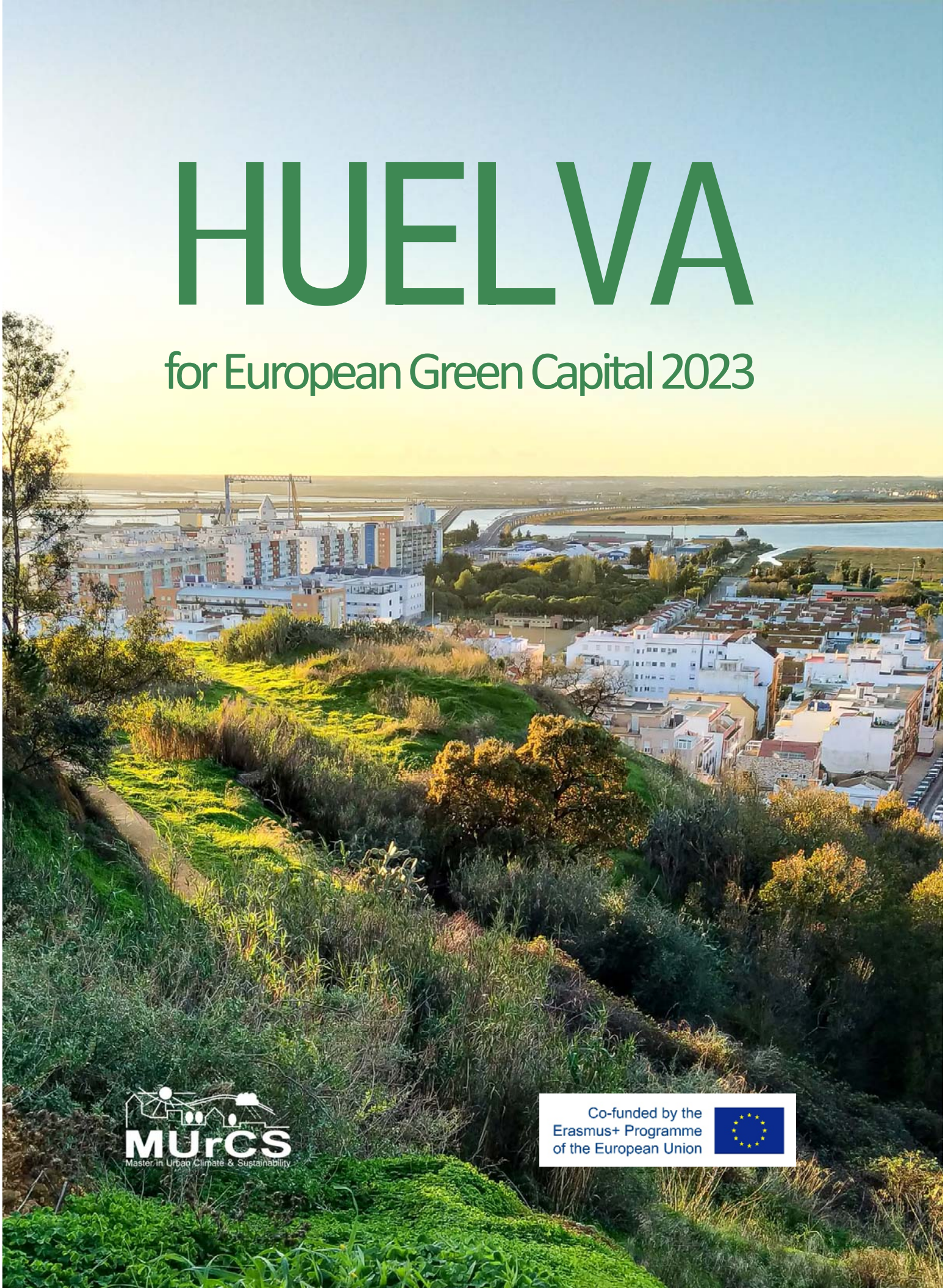
HUELVA

for European Green Capital 2023



MUrCS
Master in Urban Climate & Sustainability

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HUELVA FOR EUROPEAN GREEN CAPITAL 2023

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Preface

The MUrCS2020 Class was asked to develop a think-piece that could support a potential bid for "European Green Capital Award (EGCA) 2023" award by the Ayuntamiento de Huelva (Municipality of Huelva), in Andalucia, Spain.

The task focused on five key areas where environmental improvements could enhance the city's green credentials:

- Energy;
- Green/Open space;
- Housing
- Transport;
- Urban climate (including air quality) amelioration;

Based on background information pertaining to these sectors, students identified problems, challenges and opportunities available for change. Next, an exercise using forecasting/backcasting techniques was used to develop scenarios (WHAT change is needed in each of the chosen sectors in the mid- and long-term); identified desired end point (incremental or radical), capture stakeholder views (engagement, where possible), and finally, present how change management could be achieved (societal change, and importantly how to change minds of urban professionals and politicians) and address the management processes needed to effect the desired change (including resources, political will, etc.)

While each group focussed on specific issues, challenges and opportunities of its chosen sector, all groups based their proposals on the principles of **CIRCULAR ECONOMY**, while being mindful of the challenges posed by **CLIMATE CHANGE** and reflective of the likely realities of cities **POST COVID-19**.

The present volume brings together five thematic write-ups focusing on the identified sectors as above, outlining issues, scenarios and end goals to envision the desired change and the management processes needed to achieve them.

Short Powerpoint presentations to summarise the vision, action plan and the desired change in the form of a 'pitch' to convince the City Authorities are available upon request.

While the purpose of this exercise is to act as an integrative piece of learning to bring together the three thematic strands of the 'MUrCS approach' (**science** of climate change with nature-based solutions as the approach to its mitigation, with circular economy as the driver for urban **planning**, with sustainability leadership as the **management** goal) it is hoped the present volume could provide a useful roadmap for cities such as Huelva, Spain, to develop their own environmental improvement plans in the face of climate change.

The MUrCS Team:
Prof. Rohinton Emmanuel, Project Coordinator, Glasgow Caledonian University (GCU), UK
Dr Eeeva Aarrevarra, LAB University of Applied Sciences (LAB), Finland
Dr José Antonio Dueñas Diaz, University of Huelva UHU), Spain
Dr Craig Thomson, GCU, UK
Dr Caroline Gallgher, GCU., UK

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Prepared by:

Melis Suher

Oksana Ananyeva

Anna Mackenzie

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Introduction

Energy sector is a global driver of progress as the world needs energy to sustain its economic activities, social progress, and overall well-being. Meeting the growing energy demand while ensuring safety for the people and environment along with responsible use of resource is the major challenge for all countries. European energy policy is intrinsically tied to the alarming problem of climate change. As hydrocarbons still dominate in the energy mix of many countries, energy-related policies targeted at sector transformation remain the high priority issue within the European Union (EU).

Spain is the six-largest energy consumer in Europe and a host country of numerous renewable energy projects. The energy and climate framework of Spain is determined by EU. In 2020 country has published a National Integrated Energy and Climate Plan 2021-2030 (NECP) and announced an ambitious goal to phase out fossils by 2050. Energy transition requires actions from different levels of governance and active engagement of local administrations can facilitate the progress.

Huelva, as one of the 20 Andalucian cities that was analyzed by REDS (Spanish Network for Sustainable Development) in the context of UN's Sustainable Development Goals, has shown great potential to fulfil the targets. In this regard, taking sustainable development goal a step further, this report focuses on the city as a promising candidate for becoming a European Green capital and proposes the Action Plan for the energy sector transformation.

1. Spain: Energy Country Profile

1.1 Overview of Energy Sector in Spain

Spain is the six-largest energy consumer in Europe, after Germany, France, United Kingdom, Italy, and Turkey (Statistica, 2020). Country is known as the world's leader in renewable energies, both as energy producer and as technology exporter. Spain's renewable energy mix includes hydro, wind, solar, biogas, and other sources (biomass, marine-hydro, wind-hydro, waste, geothermal). Country ranks No. 2 in Europe in installed wind energy capacity (26 GW). In 2018, the renewable energy sector contributed 10,521 million EUR to the national gross domestic product (GDP), which is equal to 0.87% of GDP. Furthermore, in 2019, 49.3% of total electricity generation has been obtained from renewables (RED Electrica de Espania, 2020). Despite of the success in renewables deployment, overall Spanish energy sector has several problems related to energy security, grid interconnection and energy efficiency.

In 2020, country announced closure of its all coal-fired thermal stations and replacement by combined-cycle plants fuelled by natural gas. As Spain does not have its own hydrocarbon resources, national energy dependence rate remains high for already more than a decade: 81.4% in 2005 and 73.2 in 2018 (Figure 1).

International interconnections allow energy to be exchanged between neighbouring countries and are a prerequisite of the Internal Energy Market. Spain's electrical system is connected to Portuguese, North Africa, and central Europe. Currently, the interconnection ratio is 5%, which is far below the recommended goal of 15% by 2030 (Figure 2).

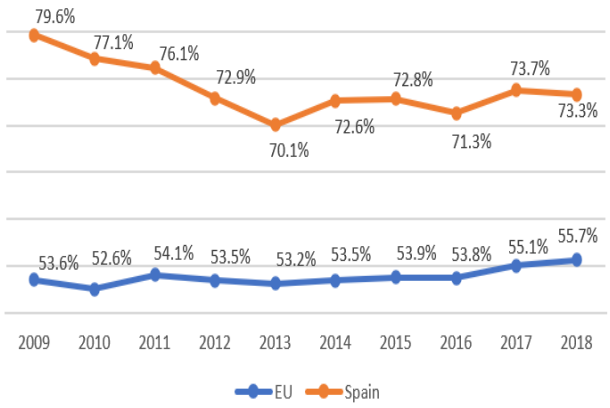

Figure 1 - Energy dependance in 2009-2018, Spain vs EU

Source: based on Eurostat data

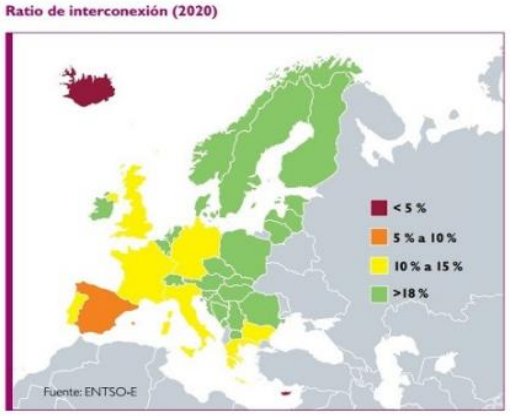

Figure 2 - Electricity systems interconnection ratio, 2020

Source: RED Electrica de Espania

According to a study carried out by EuroACE, the alliance of companies for energy efficiency in buildings, 84% of Spanish buildings are energy inefficient (Figure 3) and do not take advantages offered by renewable energy (EuroACE, 2017). This gives the rise to the fuel poverty problem as around 11% of

Spanish homeowners cannot afford proper heating during winter. Regulatory and financial barriers along with lack of support from energy companies slow down development of local energy efficiency projects.

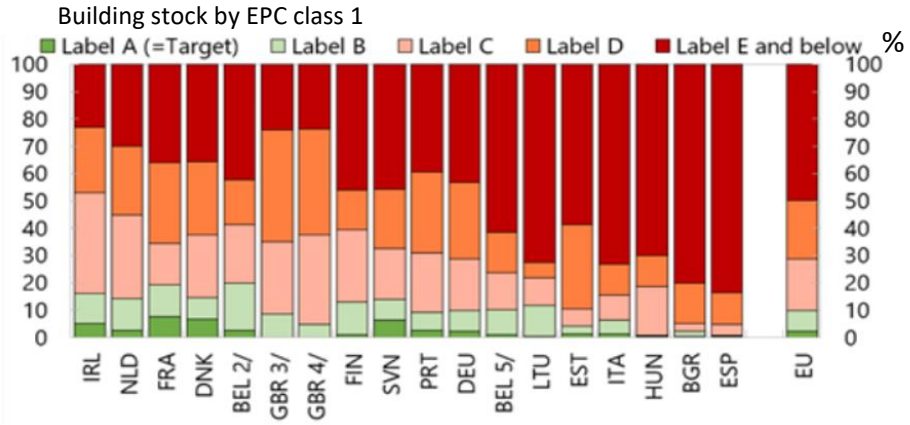

Figure 3 - Energy efficiency of building stock, Spain vs EU countries

Source: (Government of Spain, 2017)

1.2 National Energy Consumption Trends

During last decades, primary energy consumption in Spain has become more diversified due to the rising progress in renewable energy technologies (RET). Figure 4 shows evolution of primary energy consumption (ktoe) by fuel sources in 1990-2018.

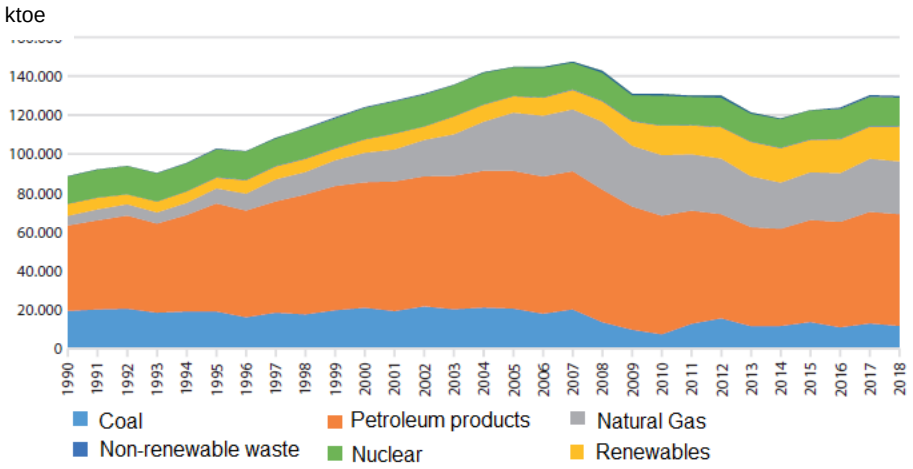

Figure 4 - Evolution of Primary Energy Consumption by Sources in Spain, 1990-2018

Source: (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020)

It is remarkable that primary energy consumption trends highly correlate with the economic fluctuations of 2007-2008 and 2014. From 2015 and onwards there was a growing demand in energy, which led to the rise of the share of renewable energy. As a result of the economic downturn due to COVID-19 health crisis,

the energy sector has faced the decrease in energy demand, especially coming from fossils, though, simultaneously, this might create a potential for the new wave of renewable energy generation. APPENDIX A contains the data on the Spanish primary and final energy consumption in 1990-2018.

Figure 5 shows the simplified Sankey diagram of the Spanish energy structure in 2018. In total, around 129.8 ktoe of primary energy was consumed resulting into 92.1 ktoe of the final direct energy and non-energy uses by transport, industry, and other sectors.

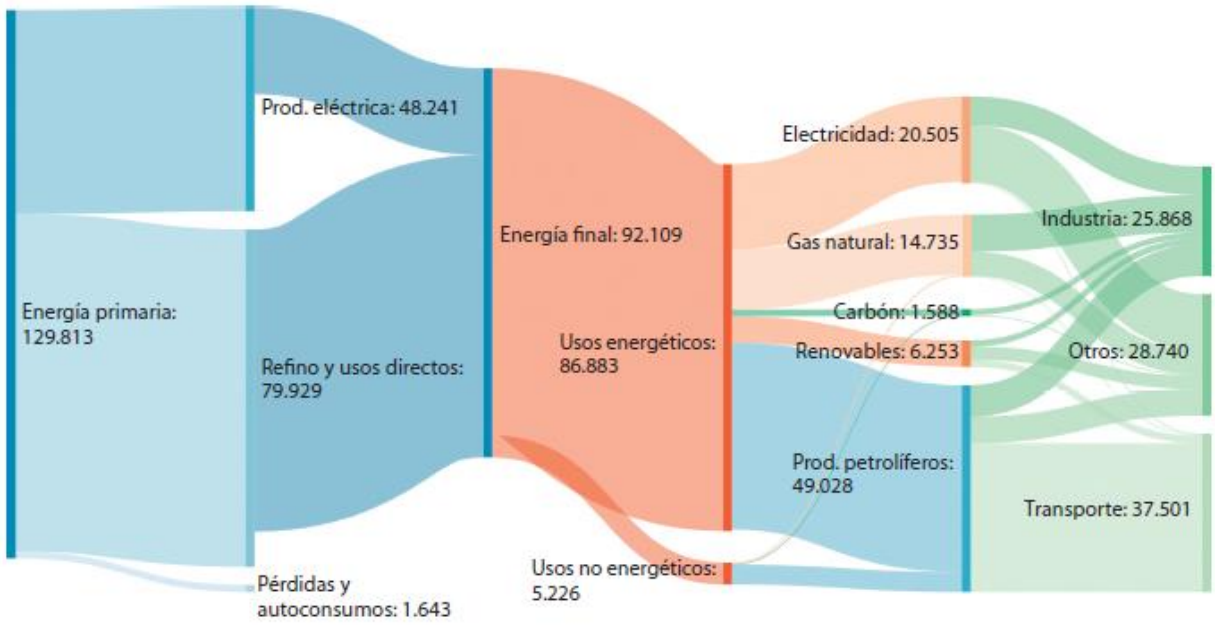

Figure 5 - Sankey diagram of the Spanish energy structure in 2018 (numbers in ktoe)

Source: (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020)

In 2018 national primary energy consumption was predominantly composed of fossil fuels with the largest share attributed to petroleum (44.3%) and natural gas (20.9%) (Figure 6). The rest accounted for nuclear (11.2%), renewable sources (13.8%) and coal (8.9%).

Overall, in 2018 the contribution of the fossil fuels into electricity mix has decreased, due to the rise of hydraulic production, increase in consumption of biofuels and deployment of solar and wind energy. The share of renewable energy has increased by 8.8% against 2017 (Table A.1 in APPENDIX A).

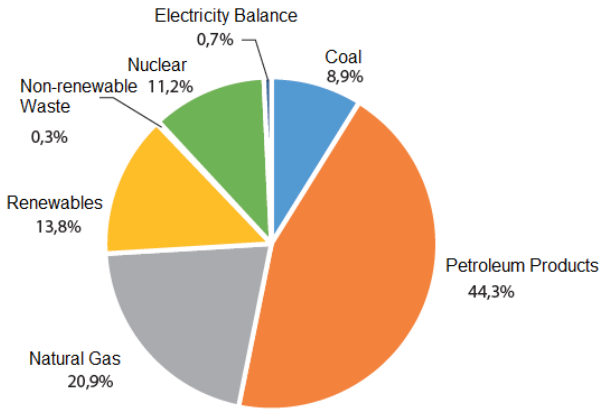

Figure 6 - Primary energy consumption in Spain by energy sources, 2018

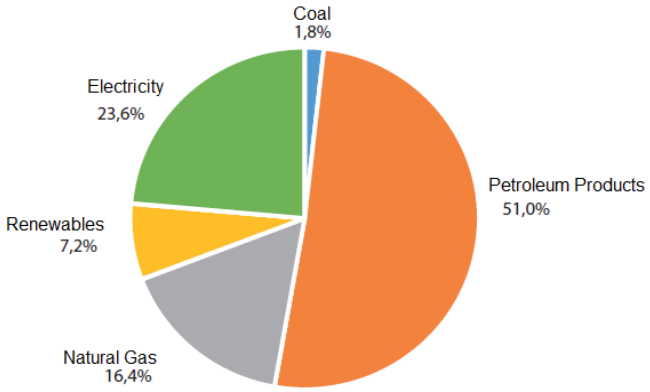

Figure 7- Final energy consumption in Spain by energy sources, 2018

Source: (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020)

Final energy consumption increased by 2.5% in 2018 vs previous year, to a total of 92,102 ktoe (Table A.2 in APPENDIX A). By energy sources, excluding non-energy uses, the highest consumption was observed for the petroleum products (51%) and electricity (23.6%) followed by natural gas (16.4%) (Figure 7).

Evolution of the final energy demand represents the pattern similar to primary energy consumption (Figure 8). Observed 2.3% increase was attributed to the rise in demand for petroleum and natural gas (67.5 of total energy demand). In respect to sectoral distribution, transport (43%) was the primary energy consumer, followed by industry (24%) and households (17,1%).

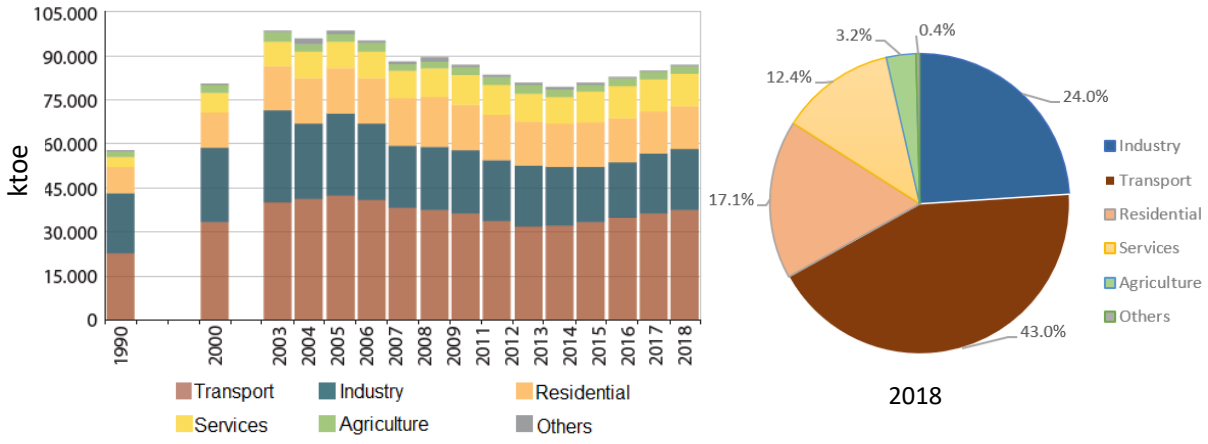

Figure 8 - Final energy consumption by sectors in Spain, 1990-2018

Source: (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020)

2. Analysis of Huelva Municipality Energy Sector

2.1 Huelva City Location and Overview

Huelva municipality, capital of the Huelva province, is located in the southwest of Spain, on the Gulf of Cadiz Coast (Figure 9). It is an industrial and logistics hub of the Andalucia, as the region's second largest port is situated here. Huelva is part of the Trans-European Transport Network (TEN-T), which is an essential EU's transport infrastructure.

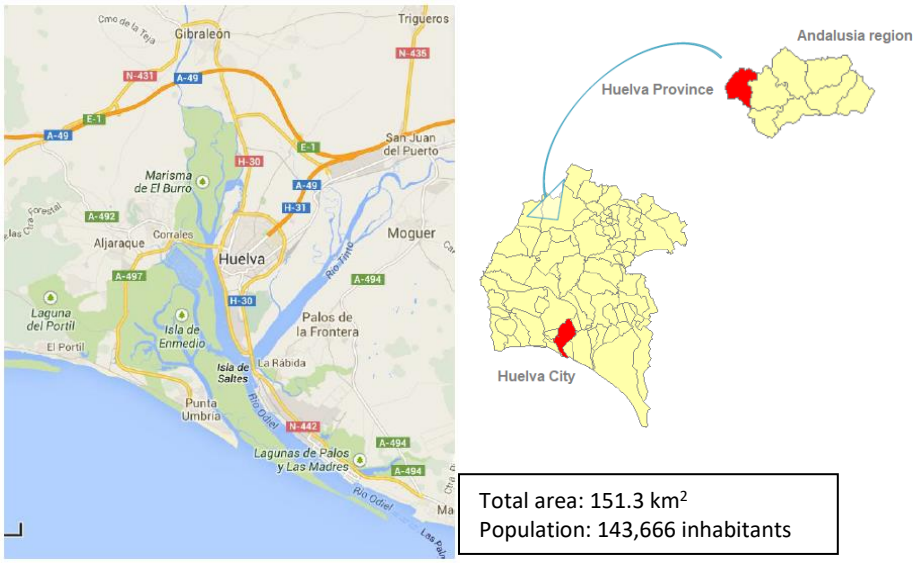

Figure 9 - Location of Huelva Municipality

According to National Institute of Statistics, in 2019, city's population was 143,663, that is 595 inhabitants less than in 2018 (Instituto Nacional de Estatistica, 2019). The population growth has picked in Huelva in 1995 and since then mostly declining trends are being observed (Figure 10).

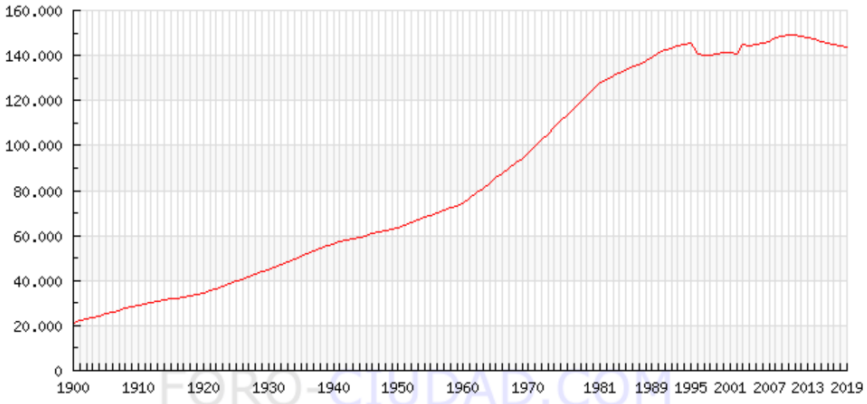

Figure 10 - Population of Huelva through 1900-2019

Source: (Foro-Cuidad, 2020)

Historically, due to its proximity to the sea, Huelva became an important hub of mining, resources trading, industrial and commercial activity. The city grew rapidly at the end of 18th century due to commercial impetus from Riotinto copper mines. Since 1950, the Huelva Chemical Development and Promotion Pole was established, a group of facilities and infrastructures of chemical companies, mainly oil refineries, regasification plants or thermal power plants, installed in the municipality (occupying half of the land of the municipality) or adjacent municipalities, and which is currently one of the most important industrial complexes in Spain. Such industrial background and concentration of industries ultimately are contributing to higher than moderate environmental impacts.

In terms of economy, Huelva hosts one of the leading European South-Atlantic ports, specialized in the traffic of bulk solids and liquids. The Association of Basic Chemical and Energy Industries of Huelva is one of the most important industrial hubs in Spain and has +$10b turnover/year (Ayuntamiento de Huelva, 2020). Furthermore, renewable energy and technologies, agroindustry, tourism, and service sectors are also highly developed. The economic downturn in 2008, drop of oil prices in 2014-2015, 2019-2020 COVID health pandemic has significantly affected the province, and whole Andalucia region, leading to the unstable situation in the labor market. Additionally, the rising share of the incoming foreign labor, and high reliance on seasonal sectors led to constantly increasing unemployment. In 2020 the unemployment rate reached 21% (Statista, 2020).

Huelva has Mediterranean climate characterized by mild winters and long hot dry summers with average temperatures around 23.9°C (*Table 1*). The region enjoys over 300 sunny days during the year and receives over 5kWh/m2 of solar irradiation, which provides a huge solar energy potential.

Table 1 - Climate table of Huelva (adapted from (Andalucia web, n.d.)*)*

Average temperature (C°)	**11**	**13**	**15**	**16**	**19**	**22**	**25**	**26**	**24**	**19**	**15**	**13**
Maximum temperature (C°)	**16**	**18**	**20**	**21**	**24**	**28**	**32**	**32**	**29**	**25**	**20**	**17**
Minimum temperature (C°)	**7**	**8**	**9**	**11**	**13**	**17**	**19**	**19**	**18**	**14**	**10**	**8**
Hours of sunshine per month	**170**	**170**	**223**	**246**	**303**	**339**	**372**	**347**	**277**	**211**	**173**	**147**
Precipitation in mm	**73**	**43**	**36**	**46**	**30**	**9**	**3**	**4**	**21**	**56**	**74**	**95**
Rainy days	**7**	**6**	**5**	**6**	**4**	**1**	**0**	**0**	**2**	**5**	**6**	**8**

2.2 Huelva Municipality Energy Consumption

Huelva, after Cadiz, is the Andalucian province with the highest primary energy consumption (Figure 11) due to concentration of the petrochemical industry in the area. In 2019 the province's primary energy demand accounted for 15.5% of the total primary energy consumed in Andalucia (Agencia Andaluza de la Energia, 2020).

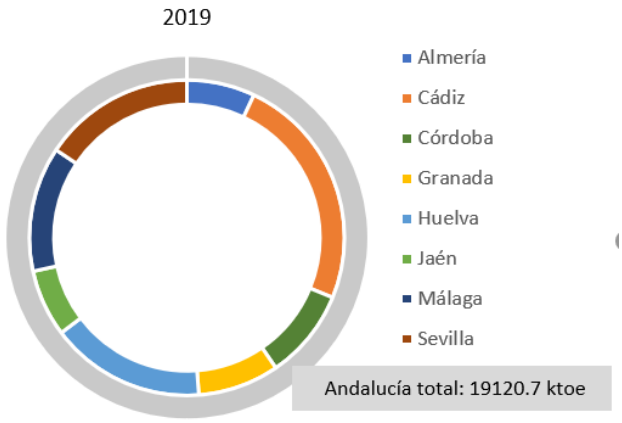

Figure 11 - Contribution of the provinces to Andalucian primary energy consumption in 2019

Figure 12 illustrates the evolution of the primary energy consumption by fuel type in Huelva province through 2005-2018. In 2019 primary consumption increased by 6%, mainly due to the rise in the use of natural gas, followed renewables and oil.

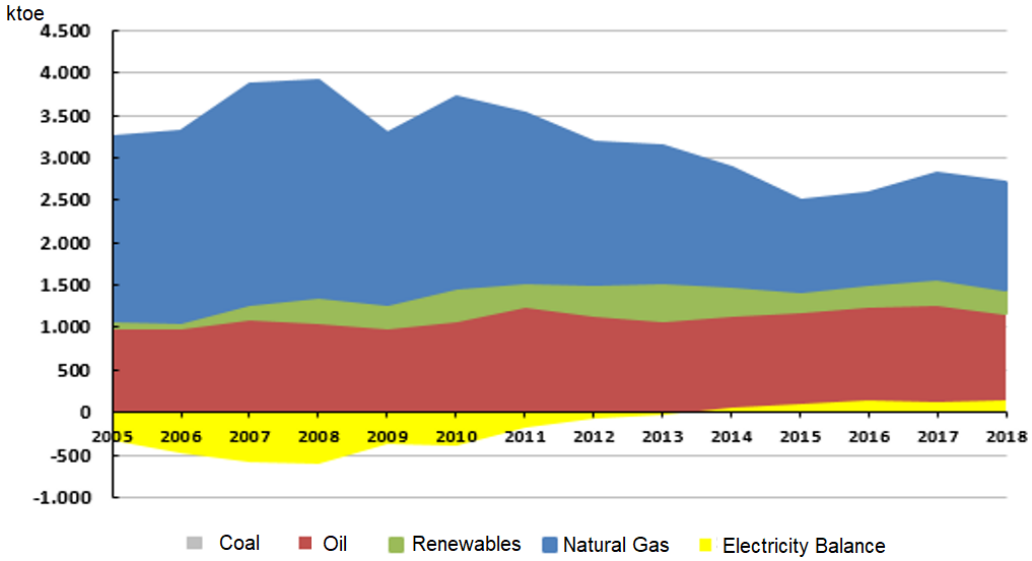

Figure 12 - Evolution of the primary energy consumption by fuel type in Huelva province, 2005-2018

Source: (Agencia Andaluza de la Energia, 2020)

In 2019 the primary energy consumption was mostly composed of fossil fuels. However, there was a slight difference from the general national trend as the largest share was attributed to natural gas (46.1%), followed by petroleum products (39.0%) and renewables (10.4%) (Figure 13). There was 8.8% increase in renewables comparing to 2018.

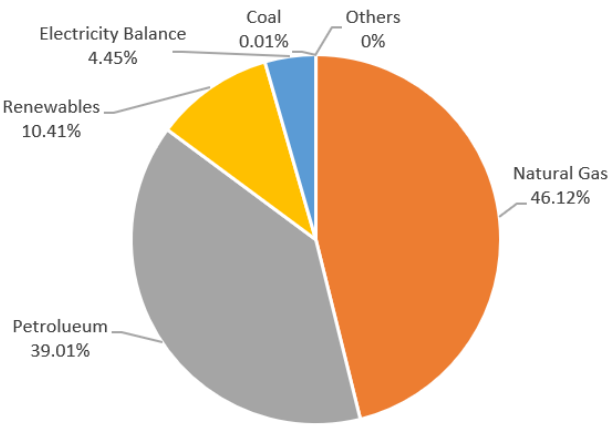

Figure 13 - Primary energy consumption by energy sources, 2019

Source: (Agencia Andaluza de la Energia, 2020)

Final energy consumption increased by around 11% in 2019 and accounted for 1807.9 ktoe for the whole province. Figure 14 shows the change in final energy consumption through 2008-2018. It is remarkable that after 2015 the consumption was slowly and steadily increasing, though no downturn was observed in consumption of fossil fuels.

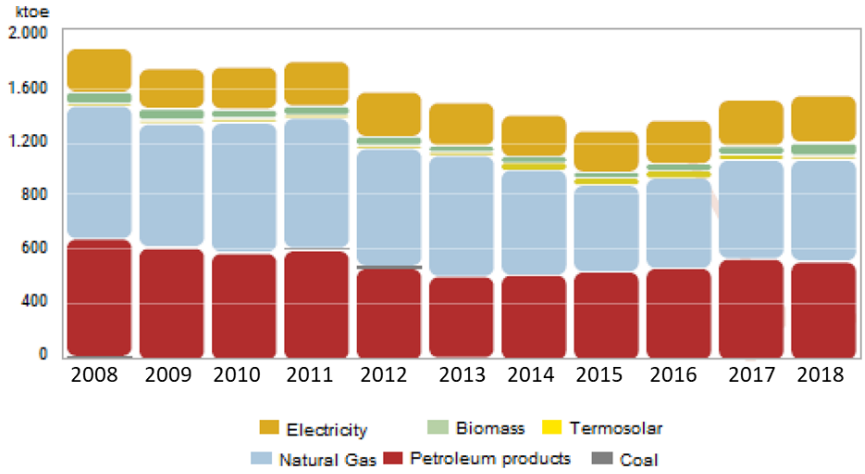

Figure 14 - Evolution of the final energy consumption in Huelva province, 2008-2018

Source: (Agencia Andaluza de la Energia, 2020)

In 2019, industry (51.8%) and transport (19.6%) were responsible for the most of final energy consumption (Figure 15). Energy consumption has increased by 20% in industry, almost by 10% in service, and by 4.8% in primary sectors (Figure 16). The slight decrease was recorded only in transport (1.2%) and residential (2.5%) sectors.

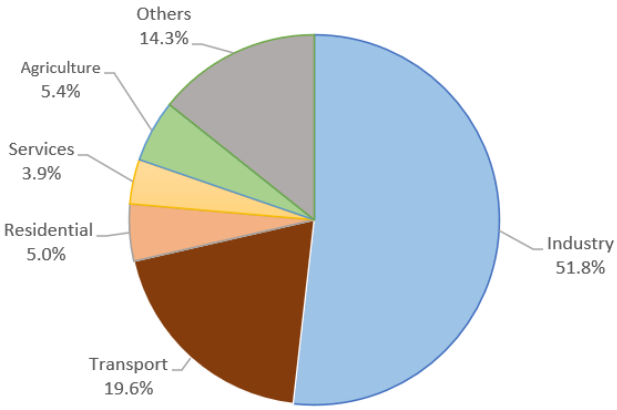

Figure 15 - Final energy consumption by sectors in Huelva Province, 2019

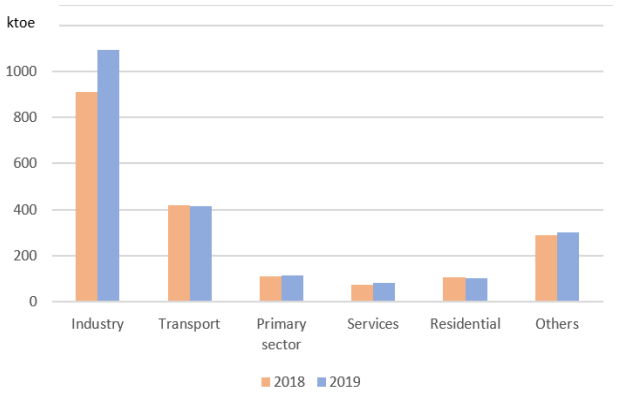

Figure 16 - Change in final energy consumption by sectors, 2018-2019

Source: (Agencia Andaluza de la Energia, 2020)

Huelva province has a high installed electricity generation power (2376 MW), which accounts for 15.1% of the total for Andalucia (Agencia Andaluza de la Energia, 2020). The generation park consists of two combined cycle plants (1558 MW), while the rest of the capacity is shared between renewable technologies and cogeneration. With respect to renewables, wind power (383.81 MW) stands out, as the largest park in Europe is in Huelva province, and biomass (136.95 MW). Since 2007, the renewable power has multiplied by more than five. Table 2 summarizes the electricity generation capacity by the type of technology represented in the province based on data for June 2020 (Agencia Andaluza de la Energia, 2020).

Table 2 - Electricity generation power by types of renewable technology (MW)

Technology	Huelva	Andalusia	% Province
Biogas	0.25	33.45	0.75%
Biomass	136.95	273.98	49.99%
Wind	383.81	3448.34	11.13%
PV	125.67	2035.84	6.17%
Termosolar	0	997.40	0%
Hydropower	15	649.90	2.31%
Others	4.5	4.50	100%
Total	666.18	7443.41	8.95%

APPENDIX B and APPENDIX C provide the list of facilities generating electricity with renewable technologies and a map of the energy sector infrastructure, respectively.

3. Current Policy Framework

The strategies Huelva applies have many levels due to different levels of governing bodies.

3.1 Supranational Level

At the supranational scale, Sustainable Development Goals, Paris Climate Agreement and ERDF's 2014-2020 Programmes are binding.

Within the context of Europe 2020 "resource efficiency", as an upper-level strategy, the ERDF Programme focuses on four main areas:

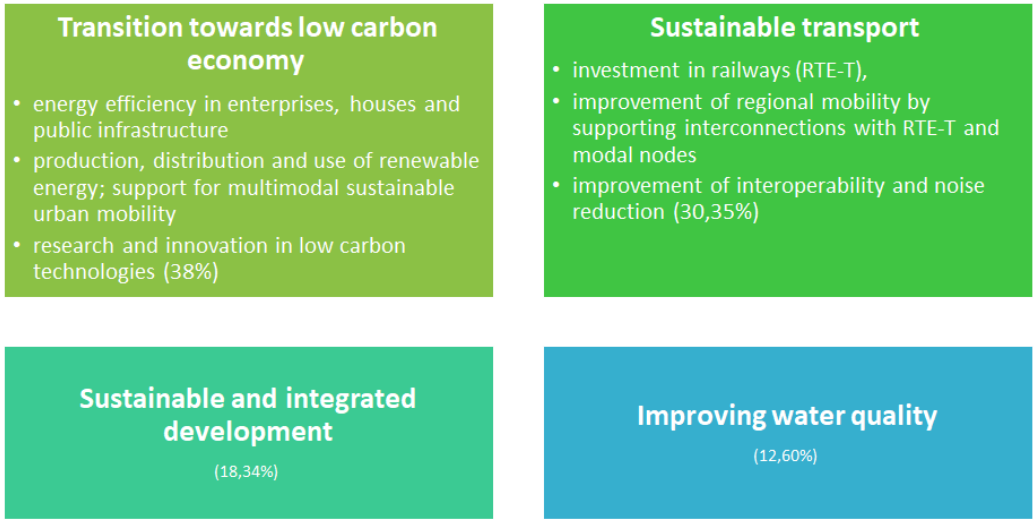

Figure 17 - ERDF Programme Focus Areas

Source: European Commission, 2014

3.2 National Level

In 2018, Spain introduced an ambitious environmental policy with the aim to get 75% of its electricity from renewables by 2030, rising to 100%, leading to be carbon neutral by 2050 (Heggie, 2020; Watts, 2020). Considering climate change impacts, country declared more ambitious targets on renewable energy and energy efficiency than the rest of EU in May 2020 (Watts, 2020). Thus, Spain adopted the goal to decarbonize its economy and reduce its GHG emissions by 90% against 1990 levels (Heggie, 2020; Watts, 2020). In this context, ceasing to issue new licences for oil and gas exploration, closing of most of the coalmines, and curbing the nuclear energy program, training of employees, clean energy jobs, and environmental restoration are counted among the steps towards these goals (Heggie, 2020). 69% of the coal powered plants were planned to be shut down throughout 2020. On the other hand, reforestation (20,000 ha) and the recovery of wetlands (50,000 ha) entered the policy agenda (Watts, 2020).

