Towards climate adaptation: a case study of a Coastal City in Portugal

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Abstract. The importance of climate-neutral and smart cities was addressed by the European Commission (EU) through the financing program EU Missions, as a response to the urban and energy challenges to promote innovative solutions and strategies and to deliver tangible results by 2050. To manifest their Expressions of Interest to join the EU Cities Mission, several cities across Europe applied for funding to support their local action plans toward reaching climate neutrality by 2030/2050. One example is the research European project Re-Value focusing on waterfront cities and aiming to transform the waterfront cities zones from a risk to an opportunity, through a New European Bauhaus (NEB) inspired value and impact model that allows urban transformation strategies to value quality and other non-monetary benefits in addition to (only) pricing and GHG emission reductions. This paper presents the results of the preliminary analysis developed in one of the 9 cities of the project, Cascais, located on the Portuguese coast. The results will contribute to a detailed roadmap actions and update of the Cascais long-term Territorial Transformation Plans to accelerate its journey to climate neutrality by 2050. As one of Cascais ambitions and main point of the developing roadmap is the adoption of the decentralised renewable energy generation, a spatial analysis of the potential for wind energy and solar PV energy in rooftops along with the wave energy potential assessment along the coast was done. In addition, a Decision Support Tool (DST) using the most relevant Key Performance Indicators (KPIs) for energy transition was used, to support Cascais implementation of the measures that will have the highest impact in inhabitant's lives. The tool enables to evaluate how KPI's from different sectors will evolve considering three different socio-economic development scenarios.

Keywords: Climate Neutrality; Resilience; Coastal Cities; Urban Rehabilitation; Renewable Energy; Scenario's simulation tool.

1. Introduction

1.1 Context

In the last years the Member States of the European Commission (EC) have been making an effort to meet the goals established in the National Energy and Climate Plans in what concerns Energy and Climate. In this scope, the EC addressed the importance of the climate-neutral and smart cities through the funding program EU Missions, as a response to these topics, especially in what concerns the urban and energy challenges to promote innovative solutions and strategies and to deliver tangible results in the horizon 2030-2050. Following these challenges the EU funded several projects in the Smart-Cities' area that present different approaches and contributions to meet the Energy and Climate goals of the different Member States, and also several initiatives have arisen in cities all over the world establishing strategies and policy recommendations guidelines for the development of these cities [1]. The European Union (EU) fully recognizes the significance of sustainable development and aims to reduce its carbon footprint and make Europe a global role model in energy transition. In 2019, all EU Member States encoded this ambition into their National Energy and Climate Plans 2030 [2]. The EU Council has set targets on greenhouse gas reduction, renewable energy production and energy efficiency for 2020 and 2030, which paves the way to the long-term goal of a climate neutral economy by 2050 [3]. According to the governance of the energy union and climate action rules entered into force in December 2018, EU countries are required to develop integrated National Energy and Climate Plans (NECPs) that will cover the five dimensions of the energy union i.e. (i) security, solidarity and trust, (ii) a fully integrated internal energy market, (iii) energy efficiency, (iv) climate actions – decarbonizing the economy and (v) research, innovation and competitiveness for the period 2021 to 2030. For Europe to be climate neutral by 2050, EC proposed several approaches to stimulate energy transition and climate neutrality in urban environment, addressing different scales from city level to districts and neighborhoods. For example, the European Innovation Partnership on Smart Cities and Communities (EIPSCC) established the initiative on Positive Energy Blocks (PEBs) in 2016 [4] supported by EC pilot projects towards Positive Energy Blocks/Districts as a core topic of the Horizon2020 Smart Cities and Communities call LC-SC3-SCC-1, with an aim to drive the deployment of PEBs in Europe. Moreover, the Strategic Energy Technology Plan (SET Plan) of the EC aims to accelerate the development and deployment of the most impactful technologies in the EU's transformation to a low-carbon energy system by coordinating research and innovation efforts amongst EU countries, companies, research institutions, and the EU itself. In June 2018, the SET Plan on Action 3.2 "Smart Cities and Communities" was endorsed by the EC [5]. The main objective is to develop integrated and innovative solutions for the planning, deployment, and replication of Positive Energy Districts (PEDs). Several aspects related to PEDs and the energy transition at district scale were addressed from definition perspective [6], [7] and implementation methodology [8] and [9]. Within the context of the initiative EU Missions launched in 2021 by EC [10] the mission on Climate Neutral and Smart Cities will help meet the goals and targets set out by international policy frameworks such as the COP21 Paris Agreement, the UN's Sustainable Development Goals (SDG11), the Urban Agenda for the EU and the Habitat III New Urban Agenda, as cities play a key role in all of them. The main goal is reaching 100 climate-neutral cities by 2030, promote and showcase 100 European cities in their systemic transformation towards climate neutrality by 2030. To support these ambitious targets the research and innovation funding programme, Horizon Europe (HE) launched several calls, one of which is the Research and Innovation actions to support the implementation of the Climate-Neutral and Smart Cities Mission (HORIZON-MISS-2021-CIT-02). In this context, the authors of this study intend to share the firsts results from a research project funded by HE within the referred call, Climate-Neutral and Smart Cities Mission, focusing on the urban planning and design for sustainable, resilient and climate-neutral cities by 2030.

