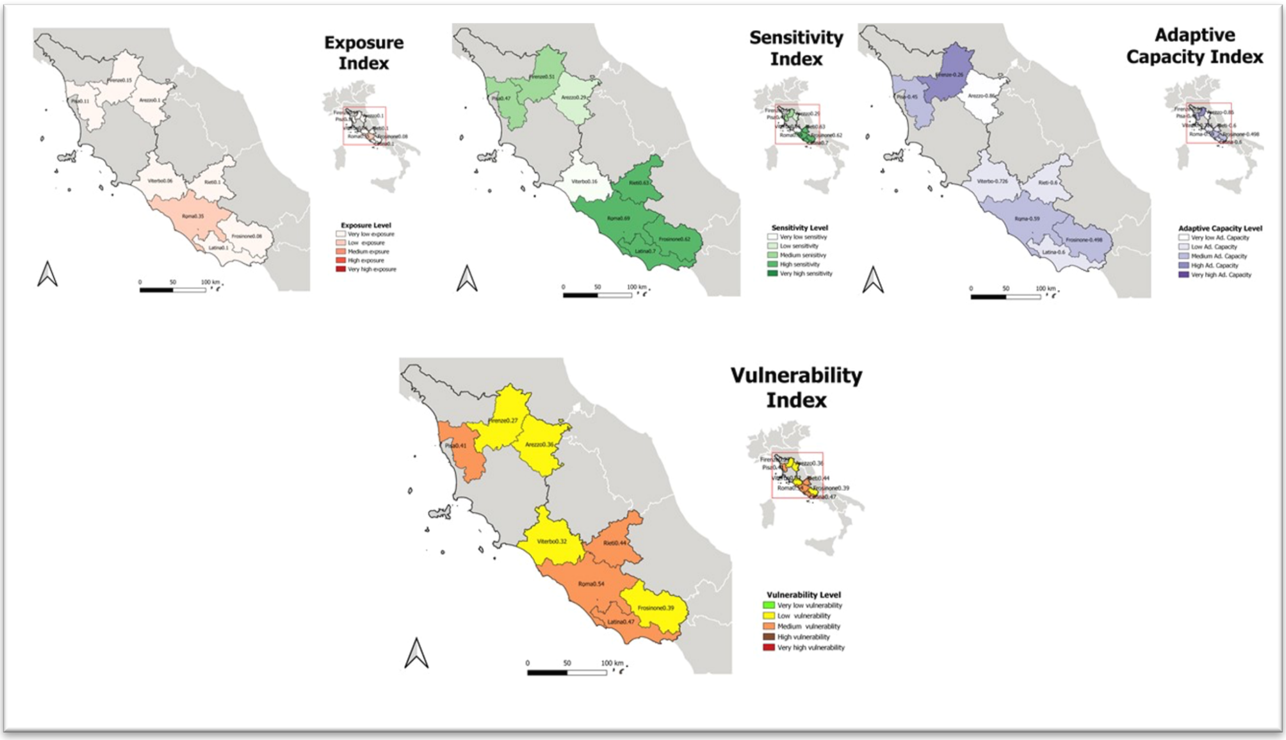


Figure 11. Vulnerability Index results

As shown in figure 11, exposure present low results in eight study cases, however sensitivity index present higher results in all cases. Adaptive capacity present high differences between the study cases. This component introduces those important social and institutional variables which are more difficult to measure (risk perception, institutional trust, climate change adaptation). Figure 12 shows the vulnerability structure triangle results.

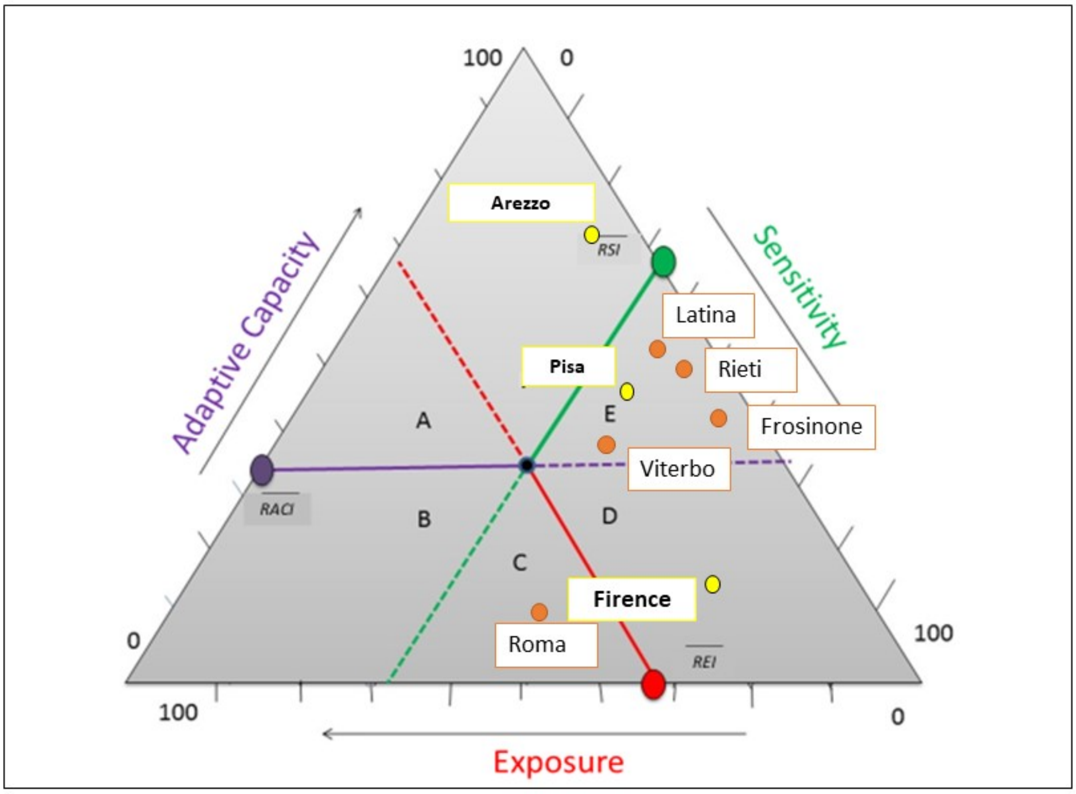


Figure 12. Vulnerability structure triangle results.

6.2.2.- Carbon Footprint solutions for Torrino-Mezzocammino neighbourhood.

For the decarbonization of the Torrino Mezzocammino neighbourhood, a series of mitigation measures have been assumed to be applied over a period of about 30 years, with the ultimate goal of achieving neighbourhood Carbon Neutrality. The following is the sequence of the hypothesized measures:

1. Reduction of energy consumption (led lamps and more efficient appliances);
2. Reduction of energy consumption for residential heating;
3. Bicycles;
4. Less waste production and water consumption;
5. Balanced diet;
6. Nature-based solutions;

7. Thermal insulation;
8. Smart working and carpooling;
9. Increase in waste recycling;
10. Local food;
11. PV panels;
12. Public transport and bike sharing;
13. PV canopy;
14. Heat pumps and Electric mobility;
15. Other PV panels;
16. Uptake, through the planting of trees.

6.2.3.- Placemaking solutions for Torrino-Mezzocammino neighbourhood.

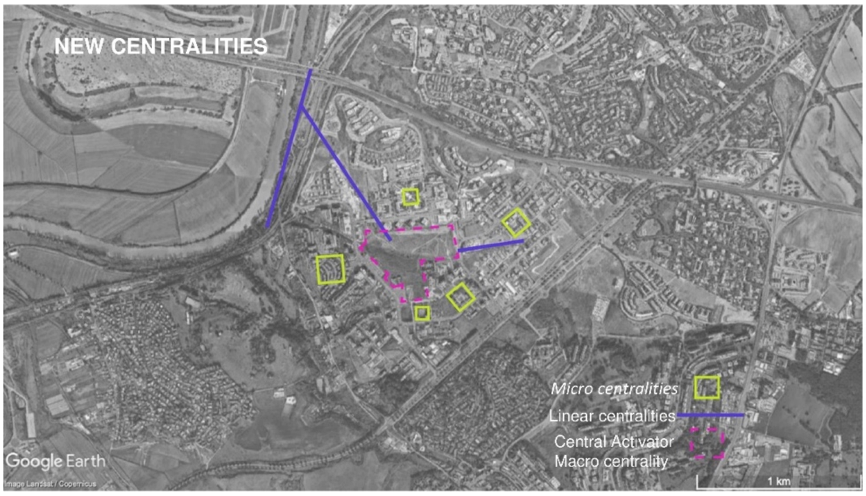
The co-working session aimed to produce a territorial analysis on the three aspects highlighted in the training session: infrastructure (private mobility, public transport, cycling), open spaces (green areas, agricultural areas, natural areas) and public spaces (squares, centralities, parking lots). Therefore, the students were divided into three groups, where they worked together on two qualitative exercises.

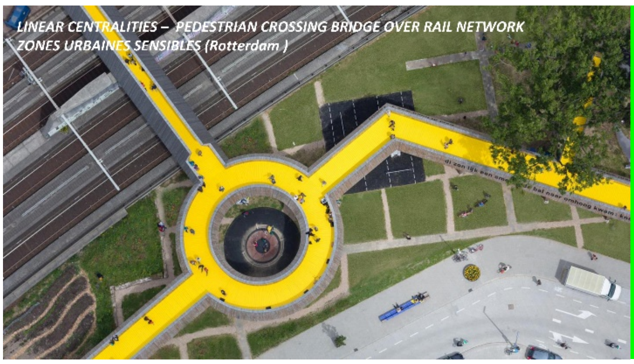
The first one had a more graphical aspect, whereby students highlighted on a satellite map three main features – barriers (natural and artificial), connections (ecological, mobility and visual) and key elements (criticalities and values) – and devised possible solutions to the problems they highlighted in the previous analysis.