With these motivations, Spain transferred an important proportion of the investment to green energy. In 2019, Spain exceeded other European countries in onshore wind along with a commitment to deploy

minimum 3000 MW of wind and solar energy every year for a decade (Watts, 2020; Heggie, 2020). The government deems that decarbonization actions will contribute to employment by 1.6% (Watts, 2020).

3.3 Regional Level

At the regional level, planning activities for energy started in 1995 with the Andalucian Energy Plan 1995-2000, which was followed by the 2003-2006 Energy Plan for Andalucia and the 2007-2013 Andalucian Energy Sustainability Plan (PASENER) (Junta de Andalucia, 2019).

The Andalucian Energy Strategy 2020 that was approved in 2015 provides guidelines for energy saving and efficiency, promotion of renewable energies and development of energy infrastructures with the targets of sufficient, low carbon, smart and qualified energy system. In this regard, following objectives were defined:

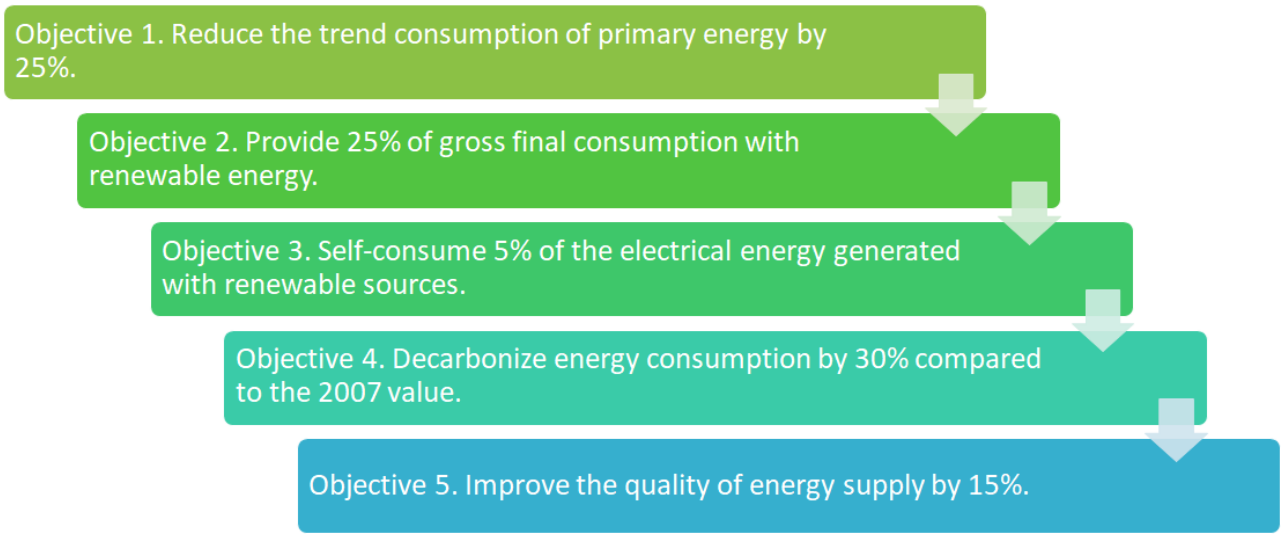

Figure 18 - Andalucian Energy Strategy 2020 Focus Areas

Source: Junta de Andalucia, 2019.

3.4 Province & City Level

City of Huelva, aware of its part in climate change, shares the national goal to reduce GHGs emissions and to become a low carbon economy. In this context, setting some targets for 2020, municipality focused on buildings (Municipal, tertiary and residential), land use planning, transport while involving stakeholders (Ayuntamiento de Huelva, 2009). Up to 2020, important energy policies that were designated can be seen in diagram below (Figure 19).

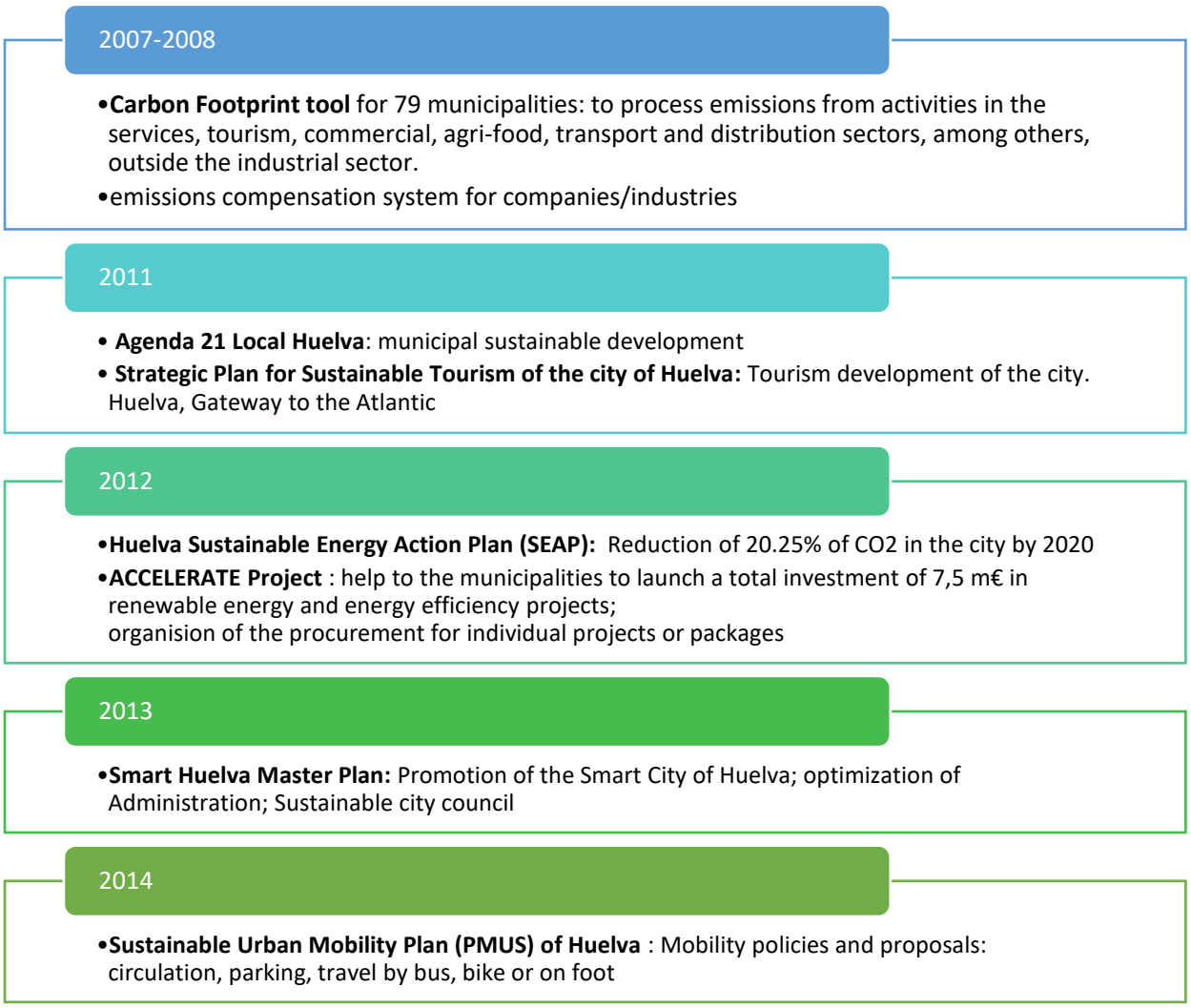

Figure 19 - Energy Policies in Huelva up to 2020

Source: Huelva Strategic Plan, 2016; Huelva Province, 2012 ; Huelva Informacion, 2010

In Huelva Strategic Plan (2016) several actions are defined for renewable energy policies and energy efficiency. The actions directly related to energy focused mostly on enhancing solar and wind energy, followed by other renewable sources like biomass considering the potential of the region. This is supported by awareness raising and training at municipal level to trigger change in production and consumption traditions. Furthermore, a need for planning for an improved energy supply network is urged around the development of a gas and electricity network (PEHU, 2016).

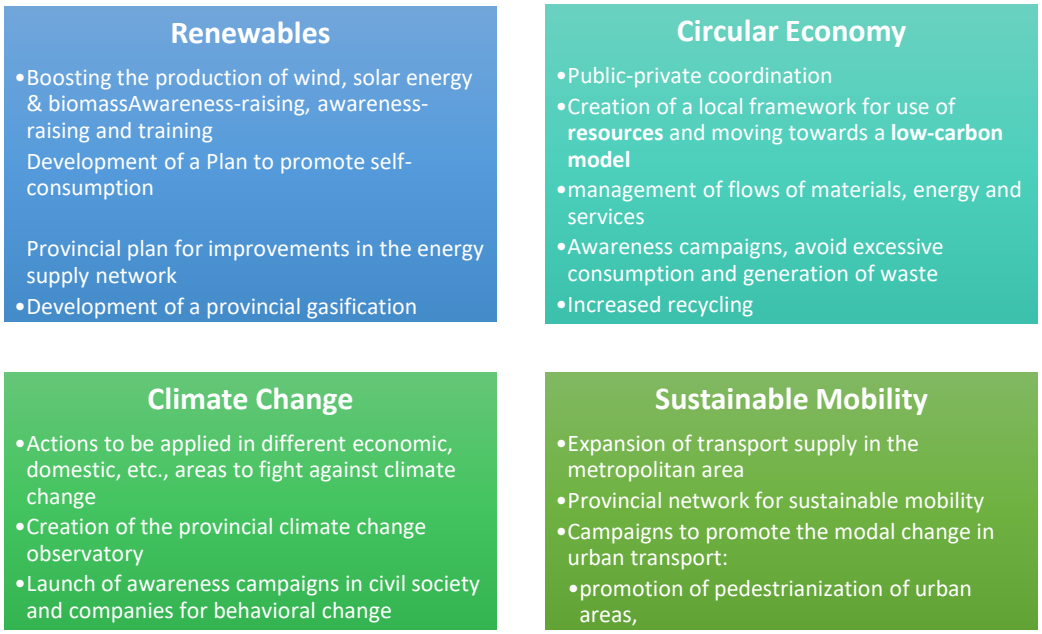

Figure 20 – Huelva Strategic Plan focus areas
Source: PEHU (2016)

The city of Huelva also recognized the potential of renewable energy for recovering from the post COVID economic constraints. There is no separate policy on COVID for Huelva regarding energy efficiency, but they embrace the ideas presented by IRENA (Ayuntamiento De Huelva, 2020). According to this perspective, renewable energy sits at the core of economic recovery which cannot be accomplished by any other industry while aiming for emission reduction. Thus, policies should focus on energy sustainability and security, creation of employment and enhancing resilience. In this sense, there is a number of actions that are defined while facilitating energy transition as can be seen from Figure 21 (Ayuntamiento De Huelva, 2020).

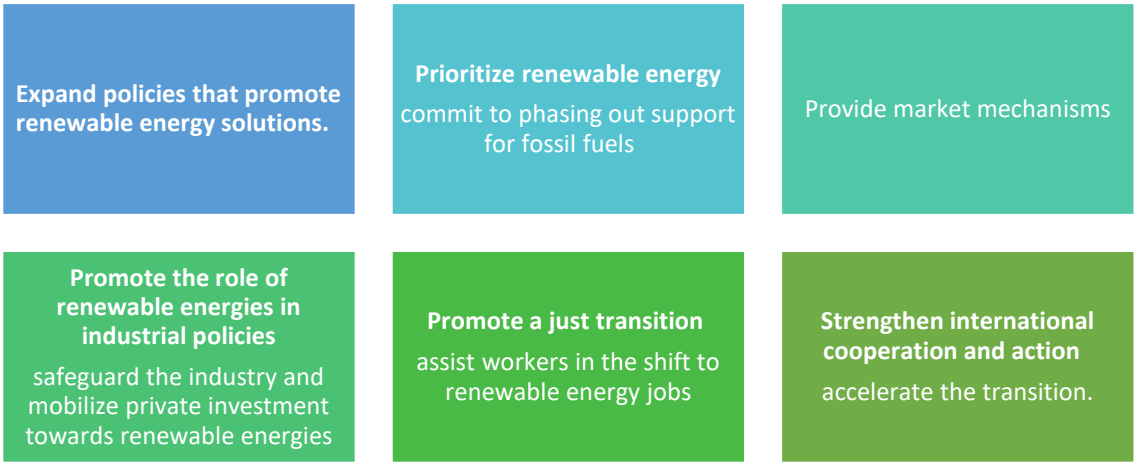

Figure 21 – COVID Recovery Action focus areas
Source: Ayuntamiento De Huelva, 2020

3.5 Current Issues in the System

Regarding the strategies that are aimed to be applied, several issues can be mentioned that might affect the strategies' execution and success. First, besides the advantages the existence of policies for energy transition at many levels has, it brings along challenges at the stage of execution. This goes hand in hand with the difficulty of coordination between different levels of governing bodies. Issues arising from jurisdiction and possible tensions between the different autonomous regions and the central administration cause difficulties in implementation of the policies (Hernández *et al.*, 2004; Dibacco, 2018). The province of Huelva made an effort to bypass this complex structure with the ACCELERATE Project to "speed up renewable energies and energy efficiency investment processes of 77 municipalities" between 2012-2014 (Huelva Province, 2012). Nevertheless, the results are not traceable.

Considering the legal framework on renewable energy, past experiences tend to have a discouraging impact on investment in renewables. After the reduction of subsidies following the Energy Reform Bill in 2012, the sector was greatly affected, followed by the fall of energy stocks and economic damage especially on wind power industry (Dibacco, 2018). The same situation was experienced in solar energy sector in 2007 where subsidies were abolished that also affected employment (Watts, 2020). Both events led to a lack of trust in the field. Thus, the regulatory background should be convincing for the investors. Another issue about renewables is that there is lacking proficiency on related issues like grid integration, storage, and management of the energy sectors competitiveness which needs to be overcome (Dibacco, 2018).

Another aspect is the free market and liberalization in the sector. Though the high number of agents in the market rises expectations of competitiveness, this has not been the case in Spain. While gas prices increased due to connection to oil prices, electricity prices increased both for industrial and domestic consumers. In a vicious cycle, the rise in energy prices impacted the competitiveness of industrial companies. Furthermore, as one of the main elements of trade balance, energy products as imports still exceed exports (Pelegry and Basterra, 2014). Furthermore, economic constraints that came along with COVID situation amplified the challenges the sector has been already facing.

One of the most important issues is the lack of a clear connection between energy sector and industries. Designation of the policies require a holistic approach towards energy and economic activities along with R&D and technology (Pelegry and Basterra, 2014).

Andalucia region, with more hydrocarbon weight especially in transport sector and having more energy intensity than Spanish and EU average is expected to face challenges in transition process. Moreover, for Huelva with highest numbers of gas consumption in Andalucia, not fulfilling its solar and wind energy potential and its public transportation dependent on motorized modes stand out as major issues to be addressed.

STRENGTHS	***WEAKNESSES***
Political agenda towards increasing contribution of renewables Huelva as the first province of Andalucia in terms of electricity generation with biomass[1], Second in Andalucia in relation to biomass installed power[2] Improvement in self-sufficiency led by the contribution of renewable energy[3]	Multilevel governmental bodies – lack of communication / partnership Not well connected to the european grid Excessive weight of hydrocarbons in the mix, especially in the transport sector, above Spain and EU numbers Energy intensity higher than the national and European average. Citizens with little training in energy consumption Low implementation of energy saving projects[3] Huelva using most of gas in Andalucia Under usage of the renewable energy potential like solar, wind Motorized transportation, PT dependent on motorways, traffic is second highest source of emissions
OPPORTUNITIES	***THREATS***
High availability of renewable resources, capability of meeting the energy demand of Andalucia University, R&D EU funding	Covid impact on economy Improvement in numbers due to Covid becoming misleading leading to investment on energy sector[4] Contaminated soil and water (Tinto and Odiel). Most contaminated estuary in the world Industrial zones

Figure 22 - SWOT Analysis

Sources: 1: (Junta de Andalucía, 2020)
2: (Huelva Action Plan, 2011)
3: (Junta de Andalucia, 2019)
4: (iea.org, 2020)

4. Future Pathways for Huelva Energy Sector

4.1 Drivers of Change

Based on the overview of the current national and local trends in the energy sector along with national economic and policy background, the major emerging patterns and drivers of possible future changes were identified and summarized through PESTEL table. PESTEL analysis is a horizon scanning technique that helps to understand the framework of envisioned changes and is often used as a preliminary step of scenario development and strategic planning. Figure 23 highlights the results of the PESTEL analysis, while detailed explanation of separate drivers is given below.

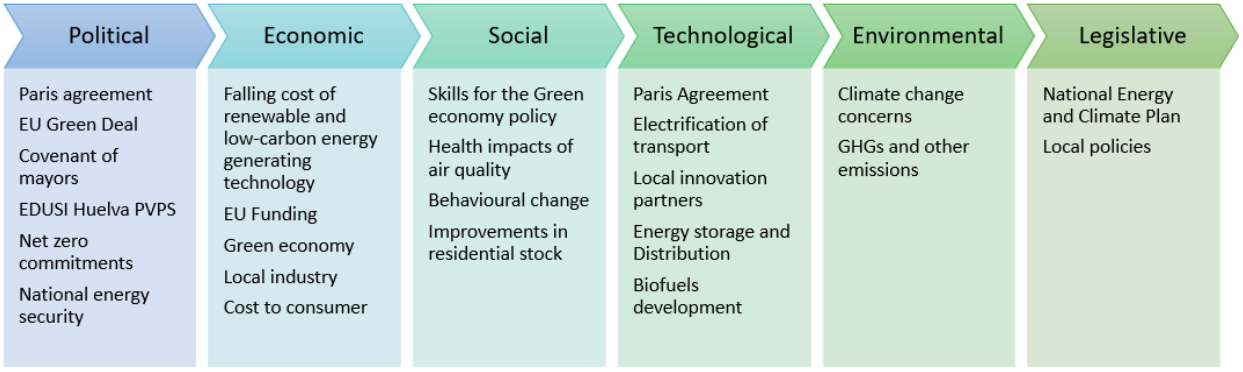

Figure 23 - Drivers defining the need for change in Huelva energy sector

Political Drivers

- **The Paris Agreement:** International agreement to limit any increase in global temperature from pre-industrial levels to below 2 °C. This target requires a rapid transformation of energy use and shift away from current reliance on fossil fuels. International cooperation required to achieve goals.
- **Energy Security:** Spain is heavily reliant on fossil fuel imports, as it does not have enough reserves for its consumption. Spain can reduce reliance of energy imports by continued investments in renewable energy production within Spain, in particularly Wind Energy.
- **EDUSI Huelva PVPS:** (Sustainable and Integrated Urban Development Strategy of City of Huelva) A strategic regeneration tool for the city, improving connectivity and permeability of Parque Moret and Laderas del Conquero, or the so called 'Green and Social Lung". Part of this work included an audit of and improvements to the Public Lighting in the city, reviewing locations and timings and updating to ensure energy efficiency. COVID 19
- **Net Zero Commitments:** Spain has committed to becoming carbon neutral by 2050. This will require innovative business models to support the required technology and behavioural change.

Economic drivers

- **Falling cost of renewable and low-carbon energy generating technology:** As as the technologies are being tested and becoming competitive on the global market. In particular the cost (per MWh) of Photovoltaic (PV) projects has fallen by 82% in the last decade, while the cost of Onshore Wind projects are now 45% cheaper than in 2010. (IRENA, 2020)
- **Local Industry:** Huelva is a highly industrialised city, much of the economic activity involves energy intensive industries and processes (i.e. Copper Smelter, Fertiliser Plant, Power/ Refinery)

Economic Drivers

- **Cost to consumer:** Energy costs are high in Spain, Gas is the 2nd most expensive in Europe and Electricity costs are above the EU average. However, Gas and Oil costs are as the cost of renewables is falling.
- **COVID 19:** The restrictions brought on by the pandemic have had significantly negative impact on the Spanish Economy, with the economy contracting by 18.5 percent in the second quarter of 2020. The Bank of Spain expects some level of econmic recovery in the coming year off the back of a vaccine. However, the Bank of Spain also expect that the economy could be 6% smaller by the end of 2022. (Dombey, 2020)

Social Drivers

- **Skills for the Green Economy:** New jobs and skills required by the 'Green Economy' will require training of the local workforce. Support for education, skills development and retraining for any redundant sectors so that local jobs can be maintained wherever possible. Support to protect redundant and vulnerable workforce and the ensure they remain economically engaged.
- **Policy:** industrial policies, labour market interventions, educational and skills development and social protection programmes.
- **Air Quality:** Air quality improvements from a fall in the use of polluting energy sources will improve public health. Air pollution is associated with increased morbidity and mortality due to coronary and respiratory disease. The International Renewable Energy Agency (IRENA) estimate that world-wide cost saving of improved public health could be up to 160 trillion US Dollars over a 30-year period. (IRENA, 2020) This would outweigh the cost of installing renewable systems. Air pollution also has an adverse effect on biodiversity and damages ecosystems. (UNECE, 2020)
- **Behavioural Change:** required by consumers and energy users to reduce consumption. Decarbonising the energy network will only go so far, there is a need to radical behavioural change to achieve net zero
- **COVID 19:** The COVID19 pandemic and associated restriction and lockdowns has had a negative effect on jobs and health. Between April and June 2020 unemployment in Spain increased by 7.5%, making the job-losses during the pandemic in Spain nearly 3 times higher than neighbouring EU countries. There are also significant concerns regarding the mental and physical health of the population, with health services struggling to cope with the pandemic.

Technological Drivers

- **Paris Agreement:** Recognition of need to transform energy systems by decarbonising the energy market. Global investment in research and development of low-carbon technology for electricity generation.
- **Electrification of Transport:** The increasing electrification of transport, in particular private vehicles and public transport will increase electricity demand, require upgrading of roads and highways and the development of a whole network of charging points. An increase in infrastructure.
- **Local innovation partners:** University and Industry - Ence Renewable, Energy Complex, Sener Biomass Power Plant.
- **Energy Storage and Distribution:** Renewable energy generation technologies require large amounts of energy storage capacity as they are not as consistently reliable or adjustable as traditional energy generating technology. Connectivity to national and international (EU) grid for distribution of energy is also an important consideration.

Environmental Drivers

- **Impact of climate change:** Reduced rainfall and increasing temperatures will result in increasing pressure on energy resources. Increasing electricity demand of air conditioning and water treatment required irrigation.
- **Green House Gases:** Reduction of greenhouse gas emissions from move to low-carbon technologies.

Legislative

- **National Energy and Climate Plan:** NECP required by European Commissions. Plan submitted by Spain sets out target for 23% reduction in greenhouse emissions on 1990 levels by 2030, aim for carbon neutral by 2050.
- **Local Policies:** Refer to previous information regarding relevant policies

Figure 24 - Description of identified drivers

4.2 Scenario Building

When considering the future of the energy sector in Huelva, scenario building approach was used to envision several futures, or scenarios, of Huelva in 2050. These scenarios are based on the drivers identified using the PESTEL analysis, as well as the background study and information gathered, considering the current trends around energy consumption, investments, policies, and climate. A backcasting technique was used to build a long-term vision of Huelva by 2050.

4 scenarios were developed; worst case, best case, no change, and alternative futures.

Scenario 1 (worst case): COVID-19 causes global economic crisis and investment in renewables falls

- The COVID-19 pandemic continues to have a global impact and subsequent lockdowns has a detrimental effect on the world economy. Investment in renewables is halted due to a lack of funding and instead of focussing on a green recovery, Spain focuses its economic recover efforts on fast turnaround but polluting industries and investment.

Scenario 2 (best case): Spain works on current commitments and becomes carbon neutral by 2050

- Spain works hard on achieving its current commitments and climate related obligations radically changing its economic model, investing in renewable energy and green technology, and cutting emissions. As a result Spain becomes carbon neutral by 2050 with a thriving green economy. Global temperatures are kept at below 2^{o}C higher than pre-industrial levels in line with the Paris Agreement.

Scenario 3 (no change): Investment in renewables and decarbonization but too late and Spain breaches Paris Agreement

- Current levels of investment in renewable technology and policy effort to decarbonise the economy. However, the current efforts do not sufficiently cut Spain's carbon emissions and as such Spain breaches its international commitments and global temperatures rise beyond the Paris Agreement of 2^{o}C.

Scenario 4 (alternative future): Post COVID-19 Green Recovery followed by energy sector transformation

- With the pandemic causing such widespread economic disruption, there is a growing understanding and acknowledgment that this is a unique opportunity for the economic recovery to focus on the transition to a 'green economy'. Investment and funding is focused on renewable technologies, decarbonisation and sustainable infrastructure projects.

Figure 25 - Developed Scenarios

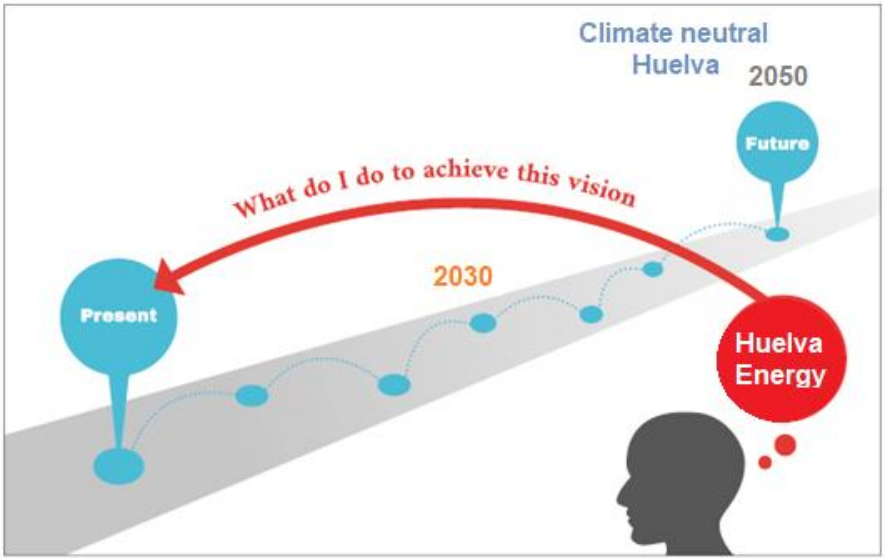

Figure 26 - Illustration of backcasting process

Considering the national targets, existing policies and dominant approach throughout the country, Huelva should aim to follow the **most ambitious scenario**. Achieving the goals that are already set in the legal documents and policies that are adopted in all administrative levels will be only possible through a determinant approach. By considering the EU's and national governments policy focus on a green post-COVID recovery, **Scenario 4** is both the most likely and ambitions vision for the future of the energy sector in Huelva.

Overview of Scenario 4

In 2020 Spain is facing economic downturn as the result of global coronavirus pandemic. Spanish economy is shrinking by 12.8%, which is the biggest disruption among EU countries. Andalucia is among the regions of EU most vulnerable to the economic impacts of Covid-19 (European Comottee of the Regions, 2020).

Due to the reliance on unsustainable productive sectors, like tourism and agribusiness, weaknesses of the labor market and infrastructure, Huelva is one of the most affected cities in the region. Hospitality, service, retail sectors and local port experience downturn due to reduced activity and Covid-19 restrictions. Unemployment rate continues to grow up to 30%. Huelva energy sector witnesses the fall in demand and supply combined with lower generation from coal, gas and nuclear vs rise in the share of renewables.

Huelva municipality sees the opportunity to initiate the transformation of the current energy model to make energy sector independent of fossil resources, self-sufficient, secure, and efficient, while facilitating local economic recovery and addressing climate objectives.

The city is set to receive financial support from the EU Green Deal Recovery Plan, Just Transition Fund and other investment facilities. Additionally, private investments boost renewable energy industry, creating added economic value, new jobs and resources for further infrastructural improvements, energy efficiency action and changes in energy end-use sectors.

Huelva municipality streamlines the post-COVID financial support into transformation of the current energy model, while facilitating local economic recovery and addressing climate objectives

By using the national 2030 targets and extrapolating the goals for RET with the opportunities for large-scale investment of renewable production in the region, **Huelva 2030 energy goals** are:

- by 2030 – Huelva is economically thriving, climate aware, innovation-leading, energy efficient and sustainable place to live and work;
- by 2045 – Huelva is the first climate neutral municipality in Andalucia.

5. Transition of the Energy Model (2021-2030): Action Plan

5.1. Objectives and Targets 2030

To achieve the **Post COVID-19 Green Recovery** scenario transformation of the existing energy model is the key. The long-term goal of the proposed scenario is to make Huelva municipality carbon neutral by 2045, five years prior the rest of Spain. To reach this target, 2030 is suggested as an interim timepoint and an Action Plan for the period 2021-2030 is prepared to ensure transition in energy sector. Figure 27 shows the steps of the Plan development.

Figure 27 - Stages of the Action Plan development for Transition of the Energy Model (2021-2030)

The Action Plan for Transition of the Energy Model in Huelva is set around 4 major objectives:

1	Economic recovery and green remediation triggered by penetration of the renewable energy technologies (RET) in all sectors
2	Electrification of end-use sectors through RET integration
3	Decrease energy consumption across all sectors
4	Enhance power grids flexibility and inter-connection

Objective 1: RET triggered economic recovery and green remediation sets a target of reaching 80% share of renewables in electricity generation. For the year 2030, the Plan foresees the decarbonization of the electricity sector through increasing the installed capacity of wind energy, solar photovoltaic, solar thermal electric facilities, supporting small-scale renewable energy schemes and exploring the opportunities to hybridize renewable and combustion technologies.

Objective 2: Electrification of end-use sectors through RET integration aims for 45% renewables in energy end use sectors and 30% decrease in GHGs emissions. The sectors of primarily focus should be industry and transport, as these are the largest energy consumers and GHG emitters in Huelva. The global

review of the existing international RET integration projects reveals wide array of the potential integration schemes for industry ranging from simple fuel change and co-generation to complex symbiosis projects.

Objective 3: Decrease energy consumption across all sectors envisions 39.5% improvement in energy efficiency. The Plan proposes initiatives related to improving the energy efficiency in housing stock and suggest public administrations to take a leadership by setting energy saving and efficiency example.

Objective 4: Enhance power grids flexibility and inter-connection to support the energy sector transformation. The integration of RET requires strengthening and expansion of transport and distribution lines in province territory, as well as Andalucia overall, and increase in the energy storage capacity. Extending the interconnections with European countries EU countries to the suggested by EU 10% will improve national energy security and strengthen the position of Spain on EU internal energy market.

The diagram given below summarizes the objectives and targets defined for the action plan and give the end-point visions of the outcomes (Figure 28)

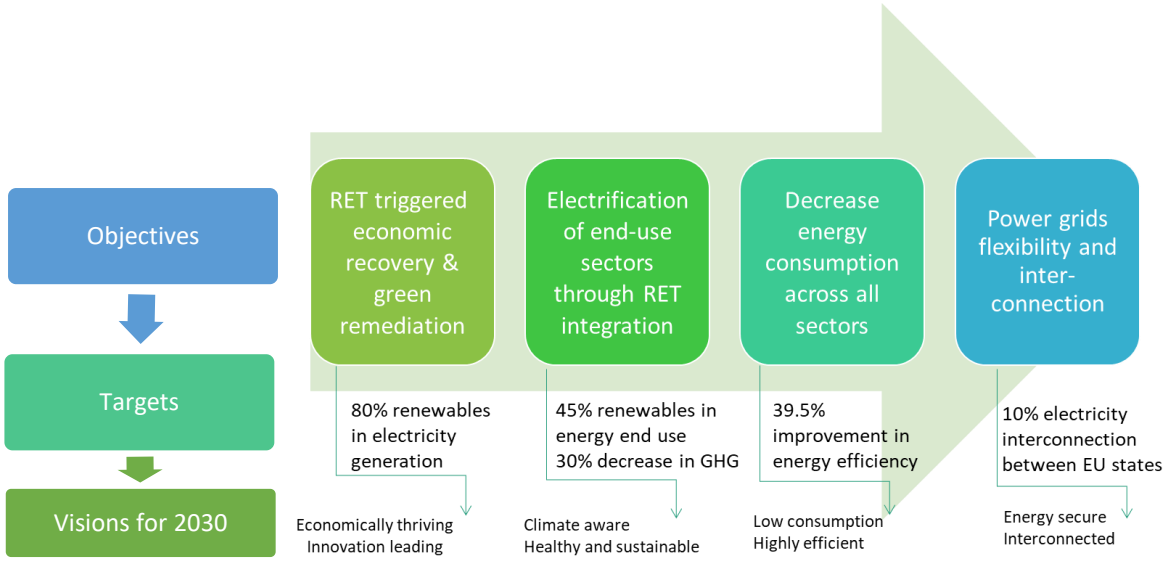

Figure 28 - Objectives and targets of the Transition of the Energy Model Action Plan (2021-2030)

The targets suggested for each objective should be taken as the corresponding performance indicators, when evaluating level of the action plan implementation in the follow up report in 2025 and a final evaluation in 2031.

5.2. Stakeholder Analysis

In the light of defined objectives, initially the existing stakeholders were analyzed in the sector. A mind map was created to understand the network of stakeholders for the Huelva energy sector (Figure 29).

According to the existing actors, the stakeholders were classified into 6 major categories:

- regulatory bodies,
- financial institutions,
- R&D and consultancy,
- energy producers,
- energy suppliers and
- energy consumers for Huelva.

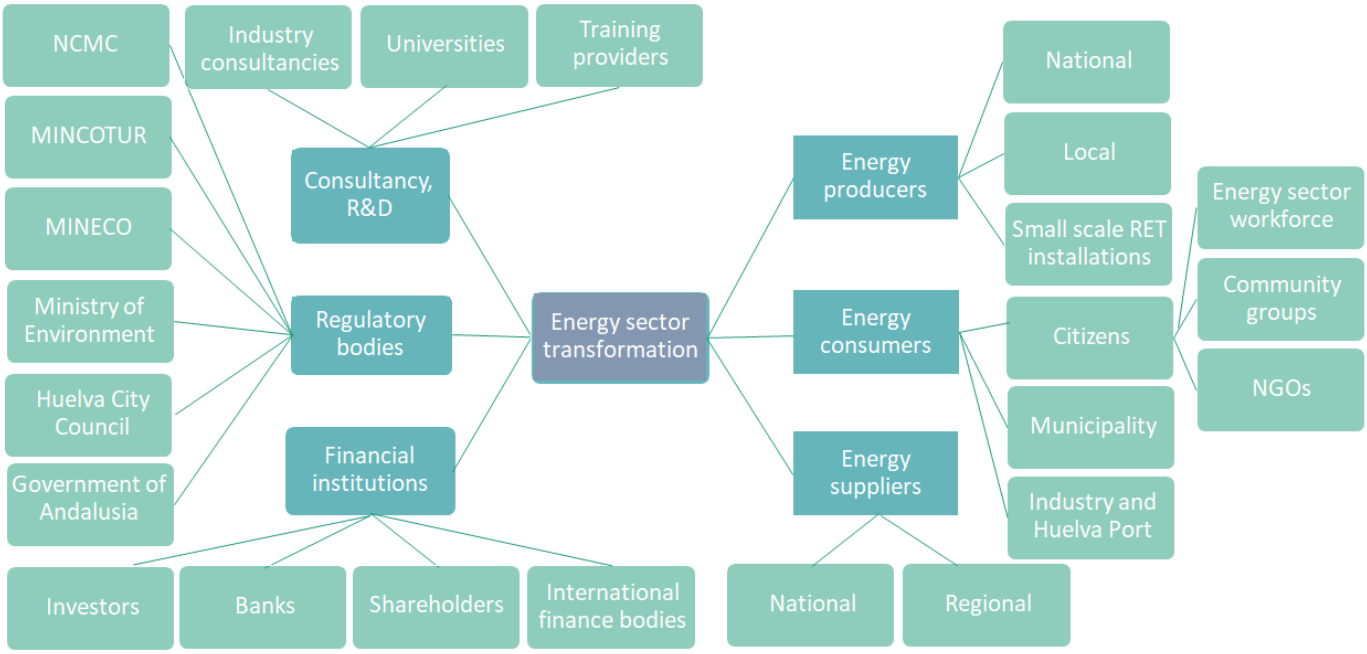

Figure 29 - Stakeholder Map

Among these stakeholders, key agents are determined that would lead the change in the transition of energy sector. The transition is planned to be initiated through the municipality as the representative of the complex governmental structure and the executor of the policies. During the economic recovery period from COVID, industries and renewable energy sector will be integrated, and energy sector will become the engine of green remediation. This will be the foremost step which will be followed by energy end use sectors' transition. At this stage, citizen involvement will be the key for sustaining the results and to make the activities long term which will lead to the economic revival and sustainability.

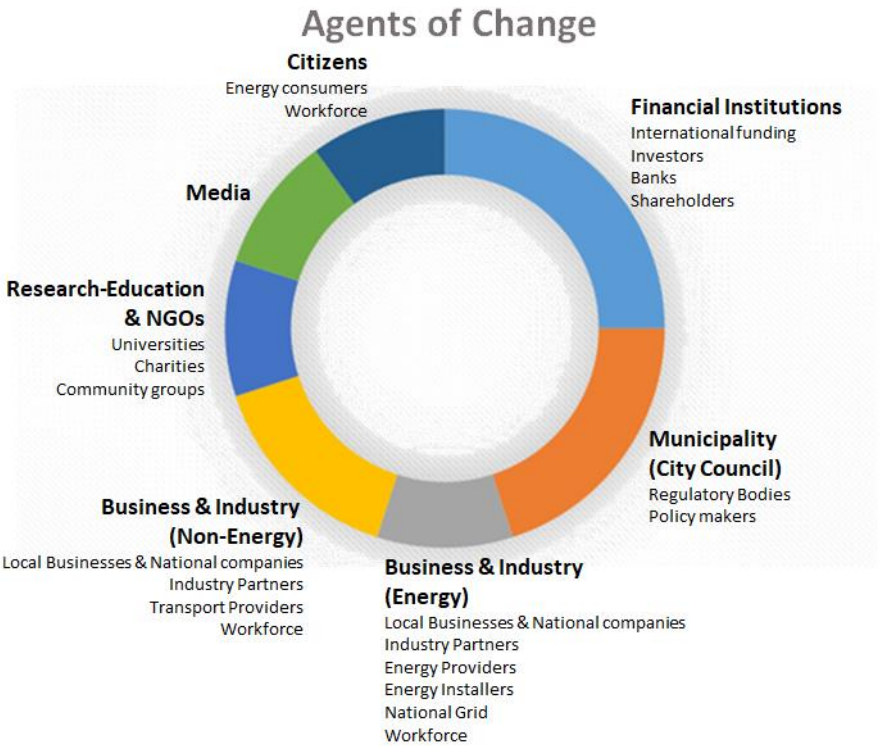

Figure 30 - Agents of Change for the Action Plan

5.3. Priority Actions and Policy Suggestions

Based on the long terms vision (2030 and 2050), analysis of the objectives and key change leading stakeholders, a set of policy recommendations and actions aimed at guiding Huelva towards energy model transition and further efficient decarbonization was proposed. The diagram in Figure 31 lists recommendations and actions in relation to the objectives and highlights corresponding stakeholders.

Successful transition of the energy model of any scale depend on the existing regional and national policy frameworks. Currently Spain does not have an explicit carbon tax and the carbon pricing here is the lowest in Europe. Furthermore, electricity tariffs cover non-electricity related costs and make them unattractive for the user. Additionally, there is a need for policies stimulating decarbonization across all sectors. The suggested actions and policies are designed to promote integration of renewables, reduce energy consumption, improve energy efficiency and access. It is expected that synergizing the policies' updates with investments into RET will catalyze sustainable and inclusive economic growth, create employment, protect health and, overall, will improve quality of life in Huelva. Proposed action plan also enables Huelva to address 6 out of 17 Sustainable Development Goals.