1.2 Re-Value project

The main goal of Re-Value project is to test, capture and share how to create value through urban quality in a holistic approach towards climate neutrality. The project started in 2023 and will develop the research activities for a period of 4 years. 9 cities take part of this project, 4 of them represent the Leading Cities (Aalesund, Bruges, Burgas, Rimini) and they will demonstrate, full-scale, how integrated urban planning and design can be optimally developed to achieve climate neutrality and significantly reduce GHG emissions by 2030. The other 5 cities represent Replication (or following) Cities (Cascais, Constanta, Izmir, Pisek and Rijeka), and will learn, replicate and develop their own participatory story-building, data-driven scenarios and financial and partnership models on integrated urban planning and design to accelerate the path towards climate neutrality. In addition, these Cities will deliver Detailed Roadmaps for their Waterfront Pilots and update their long-term Territorial Transformation Plans aiming to reach climate neutrality by latest 2050. The main objectives of the project consist of (i) proposing, developing and testing a multi-modal impact model for value-based urban design and planning in the 9 participating cities, (ii) implementing Re-Value solutions and actions in the 4 Leading cities, replicating actions in the 5 Replication cities, together with (iii) roadmaps for implementation and replication respectively, (iv) monitoring activities, (v) implementing and consolidating a community of practice between the partners and stakeholders, and (vi) disseminating the results of the project. The methodology of the project is driven by 6 Systemic Challenges (SC) along wit0h 3 Innovation Cycles (IC) as is illustrated in Figure 1. The 6 SC, namely SC1 - Changes in governance, regulatory structures, advocacy, SC2 - Cultural and spatial quality, SC3 - Data-driven co-creation and Digital Twins, SC4 - Financial and circular value chains, SC5 - Energy and mobility and SC6 - Nature-based solutions, will help the 9 cities to implement and replicate a portfolio of solutions. Building with the support of a Community of Practice, Re-Value follows an approach to capture the added value and co-benefits to the stakeholders through an Impact Model, to be then used as basis for the Innovation Cycles, namely: (i) IC1 - The story-building cycle to foster ownership by the community and to ensure implementation of the measures, (ii) IC2 - The scenario-building cycle to establish data-driven strategies to support urban planning and design, and (iii) IC3 - The investment and partnership building cycle to feed into the detailed roadmap of the Waterfront Pilot.

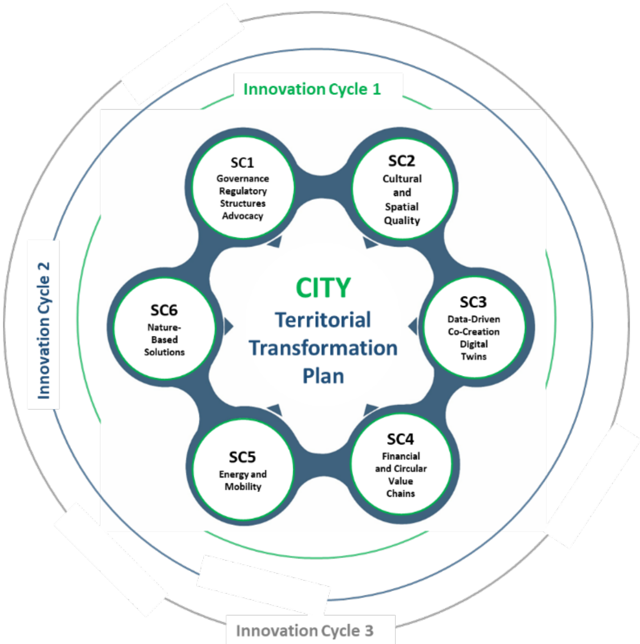

Figure 1. Re-Value approach

1.3 Objectives of the study and structure

This paper presents the initial work developed in the scope of Re-Value project, focusing on the replication city Cascais, located on the Coast of Portugal. One of the main outcomes of the project in Cascais city is the development of a Detailed Roadmap aligned with the Re-Value Impact Model and the EU Cities Mission based on feasibility studies with co-benefits and of climate neutrality and urban quality, viable investment and partnership models, a strong and widely supported story, and a well-established support base for co-creation with local citizens and professional stakeholders. The second major outcome is the long-term Territorial Transformation Plans, based on the Impact Model and the experiences along the project.

The present study intends to share the results of the first phase development of the roadmap, focusing in two main aspects: (i) the characterization of the Renewable Energy (RE) potential (solar, wind and waves) using a spatial analysis and (ii) preliminary results of the evolution scenarios related with Energy Consumption in several sectors (buildings, industry and transport) and subsequent GHG.

The study is structured in 4 main sections starting with the introduction, the methodology for the roadmap development is presented in section 2, followed by the preliminary results for the Cascais city roadmap presented in section 3. The study ending with the conclusions in section 4.

2. Methodology for the development of Cascais' Roadmap on Climate adaptation

The rationale of the Re-Value project is to demonstrate how climate neutrality and urban quality can be aligned, by re-valuing their connection to the waterfront, strengthening co-benefits and mitigating potential adverse impacts - in summary, making their urban transition irresistible for citizens and professional stakeholders. The ultimate goal in the context of this project is the development of a long-term Territorial Transformation Plan (TTP) and to develop participatory story-building, data-driven scenarios and financial and partnership models on integrated urban planning and design to accelerate its journey to climate neutrality. Although the city of Cascais has climate mitigation actions planned under the 2050 Carbon Neutrality Municipal Roadmap and Cascais Sustainable Energy Strategy, the project and the Re-Value roadmap for Cascais will therefore contribute to redesigning Cascais' ambition for carbon neutrality to make it more integrated, cooperative, and active, allowing to transcend traditional accounting and helping to invest with more value and lower risk, especially in the coastal zones.
Firstly, an analysis and identification of the coastal pilot zones has been made and these pilot coastal zones are described in the following sub-section.