AREA
UMIDA
Artificial Barriers
Ecological Connections
Mobility Connections
Main Natural Areas
Critical Points
Points of Value
Google Earth
Image Landsat / Copernicus
1 km


Artificial Barriers
Natural Barriers
Ecological Connections
Mobility Connections
Critical Points
Points of Value
Google Earth
Image Landsat / Copernicus
1 km

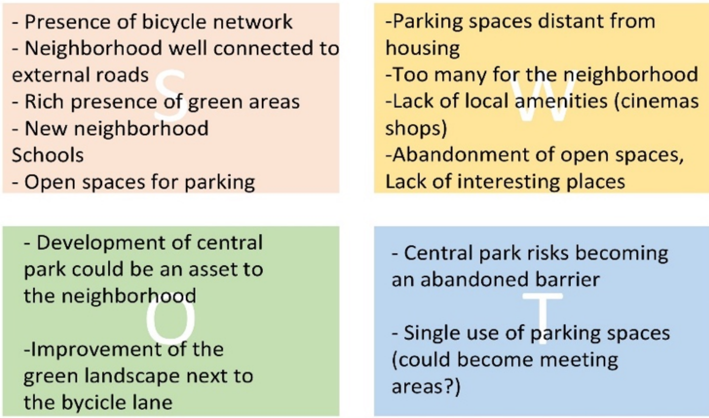
Figures 13, 14 and 15. Sample results of the first exercise on the urban analysis

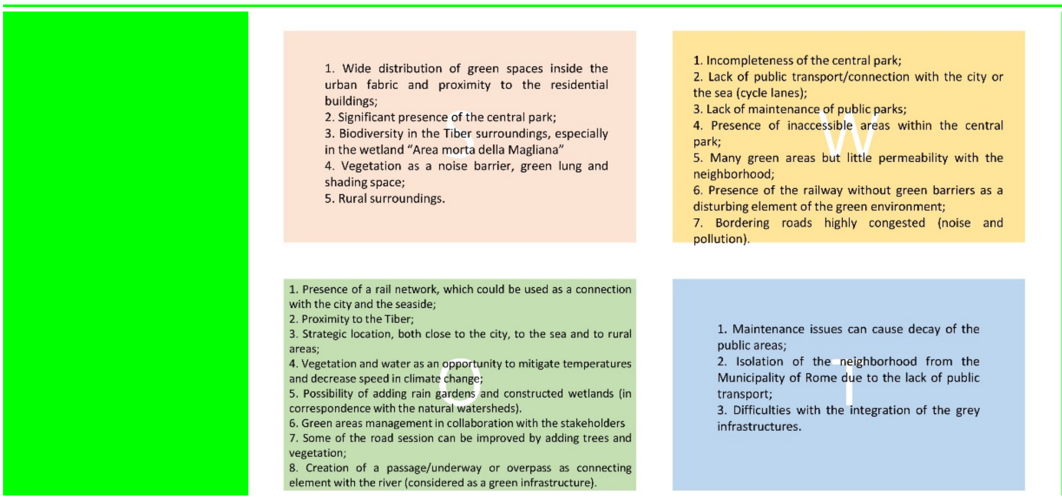




Figures 16, 17, 18 and 19. Results of the first exercise about possible solutions to be placed

The second one was a more critical thinking exercise, in which students developed a SWOT analysis in terms of landscape perception and interpretation.





Figures 20, 21 and 22. Results of the second exercise about the SWOT analysis

Overall, the results were interesting: unlike the participants in the 1st workshop in Siena, these students had a background in architecture and town planning, which allowed them to look at the neighbourhood with different, somewhat biased eyes.

They focused on specific, minor issues (such as the use of some building materials) rather than simply looking at issues of connectivity. While this hindered them during the analysis, it helped them in finding solutions, which they found remembering projects they had consulted before or searching the internet. This also helped in compiling the SWOT analysis. The students were satisfied with the session, as it allowed them to collaborate with one another on familiar topics, as well as to learn new skills and be able to employ them in this exercise.

6.2.4.- Energy efficiency and renewable energy technologies for Torrino-Mezzocammino neighbourhood.

The exercise with the students was divided into seven tasks, each following and complementing the previous one. Students were divided into three groups. The first task was to select a target building or a target zone. Each group was asked to select a different building type or a group of buildings within the Torrino-Mezzocammino neighbourhood. The first group had to select a school building, the second group an office building or commercial premises and the third group had to select a residential area (a block of apartments or a group of houses in a street). The second task was the identification of main energy consumers within the building/s chosen and to list the three highest energy consumers according to their opinion and to explain why they have chosen them. The third task was related to the proposal of energy efficiency or renewable energy interventions.

The first group selected Fiume Giallo School Complex which is composed of primary school "Geronimo Stilton" and secondary school "Lupo Alberto". The school complex has three building blocks, linked together with corridors. As the highest energy consumers within the building, the first group identified the heating and cooling system, lighting and electrical equipment and water. Proposals for energy efficiency improvement/RES included PV panels on the roof and parking lots, rainwater collecting systems, electric vehicles (EV) charging stations, vegetation and green areas as external shading systems and the use of nature-based solutions as a waterproofing system (rain gardens). The main barriers identified were lack of funds for new technologies, maintenance costs of green areas, lack of charging stations for EV, very high temperature in summer (heat island), water waste problem and waterproofing of the surfaces. Proposed solutions included the use of funds for new technologies, encouraging students to participate in the maintenance of the green areas, installation of EV charging stations, afforestation of green areas and use of rain gardens and green walls and increase of environmental awareness by conducting educational campaigns.

The second group focused on a very big shopping mall (6.000 sqm) located right in the centre of Torrino Mezzocammino. It is made up of four buildings that host different facilities and the main energy consumers identified included HVAC systems, lighting and electricity for all the appliances and systems. Proposed solutions included a roof-mounted PV system, LED lighting, solar thermal panels on the outdoor parking and a new heating pump. The group also emphasized the importance of good behaviour as an instant and free of charge way to reduce energy consumption. Some of the proposals of good behaviour included optimization of the lighting and optimization of indoor temperature during the summer or winter period. Barriers to energy renovation included aesthetic problems related to the PV installation, financial problems, legal problems (related to the ownership rights of the buildings), obsolete comfort standard and technical problems. Awareness campaigns, incentives and financial loans, and the need for more specialized and qualified workers were presented as possible solutions to overcome the barriers.

The third group studied a building complex with an area of around 36.941,00 sqm of which around 20.000,00 sqm is green area. The complex forms an open courtyard and the intended use is mainly residential. The highest energy consumers, in this case, were electrical equipment and heating and domestic hot water. Proposed energy measures included PV and solar panels due to the high energy consumption, use of LED lighting and afforestation due to the unfavourable orientation of the buildings (north-south). Identified barriers were mainly related to the possible disagreement of the residents to introduce changes in the environment or on the buildings and as the potential solution is proposed to organize an educational campaign to present long term benefits for the residents.

6.3.- The 3rd City Decarbonisation Itinerant Workshop, Seville, Spain (online format).

6.3.1.- Vulnerability Assessment of Seville's North District.

The exercise has been useful to demonstrate and discuss with students the hybrid nature of risk and the need to approach vulnerability studies from its multifaceted nature (social, environmental, institutional, economic, physical).

Figure 23 shows the vulnerability assessment results for each study case (exposure index, sensitivity index, adaptive capacity index and the final vulnerability compound index).

Figure 24 shows the vulnerability structure triangle wit result of three study cases.

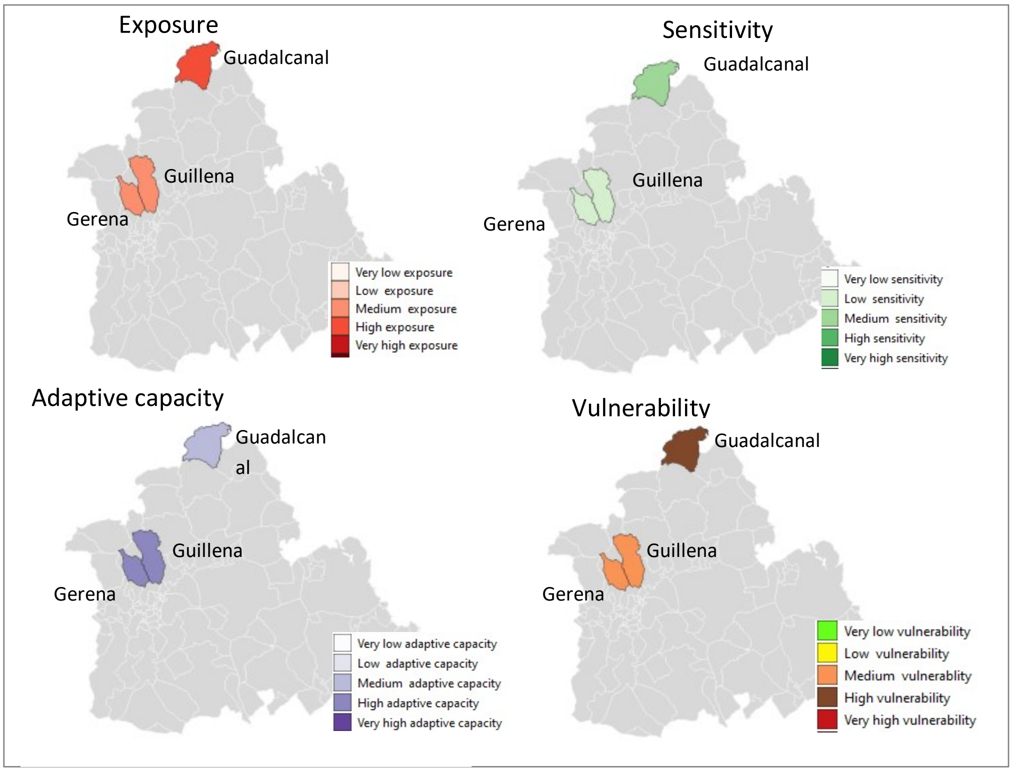


Figure 23 - Vulnerability Index results.

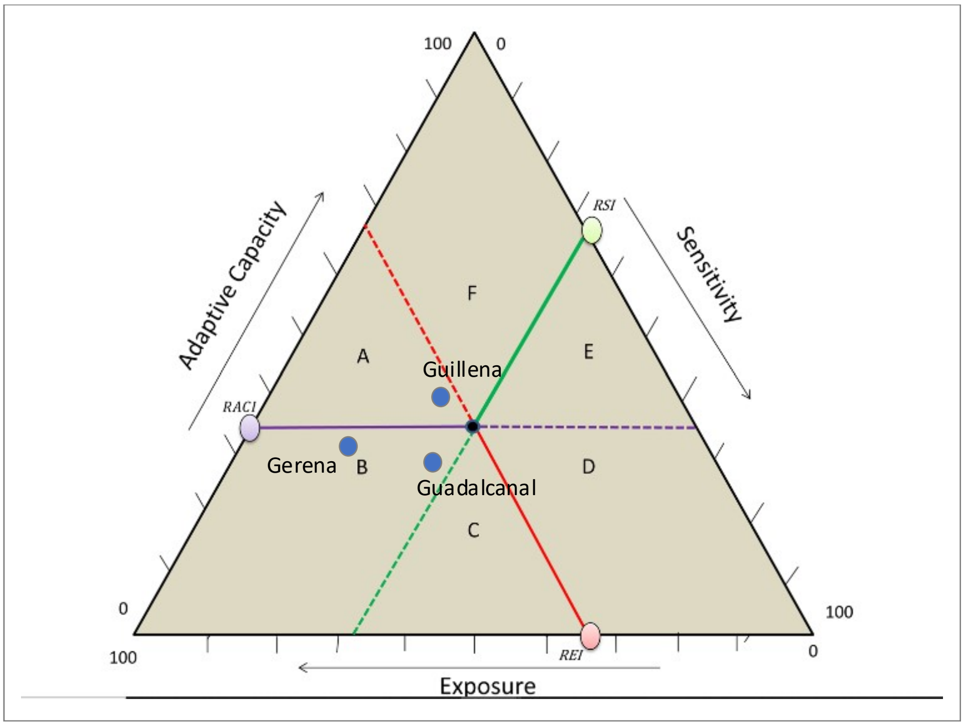


Figure 24 - Vulnerability structure triangle results.