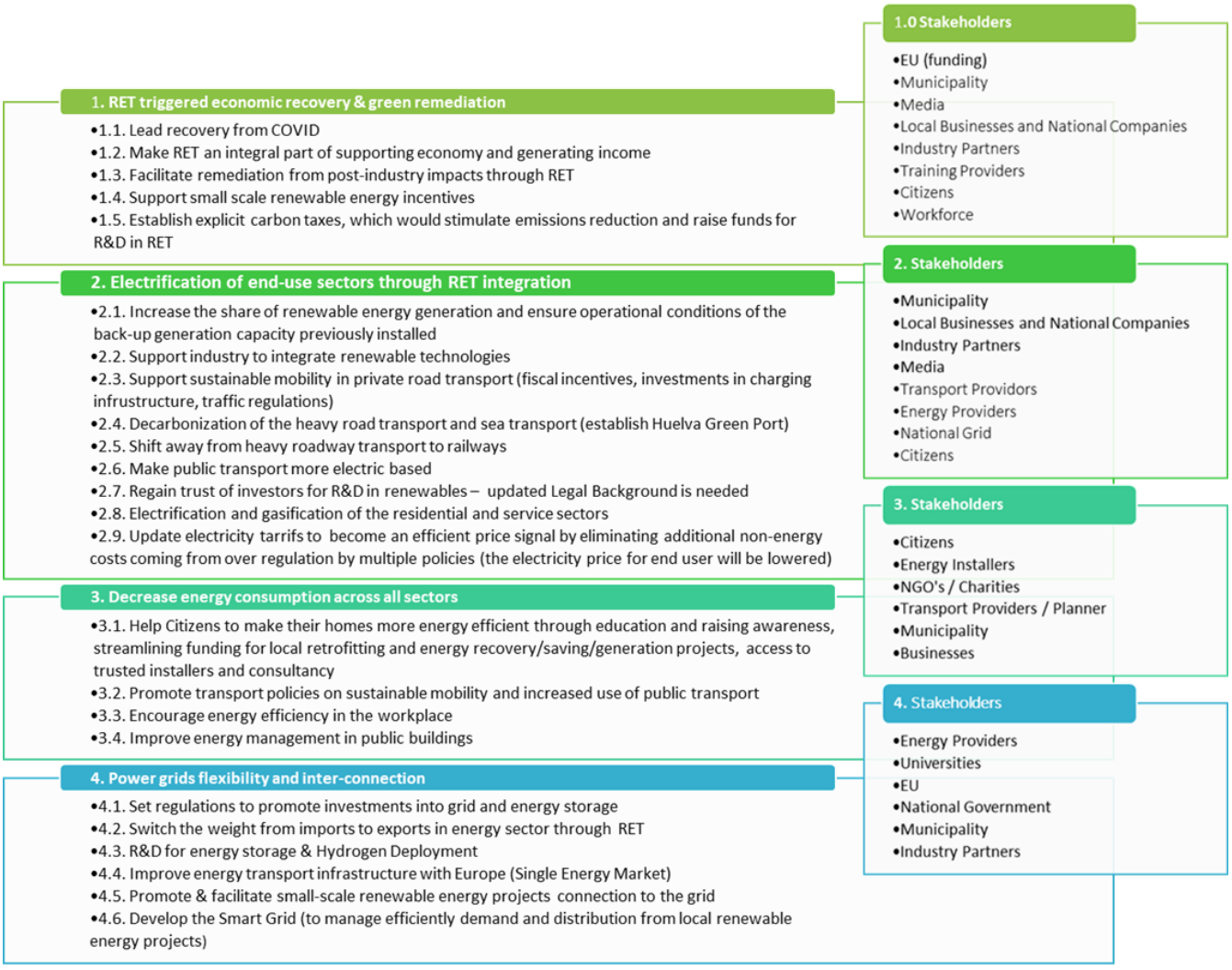

Figure 31 - Policy recommendations and suggested actions under Huelva energy model transition Action Plan

5.4. Funding Opportunities

There are a number funding streams available for RET triggered energy sector transformation and to support defined objectives, namely: the EU, European Bank, Strategic Investment Facility, National Government, Municipality, Investors, Local Sources, Charities, Community Groups and NGOs.

Specific EU funding is available for the countries though the European Green Deal mechanisms to increase GHGs reduction targets. Additionally, EU's long-term budget, coupled with NextGenerationEU, will finance a €750bn EU Recovery Plan (of which Spain expects to receive €140bn in grants and loans). Up to €720m will be available from the Just Transition Fund to support economic diversification and regeneration (Reve, 2020).

5.5. Stakeholders' Engagement

To understand the potential roles of identified stakeholder in the implementation of the proposed Action Plan, the balance between magnitude of power and interests was analyzed through stakeholders' mapping (Figure 32).

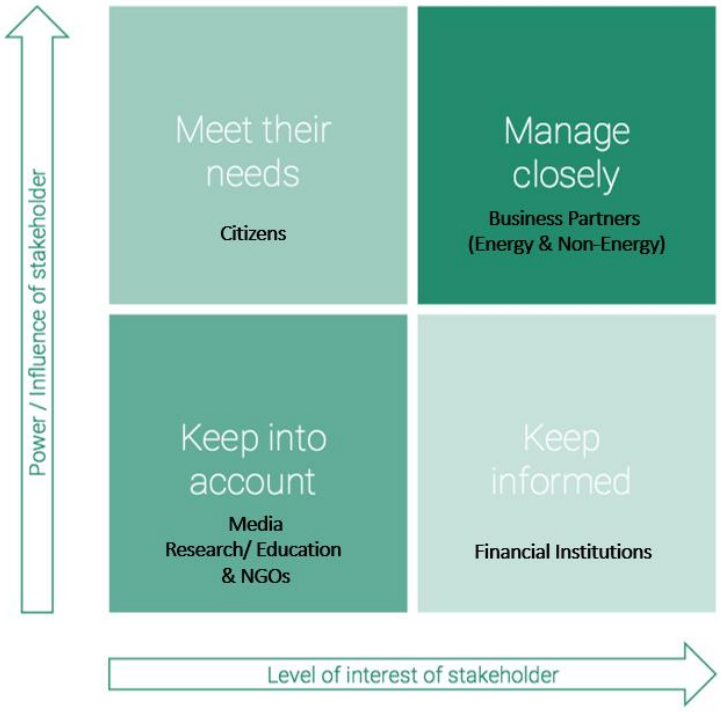

Figure 32 - Stakeholder Power-Influence Diagram

For the transition process stakeholder engagement will include the stages of informing, consulting, involving, collaborating and empowering.

Municipality, as the facilitator, will be present in the entire transformation and collaboration process. Financial institutions, as the funder of these processes, will be kept close and be constantly informed through meetings and reports.

Energy business partners will continue their key role through regaining their trust in legal background while industry that does not involve renewable energy will be turned into an important partner. Research, education and NGOs will maintain the duty of raising awareness in close contact with business and industries at the stage of training and meetings. As the last major component of the system, citizens will act as key agents in sustaining of these actions.

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
Municipality (City Council)	Manage the processes of coordination between stakeholders. The bridge between central state & governmental bodies with other stakeholders				
Financial Institutions	Keep close & informed through follow-up meetings, reports on progress Learn from previous experiences				
Business & Industry (Energy)	Inform of the projects and new opportunities and RET benefits Maintaining trust with a clear legal background	Learning from the experiences and needs/previous challenges	Benefit from opinions on how the sector could be improved	Working together in partnership for progress	Involve in decision making Support small-scale renewable energy generation projects, empower women's leadership in sector Engage into strategic planning
Business & Industry (Non-Energy)	Inform of the advantages of getting involved in RET Provide a preview of possible changes and how these might affect the industry Maintaining trust with a clear legal background	Learning from the experiences of the businesses in sector and to find RET related solutions to their needs/problems	Organize meetings with related stakeholders (R&D, business & industry in energy sector) to plan possible collaborations & contributions	Working together in partnership for progress	Support energy efficiency and RET transition projects Engage in plan making
Research & Education, NGOs	Inform on their role on raising awareness	Getting consultation on advancements in RET & how it can be improved	Bringing together with the business partners and citizens through events & public meetings	Training of employees Raising awareness among citizens	Involve in decision making processes, plan making and strategy building
Media	-	-	Form public opinion, inform the citizens Promote renewable energy technology usage	-	-
Citizens	To provide with objective information, assist in understanding problems and opportunities	Obtain feedback on planned actions and policies	To work closely though change implementation to ensure transparency and that interests are considered	To engage public in decision-making across all stages	Give opportunity for co-creation and having final word in decision making

Figure 33 - Stakeholder Engagement Plan

5.6. Action Plan Monitoring and Reporting

The suggested Action Plan is a 10-year strategy for the development and transformation of the energy sector in Huelva municipality (Figure 34). The mid-term progress monitoring timepoint is 2025, when the progress report should be prepared by the Huelva City council with further recommendations on achieving the defined objectives. City Council should serve as a monitoring and coordinating body to ensure the success of the Action Plan. The final Action Plan evaluation report should be released not later than by December 2031.

Figure 34 - Action Plan implementation timeline

Table 3 lists the key performance indicators (KPIs) for the monitoring and assessment of the Action Plan implementation.

Table 3 - KPIs for the monitoring and assessment of the Action Plan implementation

Action Plan Objective	KPI	Description
RET triggered economic recovery and green remediation	Huelva's GDP and employment rate	Economic and social impacts
	Annual investments into RET	Attractiveness of the RET sector
	Remediation of closed copper mines through integration of RE in site clean-up (of appr 2.5 million m^2 areas)	Reduction of environmental impacts of site clean up
	Number of remediation projects for brownfield and derelict industrial areas, decontamination of rivers through integration of RE in site clean up	Reduction of environmental impacts of site clean up
	Annual increase/decrease (MW) in installed RE capacity	Level of RET development
	Annual turnover of RE sector	Success and productivity of RE
	Number of partnership/symbiosis projects between RE and industry	RET penetration into industry
	CO_2 emissions reduction due to tax	Environmental and social impacts
Electrification of end-use sectors through RET integration	Annual CO_2 (Mt) avoided emissions	Environmental benefits
	% of energy generated by RET for final energy consumers	Degree of RET penetration into different sectors
	Number of electric vehicles	RE in transport sector
	Number of charging points	RE in transport sector
	Biofuel vs total fuel consumption (%)	RE in transport sector
	Share (%) of railway in freight transportation	RE in transport sector
	Number of engagement activities organized	Stakeholders participation
	Area affected by landscape alteration (km^2)	Environmental impacts
Decrease energy consumption across all sectors envisions	Primary energy intensity	Progress on energy efficiency
	% of energy efficient buildings	Degree of energy efficiency in residential and public sector
	Number of retrofitting projects and activities completed in 1 year, 5 years term	Level of public engagement
	Number of educational activities for citizens	Level of public engagement
	% of residents practicing sustainable mobility	Level of public engagement
	Number of energy poor households	Social justice
Enhance power grids flexibility and inter-connection	Degree of energy self-sufficiency (%)	Energy security
	Ratio of energy export/import for the province	Role on the energy market
	% of national and international grid interconnection	Energy security and sustainability
	Energy storage capacity (MW) in Huelva province	Energy security
	Length (km) of the energy transportation and distribution network	Progress of the enhancing electricity grid
	Grid losses	Grid efficiency
	Average duration of interruptions	Grid demand response

Conclusion

Energy sector is one of the key components of transition towards a more environmentally friendly, sustainable development approach. In the period of global ecological crises, it is crucial to lead the charge with a transformation of current energy production and consumption practices.

Huelva, with its history of industry and coal mining is now considered as a candidate for European Green Capital and energy performance is among the key indicators to be achieved by the city on the path. With its potential in renewable energy sources, the targets set to be reached at different administrative levels are more achievable. Considering the background and current situation, this report introduces an Action Plan to make the transition process more implementable and possible. The Plan proposes that the transition takes place through integration and the propagation of renewable energy within the industrial and business sectors which will first provide the economic recovery from the impacts of COVID-19 crisis and recovery from ongoing environmental impacts of past industrial and mining activities through green remediation. These goals will be achievable through involvement and active participation of key stakeholders in the leadership of the city council as the main facilitator.

Eventually, the gradual transition in the energy model towards decarbonization and broader renewable energy usage across energy consumption end-use sectors will address the emerging climate change issue, foster economic recovery of the Huelva city and province, stimulate circularity in industry and, simultaneously, will benefit the community's wellbeing.

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APPENDIX A: Energy Consumption Trends in Spain, 1990-2018

Table A.1 – Primary energy consumption in Spain, 1990-2018

	E. Primaria Total (ktep)	Carbón		Productos Petrolíferos		Gas Natural		Renovables		Residuos no renovables		Nuclear		Saldo eléctrico	
	ktep	ktep	%	ktep	%	ktep	%	ktep	%	ktep	%	ktep	%	ktep	%
1990	88.455	19.289	21,8%	43.950	49,7%	4.970	5,6%	6.222	7,0%	61	0,1%	13.999	15,8%	−36	0,0%
1991	91.891	20.064	21,8%	45.755	49,8%	5.600	6,1%	6.134	6,7%	61	0,1%	14.337	15,6%	−58	−0,1%
1992	93.747	20.448	21,8%	47.827	51,0%	5.855	6,2%	5.109	5,5%	64	0,1%	14.389	15,3%	55	0,1%
1993	90.143	18.400	20,4%	45.763	50,8%	5.743	6,4%	5.594	6,2%	72	0,1%	14.461	16,0%	109	0,1%
1994	95.306	18.968	19,9%	49.562	52,0%	6.297	6,6%	5.957	6,3%	94	0,1%	14.268	15,0%	160	0,2%
1995	102.690	19.004	18,5%	55.553	54,1%	7.722	7,5%	5.506	5,4%	214	0,2%	14.305	13,9%	386	0,4%
1996	101.342	16.062	15,8%	54.797	54,1%	8.642	8,5%	6.984	6,9%	236	0,2%	14.531	14,3%	91	0,1%
1997	107.818	18.385	17,1%	57.226	53,1%	11.308	10,5%	6.646	6,2%	253	0,2%	14.264	13,2%	−264	−0,2%
1998	113.216	17.502	15,5%	61.562	54,4%	11.609	10,3%	6.784	6,0%	250	0,2%	15.217	13,4%	293	0,3%
1999	118.690	19.615	16,5%	63.828	53,8%	13.289	11,2%	6.029	5,1%	256	0,2%	15.181	12,8%	492	0,4%
2000	124.024	20.940	16,9%	64.431	52,0%	15.219	12,3%	6.816	5,5%	190	0,2%	16.046	12,9%	382	0,3%
2001	127.283	19.172	15,1%	66.684	52,4%	16.400	12,9%	8.157	6,4%	139	0,1%	16.434	12,9%	297	0,2%
2002	130.900	21.602	16,5%	66.841	51,1%	18.751	14,3%	6.895	5,3%	97	0,1%	16.255	12,4%	458	0,4%
2003	135.461	20.133	14,9%	68.595	50,6%	21.353	15,8%	9.198	6,8%	114	0,1%	15.961	11,8%	109	0,1%
2004	141.601	21.053	14,9%	70.291	49,6%	25.172	17,8%	8.815	6,2%	122	0,1%	16.407	11,6%	−260	−0,2%
2005	144.478	20.517	14,2%	70.800	49,0%	29.844	20,7%	8.401	5,8%	189	0,1%	14.842	10,3%	−115	−0,1%
2006	144.278	17.911	12,4%	70.488	48,9%	31.233	21,6%	9.166	6,4%	252	0,2%	15.510	10,7%	−282	−0,2%
2007	146.891	20.040	13,6%	71.026	48,4%	31.784	21,6%	10.012	6,8%	309	0,2%	14.214	9,7%	−494	−0,3%
2008	141.677	13.507	9,5%	68.110	48,1%	34.910	24,6%	10.560	7,5%	328	0,2%	15.212	10,7%	−949	−0,7%
2009	130.154	9.665	7,4%	63.276	48,6%	31.225	24,0%	12.582	9,7%	319	0,2%	13.783	10,6%	−697	−0,5%
2010	129.990	7.281	5,6%	60.922	46,9%	31.129	23,9%	15.065	11,6%	174	0,1%	16.135	12,4%	−717	−0,6%
2011	129.365	12.716	9,8%	58.145	44,9%	28.936	22,4%	14.851	11,5%	195	0,2%	15.045	11,6%	−524	−0,4%
2012	128.939	15.519	12,0%	53.481	41,5%	28.574	22,2%	16.161	12,5%	176	0,1%	15.991	12,4%	−963	−0,7%
2013	120.624	11.448	9,5%	50.855	42,2%	26.163	21,7%	17.755	14,7%	200	0,2%	14.785	12,3%	−580	−0,5%
2014	117.824	11.568	9,8%	49.957	42,4%	23.666	20,1%	17.790	15,1%	204	0,2%	14.931	12,7%	−293	−0,2%
2015	122.385	13.583	11,1%	52.478	42,9%	24.538	20,0%	16.642	13,6%	252	0,2%	14.903	12,2%	−11	0,0%
2016	123.705	10.836	8,8%	54.180	43,8%	25.040	20,2%	17.481	14,1%	235	0,2%	15.273	12,3%	659	0,5%
2017	130.142	12.908	9,9%	57.300	44,0%	27.266	21,0%	16.488	12,7%	260	0,2%	15.131	11,6%	788	0,6%
2018	129.813	11.516	8,9%	57.512	44,3%	27.082	20,9%	17.944	13,8%	325	0,3%	14.479	11,2%	955	0,7%

Nota. Saldo eléctrico: Valor positivo: saldo importador; valor negativo: saldo exportador.

APPENDIX A (Continued)

Table A.2 – Final energy consumption in Spain, 1990-2018 (excluding non-energy uses)

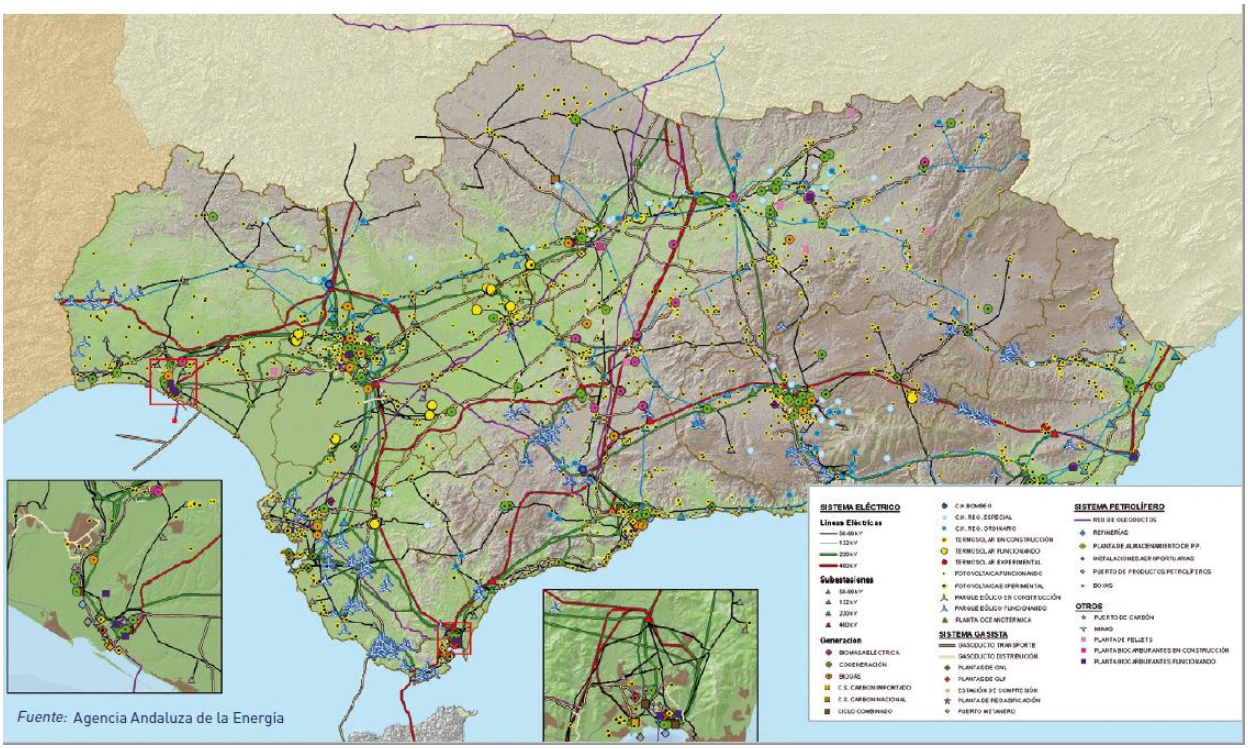
	E. Final Total (ktep)	Carbón		Productos Petrolíferos		Gas Natural		Renovables y residuos		Electricidad	
	ktep	ktep	%	ktep	%	ktep	%	ktep	%	ktep	%
1990	57.287	4.369	7,6%	34.204	59,7%	3.951	6,9%	3.946	6,9%	10.817	18,9%
1991	59.769	4.647	7,8%	36.051	60,3%	4.306	7,2%	3.704	6,2%	11.061	18,5%
1992	60.708	4.316	7,1%	37.065	61,1%	4.705	7,7%	3.379	5,6%	11.244	18,5%
1993	60.036	3.514	5,9%	36.878	61,4%	5.011	8,3%	3.396	5,7%	11.237	18,7%
1994	62.865	3.183	5,1%	39.481	62,8%	5.015	8,0%	3.410	5,4%	11.777	18,7%
1995	64.181	2.650	4,1%	39.656	61,8%	6.425	10,0%	3.334	5,2%	12.116	18,9%
1996	65.751	2.361	3,6%	40.489	61,6%	6.893	10,5%	3.353	5,1%	12.655	19,2%
1997	68.664	2.396	3,5%	41.478	60,4%	7.743	11,3%	3.372	4,9%	13.674	19,9%
1998	72.334	2.188	3,0%	43.729	60,5%	8.703	12,0%	3.511	4,9%	14.202	19,6%
1999	74.952	1.958	2,6%	44.590	59,5%	9.633	12,9%	3.530	4,7%	15.241	20,3%
2000	80.039	2.045	2,6%	46.499	58,1%	11.819	14,8%	3.471	4,3%	16.205	20,2%
2001	84.047	2.310	2,7%	47.961	57,1%	13.009	15,5%	3.488	4,1%	17.279	20,6%
2002	85.369	2.307	2,7%	48.100	56,3%	13.697	16,0%	3.595	4,2%	17.671	20,7%
2003	90.746	2.292	2,5%	50.737	55,9%	15.322	16,9%	3.659	4,0%	18.736	20,6%
2004	95.076	2.316	2,4%	52.866	55,6%	16.372	17,2%	3.689	3,9%	19.834	20,9%
2005	98.126	2.158	2,2%	53.694	54,7%	17.653	18,0%	3.793	3,9%	20.827	21,2%
2006	95.825	1.997	2,1%	53.500	55,8%	15.158	15,8%	4.007	4,2%	21.163	22,1%
2007	98.481	2.155	2,2%	54.772	55,6%	15.706	15,9%	4.284	4,4%	21.564	21,9%
2008	94.984	1.977	2,1%	51.977	54,7%	14.679	15,5%	4.417	4,7%	21.934	23,1%
2009	88.046	1.434	1,6%	47.975	54,5%	13.003	14,8%	5.017	5,7%	20.617	23,4%
2010	89.444	1.637	1,8%	47.028	52,6%	14.347	16,0%	5.384	6,0%	21.049	23,5%
2011	86.916	1.904	2,2%	44.239	50,9%	14.001	16,1%	5.834	6,7%	20.938	24,1%
2012	83.401	1.495	1,8%	40.290	48,3%	14.634	17,5%	6.323	7,6%	20.658	24,8%
2013	80.811	1.770	2,2%	39.398	48,8%	14.786	18,3%	5.073	6,3%	19.784	24,5%
2014	79.407	1.488	1,9%	38.984	49,1%	14.295	18,0%	5.130	6,5%	19.510	24,6%
2015	80.588	1.503	1,9%	40.677	50,5%	13.139	16,3%	5.317	6,6%	19.952	24,8%
2016	82.520	1.384	1,7%	42.148	51,1%	13.445	16,3%	5.550	6,7%	19.993	24,2%
2017	84.899	1.662	2,0%	43.387	51,1%	13.486	15,9%	5.806	6,8%	20.559	24,2%
2018	86.883	1.538	1,8%	44.315	51,0%	14.271	16,4%	6.254	7,2%	20.504	23,6%

APPENDIX B: Electricity Generation with RET in Huelva Province (30/06/2020)

Facility*	Municipality	Capacity (MW)
Electricity generation from biomass		
ENCE I	Huelva	40.95
BIOMASA ENCE	Huelva	50.00
ENCE HUELVA II	Huelva	46.00
Total		136.95
Electricity generation from biogas		
EDAR Huelva	Huelva	0.25
Total		0.25
Wind		
Saucito	Alosno	30.20
Tharsis	Alosno	4.25
Montegordo	Iyomante	48.00
Retuerta (La)	El Almendro	38.00
Tallisca (La)	El Almendro	40.00
Valdefuentes	El Almendro	28.00
Granado (El)	El Granado	14.45
Sardón (El)	El Granado	25.50
Cabezas (Las)	Puebla de Guzmán	17.40
Centenar (El)	Puebla de Guzmán	40.00
Majal Alto	Puebla de Guzmán	50.00
Lirios (Los)	San Silvestre de Guzmán	48.00
Total		383.80
Hydropower		
Chanza	Granado (El)	5.00
Aracena	Puerto-Moral	5.00
Zufre	Zufre	5.00
Chanza	Granado (El)	5.00
Total		15.00
Other technologies		
Enagás (oceanotérmica)	Palos de la Frontera	4.5
Total		4.5

* Provided list does not include PV installations due to its high number in the region. Source: adapted from (Agencia Andaluza de la Energia, 2020)

APPENDIX C: Map of energy infrastructure in Andalucia region



Fuente: Agencia Andaluza de la Energía

ASSESSMENT OF URBAN OPEN & GREEN SPACES IN HUELVA
IN CONTEXT OF
EUROPEAN GREEN CAPITAL

Prepared by:
Nadin Iskenderoglu
Nichamon Rattanakijanant
Raju Sethupatu Bala
Shifana Simath

MUrCS
Master in Urban Climate & Sustainability

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APPENDICES

1 INTRODUCTION

This report encompasses a critical assessment of current challenges and opportunities encountered in Huelva in terms of open/green spaces and recommends a path for comprehensive change towards the European Green Capital Award 2023.

Huelva city is in Andalusia region of Spain, in between two rivers. The below google earth image (Figure 1-1) gives an overview to the city in a general context.

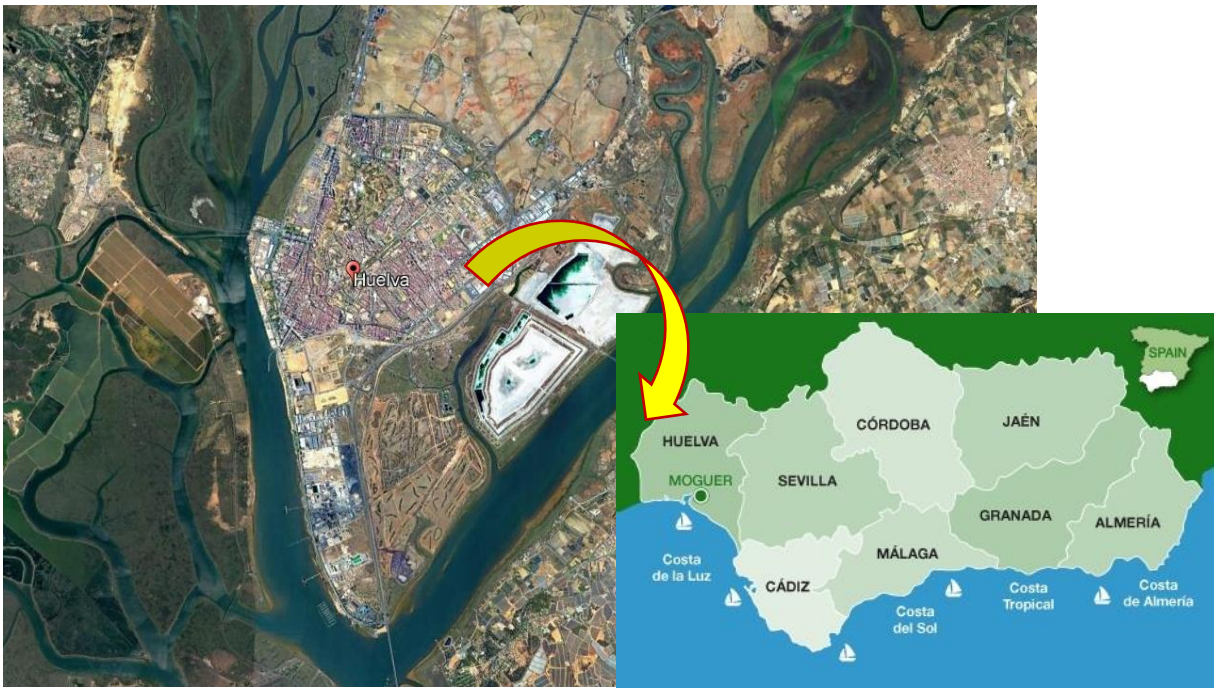

Figure 1-1 Geographical Map and the Location of Huelva Municipality in Andalucia Region

2 BACKGROUND INFORMATION AND ANALYSIS

2.1 General Overview

General information on the city of Huelva, in general context as well as industrial history and existing open spaces are summarized in the below Figure 2-1.

			
General Context • Huelva is located at southwest of Spain at Andalusia region. •Surroundings consist; rivers, coastline, agricultural lands, mining sites, natural reserved areas. •It has a decreasing population •Economic conditions are weak; GDP is declining. •Downstream location make it prone to water pollution from upstream. •Hot summer brings drought, but warmer climate increase the rainfall in winter.	**Industrial and Landchange History** • Huelva is Spain's one of the oldest industrialized cities. • City has been subject of mining activities with its valuable copper mines. • Mining activities caused high environmental pollution in the city. • Huelva still harbours to large industrial areas eg. chemical & petrochemical industries, copper refinery •The paved Urban area and intensive used of shoreline, enanger the city to urban runoff, rising temperature, and extreme events like drought, flood and heatwaves.	**Existing Open Space Typologies** • There are various type of open spaces in Huelva, which are; • Green parks and gardens • Open Squares / Pedestrian walkways /Cycle lanes • Streets • Stadiums and playgrounds • Open parking lots	**Legal Framework** • Central Government is responsible for the basic legislation of protected natural areas in Spain. • However, the declaration and management of these corresponds to the regions. • National Parks are declared by the Parliament Act and subject to the Law on National Parks Network. • This law is further incorporated into the Habitats Directive, from which the Natura 2000 Network comes from.

Figure 2-1 General Information About the City of Huelva

2.2 Urban Open Spaces in Huelva

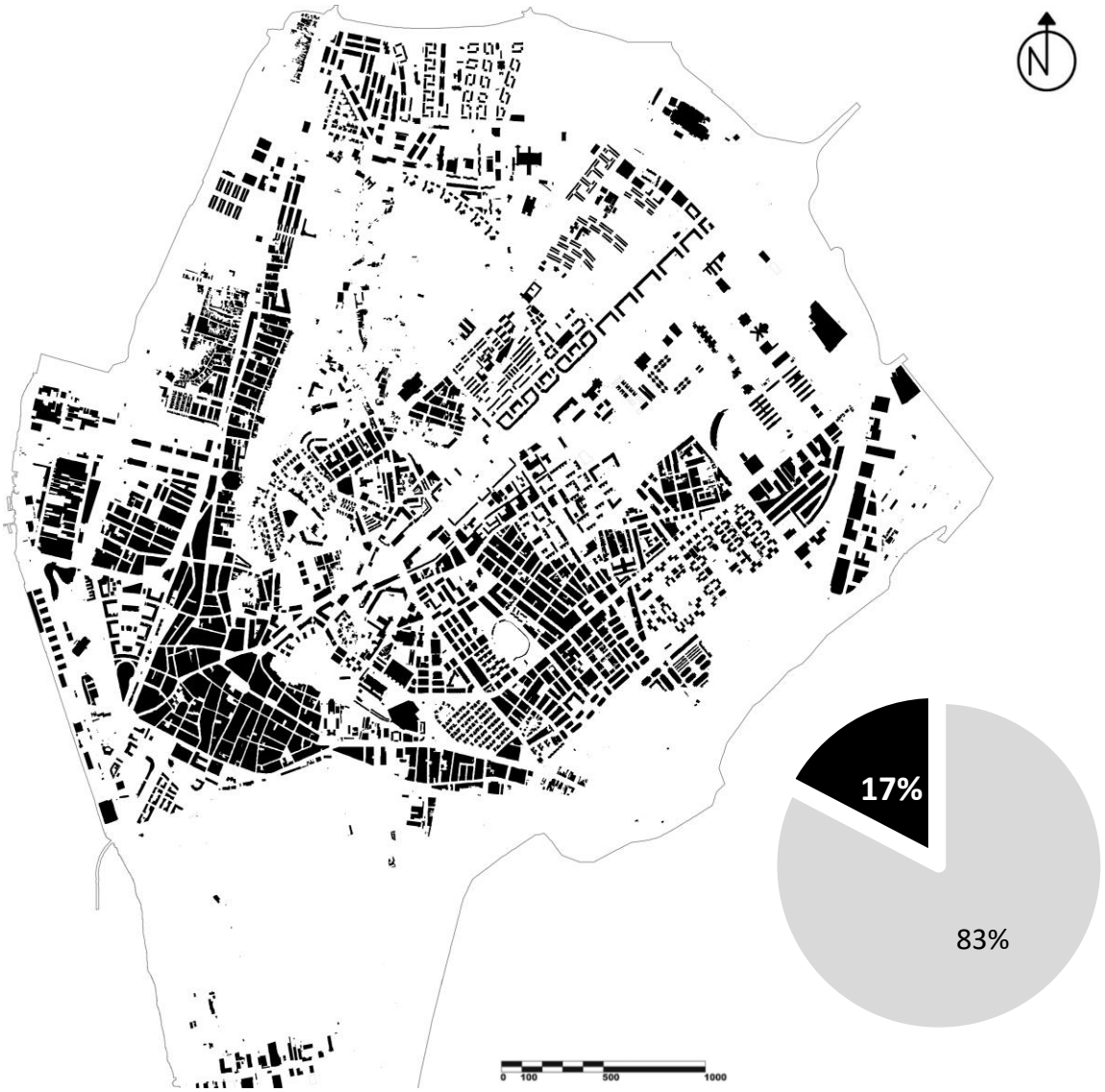

Figure 2-2 Built vs Open map, Huelva

The built vs open map above (Figure 2-2) illustrates the number of open spaces in the city. The Huelva city, including the industries on the south comprises of 17.3 km². Out of which, around 3 km² are built and remaining 14.3 km² are open. That is 83% of the city is Open. This includes, streets, public parks and gardens, school grounds, open private spaces between buildings, public squares etc. This numbers were derived from the city drawings, provided by the Architects association of Huelva.

2.2.1 Accessibility of Open Spaces

Figure 2-3 Radius Analysis, Public Open/Green spaces Huelva

Existing public open squares and parks, which enrich the social, economic, and environmental aspects of Huelva, are marked on the above map and a radius analysis was performed to understand the accessibility of this public spaces (Figure 2-3). Although, 83% of the city consists of open spaces, some part of the city has accessibility issues to the public open/green spaces. This is evident from the above map. The red squares on the map marks the location of the existing public open/green spaces of the city and each corresponding yellow circle are 500 m catchment radius.

2.2.2 Different open space typologies of the city and Sustainability:

2.2.2.1 Social Benefits

As a social breathing space, a vital part of open green areas in Huelva city provides including large parks, many outdoor pockets even within the neighbourhood, for social inclusion, recreation, and education opportunities, creating a healthy setting with community pride with a range of other physical and psychological benefits. Restaurants and cafeterias extending the dining activities to the outdoor spaces are one of the notable and successful aspects in Huelva.

2.2.2.2 Environmental Benefits

Green areas in Huelva provide a range of environmental benefits including pollution reduction, moderating urban climate, controlling urban-water runoff where permeable grounds, screening noise and obtrusive views etc. However, more environmental benefits can be achieved by upgrading green and open spaces within the city limits.

2.2.2.3 Economic Benefits

Economic benefits of green spaces can be perceived in two categories:

i. On-site benefits such as employment opportunities, revenue generation related to green parks and open spaces, and
ii. Off-site benefits including high nearby property value, economic regeneration through attracting and retaining tourism. This is a crucial aspect to be considered as Huelva has been gone through a financial crisis.

2.2.3 Different Open Space Typologies of the City and European Green Capital Parameters

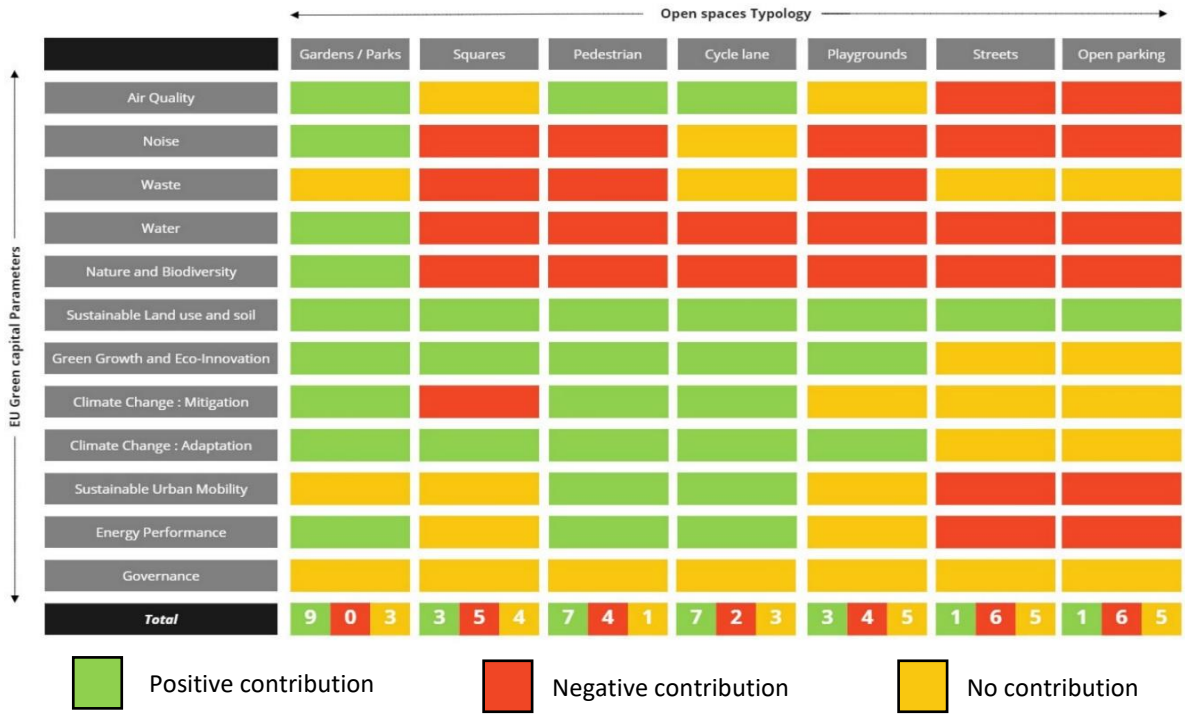

Figure 2-4 European Green Capital Parameters vs Open Space Typologies

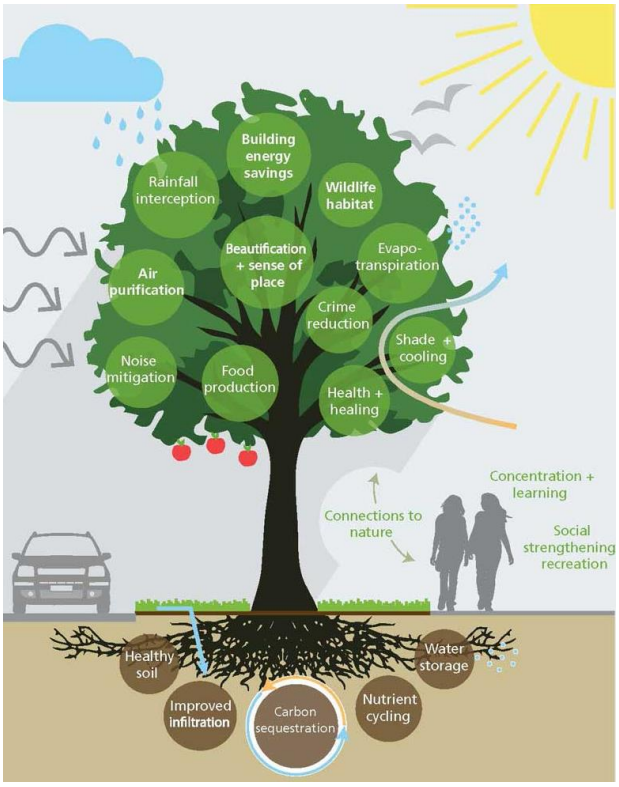

Figure 2-5 Benefits of Urban Green

As mentioned earlier, the city of Huelva has many different open space typologies. However, to understand which type of open space will help to achieve the European green capital tag, the above analysis was performed (Figure 2-4). The open space typology of the city is placed on the X axis and the European green capital's 12 parameters are placed along the Y axis. With the consideration of different theories, if a particular typology has a positive contribution towards a parameter it is marked green. Similarly, the negative contributions were marked in red and No contributions as Yellow.