2.1 Cascais Waterfront Replication City Description of the Pilots

The city of Cascais, currently with around 214,124 inhabitants, is composed of different urban centres along the coast characterised by a continuous urban line. The city has a comprehensive sustainability and climate action policy, confirmed, among others, by its PAES Cascais 2030, Local Sustainable Energy Plan and Expression of Interest for the Cities Mission and Municipal roadmap for carbon neutrality by 2050. In its waterfront pilot project, Cascais intends to test participatory interventions for nature-based solutions on natural and urban spaces to improve resilience and biodiversity and increase accessibility through the development of cycling lanes, pedestrian walks and active mobility. In the energy sector, the city intends to boost the production of renewable energy as well as promote the development of local energy communities in vulnerable areas, in cooperation with local residents' associations, schools, art and culture organizations, beach concessions, surf schools and associations, user groups (sport) and environmental associations. In its 2019 Roadmap for carbon neutrality, Cascais had already identified that electrification should contribute significantly to its decarbonization. Electricity produced from renewable energy sources (RES) has low/none GHG emissions and therefore contributes to this goal in the three sectors that will be studied, namely in buildings, industry and mostly in the transportation sector. For that purpose, the development and installation of RES is encouraged. The city will start by focusing on photovoltaic systems, namely on rooftops and Building Integrated Photovoltaics (BIPV), because it is easier and faster to install, but will also investigate the urban integration of small wind turbines and harnessing wave energy along the coast. In this project, Cascais has proposed three pilots along the coast of the municipality – Carcavelos Beach, Guia coast and Ribeira das Vinhas stream. Figure 2 shows the location of the three pilots.

Figure 2. Cascais's pilots' location

Pilot 1 - Carcavelos beach (Figure 3) is one of the most popular beaches of the outskirts of Lisbon, Carcavelos is extensively used during the whole year (incl. surf destination) with higher demand in the summer period (over 20 000 daily users). **Pilot 2 - Guia Coast** (Figure 4) starts close to Cascais city centre and extends for approximately 3 km of seaside cliffs. This coast is followed by a road and an extensive cycling and walking lane with a high demand during the whole year. Along this coastline there are numerous cultural and natural attractions such as "Boca do Inferno" rock formation and "Casa da Guia" commercial set, where there is a strong presence of high demand restaurants and terraces. The green corridor of **Pilot 3 - Ribeira das Vinhas** (Figure 5) was subjected to naturalization in over 8 km around the stream in order to reduce flood risk and heat island effect, while providing a valuable trail for recreation and sustainable commuting for over 35 000 citizens. Ribeira das Vinhas cycle lane provides therefore an easy access to the city centre promoting active mobility from densely populated zones while contributing to climate resilience.

Figure 3. Pilot 1 - Carcavelos Beach

Figure 4. Pilot 2 - Guia Coast

Figure 5. Pilot 3 - Ribeira das Vinhas Stream

2.2 Roadmap first phase development

The objective of the roadmap in this first stage was to describe the 3 pilots, collect georeferenced data and other relevant data, compile the plans and laws that apply to them and relate that information with the 6 systemic challenges that are to be tackled in this project. The 2 systemic challenges firstly analysed were SC3 - Data Driven Co-Creation and Digital Twins and SC5 - Energy and Mobility, which led to two main steps of the development: (i) the characterization of the renewable energy potential based on local resources in the city of Cascais and (ii) the preliminary simulation of evolution scenarios for energy consumption and GHG emissions in some sectors. The information used in the development of the roadmap for the city of Cascais is based on the Municipality georeferenced database, and on public information related with the different themes (layers) relevant for the establishment of the long-term

Territorial Transformation Plan to be implemented towards climate neutrality in this region. All the information is processed and introduced in a Geographical Information System, where the adequate procedures are implemented (e.g. georeferencing, map algebra, SQL conditions, among others).

2.2.1 Characterization of the Renewable Energy Potential – Spatial Analysis

Aiming to increase the use of renewable energy in Cascais Municipality to meet the carbon neutrality objectives in 2050, an assessment of the renewable potential was performed in order to understand the contribution that the different renewable sources could give to the energy goals of the city, through the use of small wind turbines, wave energy converters, and especially, photovoltaic systems. Therefore, the wind and solar resource assessment was mapped for the whole city, and for the wave energy in Cascais coastline. The 3 following methods have been used to characterize the available renewable energy sources.

Wind resource assessment. The methodology used in creating the wind energy potential map is based on the generation of a digital terrain model which includes the terrain and the existing buildings, thus representing an urban digital terrain model: U-DTM. The urban DTM can be treated as a very complex terrain and be used as input for a standard wind resource assessment model (e.g. Wasp). This methodology strongly reduces the computational costs associated with standard CFD (Computational Fluid Dynamic) models to simulate groups of buildings; it simplifies the geometry of the urban mesh and allows to extend the area of simulation to a city scale. The obtained results are then validated with experimental data obtained in two locations of the Cascais municipality – Lidar sensor installed on the rooftop of Pedra do Sal's environmental interpretation Building in Estoril (data used is referred to the period June 2012 to May 2013 with inter-annual correction of the horizontal mean wind speed values) and one anemometric station installed at Tires' aerodrome, in São Domingos de Rana (period between 2009 and 2012 of measurements). More details on the procedures and results can be consulted in Simoes et al [11].