6.3.2.- Carbon Footprint solutions for Seville's North District.

The CF of the Municipality of Seville is reported in Table 25, indicating that mobility had the greater impact (43%), followed by the electricity consumption (16%) and the fossil fuels use for the industrial sector (16%). Also, the waste sector contributes to 12% of the total GHG emissions, considering the low percentage of recycling and the massive waste disposal in landfills. A protein diet contributes to the total emissions increase of about 66%, covering a significant fraction of the total climate impacts of the analysed territorial system (44%).

The virtual equivalent forest area of the Municipality of Seville is 249,855 ha, compared to 806 ha of the current green urban areas (i.e., parks, gardens, and lawns) which, expressed in terms of virtual forest equivalent, measured 192 ha.

ACTIVITY SECTOR	CF	Percentage on the total
	t CO_2eq	%
1) ELECTRICITY	**322,095**	**16%**
Industrial sector	83,047	4%
Residential sector	131,135	6%
Transport	3,171	0.2%
Tertiary sector	93,409	5%
Agriculture sector	11,332	0,6%
2) FUELS CONSUMPTION	**584,903**	**29%**
Industrial sector	329,175	16%
Residential sector	93,504	5%
Tertiary sector	22,863	1%
Agriculture sector	139,360	7%
3) MOBILITY	**882,402**	**43%**
4) WASTE	**234,668**	**12%**
5) WATER	**11,592**	**0.6%**
TOTAL (sum 1+2+3+4+5)	**2,035,660**	**100%**

FOOD protein diet	1,336,203	40%
FOOD balanced diet	866,726	30%
FOOD balanced diet + local food	505,590	20%
UPTAKE	**-2,596**	**0.1%**

Table 25 - Carbon Footprint of the Municipality of Seville.

After this initial exercise, students were asked to reason about possible mitigation policies that could be applied to the city. Due to time constraints among the 25 possible mitigation actions[1], UNISI teachers had already set up the Excel file for students to work on two policies: the installation of photovoltaic panels and wind turbines to increase the share of energy from renewable sources.

Therefore, students have identified on the Google Earth maps the surfaces available to install PV panels and the number of wind turbines that can be introduced in the municipal area.

The installation of PV panels on the buildings and warehouses roofs in the industrial area has been suggested (red boxes in Figure 26). The installation of about 290 ha of PV panels was simulated, with the annual production of 580,000 MWh of electricity, mitigating the CF due to electricity consumption of 33% and that of the overall Municipality of 5%.

Moreover, the installation of about 42 wind turbines (4 MW each) was hypothesized in the area near the Guadalquivir River, characterized by cropland, grassland, and vacant lots just outside the boundaries of the municipality (yellow shape in Figure 10). Inside the municipal area there are no necessary spaces for the installation of wind turbines it is a densely inhabited and built territory. These turbines would be able to produce 294,000 MWh of electricity each year, mitigating the CF due to electricity consumption of 17% and that of the overall Municipality of 7%.

[1] as reported in Pulselli, R.M., Marchi, M., Neri, E., Marchettini, N., Bastianoni, S. (2019). Carbon accounting framework for decarbonisation of European city neighbourhoods. Journal of Cleaner Production 208, 850-868. doi: 10.1016/j.jclepro.2018.10.102.

Figure 26 - Potential location of PV panels (red boxes). Source: Google Earth.

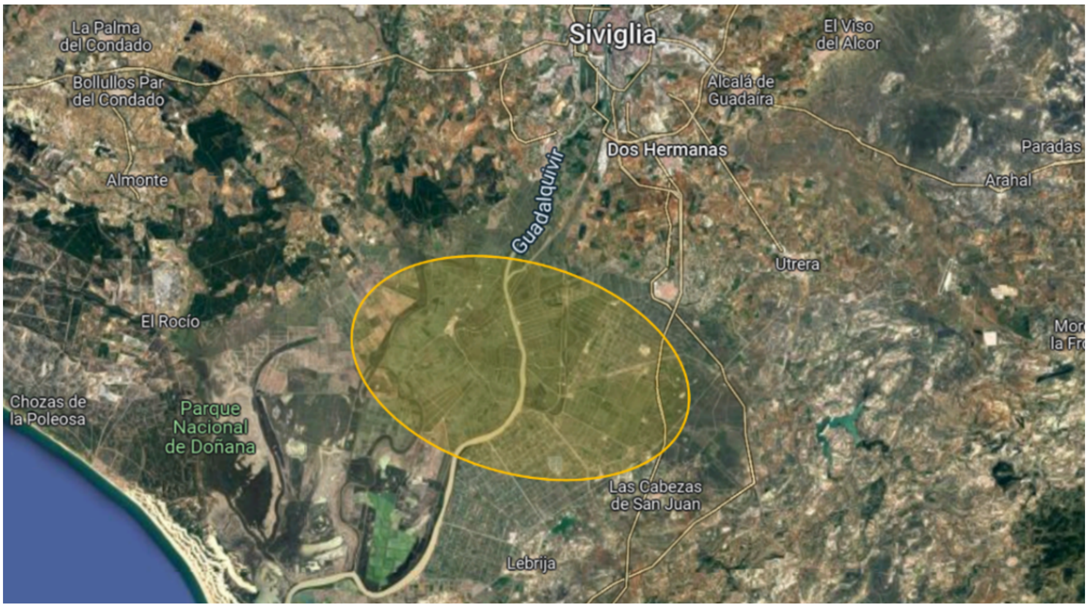


Figure 27 - Potential location of wind turbines (yellow box). Source: Google Earth.

6.3.3.- Placemaking solutions for Seville's North District.

Both students' groups produced interesting results, taking into account that they did not have a background in town planning, and many did not know the area well. However, each group had at least one member who lived in Seville and had some knowledge of the area. The simplified SWOT analysis helped the students highlighting the important features of the area. The students developed interesting lists of objectives and activities and did quick research on the area to develop solutions for the neighbourhood. To sum up, the exercise was useful to both the students, who gained knowledge of the area and acquired tools to assess it, and the teachers, who had the chance to further improve the place-making framework and co-working session.

Strengths

- There are several green areas with which you can work with ecological corridors
- There are two of largest parks in Sevilla
- Several parks in the area
- Recreational facilities
- The agricultural zone is close, which can be positive for the provision of food
- One area close to the river was developed by the community
- Lots of gardens and retail near the Miraflores park
- Willingness of citizens to work on improving spaces
- Urban gardens already exist in the north of the area

Figure 28 - Results of the first session of the exercise: Analysis – Strengths (Group 2).

Weaknesses

- There are two large industrial areas
- There is a perception of insecurity in the neighborhoods in the residential part
- One of the river channels is neglected (blue line)
- There is no public space for pedestrians, near the road that crosses the area
- Wide roads without enough illumination, nor free walking space, nor bike pathways
- Not a good connection for cyclists to get to the downtown
- Not many public transport lines

Figure 29 - Results of the first session of the exercise: Analysis – Weaknesses (Group 2).

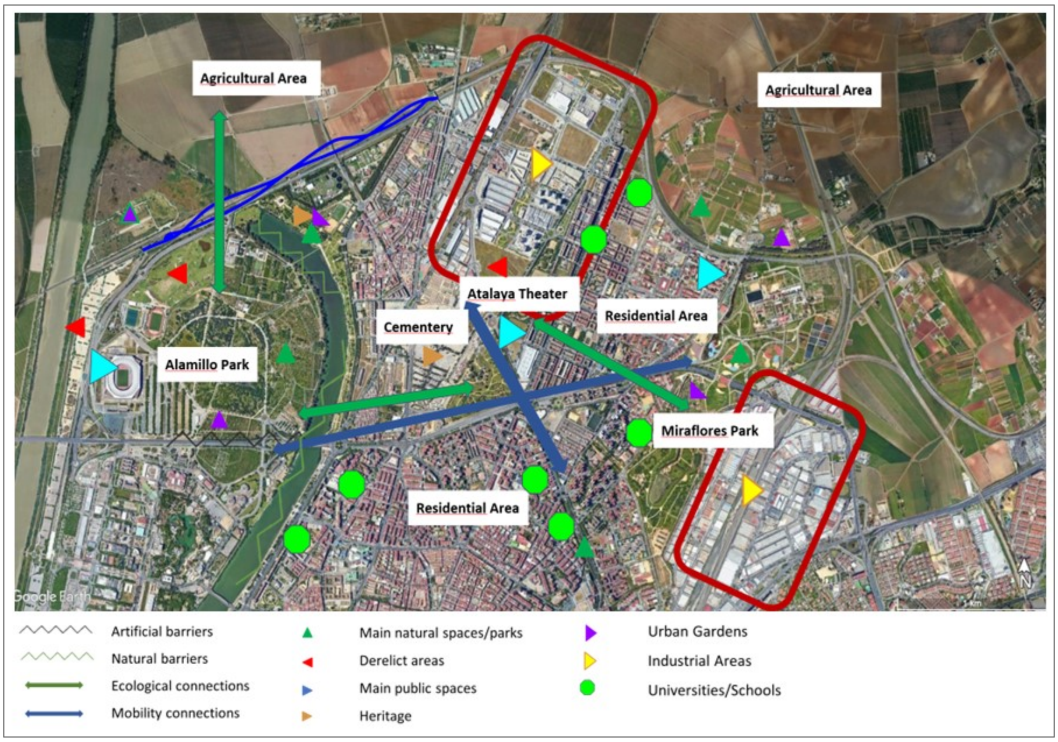


Figure 30 - Results of the first session of the exercise – City map with key (Group 2).

Objectives

- Enhancing connectivity corridors for both people and nature
- Increase the soft mobility connectivity and public transportation
- Improve community participation in planning and design (Understand demographics of the area)
- Understand opportunities for nature-based solutions
- environmental improving of buildings
- Improve community behaviour towards environmental and sustainability

Figure 31 - Results of the second session of the exercise: Strategies - Objectives (Group 2).

Activities

- Implement green corridors
- Research in nature based solutions
- enhance communitary composting
- plan new cycling pathways intra neighbour and with city center.
- Engage young people through schools and universities
- Shadow corridors
- Create paths to cross the river for both people and animals
- Design green roofs and water collectors in residential and industrial buildings
- Use tiny forests to restore derelict areas
- Reduce waste
- Change cars for bikes/walking
- Creation of local food market km0
- Identify community organizations/ONGs in the area that could support these activities

Figure 32 - Results of the second session of the exercise: Strategies - Activities (Group 2).