It is very much clear from the analysis that "gardens and parks" have more positive contributions compared to the other open space typologies, towards achieving the European green capital award 2023.

2.3 Existing Green Areas and Natural Environment in Huelva

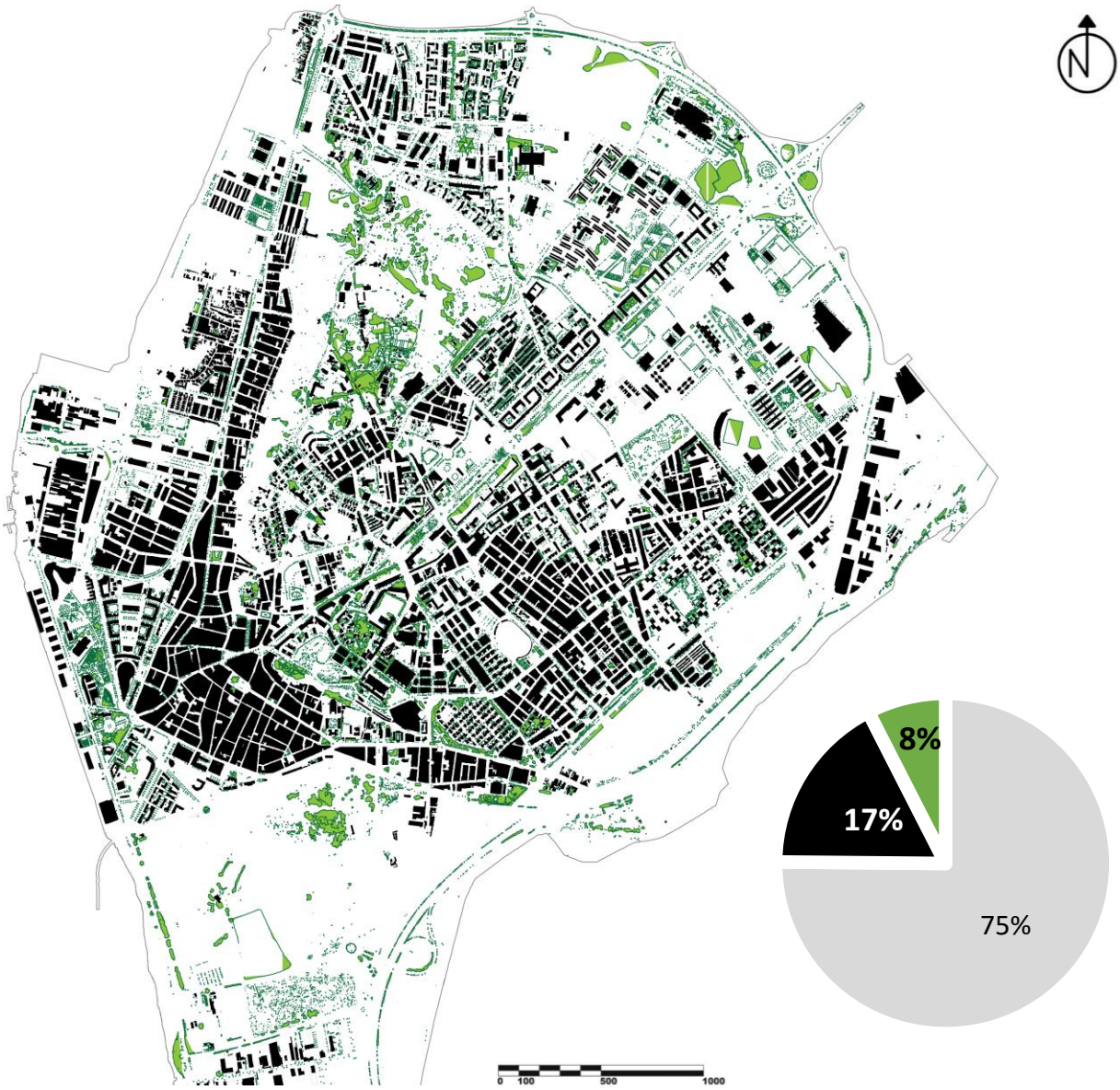

Figure 2-6 Map Showing the Urban Green Spaces within the City of Huelva

The map given in Figure 2-6 illustrates the urban green spaces within the city. Even through the city has 83% of open spaces, out of which only 8% are green spaces, such as gardens and parks. Hence, to achieve the European green capital status, the green spaces in the city must be increased with good access from any part of the city.

Huelva has a total of 1,303,043.08 m^2 of green spaces across the city, 350,000 m^2 of which consists of lawns, those are scattered in urban green areas, forests, flowerbeds, and squares etc. Green areas throughout the city have 31,000 trees, 578 plant pots and planters. The detailed surface areas of green spaces are given in the below Table 2-1.

Table 2-1 Surface Areas of the Green Spaces in Huelva

Types of Green Areas	Number	Surface (m^2)
Boulevards	4	69,751.75
Cemetery Gardens	1	18,280.53
Islets	10	11,523.12
Historic Garden	1	3,516.82
Halfways	19	28,799.28
Forest Parks	1	285,975.71
Urban Parks	20	415,371.98
Parterre (Flowerbed)	158	257,611.61
Squares	73	153,895.97
Rotary Intersections	40	58,316.31
TOTAL	**327**	**1,303,043.08**

Source: Strategy Plan of Huelva: Strategy for 2025 (Municipality of Huelva, 2016)

There are some urban parks and green spaces in the city of Huelva, among these, Park Moret is one of the most important parks with its size and feature of being the lungs of the city.

Currently, Park Moret is one of the greenest spaces in the city and the Ministry of Huelva has developed different plans and strategies to strengthen its social value (Municipality of Huelva, n.d.). "Plan Eje", one of the plans created within this scope, enabled Park Moret to host many activities ranging from environment, entertainment, adventure, exercising and healthy living to educational purposes.

As can be seen from the Park Moret example, given in Figure 2-7, it is being used by citizens for different activities, such as cycling, walking, spending leisure time, exercising, skating, barbeque, organic farming, children playground etc.

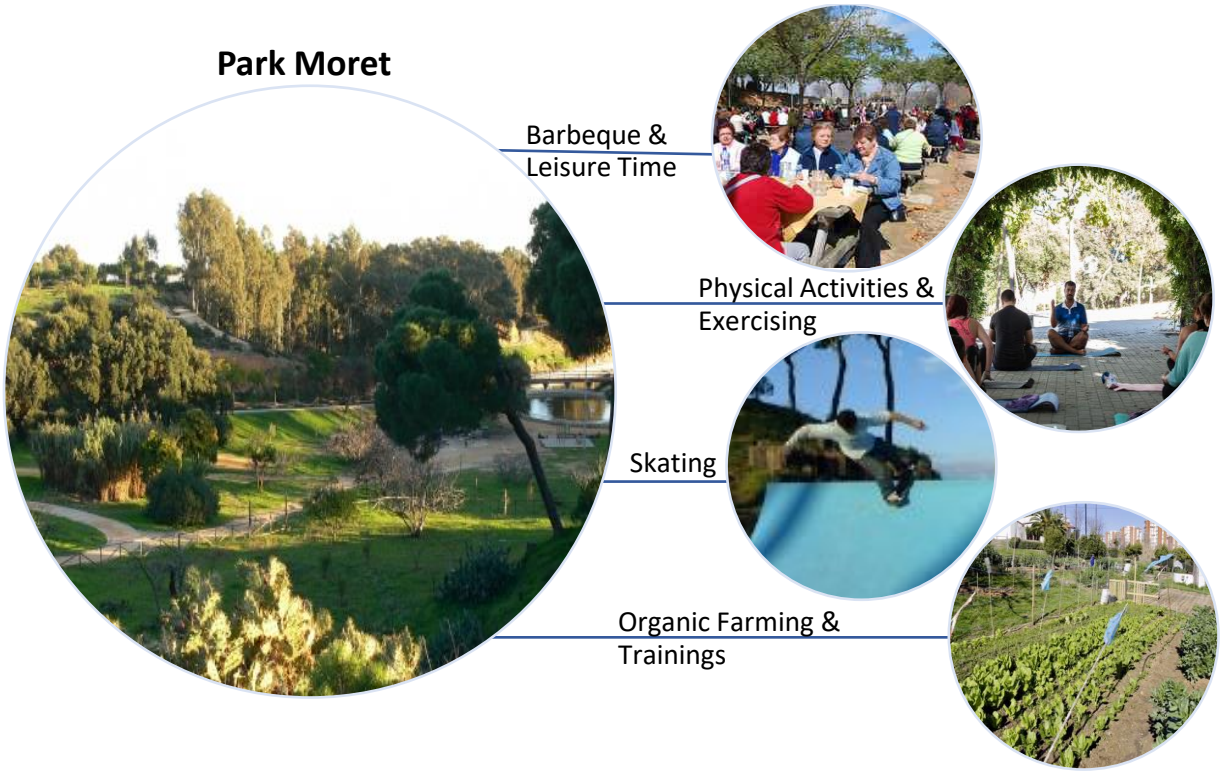

Figure 2-7 Types of Activities Performed in Park Moret

Apart from the urban green parks, Huelva is home to several protected national parks with a wide variety of biodiversity in terms of both flora and fauna.

Doñana Natural Park is one of the foremost important one among those and it is even considered one of the most important protected areas in Europe for its essential role in being the crossroads for migratory bird routes between the Africa and Europe continents and consisting the highest biodiversity (Doñana Reservas, n.d.).

Paraje Natural Marismas del Odiel, is the second important natural zones in Huelva declared by UNESCO as a Special Protection Area for Birds and Biosphere Reserve. This protected area is home to a wide variety of species, with its marshy nature and salt flats (Municipality of Huelva, 2016).

These national parks are one of the most popular natural attractions for national and international tourists in terms of their unique landscapes, flora, and fauna, and especially bird observatories, and in this sense, they offer tourists different outdoor activities.

2.4 Current Projects and Commitments of Municipality of Huelva

Urban green areas are essential not only to improve public health and quality of life in cities, but also to provide a healthy environment, especially in cities with industrial characteristics such as Huelva.

There are several projects and programs acknowledged by Municipality of Huelva under the Huelva Strategy Plan for 2025, to tackle with air pollution, and to ensure public health, social wellbeing, and quality of life in the city. The current initiatives are briefly described in Figure 2-8.

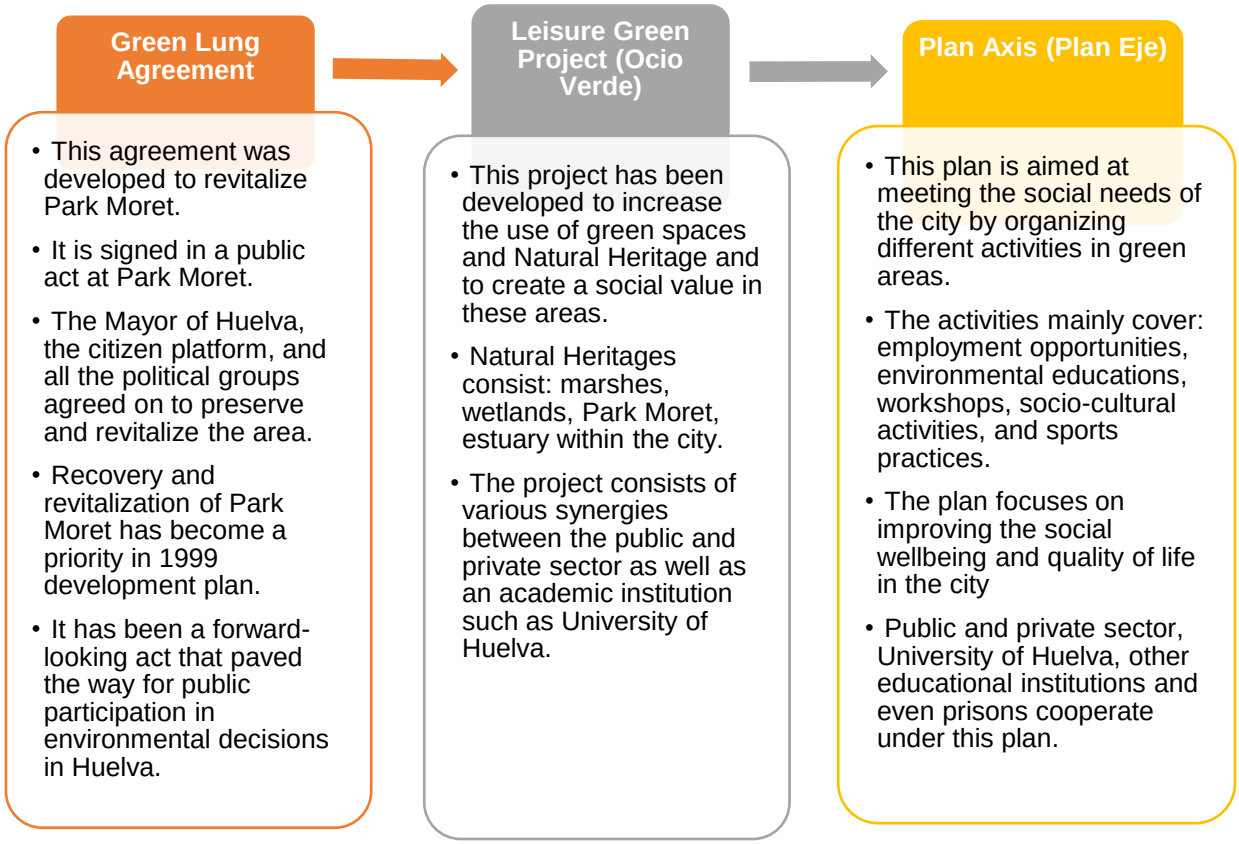

Figure 2-8 Current Projects and Commitments of Municipality for Green Spaces

2.5 Economy, Funding Allocation, and Incentives for Change

Andalucía has currently bear impact of economy crisis impact, internally and externally. The region economic structures have been dependent on agriculture, construction, and services (OECD, 2016; & Salcedo, 2010). Reported a higher unemployment rate, has rooted from low skills (OECD, 2016) and depleting green resources (Salcedo, 2010).

Accordingly, the Government National Budget 2021 contains the largest allocation to socio-economic reconstruction, emphasize the importance of this sector in sustainable development (Council of Ministers, 2020).

Despite the cut in Natura2000 for biodiversity, the budget for sustainability enhancement included-free and circular economic project (Council of Ministers, 2020). For example, the Green taxation has been used as incentive and penalty system. Although currently it has not created revenue and the tax discount does not directly cover open/green space project, it shows possibility for integration and a dedication for change.

Another probable source is the European fund under European Green Deal, to move forward resilient infrastructures, ecosystems models, and digital transition including green recovery post COVID-19 (European Commission, 2020). Not to mention European Investment Bank for green investment, that is currently team up with Barcelona for 2050's regeneration (Knight, 2020).

Huelva is ambition for change as described in Section 2.4. But for the lack of solid delivering plan and stakeholder engagement, it needs comprehensively paradigm shift in human capital development, ecosystem, and digitalization, in order to access the available resources.

3 FORESIGHTING, BACKCASTING & VISION DEVELOPMENT

3.1 PESTEL Analysis

The PESTEL analysis is a straightforward tool which is used to assess and identify the key external drivers at the macro context, which will evaluate the external influences on a project. PESTEL holds for Political, Economic, Social, Technological, Environmental and Legal aspects in the external environment of a development, which can impact its actions or performance. As such, Pestel analysis for Huelva city in terms of green/ open spaces carried out (refer Appendix 1) aiming to identify the existing positive, and negative forces that affect the future and to manipulate the threats and grab the opportunities. And this study was done based on the materials available, in-depth discussion with the professionals and vigilant observations. Hence, the main outcome identified of Pestel analysis is a broader understanding of the green and open spaces of Huelva, which can be redirected to predict the future and to develop the scenarios.

The political climate of the Huelva city is unstable, and it was identified that there is no strong political will for Huelva municipality towards improving green spaces in the city. However, there are international commitments across the European Union, and Andalusian government regarding improving and preserving green spaces. Green spaces in Huelva improve the air quality, ecosystem, mitigate UHI and help to combat climate change. Especially park Moret, park Zafra and Andalusia avenue act as the social heart of the Huelva communities containing children play areas, jogging tracks, and including activities such as barbeque activities, social gathering, dog walks etc. Further, these outdoor spaces are used for educational purposes. And tree belts along the streets give shading and promote walkability and cycling. Though these parks and open areas are highly active social spaces, the maintenance of these spaces is inferior, which needs immediate actions.

Moreover, the use of technology for the irrigation system and improving or maintaining green spaces found very lacking. However, innovative construction with material selection and methods are sprouting which are being performed in park Moret recent improvements. Less budget allocation for green spaces which reflects the weak economic conditions in Huelva city as described in Section 2.5. Further, vacant lands are identified and being developed as a housing scheme by the local authorities as to earn profit which is a burning issue currently in terms of ecological perspective. Current green spaces create commercial value to adjacent lands and have the potential in creating revenue on tourism in future, even though currently tourism in Huelva negatively impacted due to Covid-19 Pandemic.

In terms of legislative context, Spain has been committed to Paris Agreement (Nationally Determined Contribution), and Huelva has commitments on climate mitigation and adaptation through the global covenant of mayors for climate & energy (GCoM, n.d.). But environmental legislations, green taxation law is not well performed.

3.2 Scenario Development

As revealed in PESTEL, the current situation of Huelva consists such key issues; problems in budget allocations to the projects due to political instability and poor economic conditions, decreasing population leads to an increase in derelict lands and green/open spaces in the city, mindset of the city council and lack of environmental awareness across the city.

In accordance with these identified key drivers, three scenario profiles were followed to develop future scenarios for Huelva. The three profiles followed in scenario development can be defined as follows.

- **Alpha (more than expected):** In this scenario, it is assumed that the current situation in Huelva will be triggered.
- **Beta (less than expected):** In this future scenario, it is assumed that the key drivers will be slightly lessened than the current situation in Huelva.
- **Gamma (different than expected):** In this scenario, it is assumed that the key drivers will shape in a different direction from Huelva's current situation.

Alpha (more than expected)	Beta (less than expected)	Gamma (different than expected)
• High political instability, no budget allocations to urban green projects • Economic collapse resulting financial incapability for investments • Increasing derelict due to decreasing population • Polluted open/green spaces, causing rodents&insects, highly disturbing the residents, spoiling tourism • Polluted open/green spaces endanger water resources • Vulnerable to climate change impacts with limited and degraded green areas • City council seeking profits from any open spaces to earn incomes • Less technology- slow the process • Strategies & action plans focusing on economic development • No environmental awareness & responsibility • Destroyed urban ecosystem, biodiversity loss • Weak urban planning & inefficient landuse, fragmanted and unevenly distributed green spaces	• Less political instability, leading limited budget allocations to urban green projects • Economy - financial capability for investments to some extent • Decrease in population will lead to abandoned buildings, less people in open/green spaces • Open/green spaces in a better condition, occasionally observed pollution problems • Better preserved green spaces leading to better air & water quality • Increasing urban resilience • City council is still seeking profits from some vacant lots, but the mindset is shifting towards investing in urban green spaces more • Technological development is stable • Strategies & action plans focusing on economic development, but also emphasizing green growth • Lack of environmental awareness & responsibility is still an issue, but slightly improving • Urban planning and land use might improve, more attention might be paid to open/green spaces	• High political stability, leading higher budget allocations to urban green projects • Strong economy - financially powerful for investments • Well-maintained urban green spaces • Increase in population leads to city expansion/densification-requirement for more open/green spaces • Higher climate resilience • Increased air & water quality • Change in mindset regarding green preservation in the city • City Council fully supports and invests heavily in urban green growth • Technological development - Innovative technologies • Strategies & actions plans focusing on sustainable development, mainly emphasizing green growth • High environmental awareness & responsibility across the city • Enhanced urban biodiversity and ecosystem • Sustainable landuse and urban planning

Figure 3-1 Developed Future Scenarios for the City of Huelva

Each developed scenario for Huelva is summarized in Figure 3-1, and detailed under the subsections below to comprehensively understand the drivers and possible futures.

3.2.1 Scenario-1 Alpha

This future scenario is built on triggering Huelva's existing key drivers. In line with this scenario, it is assumed that there will be high political instability and economic collapse in Huelva, resulting in financial incapability for the necessary investments. Accordingly, economic development will be prioritized in strategies and action plans and urban green growth will be pushed to the background, which will further stimulate the city council's desire to profit from open/green spaces in Huelva.

The number of derelict lands will be increased by the decreasing population across the city, and the lack of environmental awareness and responsibility of inhabitants will exacerbate the current conditions of these lands by causing a limited number of preserved green areas in the city. There will be technological gaps in Huelva and maintenance & monitoring of the green spaces will not be possible due to the weak technology.

The vacant lots, derelict lands, open and green spaces in the city will be highly polluted and infected by rodents and insects, which will disturb the residents of the surrounding area and spoil the tourism in Huelva. In addition, pollution of green spaces will endanger the water resources and aquatic ecosystem surrounding the city, as well as cause a loss of biodiversity due to the destruction of the ecosystem in these green areas.

Furthermore, urban planning and land use will be inefficient, and green areas will be fragmented and unevenly distributed throughout the city. The limited and degraded green spaces will cause vulnerability in the city in terms of climate change.

3.2.2 Scenario-2 Beta

This future scenario is built on weakening the existing key drivers in Huelva. Under this scenario, it is assumed that there will be less political instability than the current condition, and the economy will be financially capable, allowing limited budget allocations to urban green projects and necessary investments. Due to the existing weak financial conditions, the strategies and action plans will focus mainly on economic growth and development, while highlighting and referring to urban green growth.

The number of abandoned buildings will increase with the decreasing population in the city, and less people will benefit from open/green spaces due to the declining trend.

In the scenario, environmental awareness and responsibility will still pose a problem within the city, however, it will be improving and will be better than the current situation. More environmentally conscious individuals will ensure better conservation of open/green spaces, which will reduce environmental pollution, improve water, and air quality through green growth in the city. The city council will still be seeking profits with the current mindset; nevertheless, the environmental awareness will broaden the city council's perspective on open/green spaces and allow the mindset to start shifting towards urban green growth.

In addition, urban planning and land use will be improved and more emphasis will be placed on open/green spaces within the city, by the gradually raising environmental awareness. Better conservation of urban green spaces and the recognition of the importance of green growth will increase the urban climate resilience of the city.

Technological development in Huelva will be stable, and it will have no impacts on maintenance and monitoring of green spaces, neither accelerating nor slowing the activities.

3.2.3 Scenario-3 Gamma

In this scenario, it is assumed that the key drivers will follow a different path than the existing. In this context, unlike other scenarios, high political stability and a strong economy were assumed for this scenario, which will make Huelva financially strong and will allow high budget allocations to urban green projects and investments.

Furthermore, with the increasing population in the city, urban expansion and densification will be observed and the number of vacant lands available for public open/green areas will decrease.

In this scenario, high environmental awareness and responsibility will be achieved throughout the city. Environmentally conscious citizens will prevent the environmental pollution, ensure full conservation of open/green spaces; and it will contribute to urban green growth that will improve the urban biodiversity and ecosystem, as well as air and water quality.

By the full awareness and change in mindsets on the significance of green, the city council will promote and invest heavily in urban green growth, which will pave the way for “the green hub Huelva.” In addition, well preserved urban green spaces and boosted green growth will also increase the urban climate resilience of the city.

With the strong economy and full environmental awareness achieved in Huelva, strategies and action plans will focus on sustainable development by emphasizing urban green growth. In this way, sustainable land use will be recognized, and better management of urban planning in terms of brown/greenfield and open/green spaces will be achieved in Huelva.

Moreover, it is also assumed that there will be a technological development in Huelva that will bring along innovative technologies in terms of maintenance and monitoring of green spaces.

3.3 SWOT Analysis for the Scenarios

To systematically analyse the alternative futures derived in Section 3.2, SWOT identified the key factors for the development of each scenario. Table 3-1, Table 3-2 and Table 3-3 describes SWOT of scenario Alpha, Beta, and Gamma, respectively.

Accordingly, while Alpha and Gamma bring forward the probable extremity of measures to achieve European Green Capital, Beta otherwise has potential for gradual development.

In Alpha (Table 3-1) most development will require international funding and NGOs movements due to recession. However, the strengths associate with a plausible shift toward a sustainable lifestyle, as well as the inability to perform harmful industries that currently polluting the existing greens. The recession circumstance could be matched with the opportunities for a natural re-establishment by the ecosystem itself. The overflowing land supplies resulting in cheaper land price, offer a possibility for revenue and jobs, attracting supportive projects from abroad such as a land lease for CSR, or other green growth. But in turn, might also attract unwanted business. Cost for safeness, health care, and environment would be too high for Huelva, where the unhealthy ecosystem is too vulnerable to promote their ecosystem service.

Scenario Beta (Table 3-2) highlighted the probable transition to a higher quality of urban green growth, activating ability for conservation, technological integration, place-making, comprehensive policies, and awareness raising upon green/open space. The semi-improvement could be opportunities for boosting business such as touristic model along with urban land use transformation, to benefit both community and local economy. Nonetheless, the development is likely to emphasize city beautification rather than ecosystem services integration. The governance that is in the transitioning phase is prone to threats like built-up pressure due to- city expansion,

Gamma development (Table 3-3) is radical, aiming for the full strength of sustainability to be built around an empowered community and their engagement. Strengthening and enhancing green growth quality in correlation to self-efficient lifestyle. In the process, it will boost the possibility for job-related to green/open space. Such drivers will give Huelva a basis for long-lasting resiliency than Alpha and Beta. Although, Gamma scenario could be weakened if several questions are not addressed. As for examples included the balanced of nature and human-modified landscape, the rising pressure from density gain, and monitoring challenge for the increased green/open space. As the city is always changing, Gamma Huelva must be constantly prepared against external threats such as second-hand pollution, climate change, and global economic crisis.

As for the investment possibility, Alpha, Beta, and Gamma put a strain on the government from lesser to a greater amount. There is a plausible cause to get a subsidy and/or partnership from EU and/or other for the Alpha, while Gamma prosperity requires a much stronger policy that will include biodiversity into economic sector.

Aiming for Huelva Green Capital 2023 foresight, scenario Gamma has shown most potential achieving the goal, therefore it was chosen.

3.3.1 Scenario-1 Alpha

Table 3-1 SWOT Matrix of Scenario-1 Alpha

Strengths	Weaknesses
○ Less strain on government budget ○ Motivate local NGOs and activists ○ Lessen excessive raw materials consumption from the natural green due to recession ○ Recession causes a shift to cheaper and greener mobility like cycling or walking. When fossil fuel is unaffordable ○ Put a stop to the city council's high environmental impact projects such as Logistic hub (Puerto Huelva, 2019)	○ Increasing land supply but decreasing demand, lowering the land price ○ Cheaper lands attract industrial allocation from abroad ○ Crime risk due to a low standard and/or under maintenance space ○ Attract squatters and spontaneous settlements ○ Health impact from polluted green e.g., the contaminants s enters the food chain and water supply ○ Carbon sink efficiency lost in the urban area, fail to meet NDCs against the global warming ○ Scarcity of clean water ○ Intensify land transformation by local farmers to meet the higher demand for provision ○ Slow action towards emergency happen to existing greens due to lack of technology ○ Existing green maintenance put a burden on the government ○ No environmental awareness & responsibility
Opportunities	**Threats**
○ Natural re-establishment of local vegetation on the vacant bare lands ○ Natural green has a period for recovery, an opportunity for carbon sink gain in nature ○ Integrate with other sustainable sectors abroad e.g., leasing space for solar PV which create green jobs in the process ○ Collaboration in PPP manner for restoration projects such as CSR, etc. ○ More supports from the EU ○ Streets and vehicular space reconsideration, adapting to support greener and cheaper mobility ○ Other sustainable lifestyle in some aspect e.g., domestic edible garden	○ Vulnerable to climate change and extreme seasonal events ○ Political chaos and long-term recession ○ Decreasing population, likely to be more abandoned by the young and working adults ○ Job slows down ○ Significance of the city fading

3.3.2 Scenario-2 Beta

Table 3-2 SWOT Matrix of Scenario-2 Beta

Strengths	Weaknesses
○ Partial supports from the EU ○ Local NGOs, activists & citizen participation in the next step of environmental enhancement rather than the basic ○ Preserves and maintains large greens, improve biodiversity ○ Transition to the growth of quality green pockets and squares from vacant lots. ○ Encourage access and benefit the locals, socially and commercially ○ Transition to placemaking, creating a tighter community connection decrease unsafeness ○ Local identity emphasized by the outdoor lifestyle ○ Several ecosystem services gains activate quality of climate mitigation ○ Strategies & action plans integration ○ Transition to technological integration for maintenance, monitoring, and emergency support ○ Mindset is shifting towards investing in urban green spaces	○ Little to non-profit in the green investment burden government with an extra budget which is unsustainable ○ Likely to prioritize a "city beautification" of urban and landscape design for tourism or other commercial business, rather than sustainability ○ Unable to benefits from the full potential of ecosystem services ○ Commercial growth replaces open space to boost economic ○ A decrease in population will lead to abundant buildings and fewer people in open and green spaces. ○ Policy not strong enough to increase carbon sink against global warming
Opportunities	**Threats**
○ Green/Open space as tourists' attraction to boost the economy ○ Possibility for low-cost citizen's projects ○ Urban greening opportunity upon natural rehabilitation with some manipulation ○ Municipal exercise some control over stakeholders for high-quality but profitable open space ○ Promotion of social & educational programs on environmental awareness, responsibility ○ Land use regulation improvement possibility	○ Vulnerable to climate change and extreme seasonal events ○ Further decrease in population number ○ Political instability and global economic slowdown ○ The building pressure on green/open spaces due to the city council's point of view & urban expansion

3.3.3 Scenario-3 Gamma

Table 3-3 SWOT Matrix of Scenario-3 Gamma

Strengths	Weaknesses
○ High quality of life and social wellbeing ○ High environmental awareness and responsibility across the city and sustainable lifestyle ○ Good environmental quality in urban built environment ○ Sustainable land use & urban planning ○ Climate resilience through urban green growth	○ For greenings need a baseline for natural recovery and man-manipulation ○ Facing density gain, the balance of open space and building footprint requires a comprehensive regulation ○ Sustainable maintenance and monitoring are challenging
Opportunities	**Threats**
○ EU Green Capital ○ Green Hub ○ A centre of attraction with its natural beauties, national parks, and rich biodiversity ○ Green jobs related with increased green spaces ○ Self-efficient production can be promoted e.g., urban farming, can reduce carbon footprint ○ Promotion of blue-green infrastructure	○ Less international financial support for investments ○ Climate change is a global issue, Huelva needs to be continually adapting ○ Possibility to develop larger carbon footprint as the city progress ○ Huelva location is still prone to water contamination and other water-related issues from the unsustainable headwater management ○ High capital costs of transition

3.4 Objectives

- Promoting **citizen participation, cultural and educative initiatives** and **increase community awareness in** the importance of green and open spaces.
- Initiating and promoting **strategies and action plans** to enhance the green spaces**,** which includes green initiative programs and maintenance plans.
- Fostering the convergence of the green/open spaces planning to **achieve sustainable land use** pattern within the city identifying potential lands for new green spaces while strengthening the presence of existing green spaces in environmental and urban policies
- Promoting **new stakeholder engagement pattern** to achieve the required change management to encourage and sustain the green spaces in Huelva city.
- Integrate **technological innovation** when designing and maintaining green spaces.
- **Securing financial support** by creating partnership financing, tax policies and planning short-term and long- term investment plans.

3.5 Backcasting

The generated scenario for future Huelva, the backcasting method was carried out to presented sustainability strategies in achieving green/open space objectives (Section 3.4). As a tool, the mind mapping was applied for the envisioning process.

As assessed in Section 2, the current situation revealed a large gap which requires a radical strategy. Together with, incremental projects considering that Huelva has limited resources and equipment.

The three pillars of sustainability are referred to, for projecting the feasible ideas in manipulating the threats of the current situation while maximize the opportunities.

Social projection mainly explores the tools to balance the influence of relevant stakeholder based on bottom-up governance. Found the vital need for social reconstruction at the foundation level like awareness and education. In this way, the citizen would understand their roles stepping towards their rightful opportunities to receive viable green/ open spaces and their given benefits. This knowledge will influence the citizen's choice to vote for the environmental sounds policy that is still lacking.

On the economic aspect, as analysed, Spain has faced economic downfall where Gamma foresight the exponential growth and strong financial support. In this case, the change in the economy cannot be restructured under a short period as it depends on the number of factors. Hence, incrementally, Huelva requires a solid economy policy to pave away from instability.

The change in stakeholder engagement needs to be made (see Section 4.2). Physically, the change could build on the current open/green space and local business relationship in the form of public amenities, emphasizing the multipurpose use of spaces.

Envisioned opportunity included the growth of green/open space, which will attract knowledge-based green employment. The kick-start-low-cost of green business model could be expected with some manipulation from the government under legislation reformed. However, the big investment is significant. When envisioned a more innovative city that most business and services might shift to the online platform rather than using the land for big commercial. This could be an opportunity for renewables energy investment (locally or from abroad) in green space, or other crossover such as tourism etc., it could generate revenues.

Interrelate with the socio-environment sector, Andalucia economic structures have been overly dependent on the intensive use of land especially the coast to satisfy the demand at the expense of greens and natural resources (Salcedo, 2010). The circumstance increased recovery costs that meeting the sustainable land use objective will be challenging - it means that business as usual is no longer appropriate. Huelva requires a radical change in land utilization beyond landscaping. Tapping into a circular economy is the key, based on the smart consumption and management of available land by focus on remediation of natural features, especially water riparian and the reuse of brownfields.

For ecological backcasting, one of the concerning issues is the Paris agreement 2050's zero-emission, which reflected in Gamma's goal for "the urban climate resilience in the city". As such, the existing green/open space contribution to carbon sink is inefficient, not to mention the low biodiversity in an urban area in the absence of ecosystem services. The ambition for enhancement, could be built upon

the existing (but limited) green infrastructure (Park Moret, Andalucia green corridor, etc.). To be overlaid by blue infrastructure, creating climate adaptation, and emergency plan upon water, air, and soil. The greens must be connected, evenly distributed across the city, and accessible for all citizen and small wildlife.

The green enhancement needs to understand the construction and maintenance price that come with. To be feasible, Huelva needs to make the most out of money support described in Section 2.5. But at the same time, the deep knowledge of climate and forestry should be integrated. First is nature has the ability to re-established itself if taken away the hard paving and connected with water resources. With some extent of landscape manipulation to make it suitable for use, the city council could add into city planning, a designated area for a natural green re-establishment, and water sensitive design. Secondly, overly decorative landscape and non-native vegetation should be avoided for more feasible maintaining cost. Third is monitoring and maintained under smart innovation that could save labour cost.

Further in the long term, is aimed for lower the cost of subsidizing health services. The green area per capita in Andalucia is deficit by WHO's standard (Russo et el, 2018). The green/open space will indirectly lighten the load from health sectors creating more revenue for the city.

4 DEVELOPMENT OF VISION INTO MANAGEMENT PLAN

4.1 Proposed Implementation Plan

In this section, a gradual implementation plan covering the short, medium, and long-term is presented based on the determined actions through a backcasting method, to achieve the “scenario gamma” and the ultimate goal “EU Green Capital Huelva” in the future.

The components of the proposed gradual implementation plan are detailed in this section.

4.1.1 Short-term Plan

The actions described under this plan is assumed to be attained within 5 years. Issues that require immediate action in Huelva are considered under this plan. Immediate actions to be taken in Huelva are determined as in Figure 4-1.

SHORT-TERM GOALS	✓Raising environmental awareness in the city, by launching environmental awareness and educational programs along with tree-planting campaigns
	✓Implementing urban green space conservation and management plan
	✓Implementation of environmental penalties / taxes within the scope of the "polluter pays" principle
	✓Involving the public in urban transition by creating motivation through various methods, such as joint decision-making processes or setting goals that meet public needs
	✓Creating a climate adaptation plan in Huelva as part of the Global Covenant of Mayors for Climate & Energy and identifying the vulnerabilities of the city, and possible actions towards climate resilience
	✓Improving the quality of cycle lanes to promote cycling
	✓Initiating green network plan that connects the existing parks, natural areas, river within the city
	✓Replacing the concrete covers adopted in the squares with permeable materials and interlocking grass, and increasing greenery at squares

Figure 4-1 Proposed Short-term Implementation Plan for Huelva

4.1.2 Mid-term Plan

The actions described under this plan is assumed to be attained within 25 years. Actions or goals that will take a certain period of time are considered under this plan. Mid-term goals are determined as given in Figure 4-2.

MID-TERM GOALS	✓Developing and implementing sustainable land use and urban planning policies to take a step forward to sustainable development
	✓Creating innovative partnerships such as PPP, to secure financing
	✓Promoting circular economy and adopting the concept in urban green spaces by using eco-friendly materials for construction or for landscaping purposes
	✓Developing and adopting green/blue infrastructure policies to strengthen the climate resilience of the city; and thereby, benefiting from the value of green
	✓Acknowledging climate resilience and sustainable development in policies and strategic goals
	✓Addressing environmental justice in policies in context of urban green/open spaces
	✓Creating/improving facilitating infrastructures to ease the urban transition
	✓Follow-up/review the developed action plan every 5 years to monitor the progress and identify possible improvements
	✓Promoting urban farming, community gardens and shared garden concepts
	✓Integrating innovative technologies for monitoring and maintenance of green spaces, e.g. automated irrigation system, solar seats
	✓Considering inactive construction sites or derelict lands for urban farming purposes
	✓Re-structuring the current tax system to promote environmental objectives more effectively in other words, making environmental tax reform

Figure 4-2 Proposed Mid-term Implementation Plan for Huelva

4.1.3 Long-term Plan

The actions described under this plan is assumed to be attained within 50 years. Actions or goals that will take time to realize in Huelva is considered under this plan. Long-term goals are as given in Figure 4-3.

LONG-TERM GOALS
✓Achieving resilience-oriented urban planning throughout the city, as well as ensuring climate resilience and sustainable development
✓Providing environmental equity for urban green spaces, thereby allowing equal opportunities for people to access green spaces in terms of health and other qualities
✓Reclaiming all brownfields (especially from former industrial sites) to public open or green space, to create a social and environmental value at derelict lands by acknowledging the sustainable development
✓River will be completely open to the public
✓Acknowledging the vital importance of the circularity in sustainable development, transition into circular economy across the city

Figure 4-3 Proposed Long-term Implementation Plan for Huelva

4.2 Stakeholder Engagement for Change Management

To achieve the proposed plans for Huelva city, the stakeholder engagement should be embedded in the core functions of the procedure. To construct a stakeholder engagement process that works in the current scenario, from top to bottom, all the stakeholders are identified and categorized in power/level of interest matrix as given in Figure 4-4.

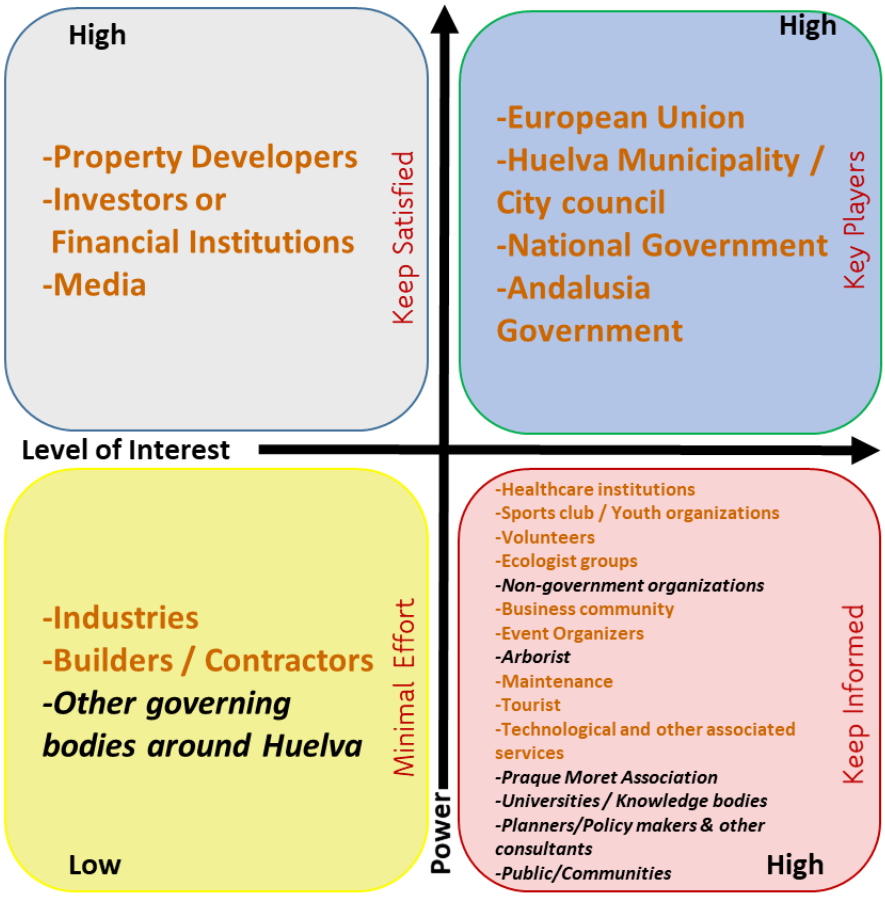

Figure 4-4 Current Scenario for Stakeholders - Power/Level of Interest Matrix

From this matrix, it is noted that the most important stakeholders who have high interest that can influence the implementation strategy during decision making and operations such as consultants, decision-makers, universities, and the public are in keep informed category where they have low power. So, a hypothetical scenario for stakeholder engagement is developed (illustrated in Figure 4-5) to make a transformation in the current system that help to achieve the necessary change needed where change is easily manageable if the stakeholders are properly identified and engaged.