Solar resource assessment. The average yearly Global Horizontal Irradiation (GHI) at ground level and in rooftops was assessed for Cascais municipality considering the terrain's slope and the buildings' shape and height by also using a U-DTM, equivalent to the one described for the wind speed assessment, and solar analysis tools in GIS software. The GIS solar radiation analysis tools calculate insolation across a landscape, based on methods from the hemispherical viewshed algorithm developed by Rich et al. [12] and further developed by Fu and Rich [13]. The total amount of irradiation calculated for a particular location or area is given as global irradiation. The calculation of direct, diffuse, and global irradiation is repeated for every location on the topographic surface, producing irradiation maps for an entire geographic area.

Wave energy. The energy contained in a sea state can be described from its directional spectrum of frequency and wave propagation direction, Mendes et al [14]. The spectra used here was obtained for a Mar3G (Ondatlas) sea wave model [15], applied in this case to four locations (Cabo Raso, Guia, Cascais, Parede) in the municipality of Cascais, that are shown in section 3.1, Figure 10.

Based on a set of spectra representative of the waves at these four points, it was possible to determine the power density of the waves and their average direction for each of these points (and for each wave spectrum observed at the site) considering the Mendes et al [14] approach. Scatter plots of the power density as a function of the average power direction were determined, which led to the bivariate probability distribution. The bivariate tables were divided into 30º sectors with the commonly used denomination (e.g. North-North-North-East, N-NNE), and power classes that are not equally spaced, their interval increasing with the value of the power density, as will be seen in the radial graphs of section 3.1. Corresponding to the direction from West to East, Cabo Raso is the most Western location and Parede is the most Eastern one.

2.2.2 Simulation scenarios towards climate neutrality Roadmap

Another step in the construction of the local roadmap towards climate neutrality is the assessment of a mitigation solution portfolio, based on different development scenarios. For this analysis, a simplified simulation tool [165] being developed at LNEG was used. This decision support tool, (DST) aids municipalities in designing their decarbonisation roadmaps and has 3 main components, as illustrated in Figure 6. Each of the 3 simulators has specific objectives and roles as follows:

(i) Scenarios' simulator that enables to design in an interactive way socio-economic scenarios for different sector' variables that inform local decarbonisation trends, developed using Excel ©.

(ii) Mitigation simulator, that enables to translate those scenarios in GHG emissions, considering the identification and prioritisation of mitigation options (technological and behavioral changes) tailored to the Portuguese municipalities' reality, being developed using Excel ©.

(iii) Mapping simulator that enables the mapping of the "hot spots" of GHG emissions at a local scale, being developed using ArcGIS ©.

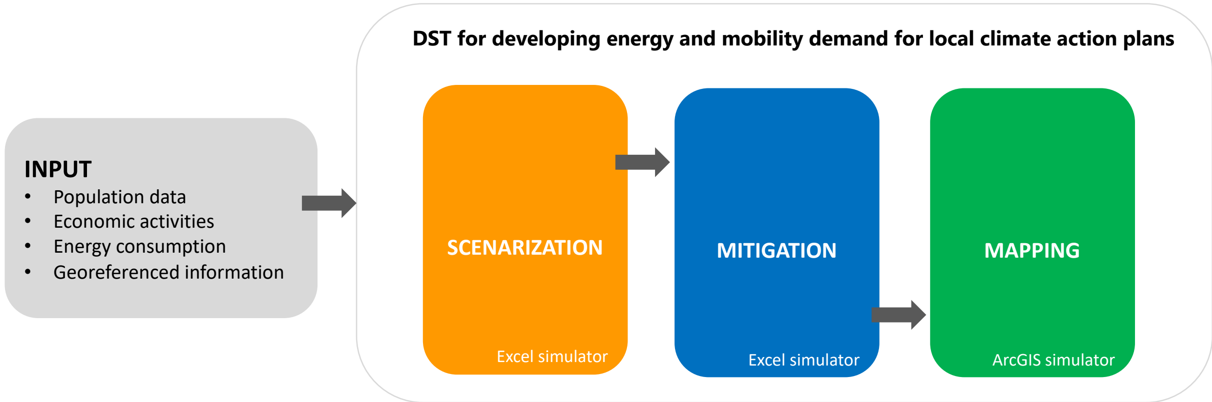

Figure 6. Decision-Support Tool for developing energy and mobility demand for local climate action plans

The tool is under development and the first simulator related with the scenarios' design is operational and has been used in this study. The architecture behind the scenarios' simulator is illustrated in Figure 7. This simulator enables to draw evolution trends and scenarios representing socio-economic and other variables' evolution and will allow to test the impact of different pre-established assumptions for the evolution of those variables in several areas from the water and wastewater management to energy supply and demand, and consequently the respective GHG emissions.