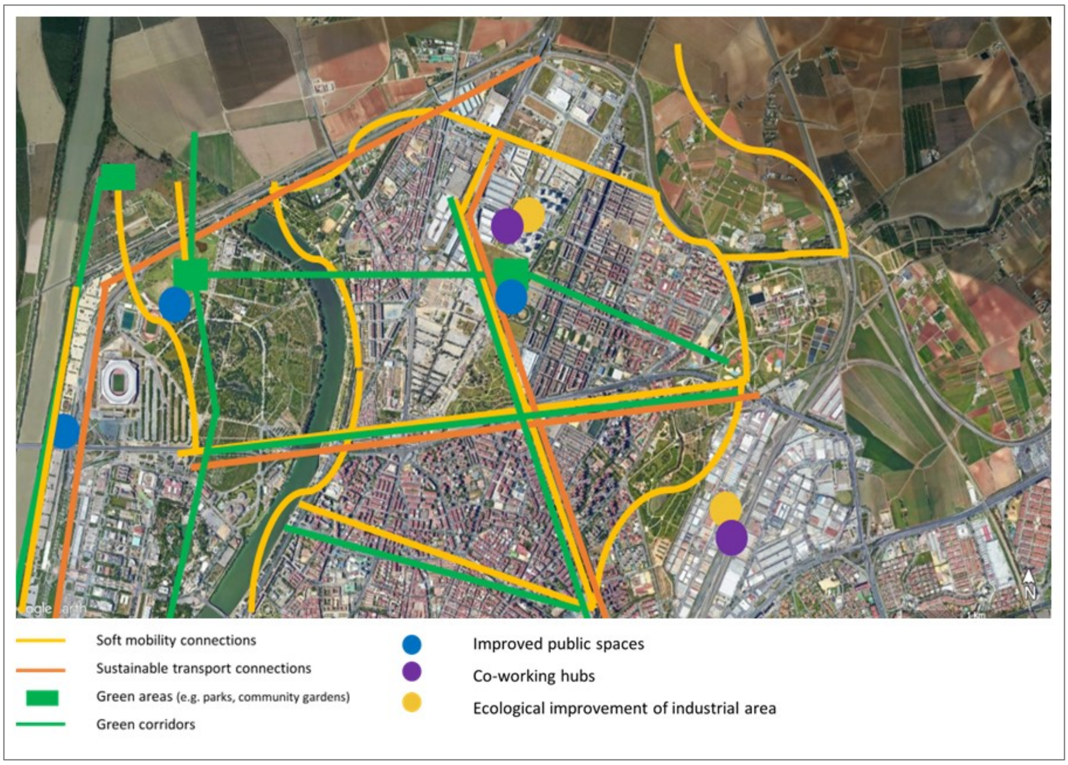


Figure 33 - Results of the second session of the exercise - City map with key (Group 2).

6.3.4.- Energy efficiency and renewable energy technologies for Seville's North District.

The first group selected the Colegio Maristas San Fernando, a religious school located in Triana neighbourhood. As the highest energy consumers within the building, the first group identified the electronic equipment (computers and other), lighting and heating and cooling systems.

Proposals for energy efficiency improvement/RES included the installation of lighting sensors and LED lights, use of PV/Solar/Thermal panels, insulation measures for windows and walls, use of the use of adequate temperature controllers and in the end, constant and regular system maintenance. The main barriers identified were the poor maintenance of the system, lack of funds and lack of knowledge about EE/RES. The proposed solutions included the development of scheduled plans for the system maintenance, the organisation of training for building owners/managers, promotion and fostering of public financing, crowdfunding and energy performance contracting, better planning of the reconstruction works and organisation of raising awareness campaigns.

The second group focused on the residential building located on the corner of Virgen de Lujan 22 street. The building was built in the 1960's and it has 8 floors on two separate stairs (areas) with 2 or 4 units per floor per area, so there are more than 30 individual units. The building is perpendicular to the North-South/East-West orientation which increases the sun exposure, and it doesn't have any taller buildings around which provide shading.

Figure 34 - Selection of target building/zone in the City of Seville.

As regards the main energy consumers, the group identified the heating system as the highest energy consumer in the building. The group stated that ubication (southwards) is not favourable for the apartments and this is the reason why one area overheats while the other is cold, creating tension among neighbours. The second main energy consumer is the air conditioners during the warm season with the consequence that all the heating from the machines is released to the street. The third main identified energy consumer is the elevators (4 of them, 2 main elevators that are new and 2 service elevators that are old). Proposed solutions related to the EE included the installation of the bioclimatic shadow of the south facade, windows with double/triple glazing, adaptation of the central heating system in order to assess the actual needs of the owners and implementation of new insulation techniques to renew the facade. As regards the RES, the group proposed the installation of solar panels and micro-wind turbines on the roof and the possible establishment of a microgrid or energy community with neighbouring buildings.

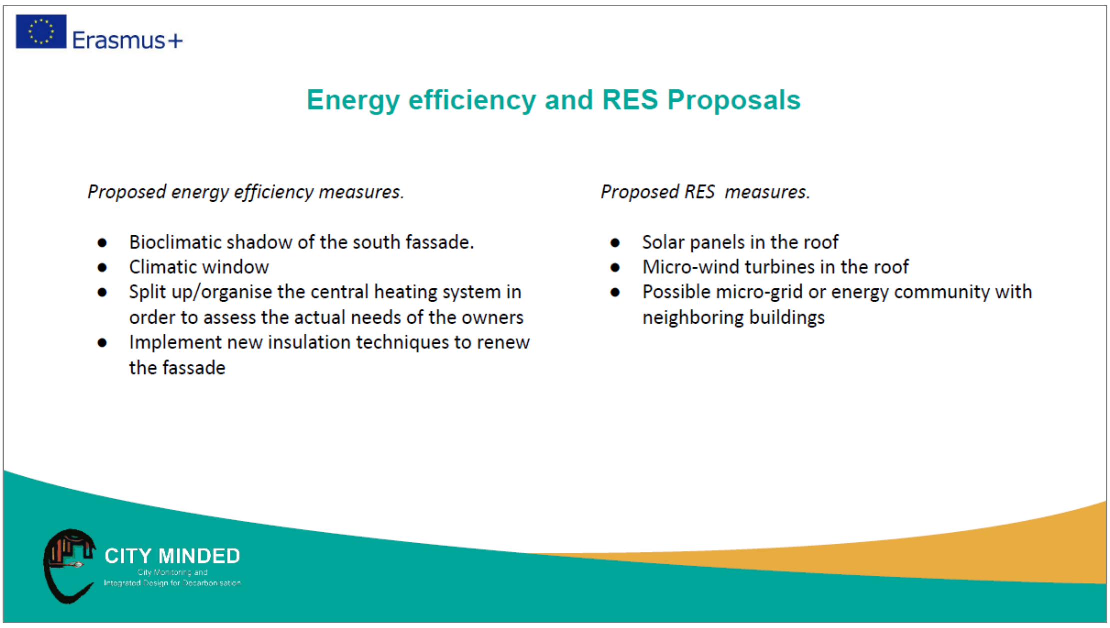
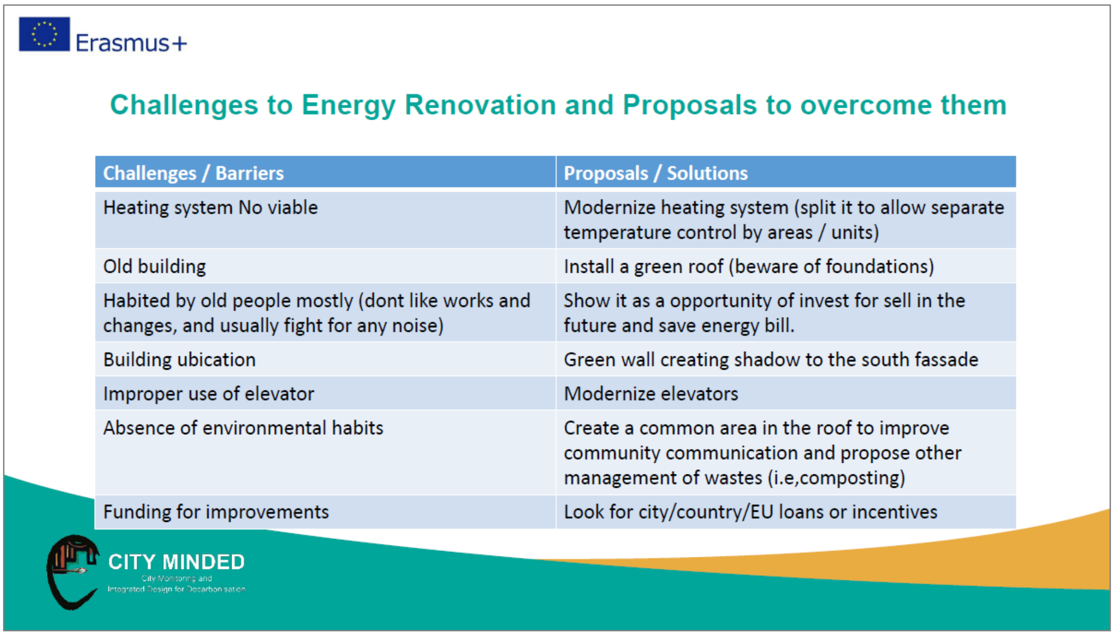


Figure 35 - Proposed energy efficiency and RES measures for the selected area.

Barriers to energy renovation included inadequate heating system, age of the building, absence of environmental habits, lack of funding, irregular use of elevators and older population of the building. As the possible solutions to overcome the barriers, the group proposed the modernisation of the heating system (by splitting the central system in order to allow separate temperature control by areas/units), building a green roof and green wall to create a shadow to the south facade, modernisation of the elevators, creation of a common area in the roof to improve community communication, improvement of the waste management (i.e., composting), use of city/country/EU loans or incentives for the EE/RES improvement.



Challenges / Barriers	Proposals / Solutions
Heating system No viable	Modernize heating system (split it to allow separate temperature control by areas / units)
Old building	Install a green roof (beware of foundations)
Habited by old people mostly (dont like works and changes, and usually fight for any noise)	Show it as a opportunity of invest for sell in the future and save energy bill.
Building ubication	Green wall creating shadow to the south fassade
Improper use of elevator	Modernize elevators
Absence of environmental habits	Create a common area in the roof to improve community communication and propose other management of wastes (i.e,composting)
Funding for improvements	Look for city/country/EU loans or incentives

Figure 36 - Detected challenges for energy renovation and proposals to overcome them.