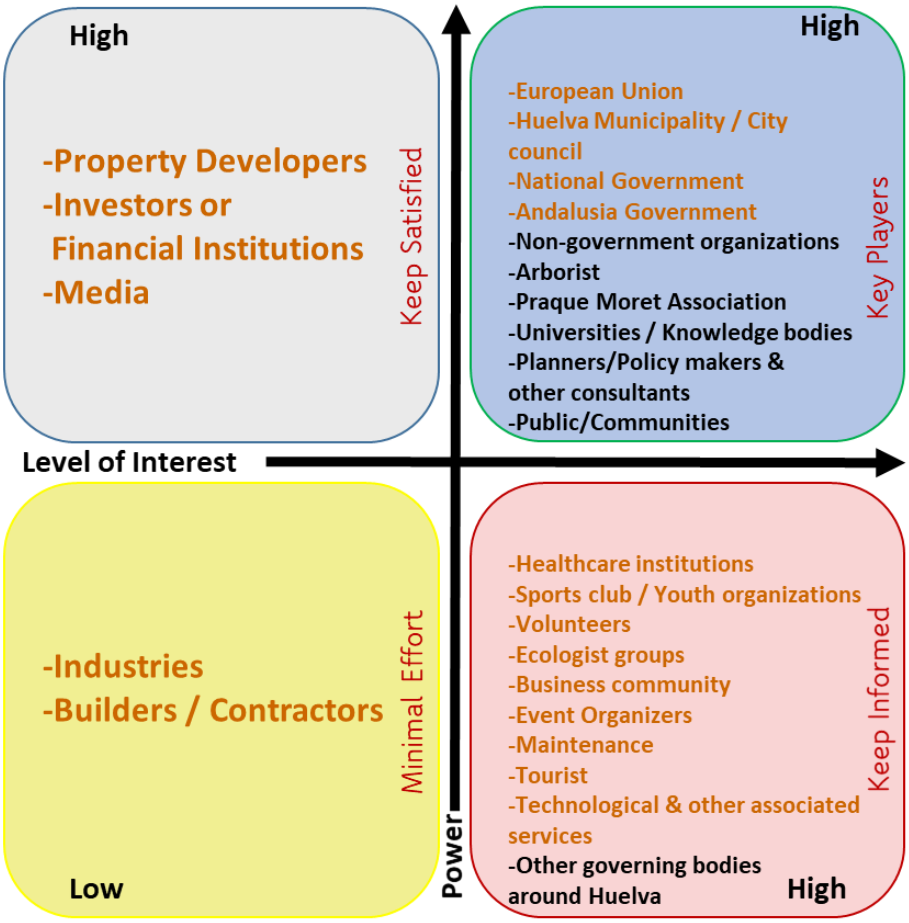

Figure 4-5 Hypothetical Scenario for Stakeholders - Power/Level of Interest Matrix

As such, as key players in the engagement process, national, regional, and local authorities, including consultants and public communities, are defined. Hence, a top-down and bottom-up approach to be administered among these players. Policies and guidelines to be embedded in local planning to sustain green and open spaces in Huelva city through authorities. Further, providing awareness to the community regarding the need and importance of green spaces is crucial because a strong and positive community is the backbone of the city, which highly influence the transformation of the city.

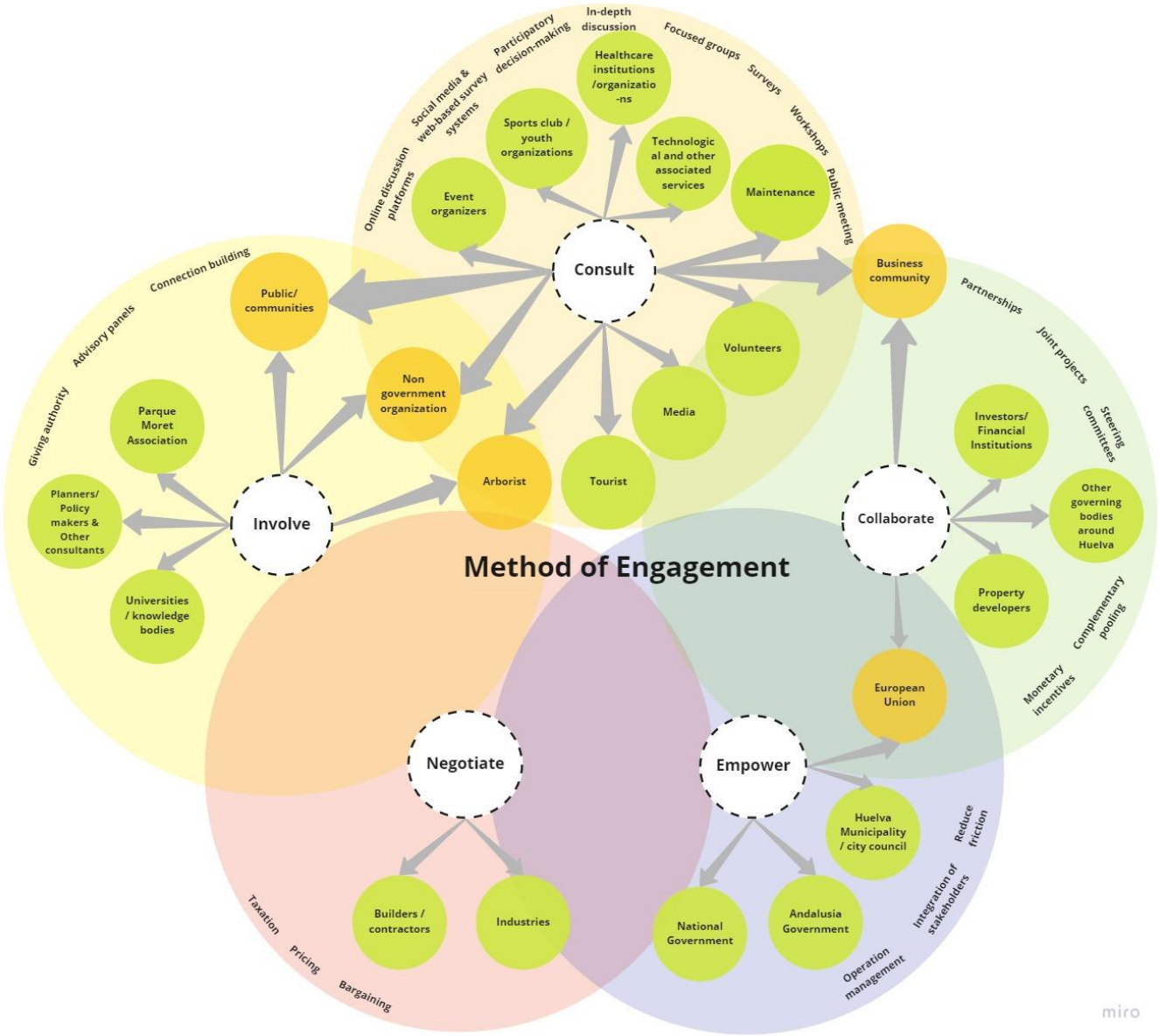

Figure 4-6 Method of Stakeholder Engagement –Hypothetical Scenario

To achieve the Hypothetical Matrix on Power/interest, a method and extent of stakeholders' engagement has been proposed.

The extent of the stakeholders' engagement for the hypothetical scenario is defined as consulting, involving, negotiating, collaborating, empowering, and method of engagement with different stakeholders as illustrated in Figure 4-6 for a credible engagement process.

For example, public, event organizers, youth clubs, health organizations, and volunteers would be identified at the consult level through online platforms, social media surveys, in-depth discussions, public workshops etc. while giving the awareness towards the importance of green/open spaces. As shown in the diagram communities and NGOs and Arborist would be considered at both consult and involve level.

Park Moret association, planners, policymakers, consultants, universities, and research bodies would be in involve level where this leads to develop innovative ideas and technologies, reinforce the connection building and realization of the developments. Further, public communities, NGOs and arborist would be in both consult and involve level concerning the context.

Further, investors, property developers and other governing bodies would be at the collaborating level with partnership agreements, joint ventures, and complementary pooling, where this level of engagement help to convince them and acquire finance for the projects. Giving authority and power to positive stakeholder will help to realize the project in a practical context. However, different stakeholders, each with distinctive character to be carefully studied and define the level of engagement to avoid diverse conflicting interests and concerns for the success of the project.

Besides strong governance hierarchy benefit, Hypothetical Scenario and Method of Stakeholder Engagement help stir the scattered available subsidies into the areas of interest.

Usually, green/open spaces are non-profit oriented, but with this method could open window to unexpected partnership in green-prioritized investment to create revenue, green enhancements could be feasible. Especially in current COVID-19 situation, green space is now hosting a safe space from health hazard and dense urban lifestyle.

5 CONCLUSION

To obtain the European Green Capital title, a radical approach to be executed with a fully-fledged, well-integrated implementation plan. As to achieve the transformation required, quality of the stakeholder engagement process is vital. Though plenty of open spaces in the city functioning well as active social hubs, most of the areas are underutilized in terms of environmental aspects. The overall green of Huelva must be improved and sustained to achieve the European Green Capital title.

The proposed implementation strategies, along with the method of stakeholder engagement for green and open spaces in Huelva lead to socially, economically, and environmentally sustainable cities and communities.

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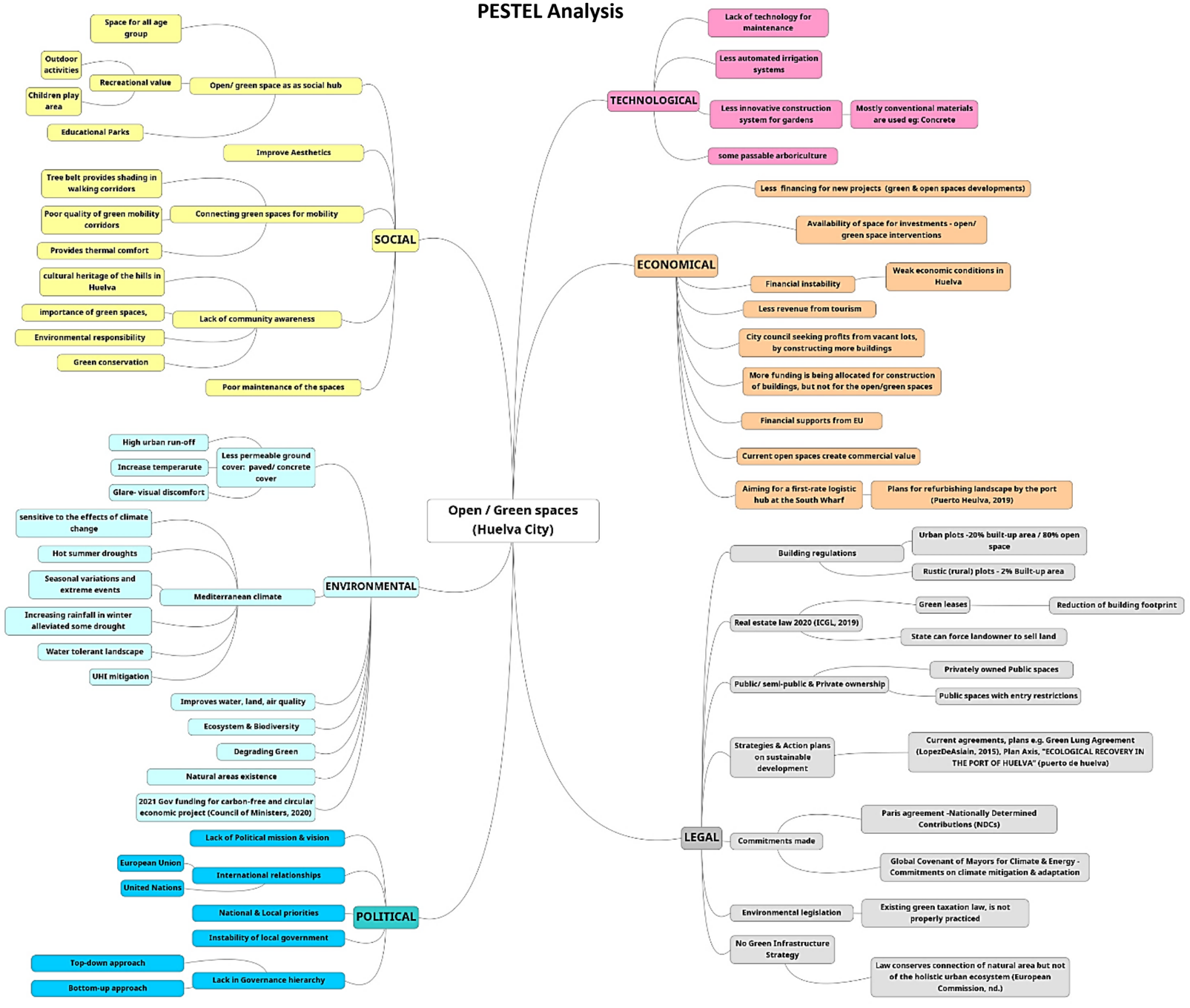
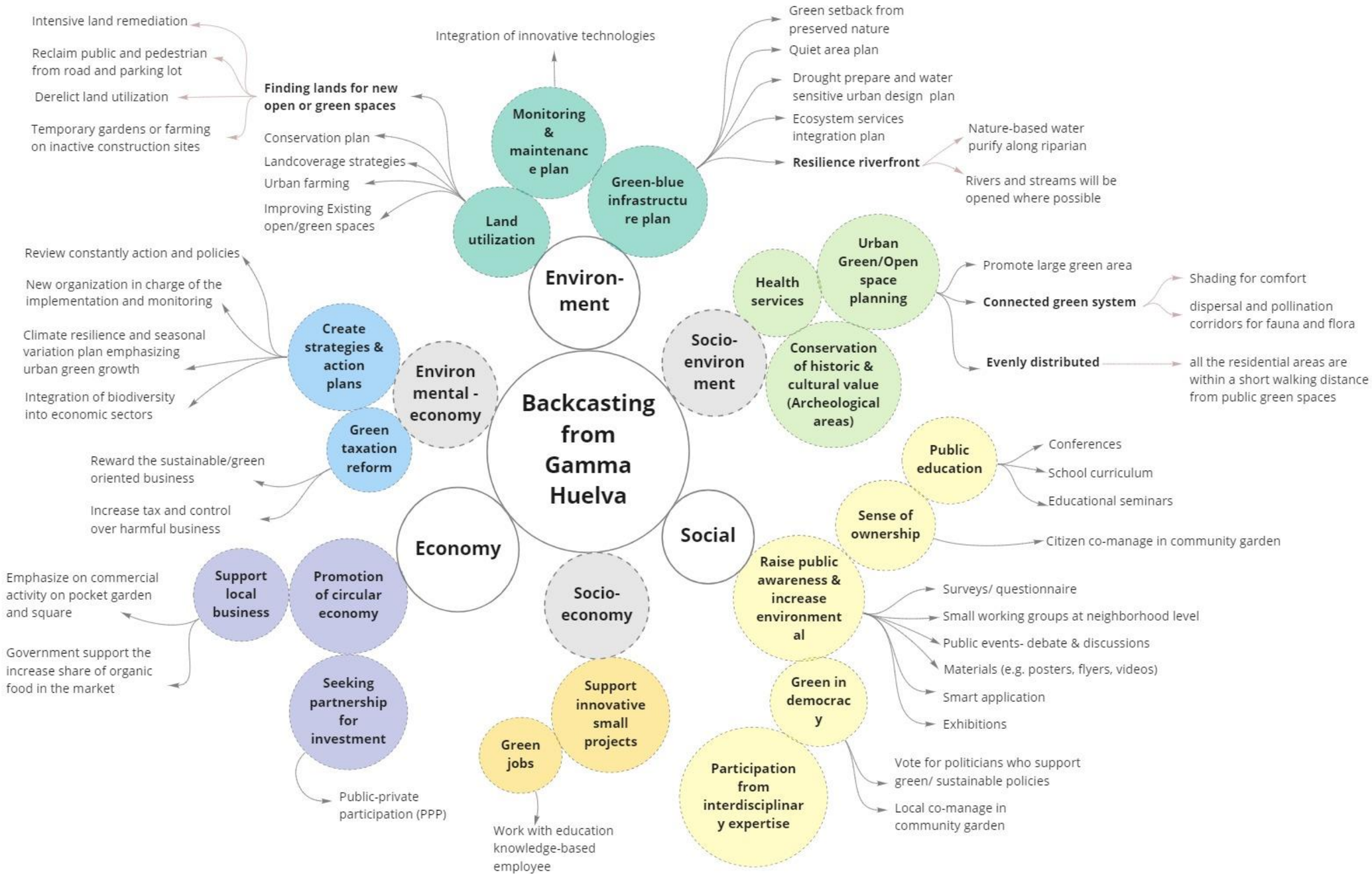
APPENDIX-1

PESTEL Analysis



APPENDIX-2

Backcasting Mindmap to Achieve Scenario Gamma



Huelva – European Green Capital 2023

Housing Sector

Prepared by:

Abinet Asefa, Sonam Dagay, Murielle Aira Valdez

MUrCS
Master in Urban Climate & Sustainability

HUELVA – European Green Capital 2023

Housing Sector

I. Introduction

In any city of Spain, the housing sector remains at the core of urban space. It plays a significant element in improving the quality of life of each inhabitant. According to the World Bank (2019), 81% of Spain's population lives in urban areas. This substantial number is mainly due to urbanisation and the overall population growth. With regards to this, the local authorities have the responsibilities of providing housing facilities to cater to the increasing population while maintaining the liveability of the city.

Table 1. Andalucía Temperature (07-07-2020)

Province	*Hour*	*°C*
Huelva	17:20	43.6
Sevilla	17:50	42.7
Cordoba	18:10	42.7
Badajoz	18:20	42.5
Badajoz	18:40	42.4
Jaen	16:50	42.3
Cordoba	18:50	42.3
Badajoz	16:30	42.1
Caceres	17:30	42.0

Source: Murcia Today, 2020

Of all the 17 regions of Spain, Andalucía is the most vulnerable in terms of temperature increase. According to Murcia Today (2020), Andalucía experienced the hottest temperature in Spain for the first time since the 1940s, with 43.6°C in Huelva (Table 1). Aside from the climate crisis, Huelva's distinctive geographical features and predominance of the built environment in its city core could have affected the rapid increase in its temperature (Appendix A).

In line with this, the government of Andalucía is implementing an environmental policy which aims to cut greenhouse gas emissions by promoting climate change adaptation measures, reducing 30% of the energy use, and utilising renewable energy (The Olive Press, 2018). It is understood that necessary actions in achieving these require Huelva a massive investment of time and money. But more importantly, the cooperation and engagement between the public and private sectors should be the core value to meet the goal effectively.

A. City Overview

The settlement in Huelva began primarily because of its geographical area, as it is along a river estuary and a vicinity of rich mineral deposits. Historically, most buildings were of Moorish architecture because Moors used the port for trade and commerce between the early 8th to the late 15th centuries. However, the 1755 Lisbon earthquake tore down the majority of these structures (Andalucía, 2020), which explains why Huelva's heritage is not witnessed in its existing buildings.

In the mid-1800s, the city experienced a period of surplus wealth. It developed a more multicultural atmosphere which is noticeable in elegant structures like the Barrio Reina Victoria Obrero – a Victorian English residential area located in the centre (Andalucía, 2020).

During the 1960s and 70s, scarcity and standards of housing were major problems not only in the city but to entire Spain. Throughout this period, Spaniards began to leave the rural area to find jobs in the metropolis which led to massive urban growth. Hence, the provision of housings for the working classes was urgent, especially in the city centres (BBC, 2020). These housing facilities were constructed vertically because it is cheaper and allows more available space for other apartment buildings. Today, the city core of Huelva is packed with building infrastructures, and a high percentage of these is shared by the apartment building and mixed-use property (Figure 1).

Figure 1. City centre of Huelva – Aerial view. Source: Huelva Informacion, 2019.

II. Background Information

A. Key Sustainability Challenges

a. Climate Change

The effect of climate change in Huelva is a combination of increased temperature and reduced rainfall. Its temperature has increased over the last century by around 1.5°C of the annual average (Fernández-González et al., 2005). It is continuously growing at a rate of 0.03°C per year (MedECC, 2019), *bringing a hotter, drier, and longer summer season.* Rainfall, on the other hand, has decreased by 25% compared to 50 years ago, and it is projected to drop again by 20% in the next years (Met Office, 2011).

The traditional houses that have endured the typical environmental condition of southern Spain throughout the decades have become incapable of providing the necessary thermal comfort.

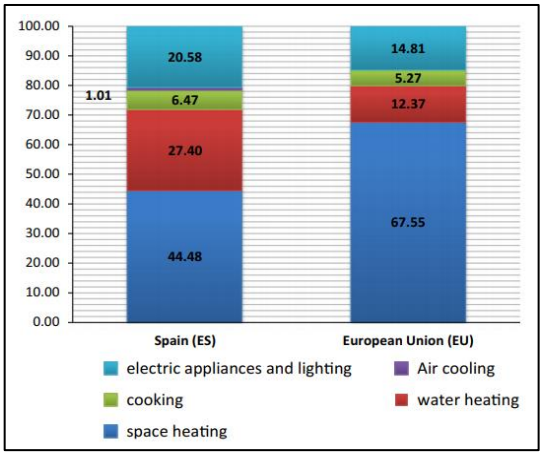
b. Population Decrease

Today, the province of Huelva has a total population of 524,576 (Eurostat, 2019), and 30% of this (143, 633) is currently residing in the capital (City Population, 2019). In 2014, the population was 147,200, which is 2.5% higher than today. According to the Instituto Nacional de Estadistica (2020), the annual population growth rate is -0.4%. If this were the same in the next five years, its population would be 140,185 in 2025.

c. Energy Consumption and Efficiency of Appliances

The residential sector plays a vital role in the increase of energy consumption due to the high energy demand of domestic appliances and the lack of sustainable heating and cooling system. Even so, Spain has been successful in reducing GHG from 2005 to 2016 (Statista, 2020).

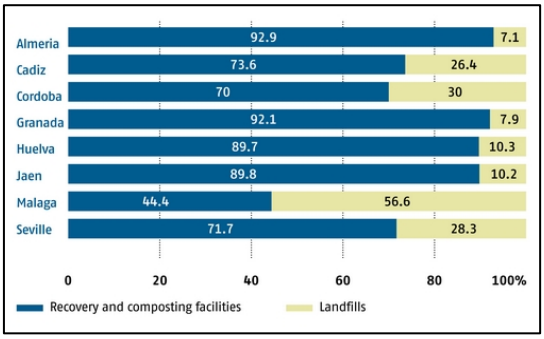
According to the statistical office of the European Union (Eurostat, 2020; BBC, 2020), "*Spain has one of the highest rates of flat residents in Europe".* Most households use electricity for space heating and domestic hot water heating (Graph 1). Reducing energy demand for cooling is not possible due to high solar radiation and ambient temperature. A higher probability of having to install both heating and cooling systems can have a large impact on initial cost, operational cost, peak loads, and energy supply networks (Ramos et al., 2015; Attia et al., 2016).



Graph 1. Residential energy breakdown in 2010.
Source: Odyssee, 2014.

d. Waste

Although a significant majority of the waste ends up in composting (Graph 2), the selective collection of waste is very low at 14.4%, implying much work must be done to achieve excellent waste management. Also, the low level of household waste selection practice is a challenge in realising circular economy in the city. There is a recycling rate of 15% considered in the waste generated throughout the lifecycle of a building, but it is well below the national and European objectives (Junta de Andalucía, 2008).



Graph 2. Urban waste collection 2011.
Source: Junta de Andalucia, 2011.

e. Land Use and Geographical Features

This increase of built environment affected the land surface temperature, consequently increasing the need for energy consumption for cooling. Additionally, the urban context – sprawl and agglomeration effects – also defined the consumption of energy or electricity (Manzanares & Álvarez, 2015).

Huelva's geographical feature consists of hills and marshes. Whenever heavy precipitation occurs, the hills are at risk of possible landslides. According to Garrido (2020), another issue of the city is that the sides of the hills have become dumping ground of domestic wastes by residents living in the hillside (Figure 2).

Figure 2. Hillside as dumping ground. Source: Valdez, 2020.

f. Housing Typologies

The trend in Huelva is an increase in urban sprawl consisting of detached and semi-detached houses. These type of housing facilities consume more electricity than apartment buildings. Likewise, it also increases the consumption of petrol for mobility because citizens will still need to visit the city centre for work and study purposes (Alvarez et al., 2019).

g. COVID-19

The housing sector has been severely affected by the pandemic making it hard for numerous households to pay for shelter (OECD, 2020). Urban centres are highly vulnerable to the spread of the virus because of the high population. Approximately 90% of the reported COVID-19 cases reside in urban areas. Health and safety measures are practically impossible to implement due to overcrowding (UN, 2020). *"Access to adequate housing is critical to protecting oneself from COVID-19, stopping its spread, and recovering from it"* (Amnesty International, 2020).

Economic activities were shut down due to COVID-19; this resulted in income loss which has aggravated the existing challenges of affordable housing in many countries. Spain introduced many measures, such as rent freeze and suspension of eviction, to support tenants during the crisis (Figure 3). But the ideal way is to increase investment in affordable public housing and to relax the restriction on land use for housing development (OECD, 2020).

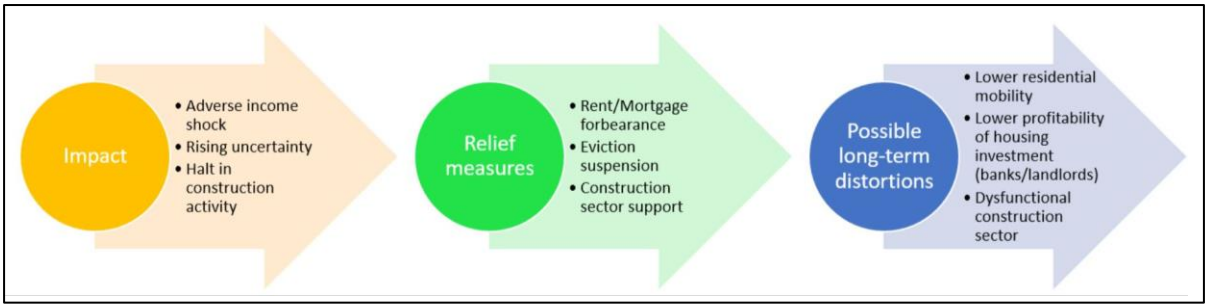


Figure 3. Impacts of COVID-19 on housing. Source: OECD, 2020.

h. Culture

Apartment living is rooted in the Spanish tradition. For the Spaniards, socialising is important, so housings are constructed near to each other. However, this sets out a problem, especially with the social distancing restrictions due to the COVID-19 pandemic.

For the older generations, waste management was not part of their custom. On the other hand, the new generations are more aware of the circular economy concept. Thus, the practice of waste management is becoming more common. Although change is slow in the people of Huelva, they are one of the last in practising sustainability compared to other countries in Europe.

i. Architectural

The architectural characteristics of Spanish buildings have resulted to various associated issues. For instance, the use of floor ceramic tiles is typical in Spanish houses has become uncomfortable on barefoot and yet, space heating is not traditionally used in houses in Huelva because of its Mediterranean climate. Retrofitting old building is difficult to upgrade because there is a need to make alterations, considering it already has a weak structural material (Boostani & Hancer, 2018). But some traditional design has been beneficial until today, such as the Spanish roof tiles (Figure 4) that protects the indoor against humidity since the city is particularly damp due to its geographical location.

Figure 4. Typical apartment building in Huelva. Source: Valdez, 2020.

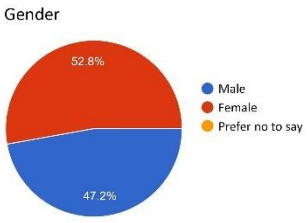
B. PESTEL Analysis

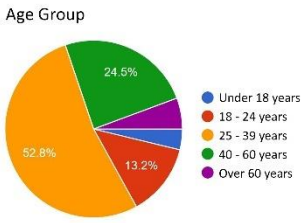
Table 2. PESTEL Analysis

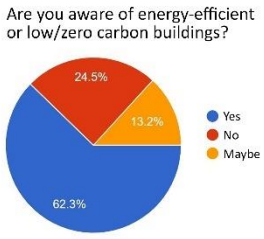
Political	*Economy*	*Social*	*Technology*	*Environment*	*Legal*
• Energy-saving and efficiency action plan until 2050 • Actions to reuse operations for construction and demolition waste • Strategy for the implementation of mobility plans in cities larger than 100,000 inhabitants • Internationally agreed and national frameworks (EU energy efficiency legislation) • Lack of clear and consistent policies addressing climate change in Huelva	• Market penetration of efficient electric HH appliances is extremely low • Economic downturn • Uncertainty in the industry itself regarding costs and demands for low / zero carbon building due to the conservative nature of the construction industry • Significant demand for energy-efficient building due to escalation of energy prices	• Depopulation in Huelva • COVID-19 pandemic resulted in income loss which has aggravated the existing challenges of affordable housing • Change among the residents is slow • Limited public awareness and demand for zero carbon building • Widespread risk-averse attitude by the building industry and reluctance to innovation • Skills shortage • The low level of household waste selection practice is a challenge in realizing a circular economy	• Lack of adequate heating and cooling system in apartment buildings • Availability of technology • Technical and design barriers • The industry's ability to embrace it • Availability of affordable technologies • Low carbon building deep renovation is technically feasible, and following best practices are a proof for that • Construction knowledge and materials medium is low	• Extreme weather effects potentially undermining energy efficiency in buildings by requiring more structures to build. But also, an opportunity since it further raises the growing awareness of climate change • Large differences between the climate zones which requires a set of indicators that permit evaluating different approaches to achieve energy-efficient building in Spain's varying climate • The risk of overheating is high, mainly because the night temperatures during summer are not low enough for natural ventilation inside the house	• Challenge of enforcing mandatory legislation with regards to the construction of low / zero carbon housing facilities is not strong enough to implement measures

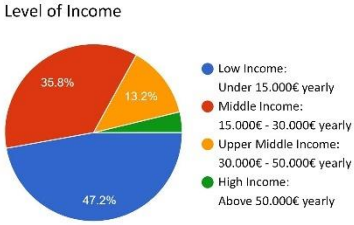
C. Community Involvement

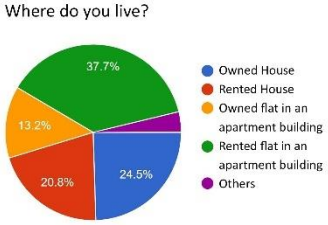
A total of 53 resident were surveyed using Google Forms – a free online survey. Although 53 is not a considerable amount compared to the whole population of Huelva, it is a good starting point in developing the necessary actions for the housing sector. The graphs below show the survey questions and results. The actual survey form was translated into Spanish so that residents can answer it without difficulty.

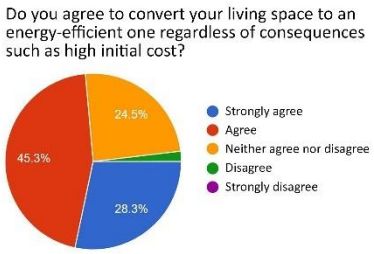


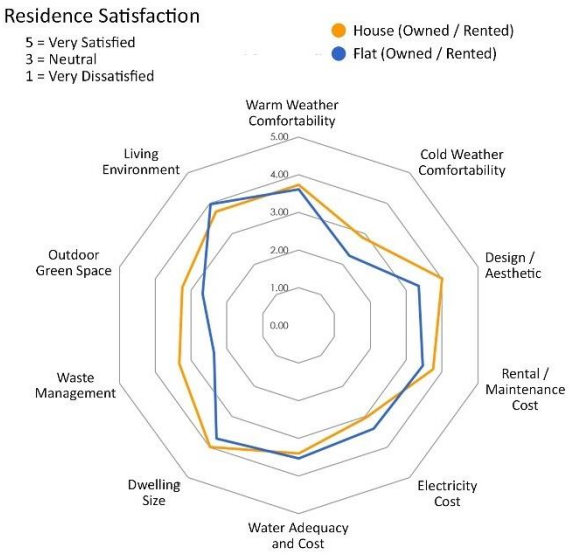


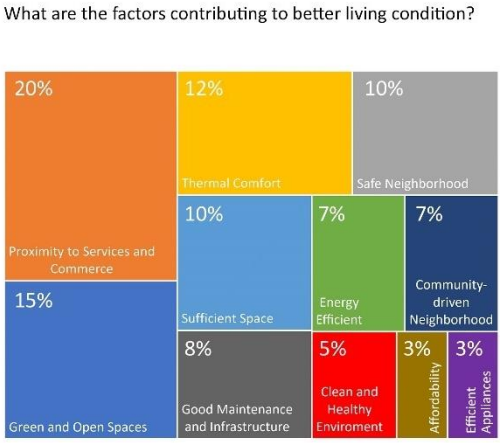


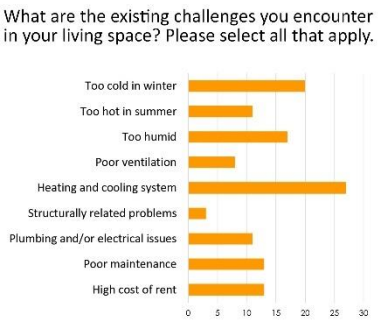


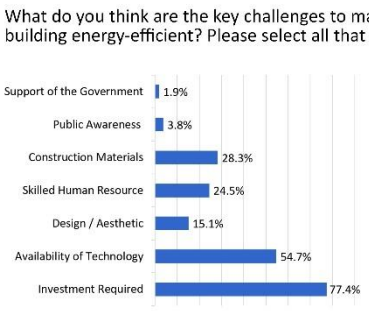


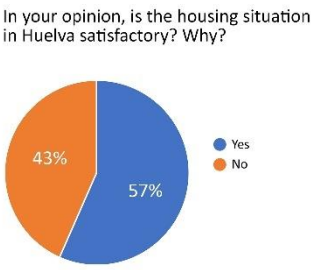


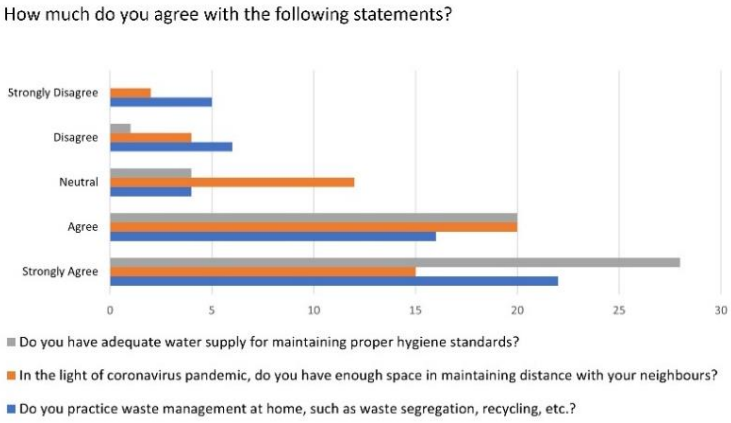












According to the survey, the comfortability level during cold weathers and waste management are major concerns. Consequently, the existing challenge the participants encounter in their living spaces is the lack of adequate heating and cooling system.

Looking at the result, the implementation of energy-efficient buildings is necessary. However, the key challenges are the finance and the availability of technology. But even with all the negative responses, 57% of the participants still believe that housing in Huelva is satisfactory. Most of their reason is the affordability and safety within the vicinity. While the remaining 43% said that poor maintenance is a problem, especially most of their apartment buildings are old.

III. Scenario Development

A. Scenario 1 – Business as usual

The changes in economic structure and improvements in energy efficiency reduced the emissions by 10% between 2005 and 2015 (EC, 2020), and 21.7% between 2005 and 2017 in Andalucía. The final energy consumption in Andalucía decreased by 6.6% between 2005 and 2019 while it decreased by 4.7% in Huelva (Junta de Andalusia, 2020a). As of 2017, 38.8% of the region's total energy production was from renewable sources accounting for 22.7% of the national renewable energy production (Climate Chance, 2020). While Spain has achieved all the annual emission reduction targets from 2013 to 2017 and is expected to overachieve 2020 target, there is a gap of 10% to meet 2030 targets (European Commission, 2019). Nevertheless, based on past trends and more ambitious goals set through the adoption of *"Spain's integrated National Energy and Climate Plan for 2021-2030"*, it is expected that objectives of a carbon-neutral economy by 2050 is achievable.

There is a consensus on the inefficiency of houses shown by high demand for energy for water and space heating. With the projected increase in temperature and declining rainfall, energy demand for space cooling in Huelva will rise. Therefore, in the absence of strict efficiency measure in the housing stock, energy consumption for housing is expected to grow further.

There is a decreasing trend in the population of Huelva mainly due to lack of employment opportunities and people moving out to the outskirts resulting in urban sprawl. In addition, the existing buildings are not well connected with a network of cycle lanes; dedicated bus lanes and footpath undermine the comfortability of living in the city centre. Therefore, in the absence of a robust economic plan with commitments of investments; options of energy-efficient homes with high connectivity, it would be difficult to retain the population resulting in more vacant spaces and increased number of abandoned buildings in the city.

The percentage of waste composted and recovered in Huelva is very high. It increased from 89.3% in 2005 to 96.5% in 2018 (Junta de Andalusia, 2019). Adoption of the *"Andalusian Circular Bioeconomy Strategy 2030" and* the *"Spanish strategy for Circular Economy – España Circular 2030"* are expected to reduce further the quantity of waste going to the landfill.

The experience from COVID-19 pandemic shows that spread of such diseases is higher in overcrowded communities and places. Access to proper housing and sanitation has been identified as the key to protect and control the spread. Since affordability of houses does not seem to be a challenge at the moment, the existing housing stock is not expected to pose major challenges in case of future outbreaks. However, in the event of an increased population and unavailability of affordable homes (public housing), the impacts and casualties from a similar pandemic could worsen.

B. Scenario 2 – Incremental Change

In establishing the incremental scenario, the recommendations of the 53 participants were critically assessed, especially the ones that are feasible with regards to the investment and overall context of Huelva. According to the residents, the elements that can improve the housing quality are:

- Proximity to basic amenities
- Redevelopment of poorer areas
- Better heating and cooling system
- Indoor thermal comfort
- Efficient appliances

To achieve this, close cooperation between stakeholders of the housing sector is vital – these are the local government, housing authority, urban planners, building and construction businesses, property developers, transportation system and road infrastructures, and community association.

The local authority should impose policies that would support economic, social, and environmental growth, wherein economic growth is emphasised to reach the investment needed. Likewise, community associations are crucial in the planning stage because they are the primary user of the city of Huelva. Their ideas should be highly considered. Hence, they should be a part of the decision-making process.

The Spanish government has the vision of a minimum level of energy efficiency for its buildings and meet 80% emission reduction target from the housing sector by 2050 (Cuchi & Sweatman, 2011). Furthermore, they should address the affordability of the housing facilities. Even if Spain is one of the most affordable countries *"when it comes to property price ratio"* (Internations, 2020), there is a need to provide more public housing programs so that all individuals have a place to live in especially during the COVID-19 pandemic.