The main variables considered in this study were, population, number of households, and energy consumption in residential, commercial and services buildings, industry, transport and the GHG emissions on these last four sectors. The general methodology for the establishment of the development scenarios is described in Figure 7.

The first step is the selection of a reference year, that will be used as baseline scenario for the whole study, and the characterization of the current situation in terms of energy consumption and equivalent CO_2 emissions. The second step is the simulation of the future scenarios that will depart from the baseline characterization data, and other inputs related with the city itself, such as population data, economic activities evolution and geographical data.

The simulation scenarios are then designed according to different sectors, namely for buildings, industry and transports, and the energy consumption evolution is obtained for each one of them. Finally, the outputs will then be used by the mitigation simulator for the definition of a set of measures related to technological, environmental and socio-economic impacts to be included in the final version of the roadmap.

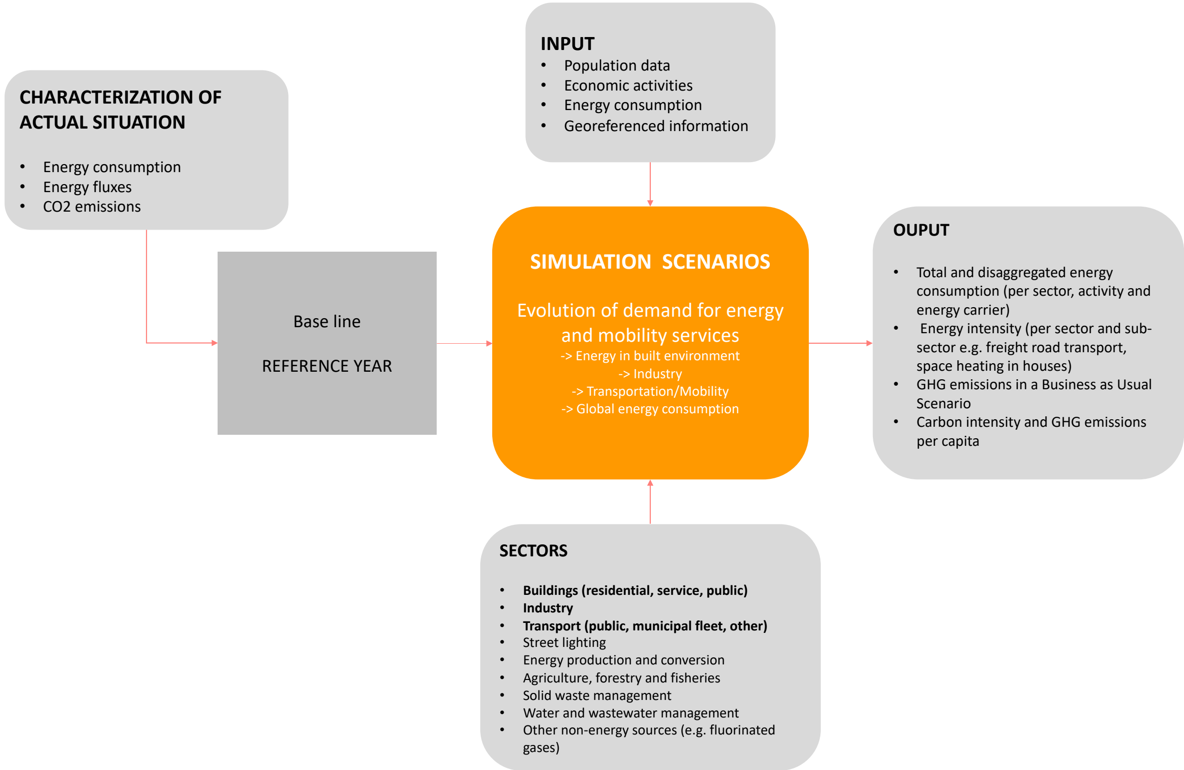

Figure 7. Scenarios' simulator

3. Preliminary results for Cascais Roadmap phase 1 results

3.1 Characterization of the Renewable Potential in Cascais City – Spatial Analysis of the Renewable Resource

Taking into account the methodology used for the characterization of the RE sources that was described in section 2, the following 3 maps were produced. Map 1shows the average wind speed at a height of 10 m above the buildings for Cascais municipality (Figure 8), were the highest wind speed obtained is 8 m/s and the lowest 3.6 m/s.

This lowest velocity is approximately the cut-in velocity for most small wind turbines, and that is the wind velocity at which the turbine starts generating electricity. Map 2 shows the solar resource considering the terrain altimetry and the buildings' influence (Figure 9). The highest values correspond to a yearly GHI of 1422 kWh/m^2 (dark orange) and the lowest values to 783 kWh/m^2 (light green). To evaluate the wave energy potential along Cascais' coast, data was collected for 4 locations that are shown in Map 3 (Figure 10).

The depth along the coast was also considered and is depicted in the green isobatimetry lines for 8, 16 and 30 m of depth, were the influence of the mouth of Tagus River can easily be seen.