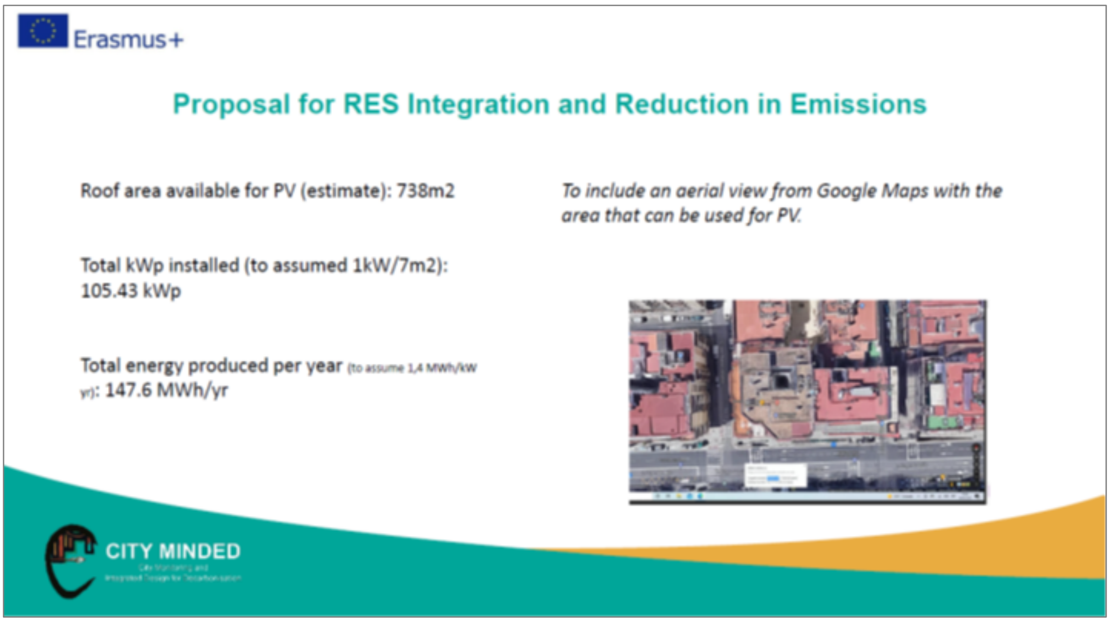


Figure 37 - PV installation potential for a residential complex in the City of Seville.

The group work showed that the students obtained a good understanding of energy efficiency and renewable energy within the urban context and how to identify the correct solutions for different building categories. A particularly important point that was highlighted is the importance of focusing on buildings located in the urban areas, both in terms of energy efficiency improvement as well as for the installation of renewable energy technologies in the buildings to minimise the use of green areas for energy production.

6.4.- Intensive Course in Valleta, Malta (face-to-face format).

6.4.1.- Vulnerability Assessment for Valletta.

Each group selected a case study (Southern Harbour district, Group 1 and Northern Harbour district, Group 2) for which they calculated the Vulnerability Index (VI) by following a series of steps included above. Starting from the indices of each of the vulnerability index (Exposure, Sensitivity and Adaptive Capacity) calculated, it was analysed how the VI is structured, that is, how each of the components influences the final determination of the value of the VI. This allows a first approach to the causes that generate vulnerability. To do this, the relative weight of each of the indices in the final value of vulnerability was calculated according to the following equations and then they are represented in the vulnerability structure triangle. Once each group had calculated the index for their case study, the results were shared and the index values for each district compared.

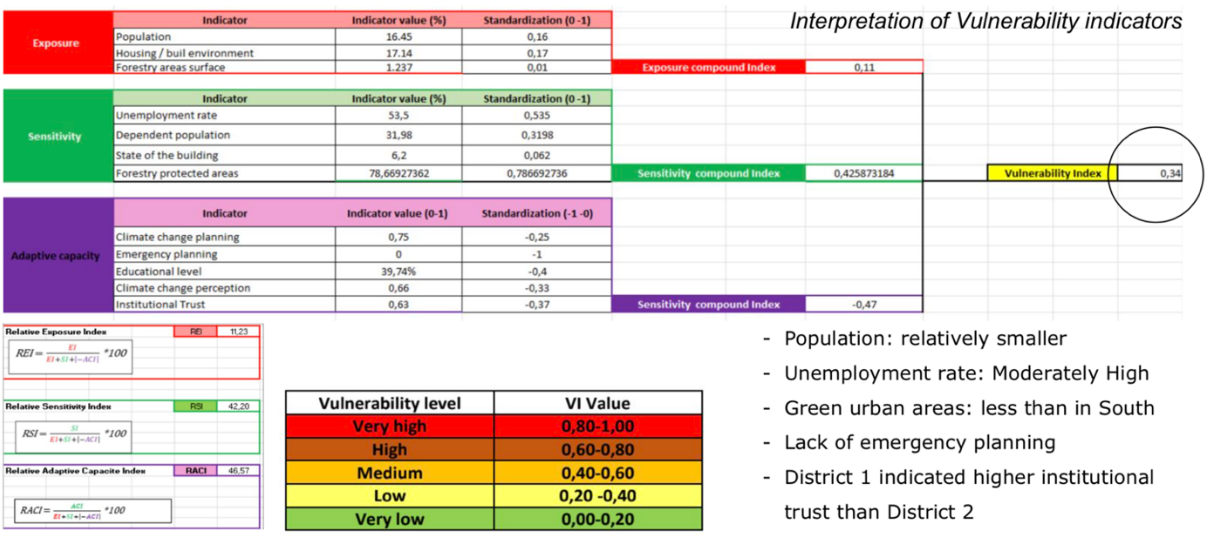


Figure 38. Vulnerability Assessment Group 1 results

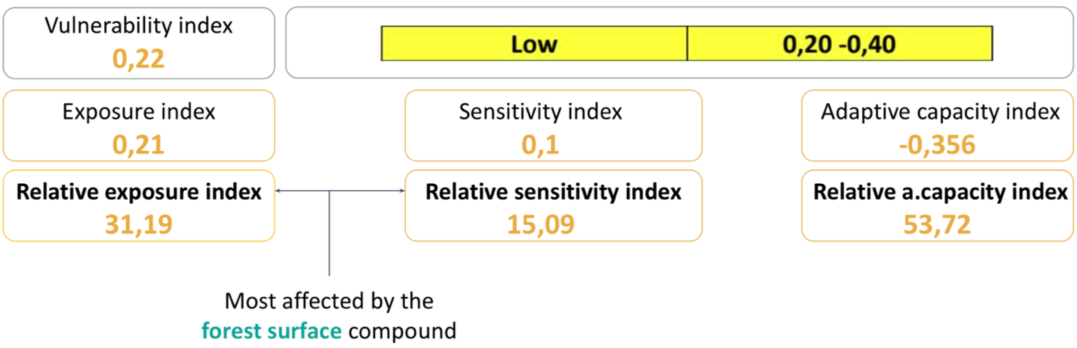


Figure 39. Vulnerability Assessment Group 2 results

At the conclusion of the afternoon's work, students fixed the summary of their reasoning and conclusions on a map and PowerPoint presentation that was presented in the last day of the workshop with the vulnerability index and the triangle results (figure. 23), and with the following main conclusions:

- Sensitivity and lack of adaptive capacity are the main component of vulnerability for Valletta (>33)
- Vulnerability is dynamic as it could change between two closely related districts (0.34 low in district 1 to 0.15 very low in district 2)
- Valletta district 1 has lower exposure than Rome or Florence but has similar sensitivity as Viterbo in global context
- We will only be able to deal with the risks posed by climate change if we understand what makes us vulnerable.

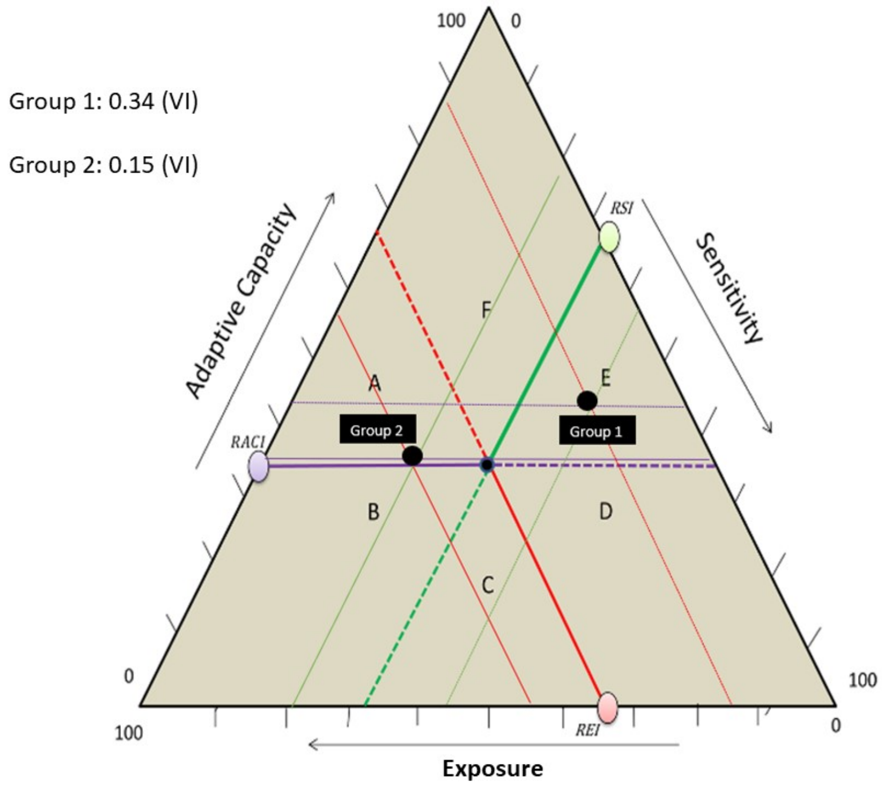


Figure 40 - Vulnerability Structure Triangle Results.

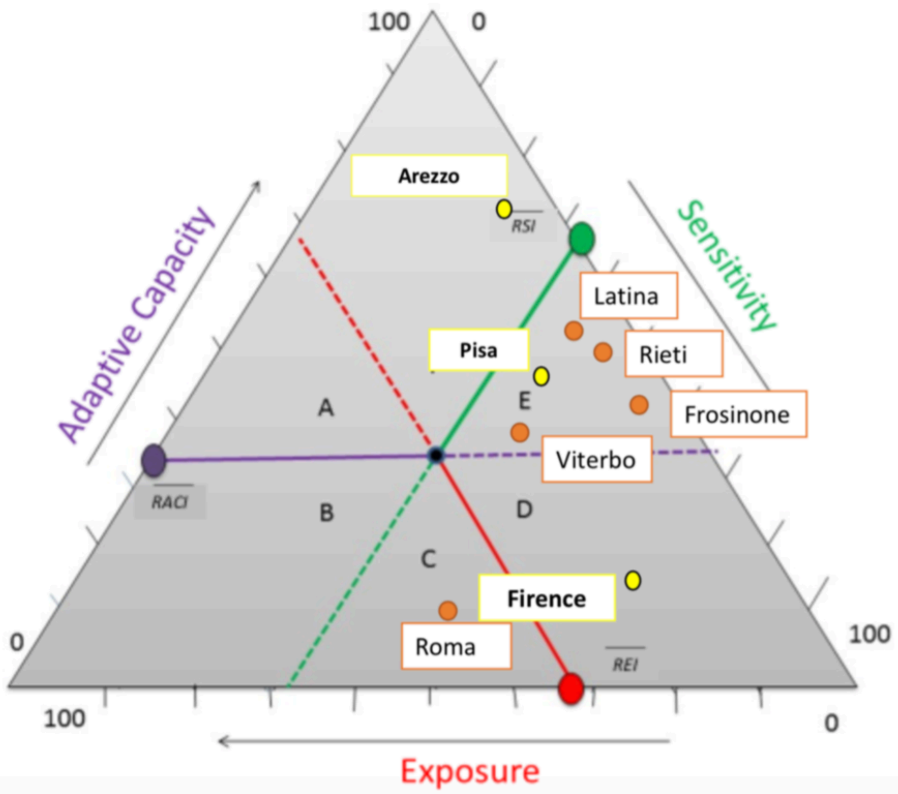


Figure 41 - Vulnerability Structure Triangle Results from previous workshops

The vulnerability structure triangle does not represent the values acquired by the components but the relative weight that each of the components (regardless of whether their relationship with vulnerability is direct or inverse) has in the final determination of the VI. To calculate the Relative Exposure, Sensitivity and Adaptive Capacity Relative Indices use the following equations.