Sustainable approaches will be incorporated in new building constructions, while energy-efficient appliances will be installed to both new and existing housing facilities. The principles of the circular economy shall be incorporated mainly through proper waste management and reuse of construction waste from derelict buildings. In new construction works in Andalucía, excavated earth may represent over 80% of construction and demolition waste (Junta de Andalucía, 2008).

The implementation of sustainable urban mobility shall be a collaboration between property developers, transportation service providers, and related businesses to achieve a well-connected city. Transportation emissions are significantly higher in low-density developments in comparison to high-density developments. In the municipality of Huelva, more than 90% of trips are below four kilometres, with 80% of trips below three kilometres (Junta de Andalucía, 2008). Hence, sustainable mobility can be achieved but would require environmental policies that would render individuals to prefer bicycles rather than private cars and implement the use of biofuels for the public transport system. The Spanish government has also been working to stop the development of growing urban areas and the dependency of the private vehicle to achieve effective use of more efficient modes of transport through the *"Spanish Strategy of Energy Efficiency (2004-2012)"* (Mattsson, 2006).

Aside from investing in energy-efficient products, energy-saving can also happen based on building design variations. Achieving this should focus on decreasing the heating demand through the reduction of envelope conductivity, infiltration, and selecting optimal glazing and window openings – which is possible for the existing buildings in Huelva. Passive cooling systems can be employed during the planning stage of the housing facility. But the idea is to implement this on new constructions only, since retrofitting old structures will be expensive and will require various measures.

The incremental scenario assumes a reduction in emission and saving in energy from each sub-sectors of housing – sustainable design measures, energy-efficient appliances, waste management, and sustainable urban mobility. Its execution, however, would require a significant transformation in the culture of each individual, they should have the dedication to change for a sustainable lifestyle. This strategy will need high investment, which requires local government to focus on boosting economic growth. The incremental scenario would likely happen in a long-term, especially that it would take time for Huelva to have the necessary investment, tools, and knowledge that northern Europe acquire in accomplishing sustainable development. Likewise, the implementation will further depend on the dedication of the citizens to change their way of life to attain circularity within the environment.

C. Scenario 3 – Radical Change

Based on the trend that is happening right now in Huelva, the city is way behind from matching with the north European cities' standard of sustainable developments. Huelva will require to transform its existing policies. If the municipality implements a sudden and radical transformation in the capital, the entire public and private sectors should bring a whole makeover within the city. The key to sustainable development is sustainable urbanisation. Achieving this means the urban area of Huelva needs retrofitting and intensification – hence, using the compact city strategy and applying a low/zero carbon building (L/ZCB) technology to all housing facilities while offering affordability.

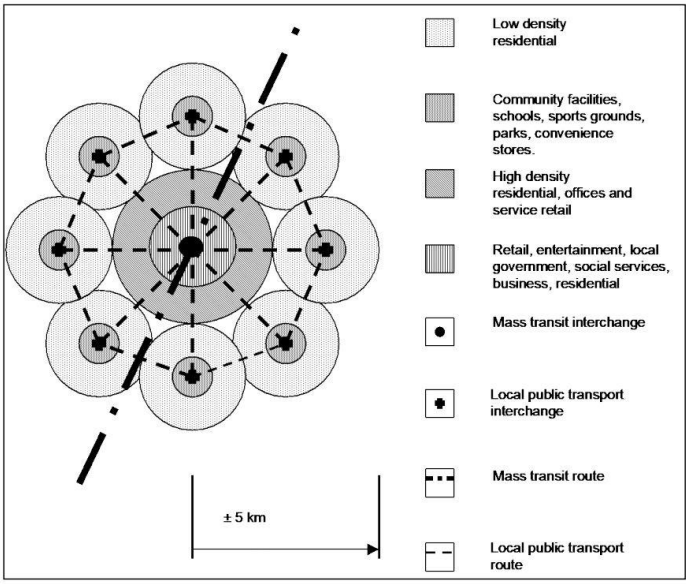


Figure 5. Compact City Diagram. Source: Plesis, 2000.

The city may look as if it is high-density because of the abundance of buildings, but this is not the case due to population decrease. The key component of using the compact city strategy for the context of Huelva is to restructure the existing urban form to improve the *"accessibility, social inclusion, and physical and mental health benefits"* of the residents of Huelva (ICE, 2010).

Figure 5 shows an ideal representation of a compact city. The aim is to locate the community facilities in the city core so that residents can easily access these areas. At the same time, services should be within residential zones to attain high walkability and more robust neighbourhood economic welfare (Blue Zones, 2020). Lastly, a sustainable transportation system to enable individuals in going from one place to another without disrupting the environment. Planners, together with the transport and road infrastructure companies, should collaborate to create sustainable and organised development.

In Spain, one of the barriers of L/ZCB technology emerges from the geography and climate of the region. Reducing energy demand for heating and cooling is one of the most crucial aspects of L/ZCB and achieving it will be a challenge, especially employing it to all residential buildings, regardless of it is old or new. Stakeholders in the building industry must have the necessary knowledge in the construction and technology of L/ZCB. However, in most Mediterranean countries, there are difficulties in getting skilled professionals, architects and engineers that can deal with such new technologies and standards. Other factors are a high investment, the willingness of the community to accept change in their household, and the governance structure that would make possible the smooth transfer of L/ZCB technologies (Attia et al., 2016).

If scenario 3 will be realised, Huelva would be a frontrunner in sustainable development in just a short time. It will benefit the residents and will attract more population. It will emit a high percentage of GHG, especially that majority of the buildings inside the city are housing facilities. Likewise, residents will not depend on cars once walkability is achieved, which is one of the objectives of the compact city. Overall, it will benefit the whole economic, social, and environmental sector of Huelva, making it one of the most sustainable places to live in.

D. Discussion

Looking at the scenarios, it is clear that radical change has the most ambitious goal. But the total redevelopment of the capital in a short span is not ideal in the framework of Huelva, mainly due to investment, absence of high-technology, and the lack of skilled professionals. Hence, the desired endpoint would be the incremental change, mostly because the circular economy within the city is feasible as observed in the statistics and also in the residents' practice. Additionally, the local authority should still deliver the existing plans of scenario 1 because it is beneficial in the housing development of Huelva.

IV. Vision

"Connectivity, energy efficiency, comfortability, and circularity"

Recognising the carbon-neutral goal of the Spanish and the Andalusian government, projected changes in the climate, high dependence on fossil fuel, inefficient buildings, preference of the residents for high connectivity and recognising the depletion of resources, issues of waste management and affordable housing, the vision for the housing sector in Huelva are to:

- Increase connectivity and accessibility of all future housing and improve the same for existing housing stock to public transport, footpaths, and cycle lanes
- Reduce emissions and energy consumption in the housing sector by setting ambitious energy efficiency standards, refurbishing the existing buildings to enhance energy performance and thermal comfort, and encouraging the use of efficient appliances
- Increase the comfort of the houses by ensuring sufficient spaces for living and recreation, safe neighbourhoods, providing affordable public housing, and strict rules on maintenance
- Enhance the circularity of resources by enforcing strict policies for reusing, recycling, and reducing waste generation during construction, and post-occupancy
- Ensure availability of investments through the creation of funds and providing financial subsidies in the form of a low-interest loan or tax incentives for sustainable practices

The 12 indicators (Figure 6) as identified by the European Green Capital (EGC) were critically addressed in creating the vision.

a. Connectivity

Initially, this proposal will offer a well-connected neighbourhood to new affordable housing developments that will utilise the vacant lots of the city centre (Figure 7 & 8). And in the long run, the connectivity of the whole capital will slowly shift to a mass scale – providing access to basic amenities to the vicinity.

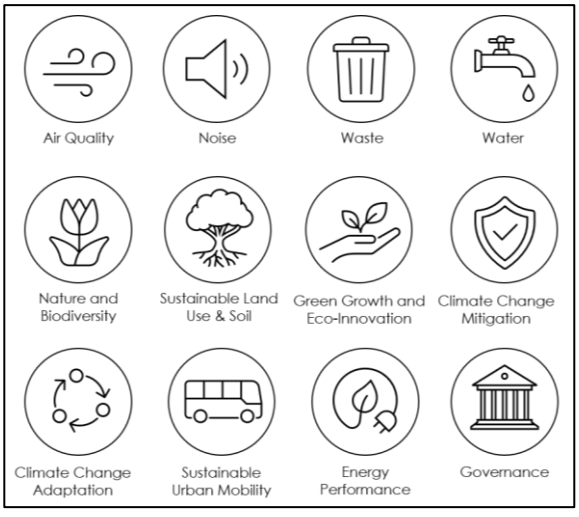


Figure 6. 12 indicators as identified by the EGC.

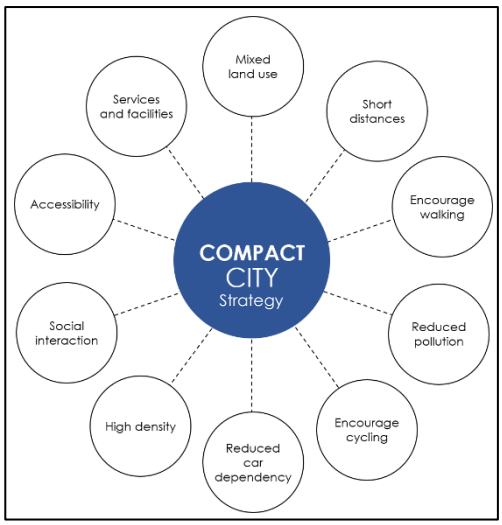


Figure 7. Compact city strategy for Huelva.
Source: Adapted from Rogatka & Ribeiro, 2015.

Figure 8. Map of Huelva.
Source: Adapted from Google Map, n.d.

Figure 8 shows the empty lots within the city centre, which comprises 11% of the whole area. In constructing the new housing developments, it should be a variety of mid-rise buildings since this type is more sustainable than low-rise. Likewise, it is to blend in and respect the local skyline of the city since the majority of the buildings here are mid-rise structures.

b. Energy Efficiency

Improved environmental policies should focus on providing energy efficiency within the housing facility while retaining affordability. With regards to this, adding more guidelines and programs would be necessary. Just like in the case of Lisbon – the EGC awardee 2020 – where their strategies include massive urban rehabilitation programme, promotion of eco-housing renovation, and providing public housing programs while conforming to the *Near Zero Emissions Building (NZEB) standards* (European Union, 2020). Figure 9 shows the proposals for the new and existing apartment buildings.

Figure 9. Proposals for the new and existing apartment buildings. Source: Luxoire, n.d.; The Specialist, 2015; Heatsaver, 2020.

c. Comfortability

The traditional non-open plan arrangement of Spain houses should be altered in attaining thermal comfort. A more sustainable strategy would be a combination of an open plan layout and passive design strategies (Table 3). This combination would be beneficial for the post-COVID-19 situation of households, giving more space for moving around and social distancing.

Table 3. Traditional non-open plan arrangement vs. open plan layout + passive design strategies

Traditional non-open plan arrangement	*Open plan layout + passive design strategies*
Too many dividing walls	Maximized natural light and ventilation
Rooms feel cramped	Good air circulation
Less space for movement	Cost-effective
Less natural light	Easy interaction
Less interaction with family	Reduced odour and noise

Source: Du et al., 2020.

d. Circularity

The government should impose a broader circular economy action plan to improve further the economic, social, and environmental growth of Huelva. Figure 10 shows the measures to achieve a circular economy, specifically targeted to the housing sector.

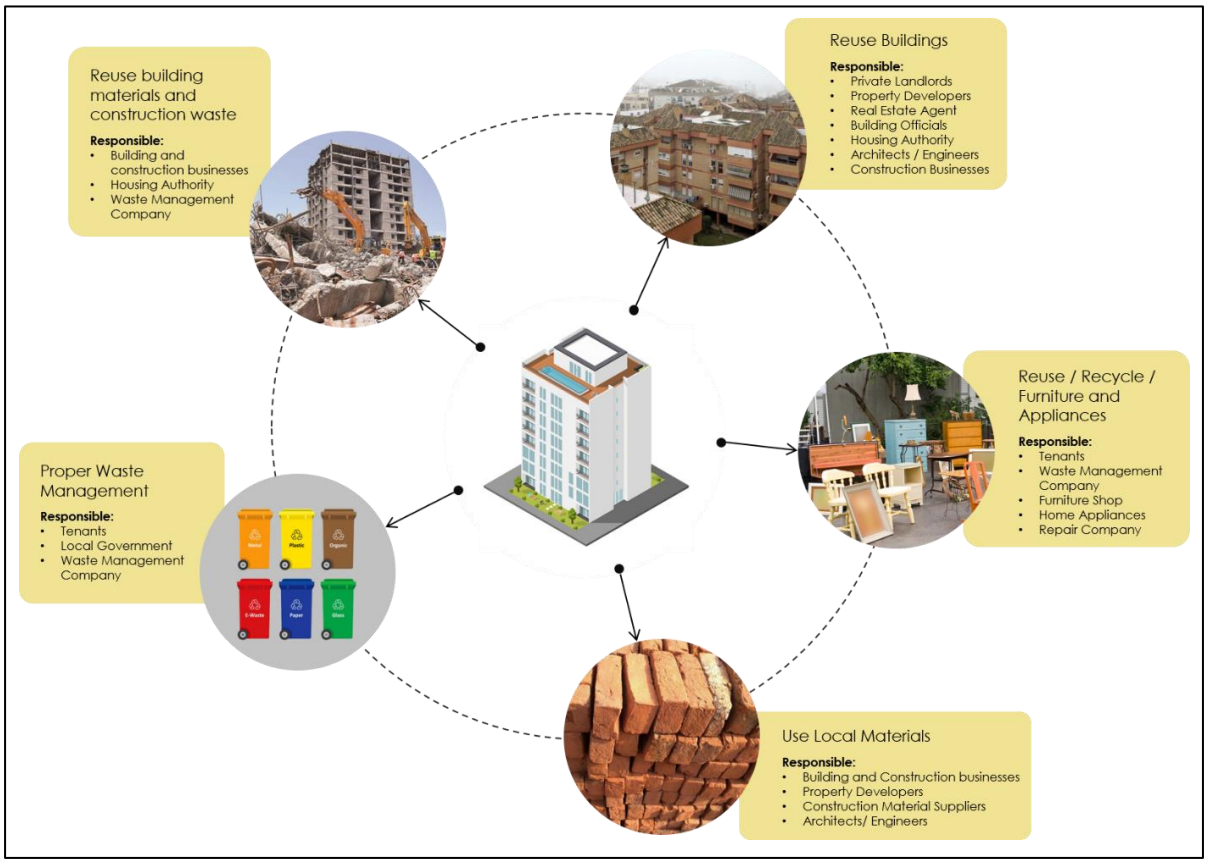


Figure 10. Circular economy action plan. Source: Dreamstime, 2020; Shuttertstock, n.d.; DT Next, 2019.

A. Stakeholder Analysis

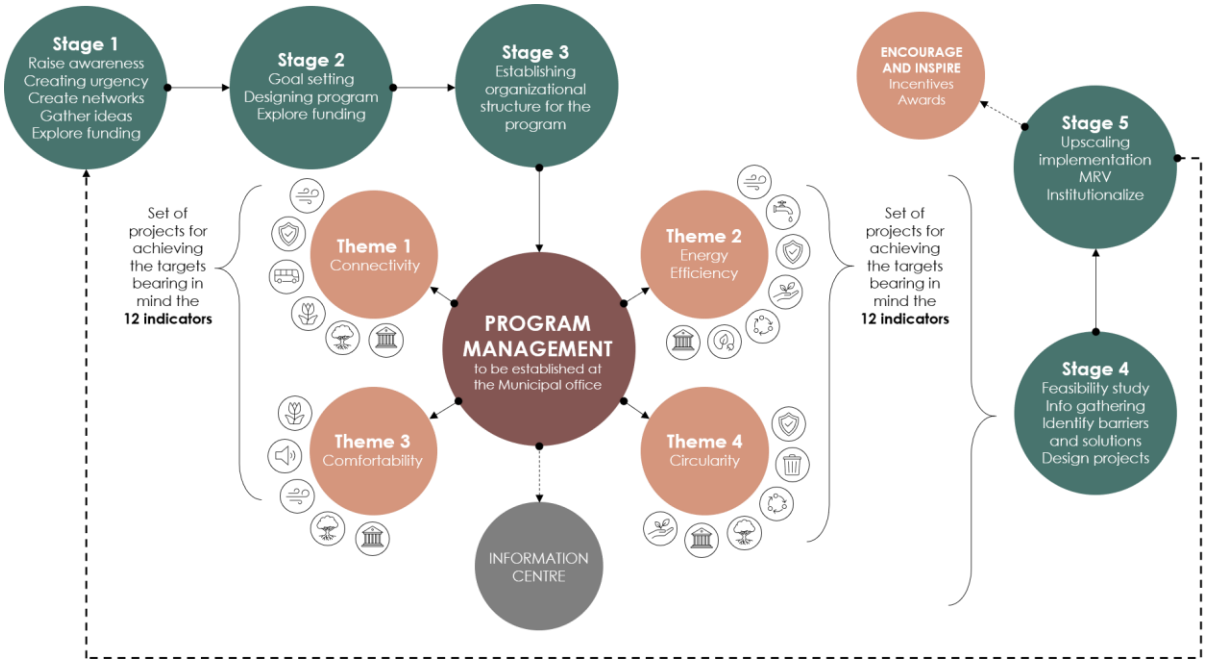
Responding to the stakeholders' interests guarantees that the needs of everyone are considered as they have an impact on the organisations (Sousa, 2012). Listed in Table 4 are the stakeholders that have significant roles in the objectives, policies, and actions for the housing sector.

Table 4. Stakeholder Analysis

Power	Low Interest	High Interest
High	***Keep Satisfied*** • Local Government • Housing Authority • Building Officials • Community Association	***Manage Closely*** • Current Residents • Private Landlords • Property Developer • Investors • Mortgage lender
Low	***Monitor*** • Repair Company • Furniture Shop • Transportation Industry • Home Appliances • Construction Material Suppliers • Waste Management Company	***Keep Informed*** • Potential Tenants • Labourer • Energy and Grid Provider • Real Estate Agent • Architects and Engineers • Construction Businesses

B. How can change management be achieved?

The strategy proposed for managing change is based on Kotter's 8-step change management process (Kotter, 2018). The 8-steps have been combined under the various stages following a similar sequence. The aim is to establish a community-led governance structure based on lessons learnt and best practices from exemplary sustainable cities of Transition Town Totnes, UK (Banks et al., n.d.) and Hammarby, Sweden (Electricity, 2020).



a. Stage 1

The Huelva municipal council must lead this stage. The main objectives are to raise awareness on the vision, solicit active participation from a wide range of stakeholder, create platforms or avenues for regular interaction and develop strong networking and interaction amongst the stakeholders. Most important stakeholders include, but not limited to politicians, resident/communities, investors, builders, utility service providers and academia. Multiple mediums – such as social media, print media, films, and talk shows – must be used for communication and engagement. It is also important to start exploring and negotiating with potential funding sources.

b. Stage 2

This is the design and goal-setting stage. Goal setting must consider comparative advantage of the climate, local availability of resources and knowledge and finance. It is important to set ambitious goals by engaging all stakeholders from the onset of the process. However, targets might change based on detailed feasibility studies and assessments planned at a later stage. It must be highly participative and consultative to encourage communities to make commitments and take a leadership role for setting and achieving the carbon neutrality in the building sector. The program must set strict targets that can be measured and monitored to track progress. Exploration and securing funding must be a continuous process since implementation would require high investments that are currently unavailable.

c. Stage 3

This stage is to establish an organisational structure for the implementation of the program with clearly defined roles and responsibilities. Similar to the Transition Town Totnes, it is recommended to establish a community-led organisational structure. Apart from economic and environmental success, the experience from Totnes shows that engagement of the community increased their social interactions and also induced individual behavioural changes local economic benefits (Banks et al., n.d.). The proposed organogram is as presented in the diagram below.

The roles and responsibilities of the various management units are described below.

1. *Huelva Municipality*

- The program management unit should be established at the Municipal office – however, decisions to be made by a board with representation from all stakeholders. Board must meet periodically to review progress and make timely interventions as required.
- The role of the program management will be to provide policy support, legal guidance, overall coordination, general administration, monitoring progress, establishing networks and collaborations, awareness campaigns, fund exploration, providing fiscal incentives and organising periodic meeting of the various core groups.
- Establish an information canter for encouraging wider community engagement, the transmission of knowledge and sharing best practices
- Establish a fund management unit and develop resource mobilisation plans

2. *Core Groups (based on Themes)*

- Must include a representative from stakeholders involved directly or indirectly in delivering the goals
- Design set of projects for achieving the targets for the theme
- Projects to be managed by community groups to encourage social enterprises

- Conduct meeting to ensure coordination and collaboration amongst various projects under the theme
- Coordinate with other theme groups and explore possibilities of integration
- Prepare communication materials, consolidated progress reports for the particular theme
- Report to the program management unit at the council office

3. *Project Management units under each theme group*

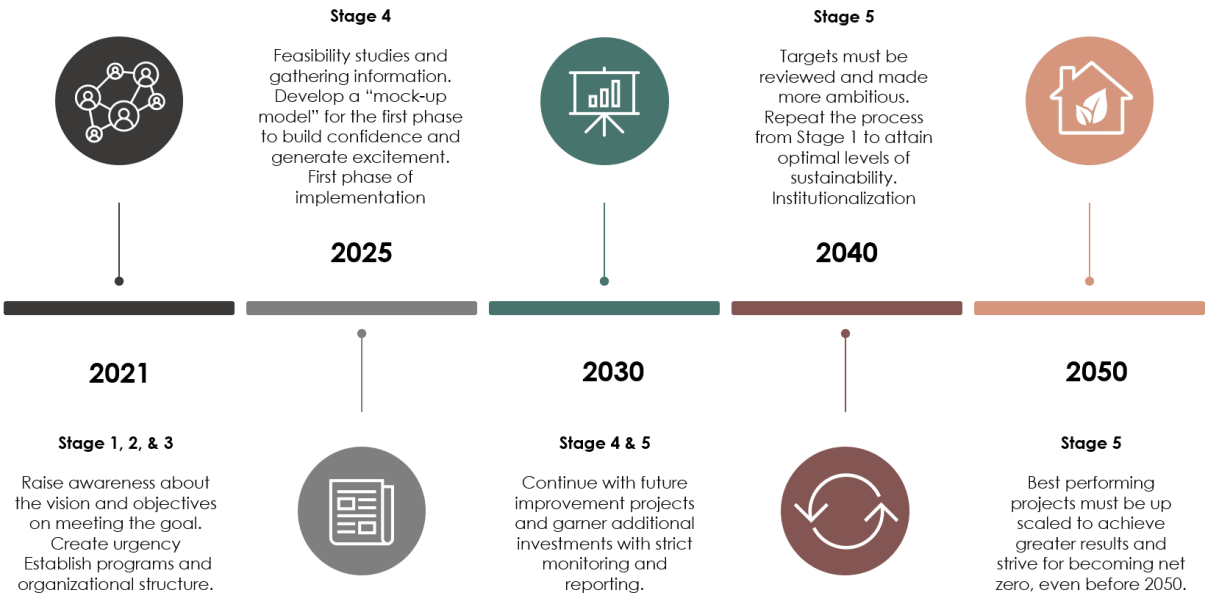
- Responsible for implementation of projects on the ground
- Report to the theme group management
- Maintain and record data/information for individual projects

d. Stage 4

Based on the target and objectives set earlier, this stage must start conducting feasibility studies and assessments to gather additional information, identify barriers and solutions and design appropriate projects. The projects for the first phase must be those that can be implemented with immediate effect to build confidence and generate excitement with demonstration projects. The success and lessons from the pilot projects must be well documented for planning future improvement and garnering additional investments/fund. The lessons learnt must be widely shared. Strict monitoring, reporting and verification system must be established.

e. Stage 5

Based on the experience from the first phase of implementation, the targets must be reviewed and made more ambitious. Best performing projects and initiatives must be upscaled for achieving greater results and strive for becoming carbon neutral before 2050. It is recommended to repeat the process, starting from Stage 1 to maintain dynamism and attain optimal levels of sustainability within the city/sector.



In line with EU ambitions, the Spanish government aims to cut carbon emissions to net-zero by 2050 (Climate Change News, 2020). The diagram above presents the hypothetical timetable of the project management process of the sustainable housing development in Huelva.

V. Conclusion

The trends over the years show a decrease in energy consumption and GHG emission, increased renewable energy generation and improved efficiency and awareness. These have been possible due to highly comprehensive policies, increased investment, and technological advancements. However, these achievements are not uniform across sectors and regions. For instance, there are no houses in Huelva fitted with energy efficiency measures. Therefore, the European Green Capital Award (EGCA) presents opportunities for tapping on the current best practices and achieving carbon neutrality within the housing sector. Huelva can earn the EGCA by setting targets and goals based on connectivity, comfortability, energy efficiency, and circularity. The change proposed aims to achieve sustainability goals through engagement and empowerment of the communities. This is expected to induce greater levels of behavioural change and ownership for sustainable practices.

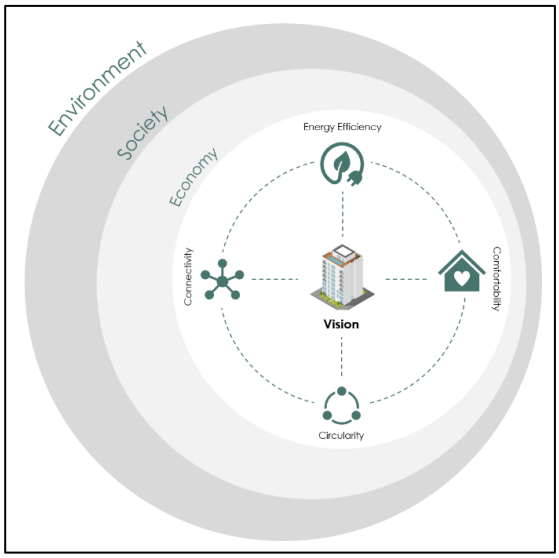


Figure 11. Sustainable development model.
Source: Adapted from Cato, 2009.

Ultimately, conforming with the sustainable development model should be the anchor in achieving the vision for the housing sector in Huelva (Figure 11) – "where the economy and social dimensions are constrained by the environment in managing sustainability" (Hunt et al., 2013) – to enable change for urban sustainability.

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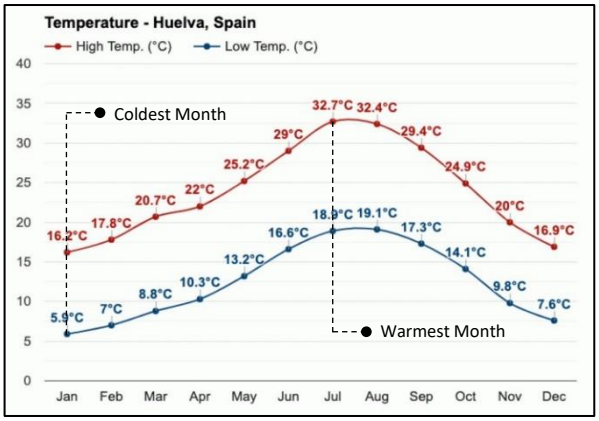
VII. Appendix A

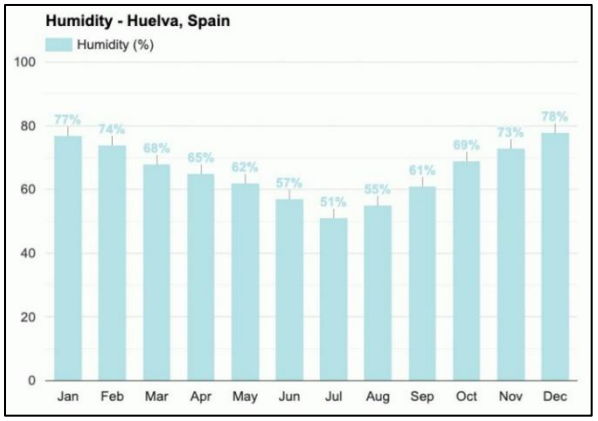
Climate

According to the Köppen climate classification (2020), southern Spain has a hot dry-summer Mediterranean Climate. Huelva is located in the Southwestern part of the Andalucía, Spain (Figure 2). It has an average temperature of 17.8°C (Graph 1), average humidity of 66% (Graph 2), and average annual precipitation of 467 mm (Iberia Nature, 2020; Climate Data, 2020; Weather Atlas, 2020).

Figure 2. Map of Huelva. Source: Wikipedia, 2016; Wikimedia, no date.



Graph 1. Average Temperature. Source: Weather Atlas, 2020.



Graph 2. Average Humidity. Source: Weather Atlas, 2020.

Huelva – European Green Capital 2023

Mobility

Prepared by:

Rabeya Begum, Shammi Keya, Abuzar Popal

MUrCS
Master in Urban Climate & Sustainability

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1. INTRODUCTION

MUrCS2020 class comprises professionals from multi-disciplinary background in the field of Urban Climate and Sustainability. Thus, Ayuntamiento de Huelva (or Municipality of Huelva) has finalized MUrCS2020 as the consultant to bid for European Green Capital (EGC) 2023 title. EGC is a prestigious accolading scheme to reward and inspire the European cities for their efforts and plans to improve urban environment, drive healthier lifestyles, and sustainable living condition. This award boosts the local authorities' willpower by providing incentive for the winning cities' sustainable development and addressing environmental challenges. European Green Capital (EGC) award is assessed based on 12 indicators (European Commission, 2020). Each indicator is judged based on its past performance, present condition, and SMART goals. Sustainable Urban Mobility (SUM) is a key indicator for EGC that identifies the social, environmental, and climatic challenges related to transport and corresponding action plans for the cities. Thus, a group of three professionals of MUrCS2020 is dedicatedly working on this indicator to make Huelva city as European Green Capital. This report will encompass the comprehensive sustainable urban mobility plan of city of Huelva based on past and present status along with incorporating current projects and elaborating progressive and radical development plan.

2. BACKGROUND & DIAGNOSIS OF TRANSPORTATION SYSTEM IN HUELVA

2.1 Spanish Political System

As per 1978 Constitution, decision of Huelva city's plan and legislation are highly controlled by regional government. Local government at the municipal level play role in managing the local police, traffic policy, taxation, social service, and urban planning (Expatica, 2020). Santana Gabriel Cruz is the mayor of Huelva since 2015 and member of Spanish Socialist Workers Party (PSOE).

2.2 Municipality of Huelva

Huelva city is the capital of Huelva province of Andalucía Autonomous Community. It is located at the bottom tip of Spain. The total population of the municipality is 143.663 as off 2019 distributed over 152.35 KM^2 which deduces a population density of 943 inhabitants per KM^2 (Junta De Andalucía, 2020). The population growth is decreasing since 2010 with a net gain of approximately 8000 people only in last 20 years (Epdata, 2020).

GDP of Huelva province accounts 6.49% of the whole Andalucía GDP which is increasing since 2013 (PMUS, 2020). At the same time, quantity of public debt is declining under the rule of current government. Even though, the public debt in Huelva is decreasing but it is still stood at 157,963,168.9 euros in 2019 which is signifies the city as one of poorest city in Andalucía (Epdata, 2020). The increasing pattern of average gross income of Huelva is supporting the statistics of public debt. The average gross income in the city of Huelva in 2018 is 25,454 euros per capita, representing an increase of 769 euros [3.12 %] than 2017 (Epdata, 2020). Moreover, the number of active companies/establishments increased in 2019 which is 7,676 in total. A decreasing trend found in the unemployment rate regardless of the exceptional COVID-19

situation, yet there was a total 17,797 unemployed people in Huelva in March 2020. Service sector is the most GDP creating sector in Huelva city [67%] followed industry & energy sector [14%] (PMUS, 2020).
Table 01 shows a comparison of budget distributed in 2018 and 2019 indicating the major sectors considered for different sectors (Epdata, 2020). It is shown that public transport is one of the least priorities for budget allocation along with Education sector.

Table 1: Budget allocation for different sector in Huelva Municipality (Epdata, 2020)

Type of policy	Spending in 2018 (Million euro)	Spending in 2019 (million euro)
General Actions	23,439	23,896
Security and citizen mobility	21,049	22,597
Public debt	17,155	19.47
Community Wellness	14,631	13,888
Social service and social wellness	11,316	11,735
Culture	6,926	7,628
Housing & urban planning	5,263	6,577
Public Transport	5,144	5,534
Environment	4,297	4,888
Promotion of employment	2,794	2,844
Sport	2,872	2,756
Commerce, Tourism and SMEs	1,153	2,146
Education	1,255	1,455
Other Economic Benefits	2,022	1,116
Health	0.155	0.233
Other economic actions	0.128	0.156

2.3 Mobility system of Huelva city

Transport system is one of the major sectors for energy consumption, CO2 emission, and air pollution level in both Huelva city. Many factors including individual, social, national, and global are affecting the mobility system of Huelva city either in favor or hindering sustainable urban mobility system as shown in Figure 01.

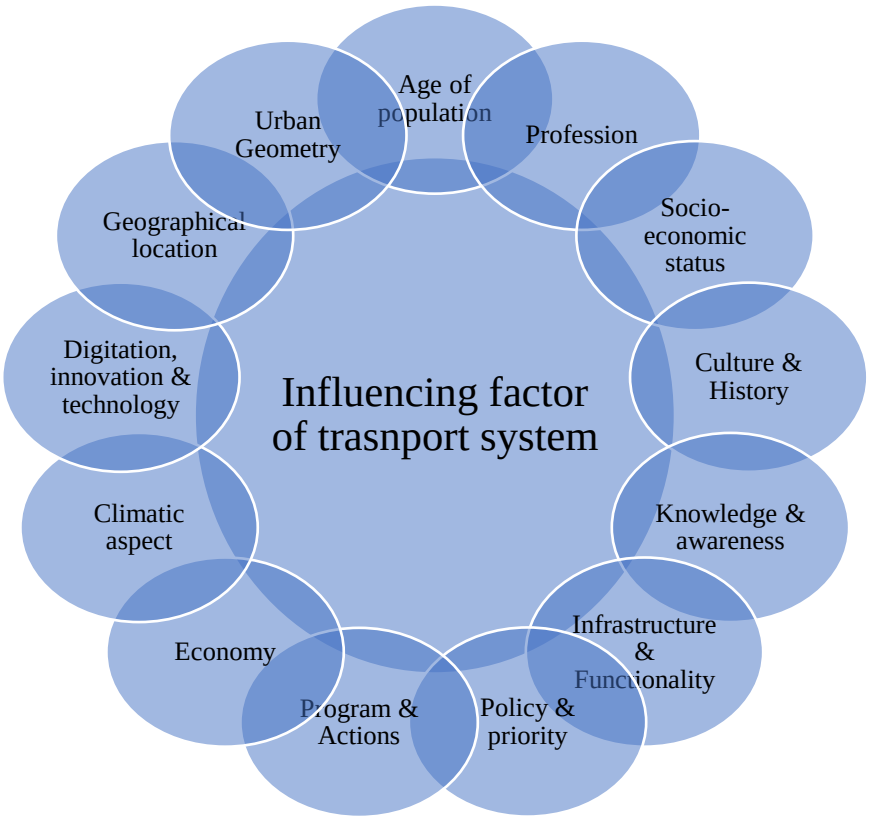


Figure 1: Factors influence the transport system of Huelva (Authors)

The city evolved from south-west corner which is very compact in geometry and functionality. On the other hand, the city expanding toward north-east where the new campus of University of Huelva is built. North-east part is still under development. Thus, the history of Huelva's evolution heavily affected the city's street pattern.

The city is walk-friendly which is the biggest strength of its sustainable urban mobility scheme. The whole city can be covered on foot as the distance is only 4KM from north to south and 3KM from east to west. The farthest distance is 3KM from city center. Thus, walk is the second popular transport mode in Huelva.

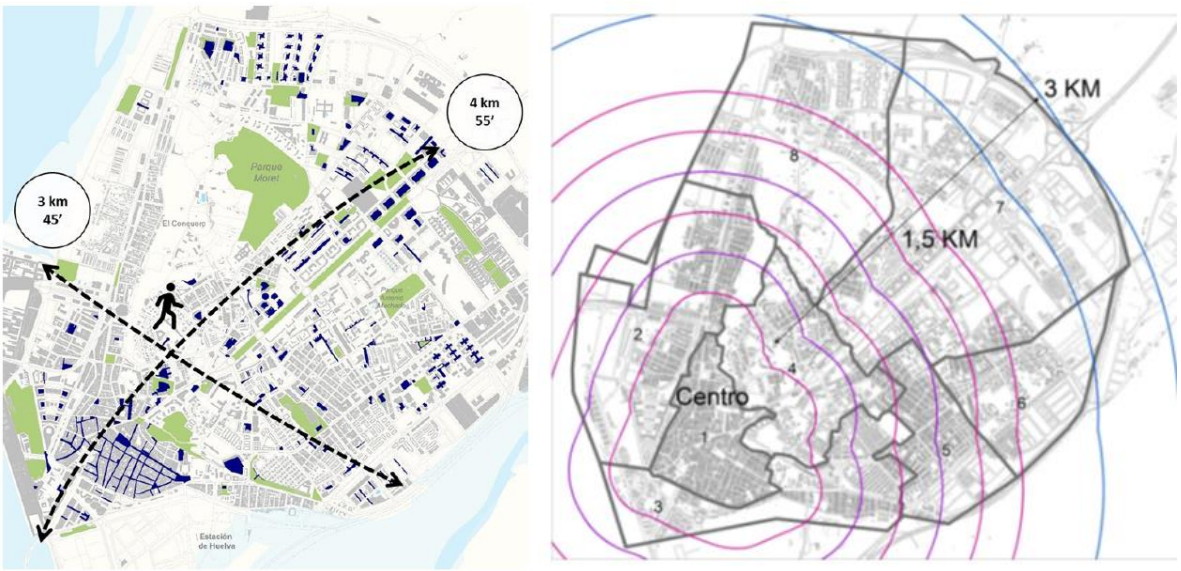
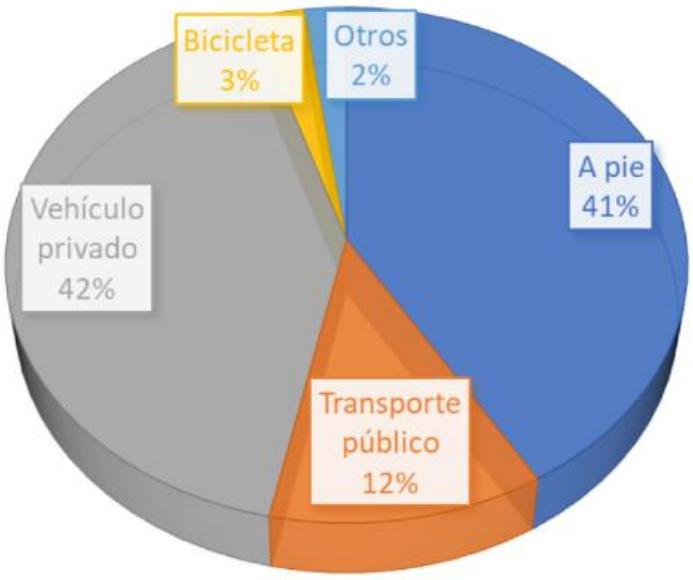


Figure 2: Walk friendly Huelva city (PMUS, 2020)

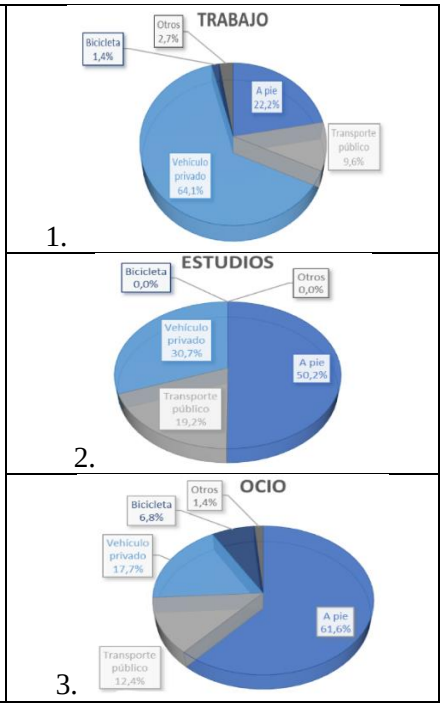
Other transport mode within the city is public bus, taxi, private vehicles, bicycle, and electric scooter. Besides, bus, train, trucks, and lorry are used for inter-city communication that follows outer route and ring roads to enter and exit the city and avoid intra-city streets.