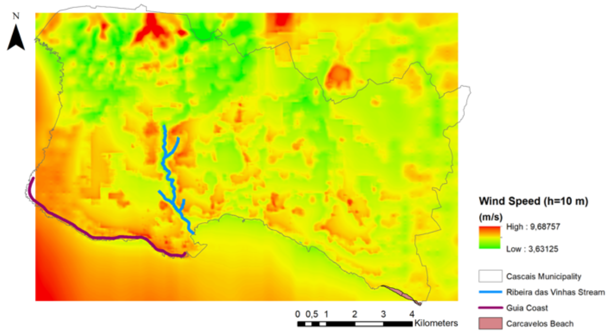

Figure 8. Map 1 - Cascais' average wind speed at a height of 10 m above the buildings

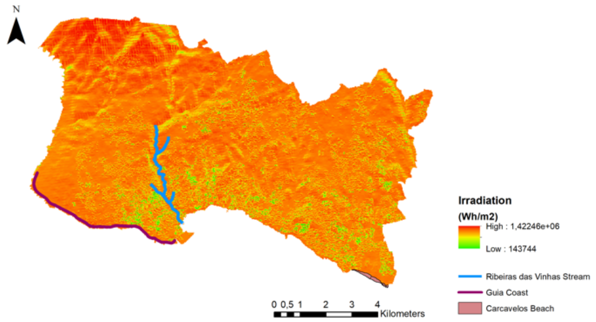

Figure 9. Map 2 - Cascais' average yearly GHI considering the terrain altimetry and the buildings' influence

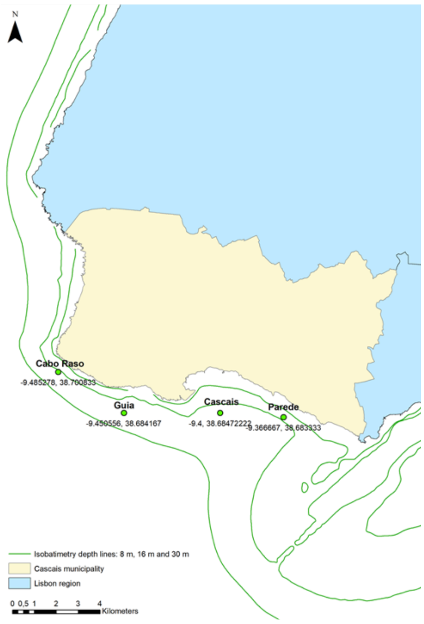

Figure 10. Map 3 - Cascais' coast wave energy potential assessment locations

The average annual power density for the wave energy at each location was obtained using the bivariate probability density function of power density and power direction, leading to a value of 26 kW/m for Cabo Raso, 19 kW/m for Guia, 26 kW/m for Cascais and 15 kW/m for Parede. The radial graphs corresponding to the 4 locations are show in Figures 11 to 14.

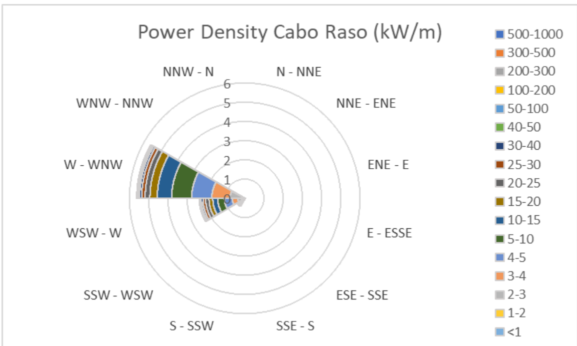

Figure 11. Wave power density at Cabo Raso

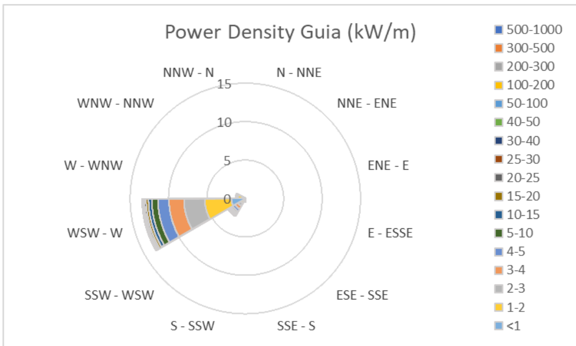

Figure 12. Wave power density at Guia

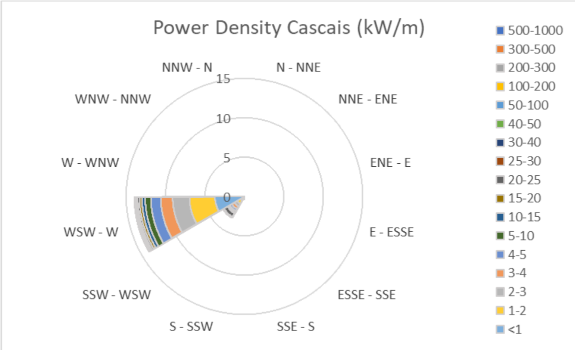

Figure 13. Wave power density at Cascais

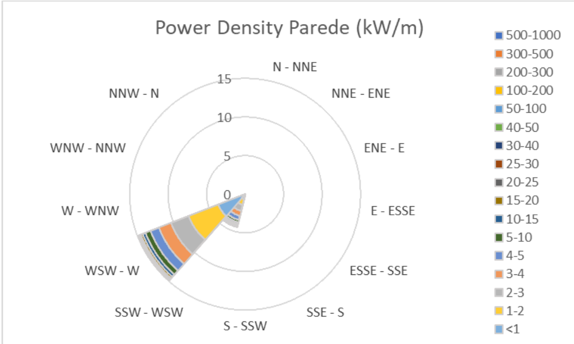

Figure 14. Wave power density at Parede

3.2 Scenarios of Energy Consumption in Several Sectors and GHG Emissions

The scenarios' simulator has been used and three different scenarios are studied. A reference scenario aims to reflect an "average" year representative of the current situation of the municipality and is denominated as **"Business as Usual" (BAU)**. For this purpose, the year 2019 was selected, the most recent year with completed information that was not affected by the pandemic situation experienced in 2020/21. The two other scenarios are the **"High Development"** scenario were the increase of population, investment and usage of innovative technologies is considered, and **"Recession"** scenario where there is a decrease in population, investment and the continued use of outdated technologies.