Some of the conclusions regarding a vulnerability that can be extracted from the on the workshops results are:

- Vulnerability is multifaceted (social, environmental, institutional, economic, physical)
- Vulnerability is dynamic (temporal and spatial changes)
- Vulnerability assessment is Hazard and context (territorial scale, availability of data...) specific.
- There is still a long way to go and many challenges in which to continue advancing in these methodologies.
- Only by knowing what makes us vulnerable will we be able to cope with the risks posed by climate change.

6.4.2.- Carbon Footprint solutions for Valletta.

At the conclusion of the afternoon's work, students fixed the summary of their reasoning and conclusions on a map and PowerPoint presentation, and one representative from each group carried out a brief final presentation.

Both groups met and exceeded the Carbon Neutrality goal for the city of Valletta as they focused heavily on the implementation of renewable energy facilities (particularly PV panels and wind turbines, both onshore and offshore floating). The solutions, however, also range in other areas, such as increasing urban greenery, reducing energy waste through the use of LED bulbs and more efficient household appliances, and optimizing cycles through increased recycling and reuse of processing waste (e.g., for the production of biogas and biodiesel), changing individual diets by reducing meat consumption (imagining, for example, the gradual increasing inclusion of products derived from insects), and much more (the Figures 42 show some of the results and mitigation measures identified by the students).

INPUT	UNIT	Activity data		CF
				t CO_2eq
Population		5,859		
Electricity (INDUSTRIAL)	MWh_e	2,171		565
Electricity (RESIDENTIAL)	MWh_e	3,428		893
Electricity (TRANSPORT)	MWh_e	83		22
Electricity (TERTIARY)	Mwhe	2,442		636
Electricity (AGRICULTURE)	MWh_e	296		77
Thermoelectricity (Natural gas)	m^3 natural gas	3,357,852		6,490
Fuel (INDUSTRY SECTOR)	MWh_{th}	12,227		3,123
Fuel (COMMERCIAL AND PUBLIC SERVICES)	MWh_{th}	25,527		6,535
Fuel (HOUSEHOLDS)	MWh_{th}	3,032		479
of which ***Water heating***	MWh_{th}	*779*		*123*
of which ***Cooking***	MWh_{th}	*455*		*72*
of which ***Air Conditioning***	MWh_{th}	*376*		*59*
of which ***Electrical appliances and lighting***	MWh_{th}	*840*		*133*
of which ***Space heating per dwelling***	MWh_{th}	*582*		*92*
Fuel MOBILITY	MWh_{th}	26,013		6,850
of which ***Cars***	MWh_{th}	*15,816*		*4,165*
of which ***Bus***	MWh_{th}	*2,471*		*651*
of which ***Motorcycles***	MWh_{th}	*234*		*62*
of which ***Trucks and light vehicles***	MWh_{th}	*6,009*		*1,582*
of which ***Rail***	MWh_{th}	*0*		*0.00*
of which ***Water (ships and ferries)***	MWh_{th}	*1,405*		*370*
of which ***local airport (private airplanes)***	MWh_{th}	*78*		*21*
Waste (LANDFILL)	t waste	5,993		4,423
Waste (INCINERATOR)	t waste	0		0.17
Water	m^3 water	989,754		277
FOOD proteic diet				11,273

Carbon footprint mitigation

City of Valletta

Valletta's current CF : 41643

Reduced Carbon Footprint -8.188

Figure 42 - Group 1: Carbon Footprint results and mitigation effects for the City of Valletta.

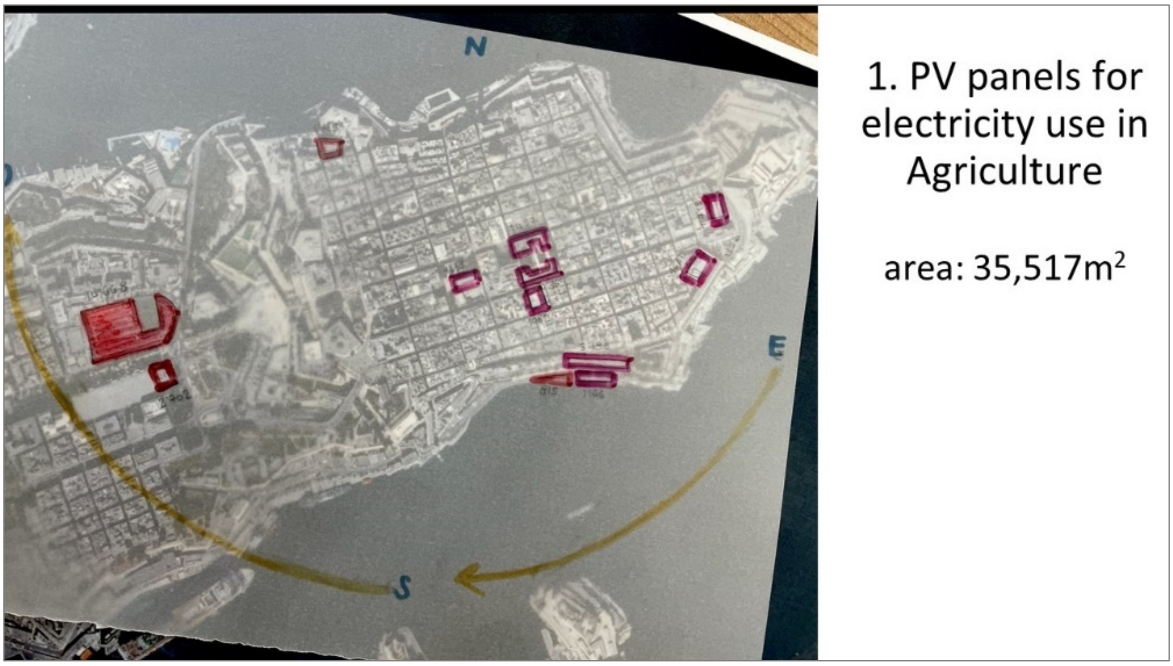


Figure 43 - Group 1: Map of the city of Valletta with areas for the installation of PV panels highlighted.

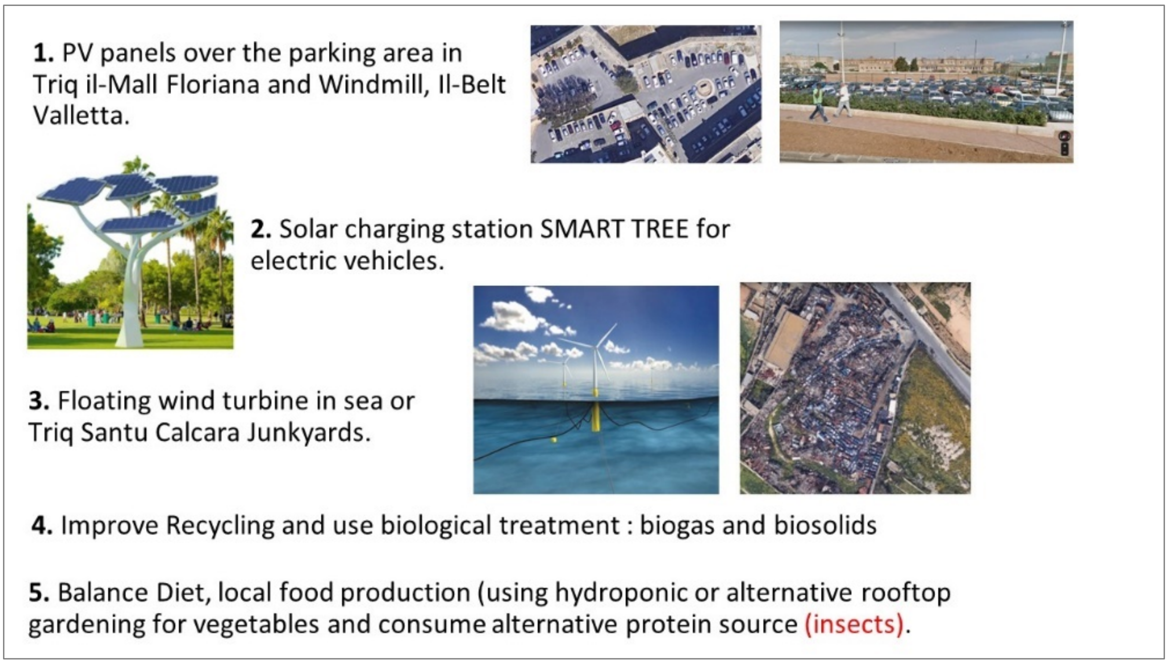


Figure 44 - Group 1: Examples of GHG mitigation solutions.