The reason of travel and location of residents highly shapes the distribution of different transport modes in the city. As displayed in Table 2, both walk (41%) and private vehicle use (42%) covers majority modal share in general which are subject to vary. Public transport can be used from majority part of the city as the convenient bus stop is found within 5 min walking distance from residences. The use is also heavily affected by covid-19. Furthermore, the use of public transport and walkability is inversely related to ownership of private vehicle. Statistics shows that people who owns more than three vehicles do not use public transport and upholds the smallest percentage of walkability (PMUS, 2020).

Table 2: Overall modal share and different modal share for work (1), student (2) and leisure (3) of the city of Huelva (PMUS, 2020).



Overall modal share of Huelva city



Moreover, different locality within the city has different share of transport mode as shown in Figure 3. The city is divided into 8 major macrozones and two more growing macrozones possessing different modal share pattern.

On an working day, an average of 190,625 trips are made in Huelva which implies a ratio of 1.57 trips per person. More than 95% of trips are made in a single stage, which implies a low rate of intermodality. The fleet is increasing in the surrounding area of the Huelva city as the city only a working destination for many people but reside outside of the city. (PMUS, 2020)

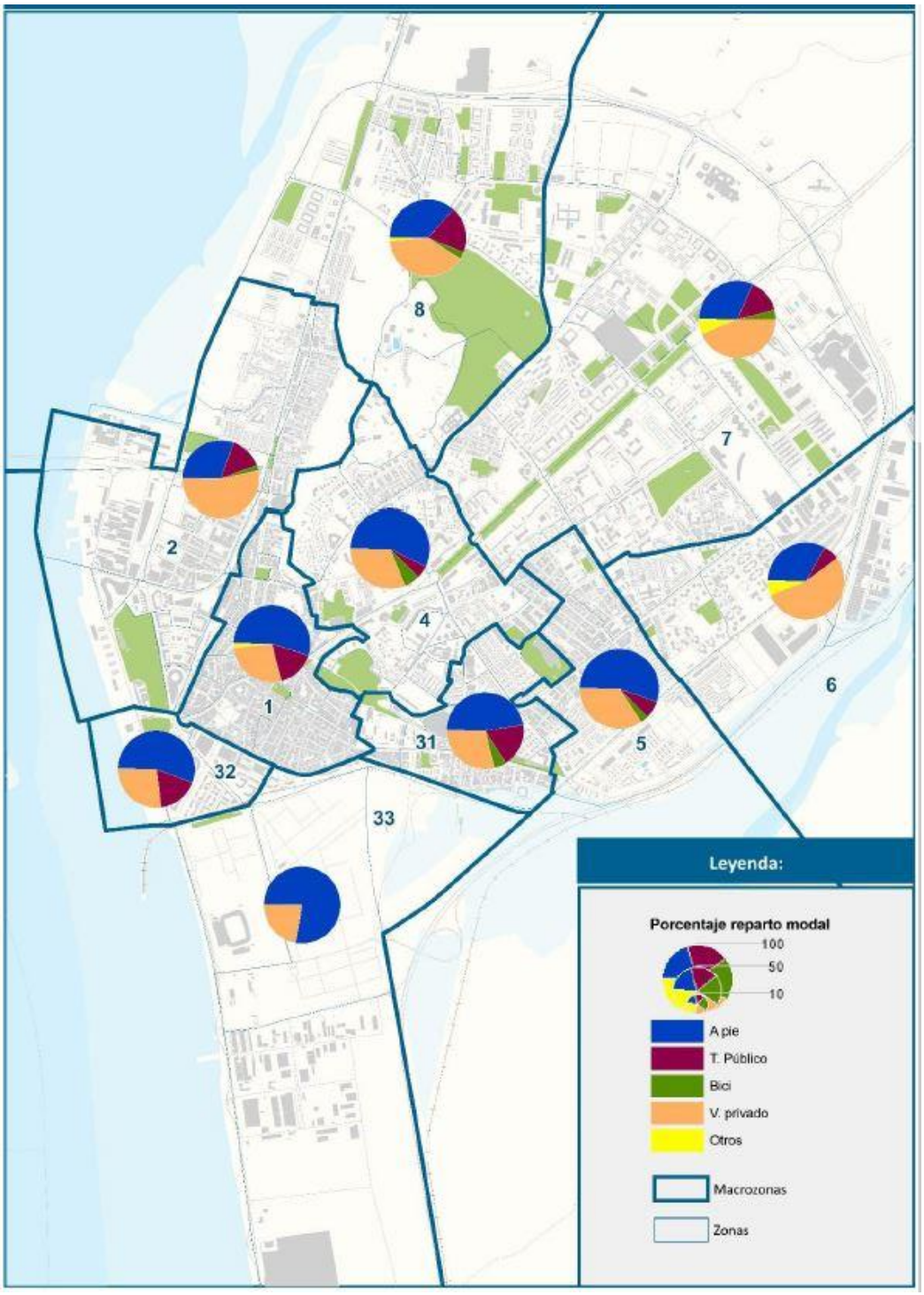


Figure 3: Overview of trips generated and modal share in different macrozones of the city (PMUS, 2020)

Huelva's unique working culture is reflected in its typical traffic pattern. The city's three hours of break in the middle of the day from 2PM to 5PM instigate more fleet within the city. Typical traffic flow at 9AM, 3PM, 4PM, and 9PM as displayed in Figure 4 chronologically infers that most of the streets around the city center face high traffic over the week except weekend.

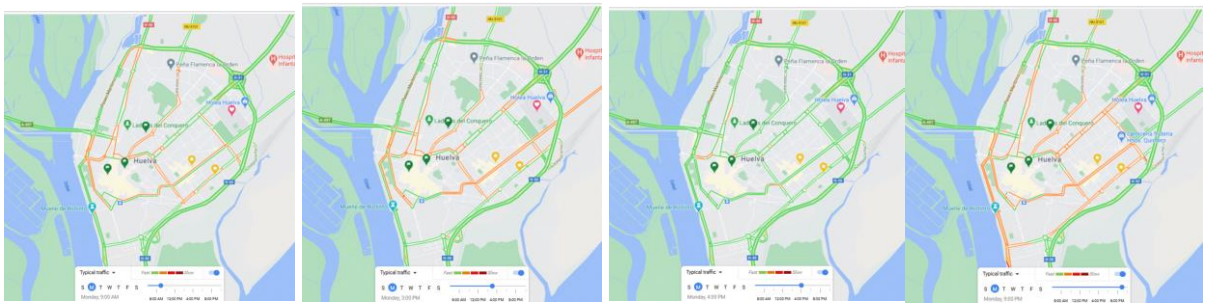
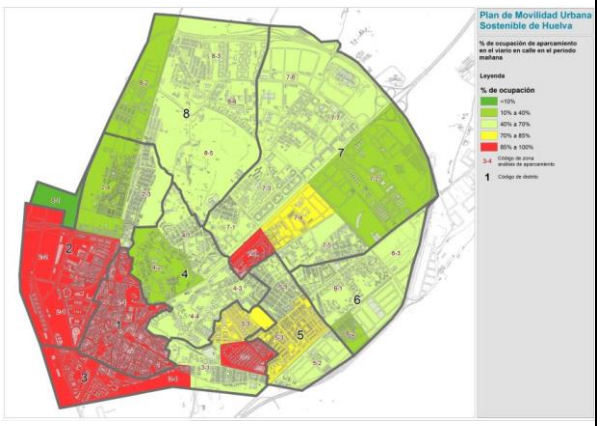
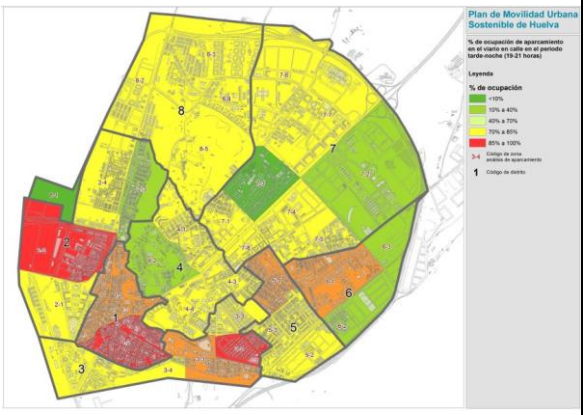


Figure 4: Typical Traffic in Huelva city over the week (Google Map, 2020)

High number of private vehicles use put pressure on urban fabric and disrupt walkability and bicycle use. Studies show that 58.2% of the cases park the vehicle in the free street, 16.3% in parking public and 15.6% in own private parking (PMUS, 2020). Table 3 displays where the majority parking is seen during morning and night in 2014.

Table 3: Parking intensity in the city in 2014 (Ayuntamiento de Huelva, 2014)

Morning parking intensity	**Night parking intensity**
	

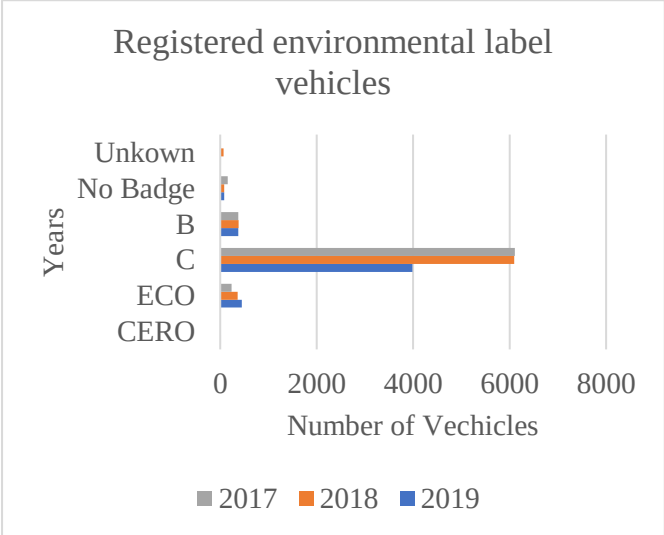


Figure 5: Graph of environmental sticker vehicles in Huelva Province (DGT, 2020)

Approximately 99% vehicles use both petrol and diesel almost equally although the number of petrol vehicles are increasing. Statistics shows that 68% of vehicles in Huelva is more than 10years old that lead to concerns like fitness, fuel efficiency and pollution (Huelva Informacion, 2019).

Air pollution is the highest environmental problem in Huelva whereas it stands in sixth place in Andalucía. The pollution is resulted from industrial activities, road traffic and other emission related activities (Huelva Informacion, 2010). 2019 Air Quality report stated that air breathed by

Huelva residents was more polluted than WHO standard. However, during COVID pandemic, the pollution decreased drastically. (Diario de Huelva, 2020).

However, vehicles are being categorized with different environmental levels (zero, Eco, B and C) due to increasing environmental awareness and movement and to address the climate change issue in transport sector. Figure 5 is showing the details of different environmental sticker-based vehicle quantity.

2.4 Stakeholder Engagement

Different stakeholder group contribute and influence to Huelva's mobility system in different ways (as given in Table 4) .

Table 4: Identification of stakeholder connected to Huelva's mobility system (Authors)

		Level of Interest	
Power		High	Low
	High	Key Players: • Residents/citizen • Large enterprises (Port of Huelva) • Politicians • Local and regional Government Authority • Transport authority	Keep Satisfied: • Neighbor cities • European Commission/investors
	Low	Keep Informed: • Immigrants • National and Internationl NGOs • Industry Association • Knowledge partners like Universities	Minimal Effort: • Tourists/ visitors • Media • SMEs

Local government is responsible for creating policies and rules related to transport but has to align with the regional and national goals. Port of Huelva authory holds a significant role in transferring goods and industrial products via marine, road, and train mode. The port authority actively engaged in different projects like Connecting Europe Facility (CEF) to promote LNG based logistic system and ECO-GATE projects to identify innovative solutions for vehicle. (Puerto de Huelva, 2020).

The city council value the public opinion which is why it leave a scope of public participation in planning and decision making to improve city's mobility system. People can directly write the council and. It engage public through various social and sectoral focus group discussion. Overall the city follows a consultative and involvement style to engage its stakeholder especially the citizen and residents. It has open feedback section in the website of Ayuntamiente de Huelva.

The local government receives fund from various sources to implement sustainability measures. European Commission issued a grant of 15 millions euros to achieve the goals of EDUSI project (Diputacion de Huelva, 2020). In 2018, the Port of Huelva has announced an

investment framework 2018-2022 under its 2019 Business Plan where it committed to spend 113 millions euros to invest in infrastructure (Huelva Informacion, 2018).

2.5 Policy and Strategy

The city has incorporated Sustainable Urban Mobility Plans (SUMP) in 2014 which is updated in 2020. According to the plan the local government has taken mode specific plan to achieve sustainable mobility. Urban Strategy 2025 has been merged with mobiligy goal. Other regulations includes the Strategic Plan for Infrastructure and Transport (2005-2020), Energy Saving and Efficiency Strategy in Spain (E4) 2004-2012, and Spanish Air Quality Strategy are directly and indirectly promoting sustainable urban mobility of Huelva. (Ayuntamiento de Huelva, 2020).

2.6 SWOT Analysis of the transportation system of Huelva

The SWOT analysis in Fig 6 explains the Huelva city's existing strength and weakness. Besides, figure 7 shows some photos of real-life experience regarding walkability and bicycle route which buttress the SWOT analysis.

STRENGTH	WEAKNESS
• Existing arterial connection towards City-center and peripherical intercity connection • Well-connected bus route projects • Huelva has adequate land accessibility with Seville and Portugal • Existence of the port, which is expanding, healthy, with the capacity to invest, land and connectivity • The climate of Huelva is very suitable • The availability of energy sources, in particular water quantity and quality • Huelva is well positioned for international maritime traffic, in particular the coastal connection with Portugal	• Lack of interactivity between modes of transport, schedules, and platforms • Need for EMTUSA to modernize and optimize the fleet • Lack of incentives for inexpensive vehicles and alternative energy sources • Dirty sidewalk route and blockage on the footpath • Huelva has an adverse topography in terms of mobility, and currently there is a separation between upper city and lower city that is not properly addressed • The accesses to the city and its urban image are of poor quality • The absence of a parking forecast • Non-motorized transport is not being adequately promoted • Low level of pedestrianization and in application of the planned investments of the accessibility plans • Poor air quality
OPPORTUNITY	**THREAT**
• Strengthen the geostrategic position of the capital and its province. • Huelva has enough land area for future • Promote the logistics platform, starting from the Port of Huelva. Possibilities of attracting investment to improve rail connections, and their inclusion in the Strategic Plan for Infrastructure and Transport • Existence of European Funds in general, and in particular for the rehabilitation, regeneration and renovation of buildings and urban areas. Possibility of urban renewal of 'obsolete neighborhoods' • Transfer of some activities from the Levante Dock, facilitating the city's approach to the Ria. • Develop archaeological routes to 'visible' sites and enhance 'invisible' sites • Enhance closed official buildings as cultural centers • Expand the port, with new lines for passengers and adaptation of the estuary • Promote natural spaces as a source of wealth.	• Economic crisis with its consequences of low prospects for work and investment. This is compounded by the already weak economic situation in the city • Reduction of public and private investment, with a clear lack of visibility of public investment, and little competition on the coast • Huelva is close to other cities that currently have a greater attraction • The lack of modal intercommunication with little communication with other provinces other than Seville • Competition with other cities and urban centers with building typologies that respond to the demands of the population. Thus, there is a growth of the metropolitan area at the expense of Huelva • Occupation of port spaces by industry • Lack of a spatial planning instrument, with an imbalance between the burdens borne by the city and the territorial compensation. • Available parking space and flexible rules for car purchase

Figure 6: SWOT analysis of Huelva city's transportation system (PMUS, 2020; Authors)

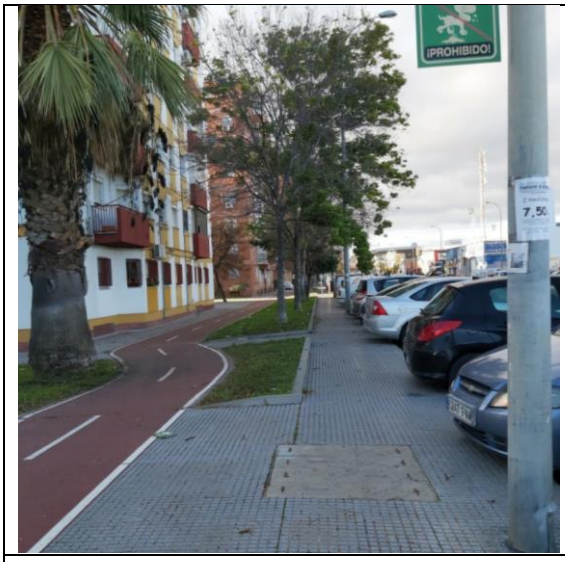
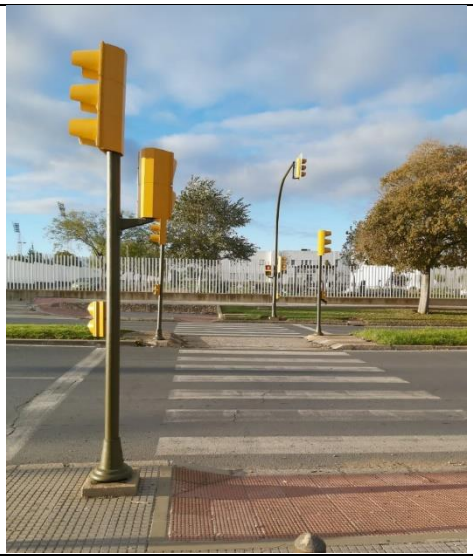
	
Car parking blocked footpath	No traffic signal button for pedestrian to press
	
Damaged bicycle route	Blockage on the footpath

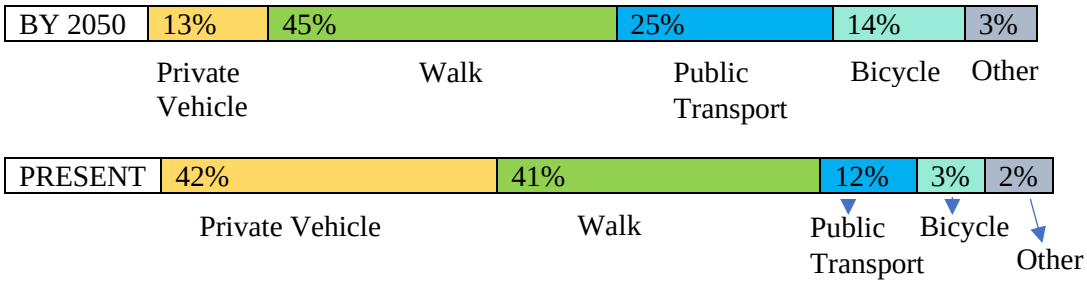
Figure 7: Photos of few contraints for footpath and bike route (Authors)

3. VISIONING

As Albert Einstein said, “We cannot solve our problems with the same thinking we used to create them”, so we are proposing both progressive and radical changes in the transportation system and network of the city of Huelva to achieve sustainable urban mobility (SUM) (McDowell, 2020). Both existing and new strategies of SUM will enable the city to be ahead in European Green Capital competition. This section will envision the future through demonstrating different management tools to identify the potential scopes of improvement and justification of the master plan and programming.

THE VISION IS TO PHASE OUT ‘’CONVENTIONALLY-FUELLED’’ CARS BY 2050 THROUGH PROMOTING ACTIVE MOBILIY, PUBLIC TRANSPORT, AND INTERMODALITY PRACTICES

Exiting data and information is used to forecast the near future whereas scenario planning method is applied to encompass both certainties and uncertainties for mid-term future planning. Backcasting is adopted for radical decisions to shape the next steps rather than following the trends. The plan is to reshuffle the existing modal share by 2050 by prioritizing walkability, public transport and bicycle chronologically as shown below:



3.1 Visioning Private Vehicle

The aim is to reduce the personal vehicles especially phasing out the conventional fuel-based vehicles and categorize rest of the private vehicles with environmental labels.

As per figure 8, the present number of registered vehicles anticipates that registered vehicles in Huelva province will be decreasing even though there is an increasing trend for the whole Andalucía. Thus, it can be forecasted that reducing conventional fuel vehicle is achievable.

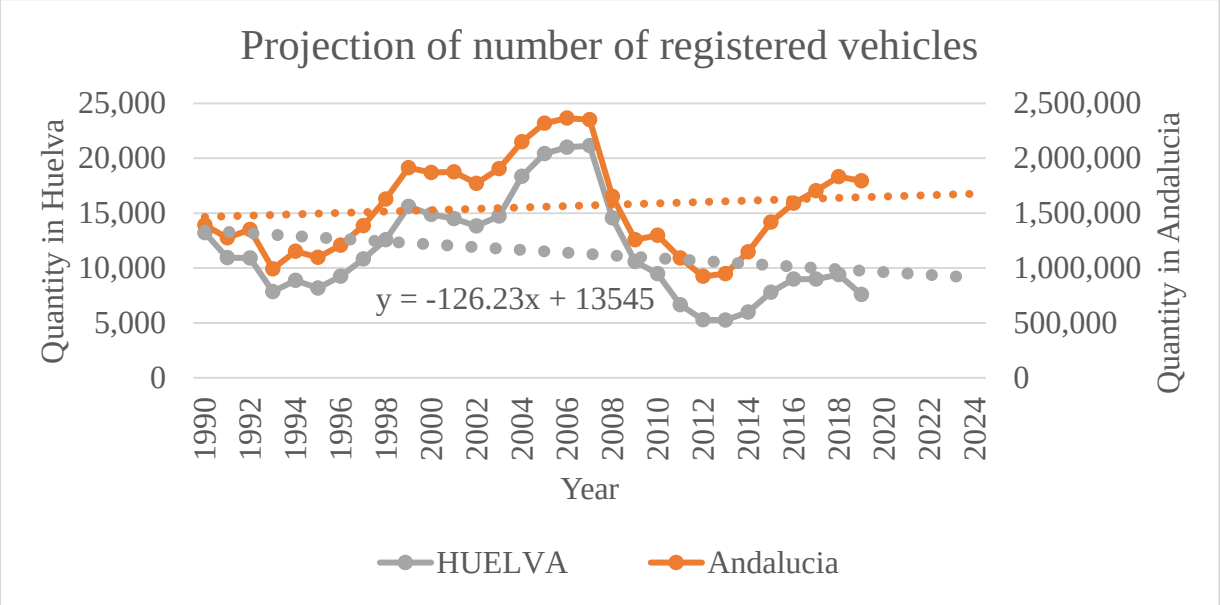


Figure 8: Forecasting of number of vehicle in Huelva province (DGT, 2020)

The tread alone does not imply whether we are heading toward the right direction or not. Thus, scenario planning is done to foresee the relevant positive and negative outcome which will help to shape the master plan.

Figure 9 displays possible outcomes for the key decision of reducing private vehicles. Six different areas of PESTEL analysis tool is incorporated to justify the key decision from diverse perspectives. Only prominent factors are taken into consideration to create different scenarios for 'private vehicle reduction' decision where both positive and negative results are anticipated.

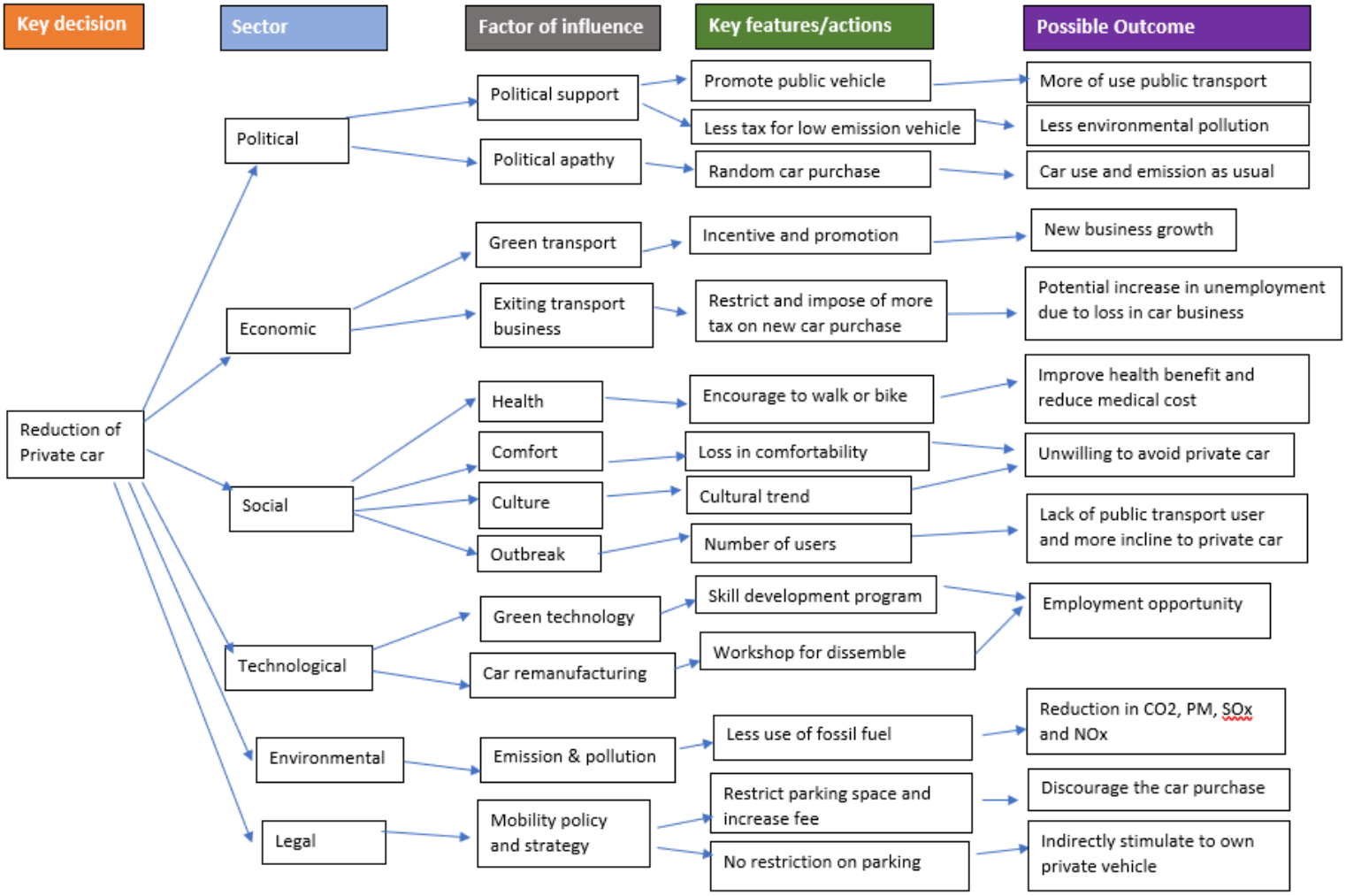
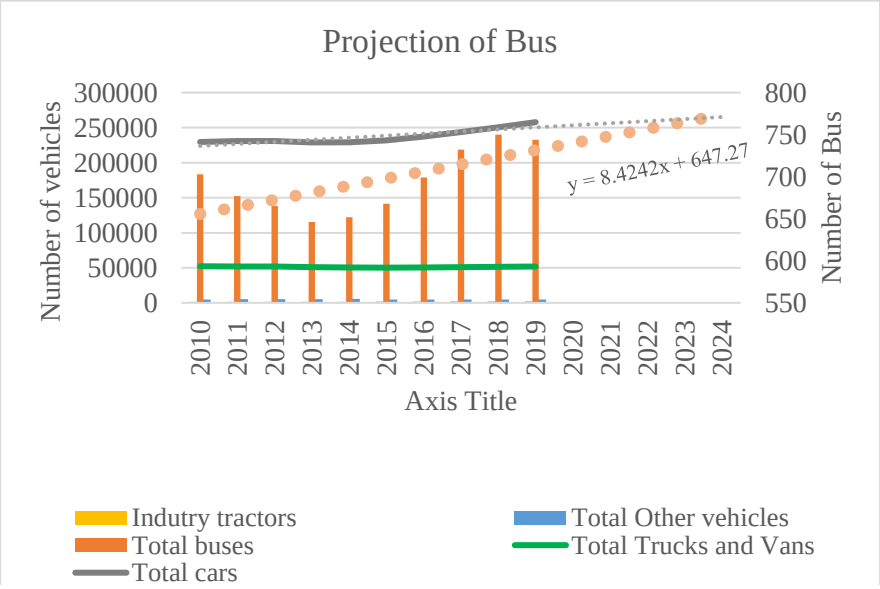


Figure 9: Scenario planning for private vehicle reduction decision (Authors)

3.2 Visioning Public Transportation



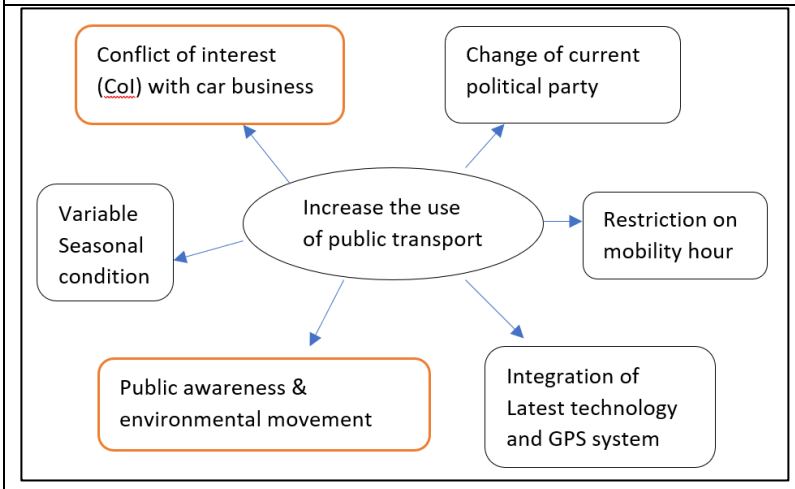
The forecast of bus quantity in Huelva province (in Fig 10) indicates that the use of public transport is increasing. Even though bus quantity is very nominal compare to the number of cars, a rise in public vehicle can be expected in the future through proper planning and strategies.

Figure 10: Forecasting the number of bus in Huelva province (DGT, 2020)

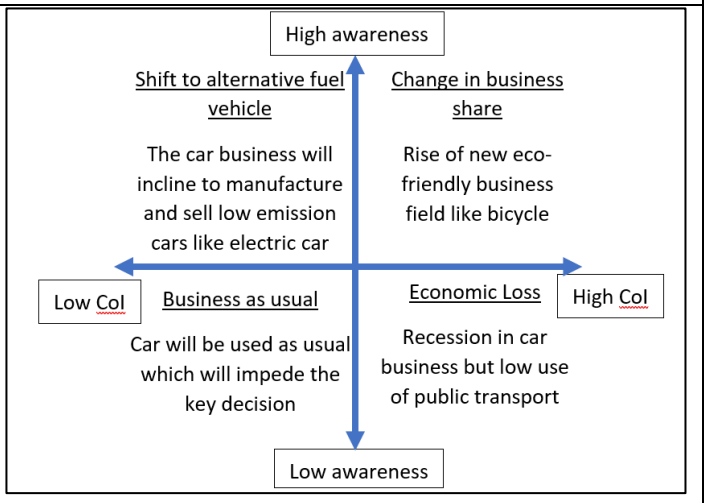
Target of making public transport into second most popular transport mode of the city of Huelva is challenging. In order to foresee the mid-term future, scenario planning is applied to identify the public transport related uncertainties in three steps as shown in Table 5. At first, six major trends are identified of six sectors of PESTEL analysis tool. Secondly, four scenarios are created in step 2 by applying two selected major trends of step 1. In step 3, a test is done to check whether suitable strategies can improve the scenarios or not.

Table 5: Scenario Planning for public transport in three steps (Authors)

Step 1: Identifying the major trends



Step 2: Analysing four scenario by using two selected trends



Step 3: Testing the four scenarios by applying sample strategies

Strategies	scenario			
	Shift to alternative fuel vehicle	Change in business share	Business as usual	Potential economic Loss
Develop and explore new market	Use of expertise and knowledge on shifting to low emission car business	Bicycle business can be flourished to keep the economy running	Connecting and diverting to new business strategies	Use of incentive and subsidy to have smooth transformation without losing economy
Awareness and education program	Increase in public transport use and intramodality practice	Reduce medical cost and healthy livelihood	Focus on changing the mindset	Focus on knowledge sharing to overcome the crisis

3.3 Visioning Increasing Bicycle

A different approach is taken to visionize the future of bicycle use in Huelva city. With current flow, the future of bicycle use is very limited and the share supposedly will not cross more than 5% as assumed. However, we are expecting to switch bicycle use into third popular transport mode within Huelva city. Thus, we fixed a target 14% bike use by 2050; hence, designing our short-term and long-term steps accordingly (as displayed in figure 11). However, we assume that many uncertainties may arise in between, so we have applied scenario planning management tool to visualize maximum possible outcome of our decision (in figure 12). In this case, DEGEST analysis tool is incorporated into this visioning stage. As bike use growth trend is very slow during last five to ten years, attaining a fourth fold bike use will need a cultural and mindset transformation by 2050 in Huelva city. ,

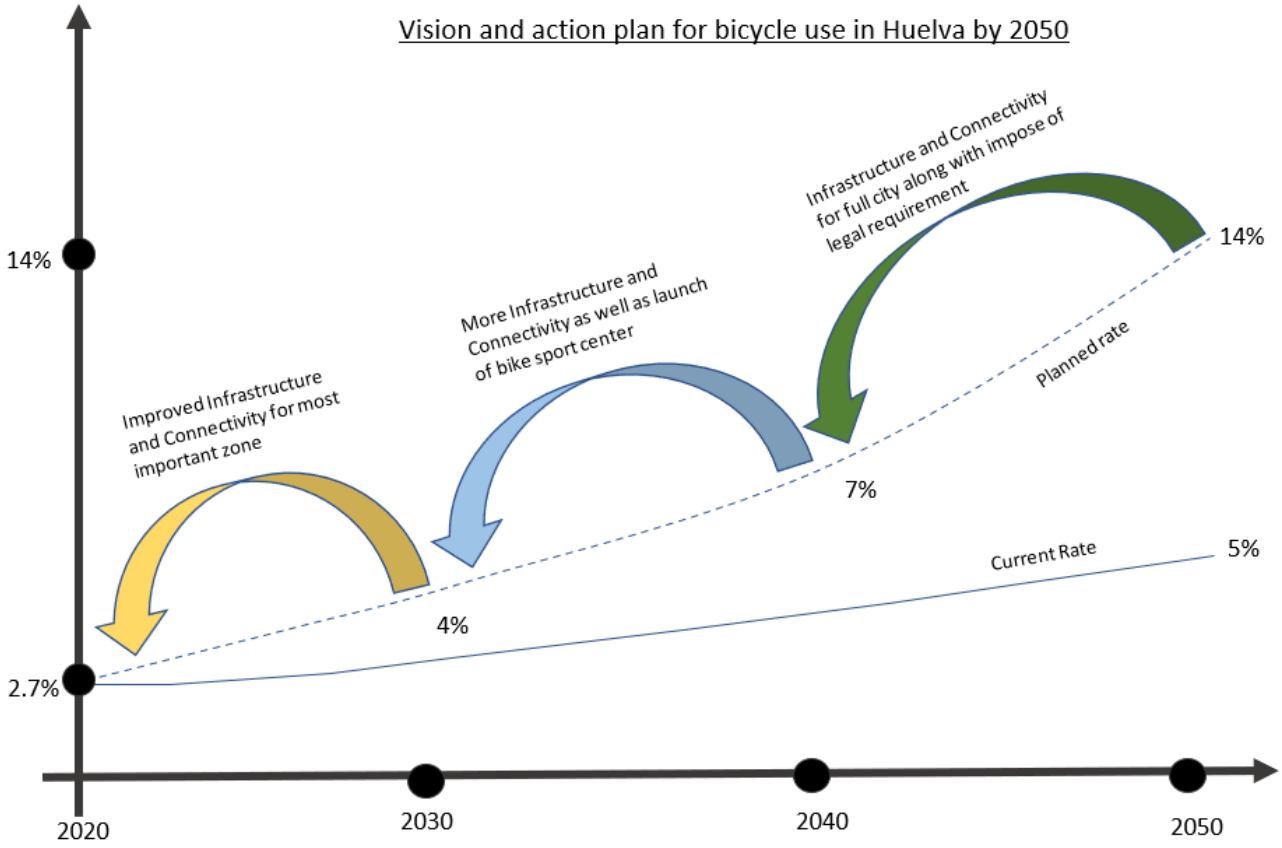


Figure 11: Backcasting for Bicycle use target (Authors)

Overall, visioning helped us to be digillent, thoughtful and realistic while building our master plan and corresponding action plans. Next section will act as an bridge in between vision and master plan to explaining a transitional analysis of Huelva city's different transport modes.

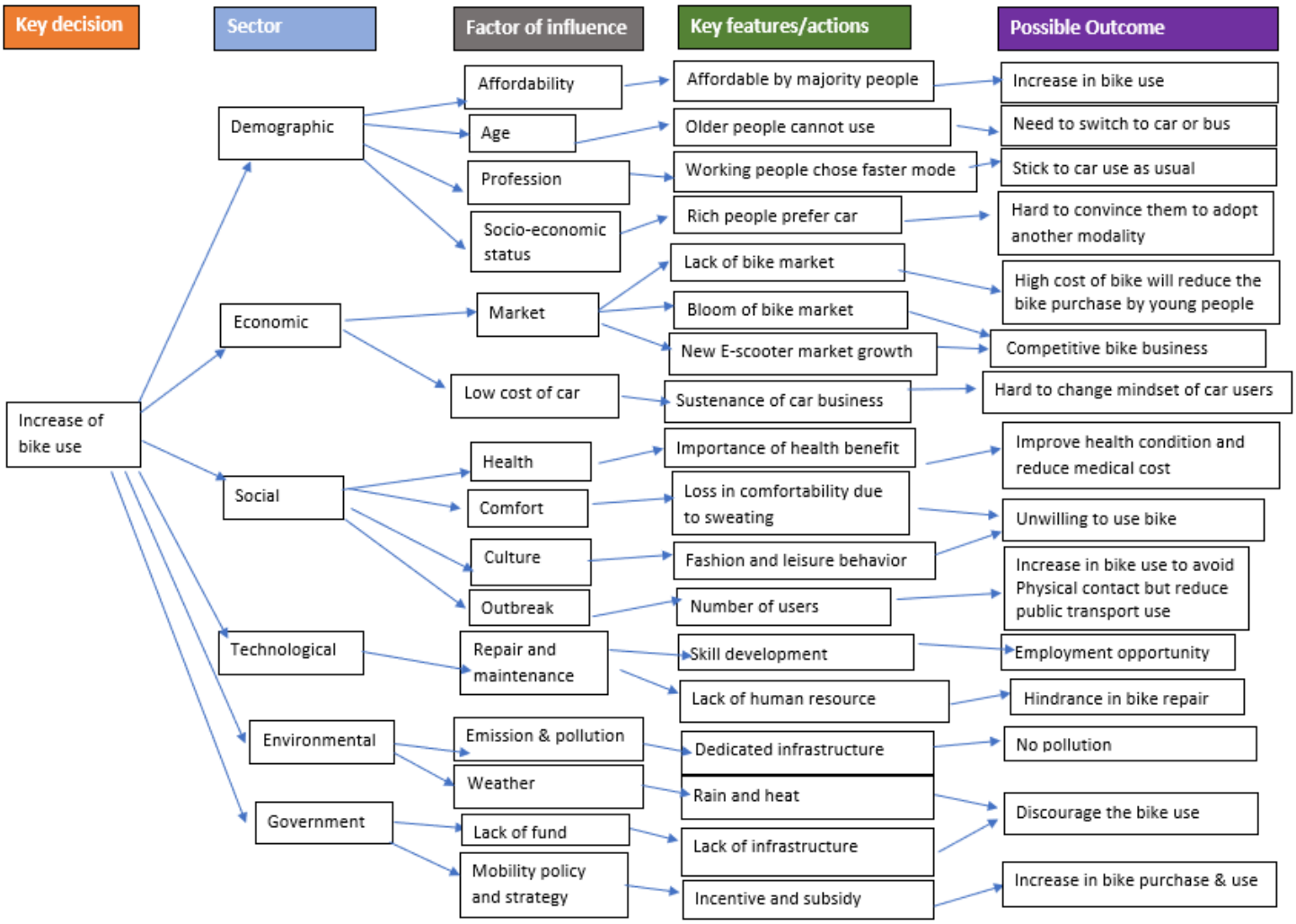


Figure 12: Scenario planning if to plant increasing bike use (Authors)

4. ANALYSIS OF PROMONIENT TRANSPORT MODE

Mobility in Huelva, relative to cities of comparable size in the same socioeconomic environment, is characterized by the extensive use of a private vehicle which accounts for 4 out of 10 journeys, significantly lower than the Andalusian average (6 out of 10 journeys). This is complemented by 40% of travel being on foot (IECA, 2011). According to the 2011 IECA Social Survey, the number of walking trips in the metropolitan region of Huelva is 10% higher than the average Andalusian city and is very high compared to other parts of Europe. The key reason for this trend is the very compact urban layout of the central core of the municipality, keeping travel distances within reasonable walking limits. Favorable climate, often with minimal rainfall, and pedestrian zone in city centre work together to meet these conditions. The share of public transport is around 12% and bicycle/other alternatives account for 5%. Mediterranean culture/lifestyle prefers walking for short distances and using a private car for prolonged distances with little consideration for other more sustainable modes of transport. The ratios of transportation methods are consistent with the typical Mediterranean urban areas comprising of a compact city that enables distances to remain within tolerances that make it

accessible to pedestrians. The fact that these mobility patterns are so accentuated responds to certain strengths and weaknesses that will be discussed in the following sections (IECA, 2017).