The 2 first scenarios were chosen because the goals established in the first roadmap for 2050 developed for Cascais, foresee a BAU and a "High Development" scenario. But in this case, and especially motivated by the current global economic crisis that the majority of the countries all over the world are experiencing, it was decided to add a "Recession" scenario, especially relevant in the energy sector, that would allow to consider a slight decrease to the values of some of the simulated parameters, particularly to the CO_2 emissions reduction, because Cascais' best predictions regarding this aspect, are a reduction of about 94% of equivalent CO_2 emissions for the "High Development" scenario when compared to BAU scenario in 2050.

For the future scenarios, the years 2020, 2030, 2040 and 2050 are considered regarding the evolution of the sector's energy consumption in the municipality and subsequent CO_2 emissions. Based on the information available from 2011 to 2021 in the Portuguese databases of the National Statistics Institute (INE), the General Directorate for Energy and Geology (DGEG), PORDATA platform, and the Cascais Roadmap for 2050, the different scenarios were built for the energy sector and transports. The following graphs show the different variables that were analysed, Gross Domestic Product (GDP) per capita, population, inhabited residential buildings, electricity consumption per capita, and energy consumption for the sectors mentioned in section 2.2.2.

3.2.1 Socio-Economic Evolution in Cascais Municipality

For the GDP, the population evolution, the inhabited residential buildings and the electricity consumption, the information from previous years was considered to extrapolate for the future. In the "High Development" scenario for GDP a yearly increase from 2% to 4% was considered (with a decrease of 1% between 2019 and 2020 due to COVID pandemic), and as for the population, the increase was from 2% to 6% (with the same population numbers between 2019 and 2020). For the "Recession" scenario, GDP decreased yearly from 1% to 4% and the population from 1% to 2.5%, as shown in Figures 15 and 16. Considering the inhabited residential buildings, the increase in "High Development" was from 1% to 2.5% and the decrease in "Recession" was from 0.5% to 1.3%, Figure 17. The electricity consumption has been growing steadily in the last few years so increase percentages were considered for both "High Development" and "Recession" scenarios, respectively, 3% to 6% and 1.5% to 2%, Figure 18.