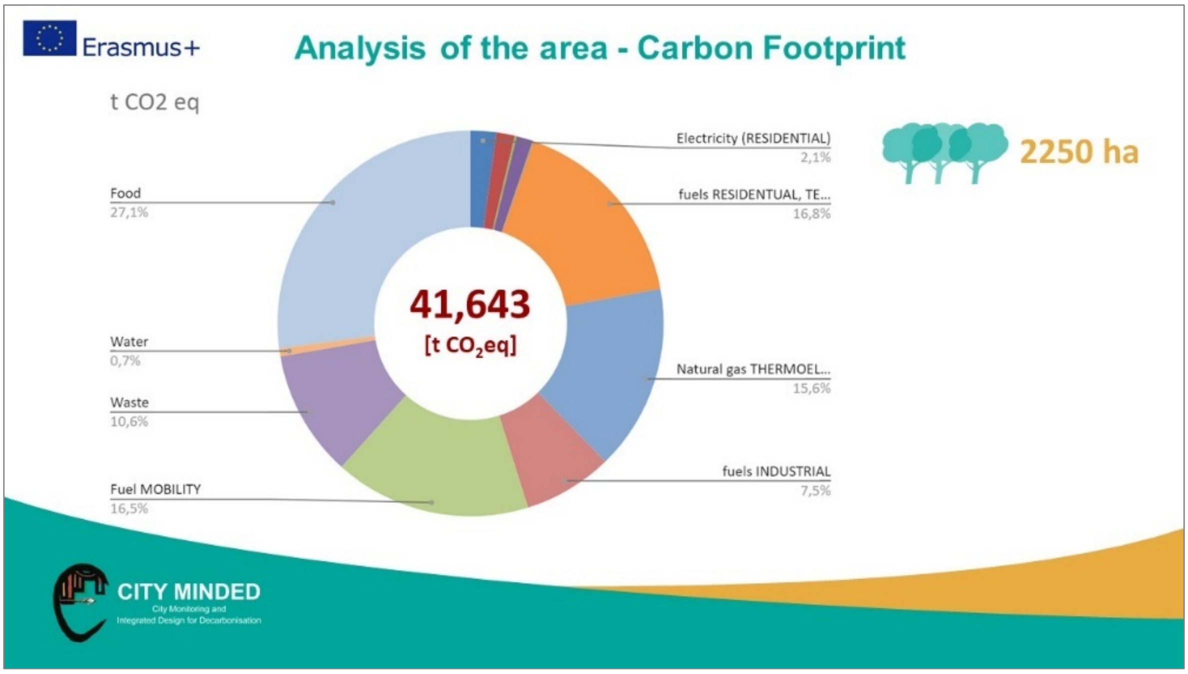


Figure 45 - Group 2: Carbon Footprint results for the City of Valletta.

Figure 46 – Group: traffic modifications and the increase and development of urban green areas.

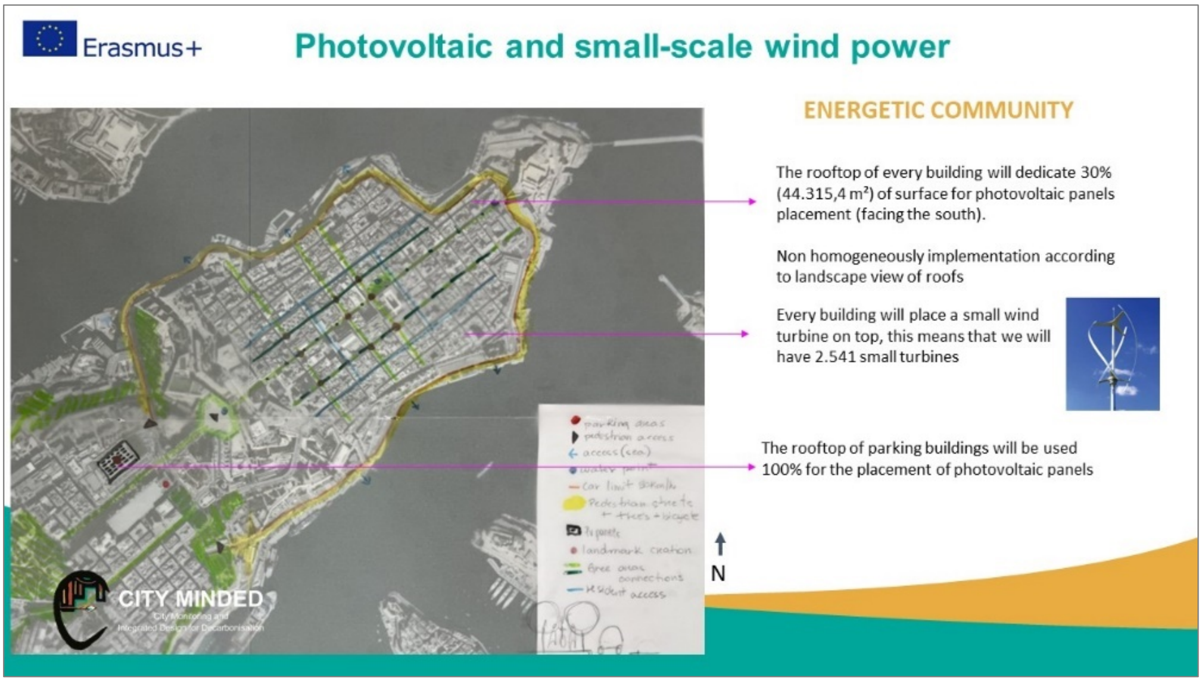


Figure 47 - Group 2: areas for PV panels and small vertical-axes wind turbines (energetic community implementation).

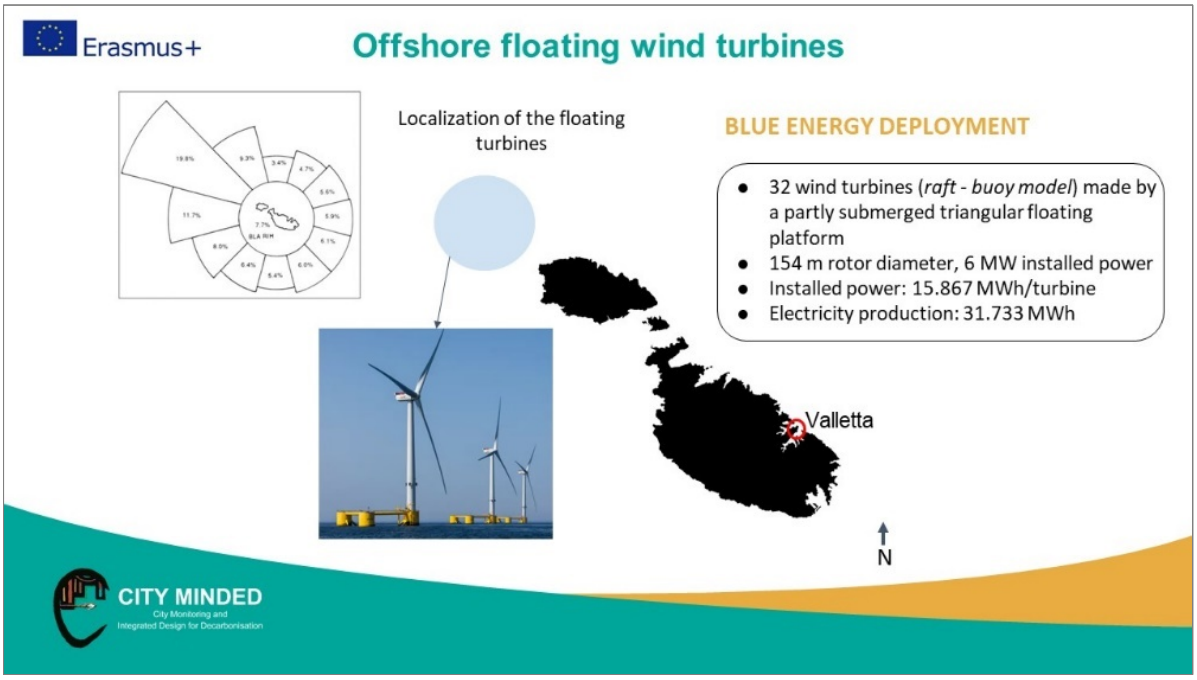


Figure 48 - Group 2: Map of the Malta archipelago with the location for a hypothetical floating wind farm.

6.4.3.- Placemaking for Valletta.

Both groups produced original results, taking into account that most students had no background in town planning and did not know the area well. The students prepared a power point presentation to illustrate the results of their analysis and strategies for the sustainable development of Valletta and for the improvement of its liveability.

Both groups used effective representation methods, focusing their attention on the themes of sustainable mobility and pedestrianization but also on the increase of green areas and trees for cooling the city. Their strategies have created tangible and intangible networks within the city of Valletta but also with the surrounding areas

The students greatly appreciated the opportunity to be part of an in-person workshop, those who had already participated in the City Minded online workshops a few months earlier. The difference between actually engaging with people and places personally as opposed to through a computer screen was very evident, not only for the human contact factor, but also because of the importance of experiencing a place in person in order to better plan for it.

6.2.4.- Energy efficiency and renewable energy technologies for Valletta.

The first group started their exercise with a walk around the building to identify the implemented measures on/in the building. As the implemented measurers, the group identified the rooftop garden, green wall within the main courtyard, solar electricity panels panel on the canopy, good use of natural light (glass walkways), efficient use of space (module rooms + external corridor), use of adaptive and resistant materials (wood and steel), use of LED lights and restored existing cisterns (Figure 49).

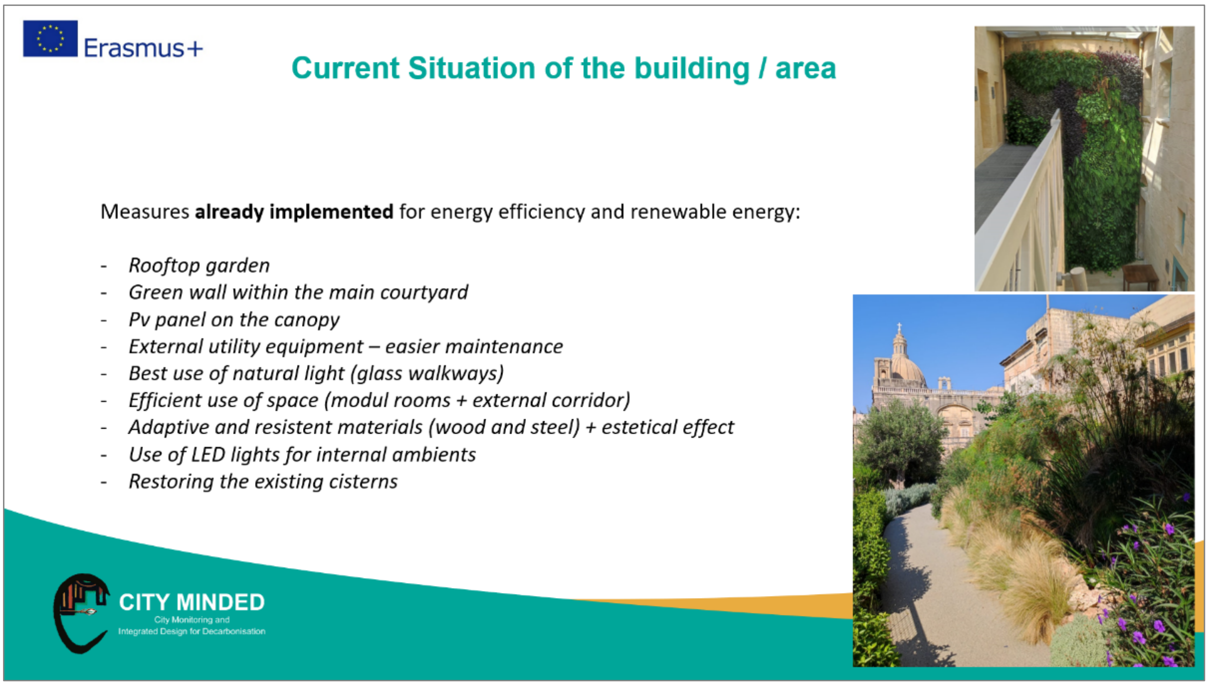


Figure 49 - Identified and implemented measures on the Valletta Design Cluster

Following the analysis of implemented measures, the group proposed several solutions in order to improve the energy efficiency of the building and maximise the use of renewables (Figure 50). The proposals included the following: increase the number of PV panels, movable PV canopy to increase the efficiency of solar retention, install sensors for the lights and water taps in the building, limit air condition temperature, ensure shadow (lighter tents) in roof garden to improve usability, improve air circulation to reduce the greenhouse effect, improve accessibility for person with reduced mobility and provide a key map of the building. The identified challenges by the group were the establishment of the maintenance plan, how to ensure regular checks for PV and service equipment and the conservation rules.