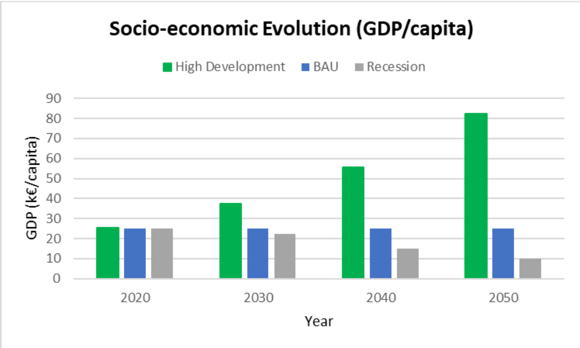

Figure 15. Socio-Economic Evolution

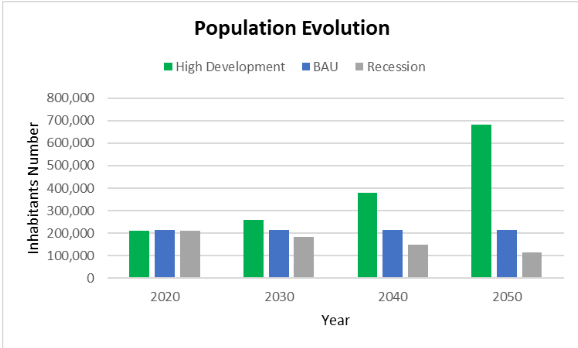

Figure 16. Population Evolution

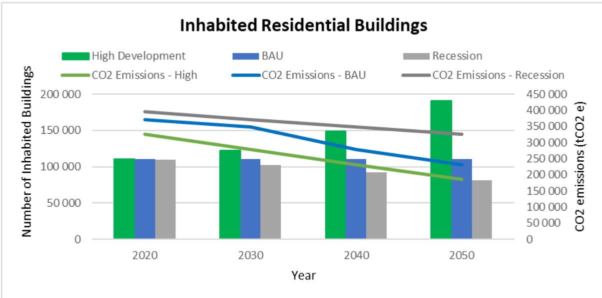

Figure 17. Inhabited Residential Buildings Evolution

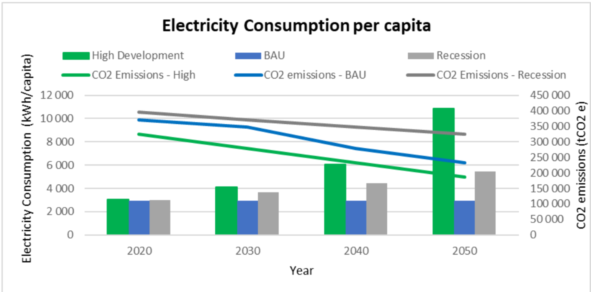

Figure 18. Electricity Consumption Evolution

3.2.2 Energy Consumption and CO_2 Emission Evolution in Cascais Municipality

The consumption per sector is affected by the above variables and its evolution is depicted in Figures 19 to 22. It is also important to compare the evolution scenarios with the CO_2 equivalent emissions, so the graphs show this information as well. As can be seen, the trend is always a decrease in emissions irrespective of which scenario is being considered, although, as expected, the emissions' decrease is higher in the "High Development". The increasing percentage of renewables in the electricity energy mix, the increase of Electrical Vehicles (EV) usage, energy efficiency in buildings and in equipment, the penalties that will have to be paid for extra emissions, the international pacts that have been signed, the raising consciousness of the population, etc, create a large pressure for decarbonization. It is also noticeable that the greatest potential for reduction lies in the residential buildings and transport sectors.

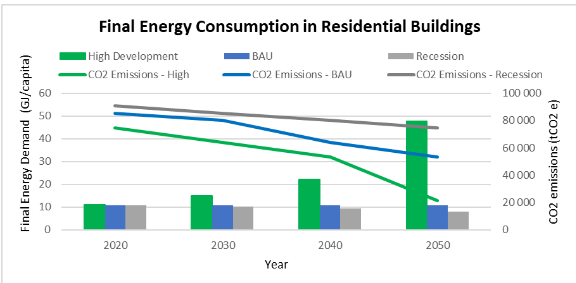

Figure 19. Residential Buildings' Final Energy Consumption

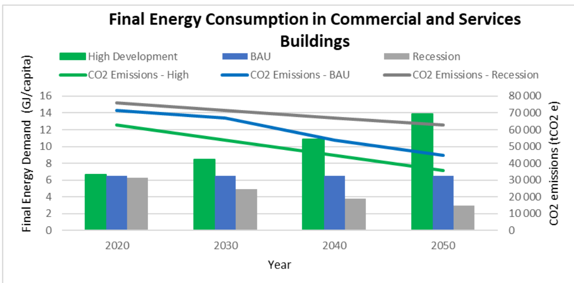

Figure 20. Commercial and Services Buildings' Final Energy Consumption

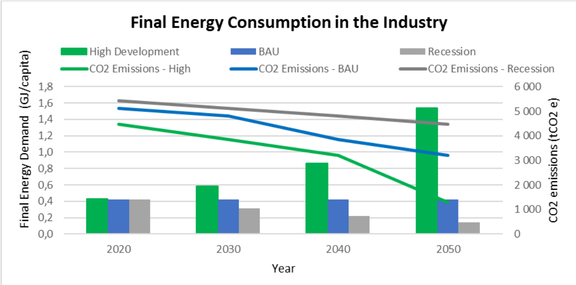

Figure 21. Industry Final Energy Consumption

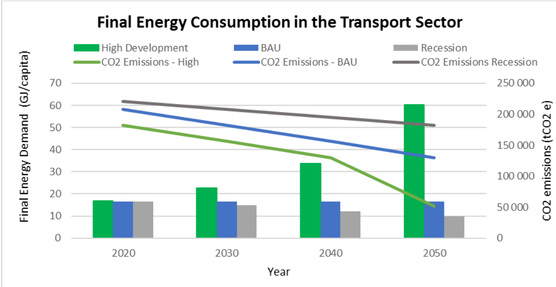

Figure 22. Transport Sector Final Energy Consumption

4. Conclusion and future work

This paper presents the preliminary work developed so far in the scope of the Re-Value project focussing on the implementation of the project's objectives in one coastal city located in Portugal - Cascais. The main highlights go to the strategic goals of this follower waterfront city, its RE potential assessment and the first outcomes from a dedicated tool that was used to analyze the development scenarios in the Energy and Transport sectors. The DST tool outputs have shown that the greatest potential for reduction in equivalent CO_2 emissions within the municipality can be found in residential buildings and transport sectors. This will allow the municipality to implement priority mitigation measures focused in these sectors, like the improvement of the energy efficiency in buildings, starting with municipal buildings, disseminate information about how citizens can have access to funds for the improvement of their houses' energy performance, facilitate the use of public transport (the city already has 44 municipal bus lines that are free for city inhabitants, workers or students) and alternative means of transport, other than a private vehicle, give incentives to EV users, like free parking in certain city areas, etc.

According to the results obtained in this phase of the project, it is possible to conclude that the city (and the whole municipality) is characterized by a high renewable potential, especially for the development of solar PV projects. In terms of the pilots' location, and when looking in detail to what was proposed in the scope of this project, the use of renewable energy systems for the electrification of the majority of the activities, has a large potential in the pilot areas, some possibilities are the installation of PV car parking shading systems with charging stations for electrical vehicles in Carcavelos beach and Guia coast, PV charging stations for electrical bicycles in Ribeira das Vinhas cycle lane. The expansion of these strategies to other areas beyond these pilots should also be considered.

As future work, the transport sector will be analyzed in more detail, especially the existing structures for light mobility, the modal platforms that allow the flexibility to change between different means of transportation, the available parking spaces outside the city centre, the municipality fleet, etc. Step by step, all 6 SC will be analyzed within this project.

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