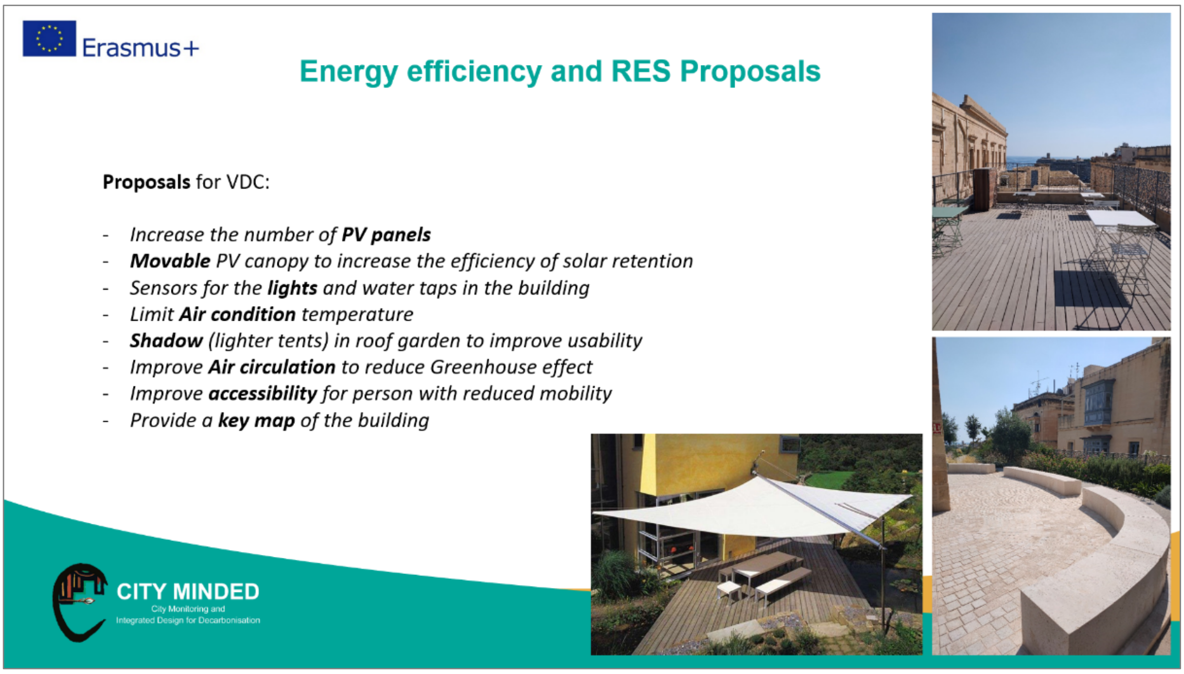


Figure 50 - Proposals for the improvement of the Valletta Design Cluster

The second group started their exercise by the on-site visit of the target area. The group selected for their exercise a group of buildings located in Triq San Duminku in the historical centre of Valletta (Figure 51).

Figure 51 - Target area chosen by the group 2

The group has analysed the buildings in several ways. First, they have done a walk around the building and took notes about the visible interventions or weaknesses. Then the group interviewed several users and flat owners in order to collect valuable inputs regarding the energy performance of the buildings, interventions made and what are the challenges that the owners are facing, particularly in terms of energy consumption and living comfort. The detected are shown on the Figure 52.

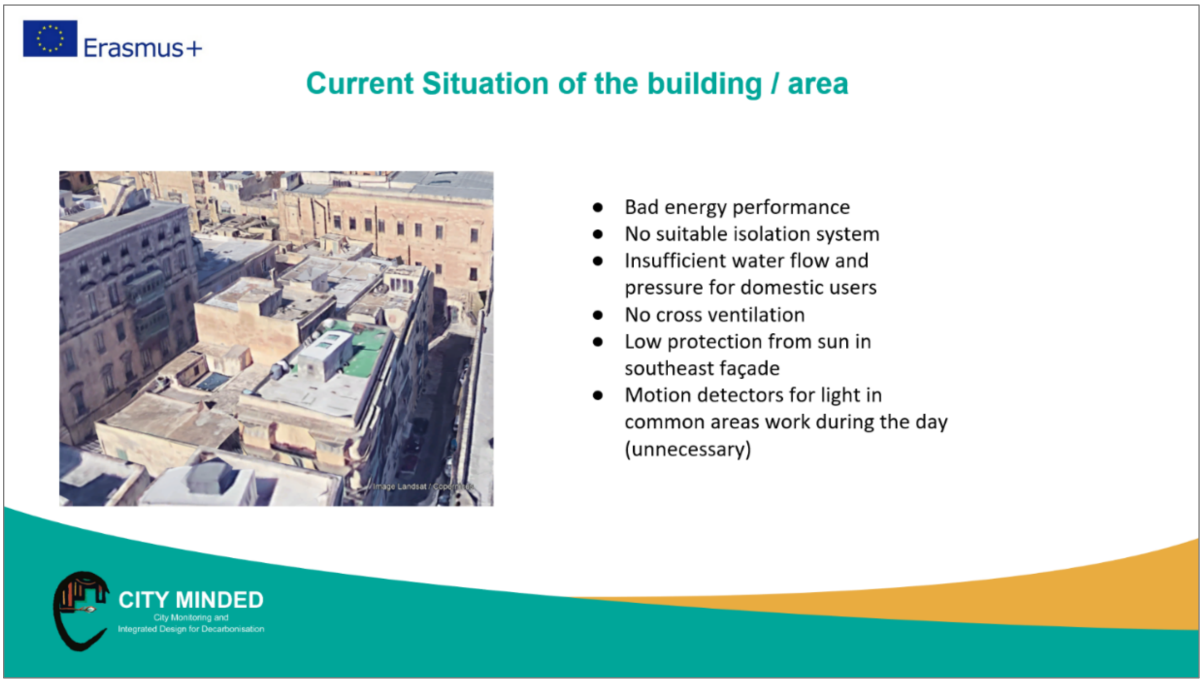


Figure 52 - The analysis of the selected area

Following the analysis of the area, the group proposed the following energy efficiency measures and renewable energy systems as shown on the Figures 53 and 54:

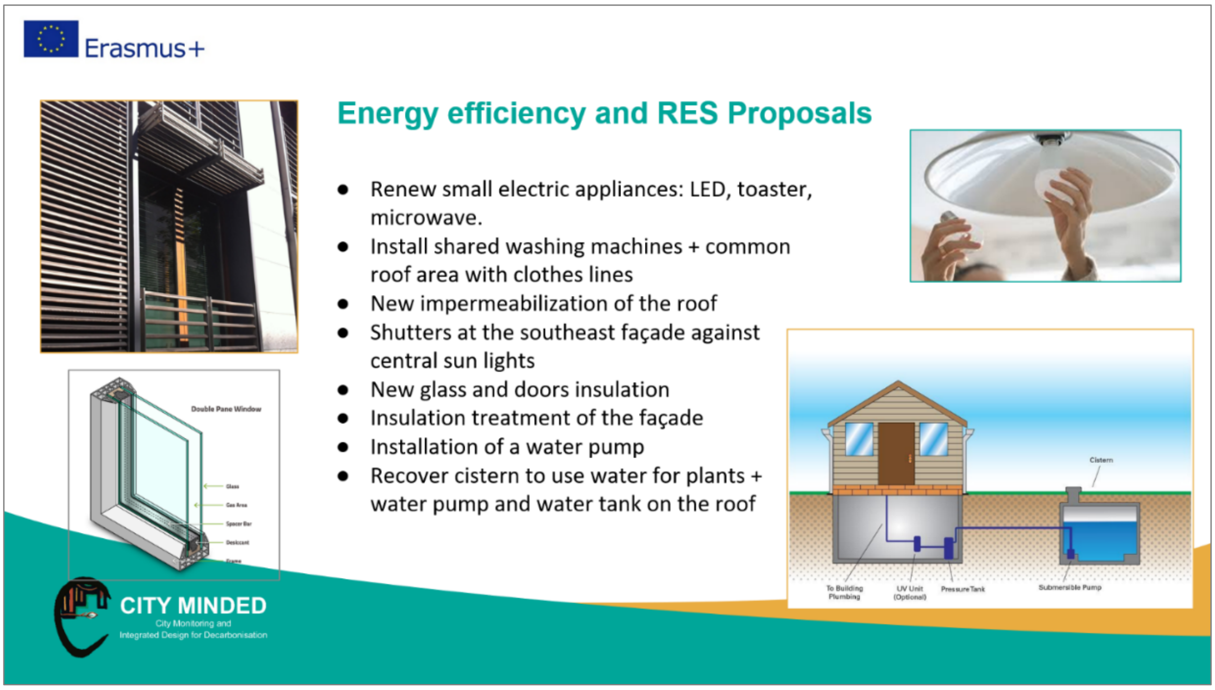


Figure 53 - The proposed solutions by Group 2.

Figure 54- The proposed solutions by Group 2.

The group identified absence of common areas, heritage regulation and accessibility as the main challenges of the area. As the mitigation measures, the group proposed the organisation of common areas on the roofs, the use of roofs for the installation of renewables and use of glass PV cells if possible. As regards the accessibility, the group proposed installation of common wood ramp to avoid steps in the entrance of the block, and the adaptation of stairs and access from street to the roof for people with accessibility problems.

As the common conclusion after the presentation of the results by both groups, it was concluded that the developed methodology worked very smoothly in the real condition and that the workshops in presence give more opportunity to produce tangible results than the online ones. Nevertheless, the developed methodology can work in both conditions, and this is for sure an added value of the project. The work between the students and teachers from different Universities and with different level of knowledge has provided significant proposals for the energy efficiency improvement of the target area and Valletta in general, which then can be used by stakeholders and practitioners to prepare actions aiming at achieving carbon neutrality in the upcoming years.

Annexes

Annex 1.- Collection of Data used during the workshops and the intensive course (see corresponding folder)

Annex 2.- Workshops' Results Compilation (see corresponding folder)