4.1 Bicycle Network

Huelva currently has no public bike sharing schemes with the previous venture lasting from 2010 to 2014. Largely due to this fact, the bicycle usage ratio in Huelva is only 3 percent. The low precipitation and the mostly flat topography offer Huelva a great opportunity for future growth. Nevertheless, the lack of infrastructure in terms of dedicated bike lanes, the lack of integration with other means of transportation, the lack of continuous investment and maintenance, directed to the failure of the last venture. Huelva currently maintains 16 km of dedicated bike lane, with only one continuous path from the center to the city's northern edge (Figure 1a). Other routes are patchy, and most lead to main streets designed for cars that pose a severe risk to the cyclist's safety. The accessibility of the routes is also limited to the areas around the center and Avenida Andalucía, which makes it unfeasible for most of the population (Figure 1b). Figure 1c shows the area of Huelva covered by a traditional bike (diagonal line) and electric bike/scooter (green) within 10 minutes by bike ride from the center. Over 90% of bike journeys currently last less than 4km and nearly 80% are less than 3km largely attributable to the vast time it requires and cyclist safety, owing to the unavailability of dedicated bicycle lanes. The urban sprawl away from the center in the last decades has resulted in increased distances making walking impractical thus increasing the need for a better network of bicycle lanes. The significant decrease in the prices of electric bikes in the last few years could play a major role in mitigating certain limitations of the elevated slopes around Huelva. The

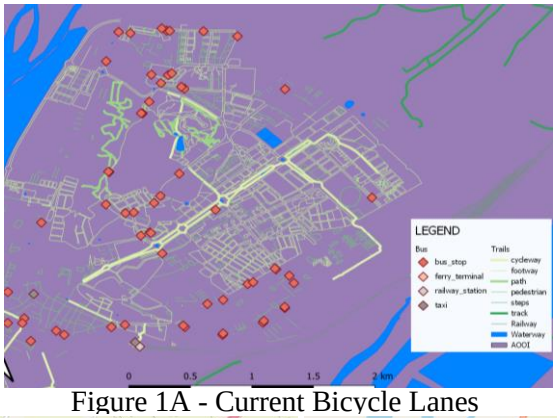


Figure 1A - Current Bicycle Lanes

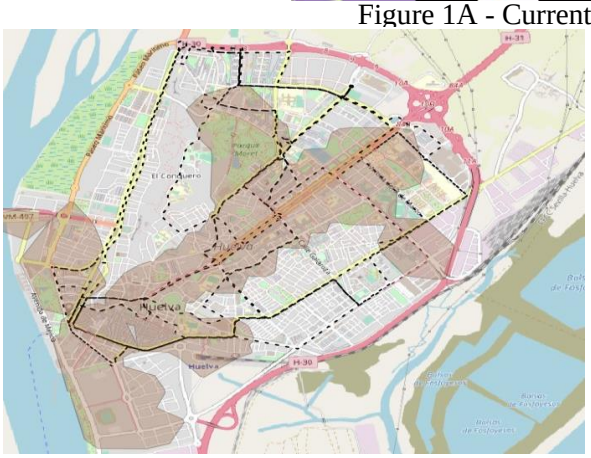


Figure 1B- Accessibility to Bike Lanes

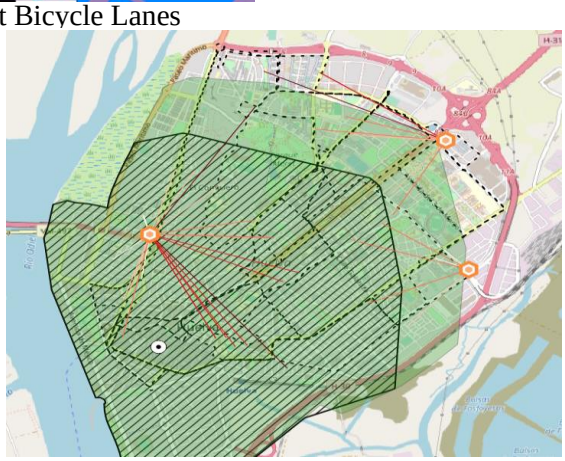


Figure 1C - Area Within 10min

Figure 13 - Bicycle Path Analysis (Authors)

integration of the bike routes with the public transportation network is essential for the customer to create a system with the vision of "one network, one timetable, one ticket, one fare – from door to door" (IECA, 2011).

4.2 Walkability

The compact urban design that has been promoted for so many years has been diluted in the last decade because of increasing urban sprawl. Residential developments in outer regions, mainly to the west of the city (Nuevo Corrales, Aljaraque, La Monacilla) and the dispersion of a large part of the commercial-industrial activities to the periphery, such as Polígono, Agrifood, Holea Shopping Centre, Science Park, and Technology of Huelva, have led to a decline in leisure and shopping activities in the city center. The development of the La Rabida University Campus in the outskirts of Huelva has also been attributed to the commuter traffic away from the center (IECA, 2011). The distance of travel is the main factor that influences the weight of the pedestrian transport ratio. The center is well pedestalled, but as you move away from the center, the dependence on private vehicles increases. In the future, providing the local population with other means of transport that are more sustainable is essential, in the form of a better public transport network aligned with the bike lanes (Speck, 2018). Attention must also be paid to the development of routes around the city, which are designed to be "pedestrian first" due to a larger population moving away from the center of the city. High walkable

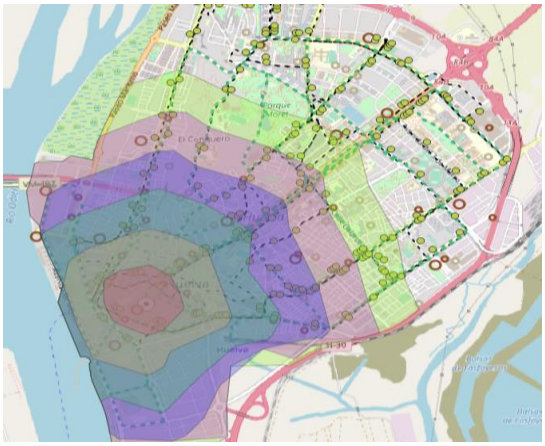


Figure 2A -Walking Distance By 5min Interval

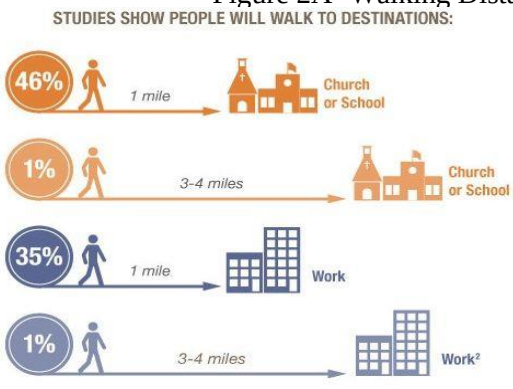


Figure 2B -Walking Distance Preferences
Source: Rebecchi et al., 2019

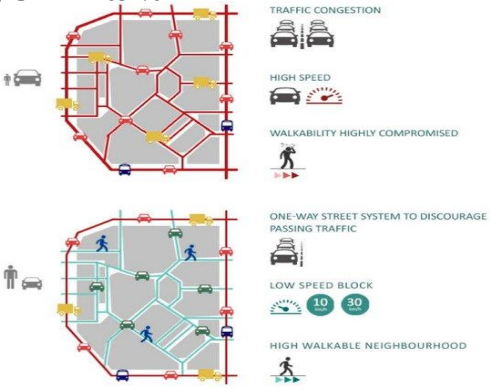


Figure 2C -Pedestrian First Design
Source: Rebecchi et al., 2019

Figure 14 - Walkability Analysis (Authors)

neighborhoods can be promoted through pedestalized streets and one-way street systems to discourage passing traffic and enforce low-speed blocks (Rebecchi et al., 2019).

4.3 Private Cars:

The share of private vehicles in Huelva is 41 percent which represents a lower percentage than the average of Andalusian cities but is significantly higher compared to the rest of Europe. Behind these high numbers are the growth of Huelva and the increase in the dispersion of residential, industrial, commercial, leisure, and educational facilities. Traffic movement throughout the city is fluent, except around the center during rush hours. For most long-distance trips, these conditions lead to the use of private transport. With the rise in cars and the lack of suitable facilities, the availability of parking is very competitive. The city is enforcing the regulation of parking in the center to switch the locals towards more sustainable means of transport, but it must be accompanied by a significant improvement in the competitiveness of

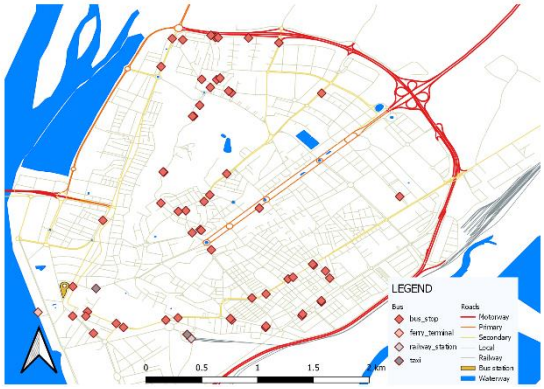


Figure 3A -Road Network Analysis

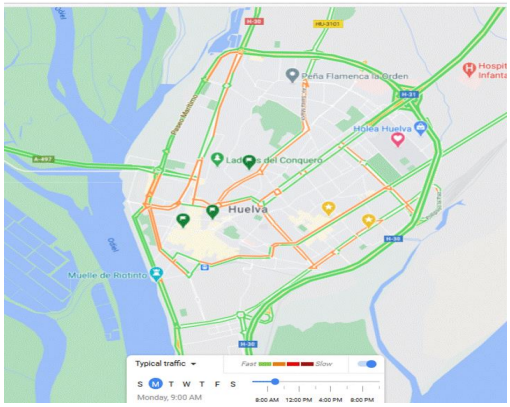


Figure 3B – Traffic Analysis (Google

Figure 15 - Road Analysis

public transport (IECA, 2011). Deployment of a shared vehicle system (car-sharing) and the formulation of a paid system for controlled parking areas are other plans being considered. The implementation of regulations for emission/smog testing and dedicated carpool/bus lanes will improve the safety of pedestrians and cyclists while providing a valuable alternative transportation option for locals (Thiel et al., 2016).

4.4 Public Transport:

In Huelva, public transport accounts for 12% of overall transportation, which is much lower than the Andalusian average and similarly in European/OECD context. The existing network provides urban and suburban travel through a network operated by the municipal company EMTUSA and intercity services provided by the Metropolitan Transport Consortium, operated by Grupo Damas, which links the capital of Huelva with the most important municipalities in the province (IECA, 2011). Although the transportation network within Huelva has excellent coverage with almost all the areas within 5 minutes of a bus stop, due to the long waiting times, length of routes, and disjointed route network with the surrounding towns/suburbs, the route network is inefficient. The bus routes go in a meandering pattern and take many local roads that unnecessarily extend the time of the trip. To shorten the distance and make the routes more efficient while maintaining the same coverage, the notion of linearity which considers the shortest distance from point A to point B can be utilized. GPS mapping APIs such as Here

Maps and TomTom can be applied to calculate the shortest routes from different strategic points around Huelva and then combine them to form a network focusing primarily on route length. In essence, this can lead to shorter trips and reduced waiting times, making it more beneficial and attractive to the customer (Geertman, Zhan, Allan & Pettit, 2019). In terms of pollution, the shortened routes may also have a positive environmental impact. There is also a lack of integration and efficiency in network connectivity with the surrounding towns, which can be reduced by the introduction of bus hubs on the edges of Huelva, where shuttle buses can be used in a single unified system to connect locals living in the outskirts to the public transport network (Heddebaut, Heddebaut, Di Ciommo & Di Ciommo, 2018). The hubs will then be connected to the center within 5-10 minutes by an express bus rounding off the ring road around Huelva and connecting all areas of Huelva to the center.

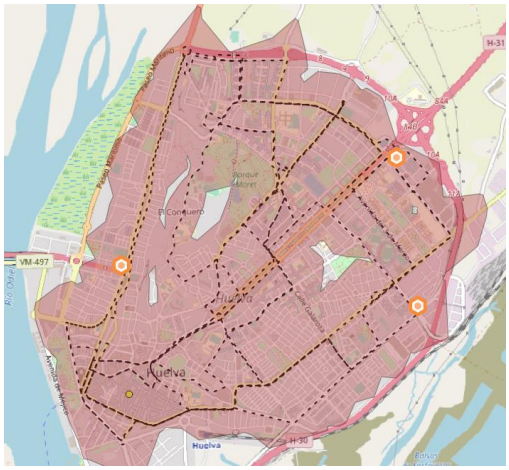


Figure 4A - Area Within 5mins to Bus

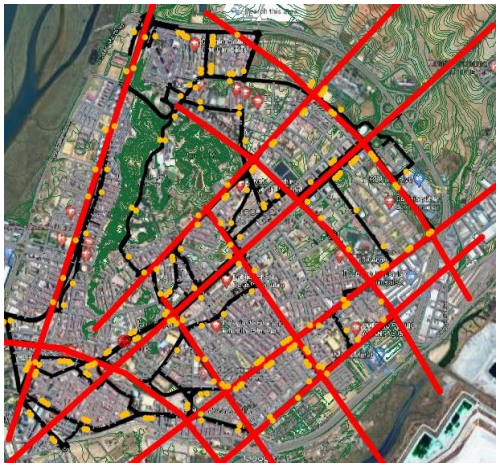


Figure 4B – Linearity intersections of Main Roads

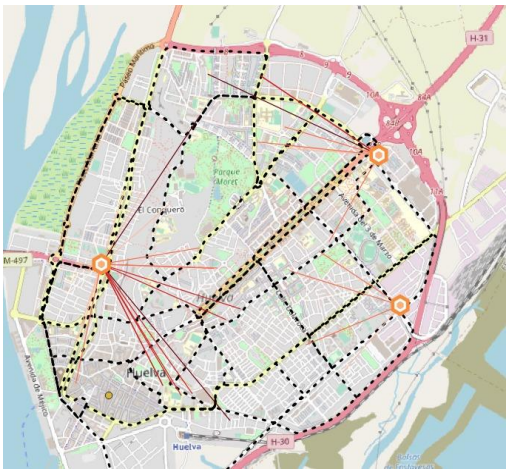


Figure 4C - Hubs to Transport Routes Analysis

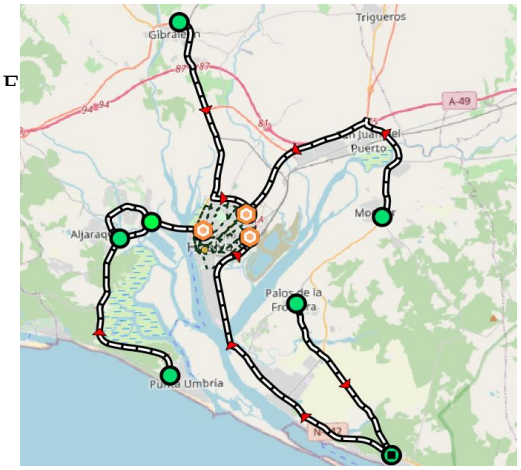


Figure 4D – Suburb Connectivity Network

Figure 16 - Public Transportation Analysis (Authors)

5. PROGRAMING:

A master plan or development plan that incorporates our vision towards Huelva as the European Green Capital includes three phases. The aiming factors for a SUSTAINABLE TRANSPORTATION SYSTEM (STS) in HUELVA within 2050 are the followings:

TRANSPORT MODE INTERVENTION

- Increasing walkability from 41% up to 45%
- Increasing usage of public transport from 12% up to 25%
- Increasing bike usage from 3% up to 14%
- Decreasing car usage from 42% down to 13%

INFRASTRUCTURE RELATED INTERVENTION

- Shortening bus routes to reduce the trip duration and in trip intervals to promote public transportation usage
- Zoning out car usage within walkable distance
- Infrastructure development for bike routes
- Implementing cleanliness regulations

PUBLIC ENGAGEMENT & AWARENESS

- Media & workshops to raise awareness
- Promoting biking activities as a cultural component
- Stakeholder involvement to gradually phase out car use
- Introducing Car-free days to restrict abundant car usage inside the city and more usage of public transportation and bike-sharing

The three phases here for incorporating the development plans bases on different strategies adopted by the municipality before:

- the goals of Sustainable and Integrated Urban Development Strategy of Huelva (EDUSI) (Ayuntamiento de Huelva, 2020),
- Andalusian Bicycle Plan (approved in 2014) to add 38.99km more to the existing 18.49 km bicycle lane (Ayuntaminet de Huelva, 2020),
- A 113 million euros investment framework 2018-2022 by the Port of Huelva to improve transportation infrastructure.

PHASES

1st Phase (First 5 years: 2020 to 2025)

The first phase focuses on the public transportation route development using the existing infrastructure and linearity analysis derived from GPS mapping API (software: QGIS). Here, strengthening the network between the city center with the El Carmen University campus will help develop the uprising sub-hub targeting the students and staff population to promote commerce in the area. This will promote economic development and more stakeholder interest in the future activities.

Passive actions	• Awareness programs • Integration of sustainable mobility into education • Promoting stakeholder involvement through workshops
Infrastructure development	• New sub-hub development near the El-Carmen Campus • Optimized bus routes • Bike lane development aligned with the public transportation routes within 400m radius distance from the Ave de Andalucia targeting the wide lanes of the city for first intervention
Stakeholder	• Local government, citizen, knowledge partners (universities and schools)

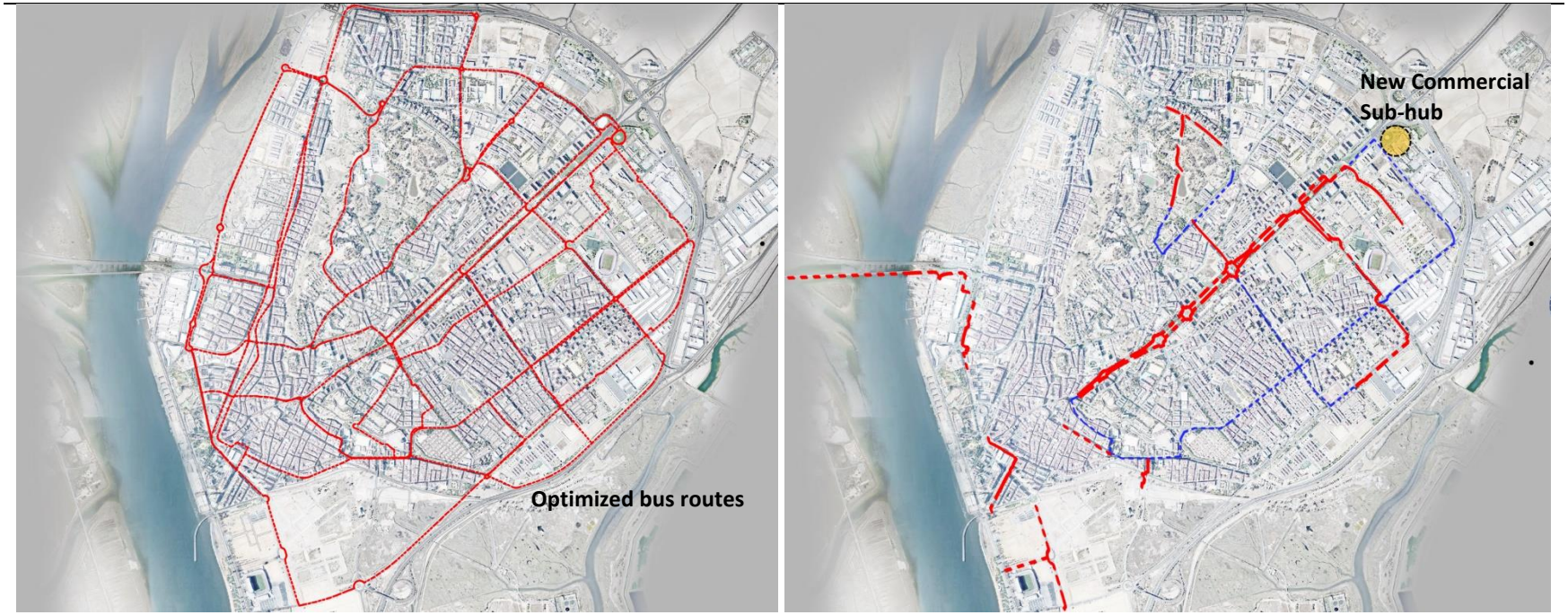


Figure 17: Public Transportation and bike route development plan (2020-2025) (Authors)

Figure 17 Shows the infrastructure intervention in terms of 1. Public transportation and 2. Bike routes development. Left image shows the optimized bus routes (22% less than existing ones in length) derived from the linearity analysis of the existing routes and omitting

overlapping amongst bus travel routes. Right image shows the loop development to connect city center with the El Carmen campus to promote student mobility using bikes.

2nd Phase (Next 10 years: 2025 to 2035)

The second phase mainly focuses on the cultural promotion to change people's perception towards biking and stakeholder involvement in the new commerce connected to the proposed sub-hubs and Bike Sports Center.

Passive actions	• Legal restrictions for car-pooling and public transport dedicated lane • Promoting vehicles with Euro 6/VI level emission • Installments from Govt for transition from fuel-based cars to green cars • Arranging annual bike sports event on including new developed bike lanes inside the city and the centre
Infrastructure development	• Second layer of Infrastructure improvement for bike facility connecting areas within 600m radius from the Ave de Andalucia including residential areas of the Avenida del Nuevo Colombino • Inauguration of Bike Sports Center • Developing second sub-hub connecting Suburbs on western direction
Stakeholder	• Junta de Andalucia and Huelva Municipality authority • Europrean Union, Port of Huelva authority, Local Sport authority, • Citizen, Media, Tourists

Figure 18: Additional bike lane development and second Sub-hub development connecting areas on the western direction (Authors)

Figure 18 shows the bike lane development surrounding the bike sports center and connecting Avenida del Nuevo Colombino with the city center.

3rd Phase (Next 15 years: 2035 to 2050)

The second phase mainly focuses on the cultural promotion to change people's perception towards biking and stakeholder involvement in the new commerce connected to the proposed sub-hubs and Bike Sports Center.

Passive actions	• Recycle business promotion and funding for the transition from outdated cars towards green cars • Online App development to monitor public transport and bike usage by individuals for giving benefits based on percentage of use • Implementation of digital emission testing

Infrastructure development	• Completing third layer of bike route • Restricting city boundary for non-DGT ENV level cars • Developing third sub-hub connecting Suburbs on eastern direction • Inauguration of shuttle bus service
Stakeholder	• EU, Andalucia authority and local government • Citizen • Media

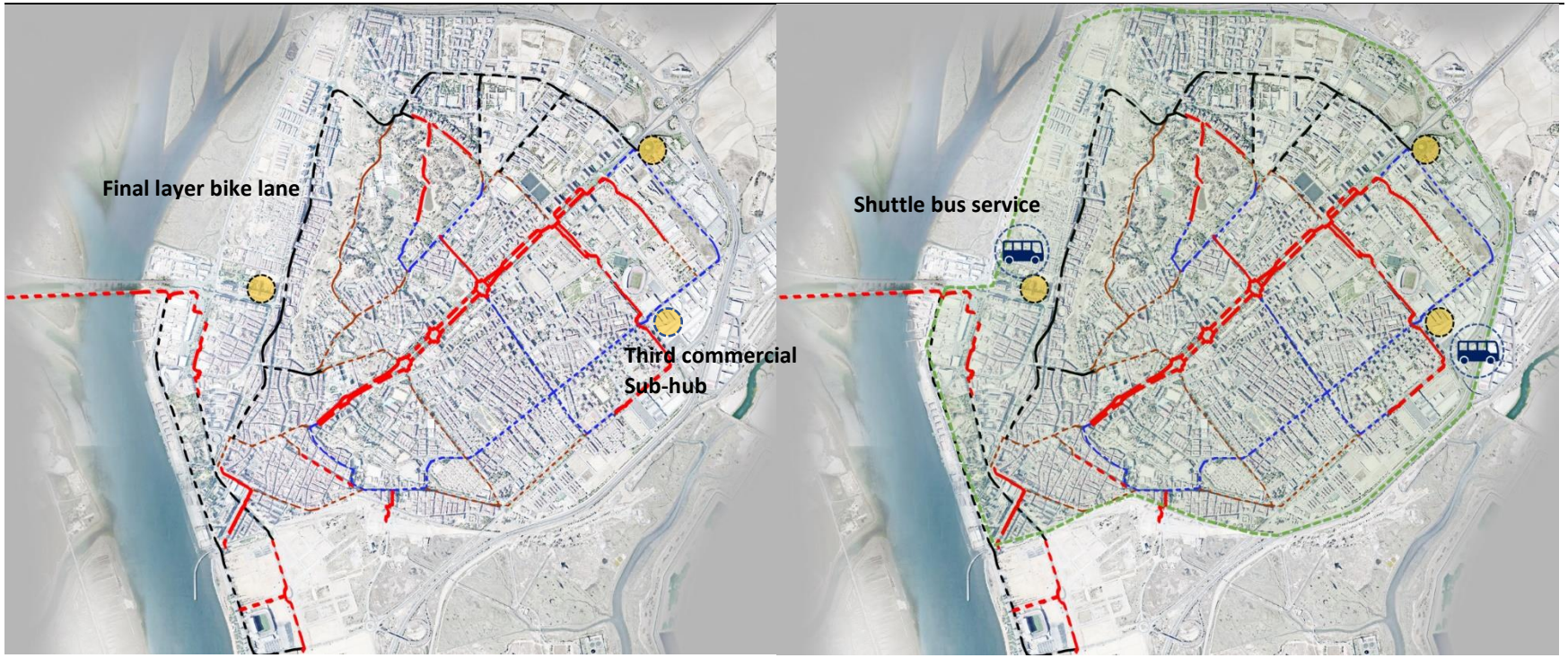


Figure 19: Third bike lane development including outmost boundary of the city next to the outer ring road and third sub-hub development connecting the areas on the eastern direction from the city (Authors)

Overall Adopted Strategies

Alongside the step by step active and passive actions, many infrasture and policy based strategies are idenfied in Table 6.

Table 6: Strategies to implement for the master plan (Authors)

Infrastructure Related	Policy Based
1. Improve connectivity and road infrastructure • Additional Ring road public transport connection • Bike route development on the hill (Zone 8) for annual biking sports to promote biking • Dedicated biking routes and parking space within 400m • Carpooling routes • Public bus routes simplification (time reduction) • Identifying dead-point of footpath and showing to overcome them in different phases. 2. Reduction of street parking/parking space 3. Improving pedestrian route cleanliness 4. Increasing crosswalk and signal in internal routes	1. Workshop, media, education, biking sports promotion policy 2. Green transport promotion (purchase, taxation, policy) 3. One-hour ticket system for public transport 4. Siesta time free public transport facility 5. Free bus service for senior citizens (60 up) 6. Restricted car parking in the three-parallel street- and dedicated bus and cycling 7. Shuttle service and school bus: school can provide bike renting with a subsidized price 8. Allowing bike in the public transport / shuttle service (time limit) 9. Value system of the city based on politics: tax, money spent on education etc 10. Random emission test and impose environmental sticker in every car 11. Implementing fine system for not maintaining pedestrian cleanliness 12. EV charging stations along main avenues 13. Subsidies and promotion

Change Management

As the city is aiming to adopt radical transformation, it is required to tactfully plan the changes. Thus, by following Leavitt's Diamond technique, a change management plan is built to attain the goals. Detailed explanation on these 4 key aspects are already included in section 4 and 5 of these. Figure 20 depicts only a template to show what aspects have been prioritized for change management of the proposed master plan and programing.

Implementation and monitoring

The Government and citizens are involved in the sustainable mobility scheme where the implementation and monitoring plan incorporates the stakeholders. Monitoring after completing the phases is necessary to observe citizens' adaptability to the changes. This process will help to update the system continuity based on two-way feedback. Public participatory programs run at regular intervals (6 months) can help achieve optimum impact for the implemented actions.

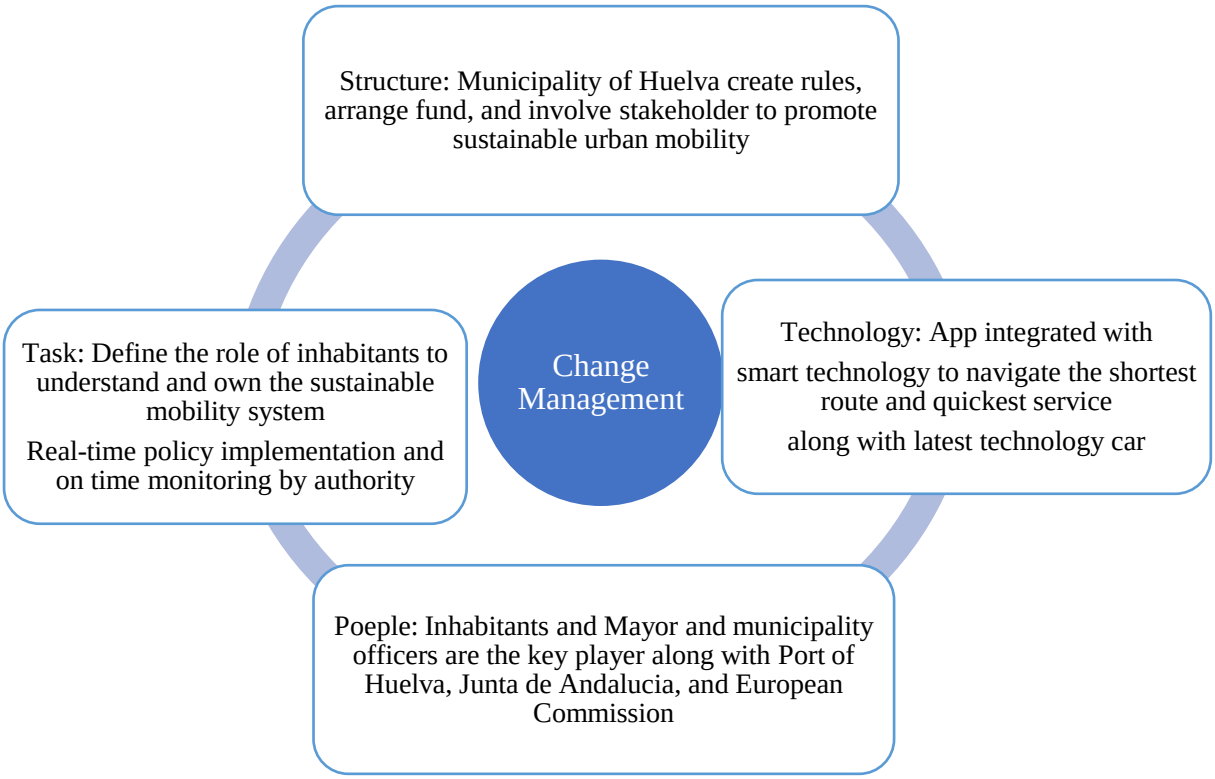


Figure 20: plan for change management while implementing the master plan (Authors)

6. CONCLUSION

The comparative analysis of the existing transportation condition and proposed transportation system in Huelva shows that most proposed interventions are possible with minimum intervention. A 22% reduction (from the current footprint of 80.835km to 63.334km) in public bus routes linear length is achievable through the three intervention phases. The proposed infrastructure change for public transportation requires very little intervention compared to the bike lane development for promoting biking activity amongst citizens. The proposed 27km new bike routes include alignment with the existing major wide lanes for public transportation in most areas. Still, initial consideration to remove streetcar parking based on the daytime and night-time parking is necessary to incorporate the dedicated bike lanes. However, the cultural practice of car usage and the economic dependency of stakeholders related to car usage might be the possible barrier to achieve this goal. Therefore, passive actions in each phase to slowly insert the idea of bike usage amongst citizens through Bike Sports Center activities, workshops, dedicated public transport, and bike lane, allowing bikes inside the public transportation for uninterrupted mobility, lesser ticket price during siesta time will help promote inclination towards bike usage. The development of 30 pedestrian dedicated microzones inside the city with 300m walking distance towards public transportation aligns with the existing walking trend in Huelva. This step will reduce unwanted car parking on the streets. Restricting street parking within the proposed new car parking spaces of residential areas will finally lead to optimized car usage and promote more walking activities. In terms of GHG gas emission reduction, the omission of 48141 private cars (according to data of 2015) that is 70% of the

total car usage in Huelva city, might seem too radical intervention considering the current situation. However, the fact that the transportation sector is the topmost contributor to the GHG emissions in Andalusia has contributed to this consideration. Moreover, this radical intervention has been designed in three phases considering 30 years span in overall design phases to slowly phase-out conventionally fuelled cars within 2050. The key ingredient here is- the integration of the passive actions with the direct interventions while continuous monitoring to integrate necessary updates to the proposed system in Huelva to steadily proceed towards achieving the European Green Capital Award.

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Huelva – European Green Capital 2023

Urban Climate Amelioration

Prepared by:

Asiye Irmak Ozkan, Milagros G. Saloma Pacheco, Roberto Enrique Stohmann Aguirre

MUrCS
Master in Urban Climate & Sustainability

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1. Introduction

The Municipality of Huelva plans to apply for the European Green Capital Award (EGCA) 2023. It has hired the consultancy team for developing a baseline document in the urban climate and air quality components to achieve this goal.

In this understanding, the paper includes a thoroughly concise but critical analysis of the current situation of Huelva, considering the most significant aspects that have shaped its development until the present date. The initial evaluation includes a diagnosis of the political, economic, social, technological, environmental, and legal factors. It provides a deeper understanding of the policies and urban structure and its main ecological concerns: pollution and climate change impacts.

A futuristic view for development encompasses identifying crucial factors for change, allowing the consultancy work to design a vision and proposal to accomplish EGCA 2023. A structured plan includes the necessary steps that the identified stakeholders and involved parties must consider, containing funding mechanisms as potential igniters to incentive an integrated approach, especially under existing limitations due to the economic recession.

Finally, our proposal's added value is included in the EGCA section that falls under the consultancy work's reach, followed by the conclusions and recommendations for a successful result.

2. Background

2.1. Diagnosis of Problems, Challenges and Opportunities for Change

Like some other European port cities, Huelva has been facing a deindustrialisation process that carries along with consequences at different levels of living and developing conditions. The following sections give a brief but concise analysis of the situation while the identified main problems, challenges and opportunities are summarised below (Table 1).

Problems	Challenges	Opportunities
• Air Pollution • Climate Change • Phosphogypsum Stacks • Ecological Degradation • Unemployment • COVID-19 Economic Recesion • Lack of KPIs and monitoring	• Declining Industry • Linear Economy • Slow decision making • Lack of interest from major stakeholders • Lack of information web (no interactive presentation for plans and existing policies) • Decrease of population	• Low awareness that can be shaped towards goals • Sustainability trends in current policies • Disjointed plans and policies exist which can be integrated • Citizens with environmental awareness • Academia's desire to be involved in planning and implementation • Potential for Funding

Table 1. Summary of Problems, Challenges and Opportunities for Huelva (Own elaboration).

2.1.1.PESTEL Analysis

The PESTEL tool has been adopted from the business environment into forecasting methods. It allows one to understand an entity from its macroenvironment, permitting to comprehend its components (political, economic, social, technological, environmental, and legal) with a broad perspective (Kreutzer, 2019). In this order, Table 2 displays the most critical factors in each of the PESTEL elements.

POLITICAL	ECONOMIC	SOCIAL	TECHNOLOGICAL	ENVIRONMENTAL	LEGAL
Political majority in charge (region & local)	Deindustria-lisation process consequences	Population Decrease	Developing renewable energies sector	Residual impacts on air, soil and water	Planning documents diversity
Vision of development with industry	Covid-19 recession effects	Increase in social gap and inequality	Personal electrical mobility acceptance	Differentiated waste collection but low recycling rate	Slow decission-making processes between levels of government
Municipality openness to public participation	Historical high unemployment	Social inequality	Differentiated waste collection	Potential environmental recovery	
		Highly-involved community			

Table 2.PESTEL matrix summary (Own elaboration, 2020).

The current situation in Huelva encompasses some difficulties, especially in the economic, environmental, and social levels. The coronavirus pandemic adds uncertainties regarding the economic growth, not only for the city but also for the region of Andalusia and the country of Spain itself. Moreover, Huelva's Municipality has been going through historical unemployment rates surpassing 20% every year, and with an average of 27,3% in the last decade (datosmacro.com, 2020). In terms of composition, the Province has a high reliance on public expenses[1] (22% of GDP), trading[2] (20% of GDP) and extractive industries[3] (18,8% of GDP) as the three main activities in the economic sector as of 2011 (INE, 2020). Despite the ongoing deindustrialisation process in the Andalusia Region (Vilchez, 2020), AIQBE[4] and public administrators venture to propel economic and social development through this sector since it constitutes one of the well-paid formal employment pillars (M.G., 2020).

Regarding the environmental state, due to the industrial movement, particularly in the mining-related sector, essential water bodies (Tinto and Odiel Rivers), soil, and air have been affected considerably. The most noticeable issues currently being discussed by different stakeholders are the Phosphogypsum Bay, the hills (known as *los cabezos*), and the Port of Huelva. For instance, the government levels in Spain (national, regional, and local) face a law sue against Fertiberia, a company in charge of managing the Bay's chemical residuals since the 1980s. Now, the company is expected to remediate the soils in the area. Its proposal generates countered positions by administrators, environmental groups, and society, impeding its plan to start (Dominguez, 2018 & Huelva Informacion, 2020).

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[1] *Includes expenses/investment of public administration and defense; compulsory social security; education; health and social service activities. Artistic, recreational and entertainment activities; repair of household items and other services.*

[2] *Includes expenses/investment of wholesale and retail; repair of motor vehicles and motorcycles; transportation and storage; hostelry. Information and communications.*

[3] *Includes expenses/investment of extractive industries; manufacturing industry; supply of electricity, gas, steam and air conditioning; water supply, sanitation, waste management and decontamination activities.*

[4] *Association of Chemical, Basic and Energy Industries – AIQBE, for its acronym in Spanish*

Additionally, the Municipality is developing the fourth PGOU[5] which will have a different focus than the previous land-use plans and consider preserving natural landscape (the hills), the integration of the city, brownfields´ use, and more participation from the stakeholders (Ayuntamiento de Huelva, 2020). Moreover, the Port Authority has addressed the port area with investment in infrastructure to reclaim public space and amenities, as shown in Figure 1. Paseo de la Ria aerial view. Lastly, external actors are also participating in planning investment projects to recover biodiversity and diminish pollution in the marshlands (Diputacion de Huelva – DDH, 2020).

Figure 1. Paseo de la Ria aerial view (Ondiseno.com, 2020)

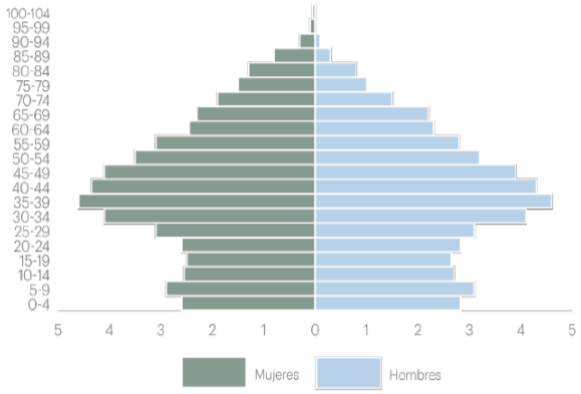

Figure 2. Population pyramid by age group and gender % (DDH with SIMA data, 2020).

In the social aspects, the Province's population has experienced a decrease in the last years, attributed to a lower birth rate and migration for job opportunities to other cities. The age group pyramid displayed in Figure 2. Population pyramid by age group and gender %denotes an ageing pattern with an average of 39,5 years for men and 41,9 year for women (DDH, 2020). Furthermore, inequality is another concern for public authorities. The Region of Andalusia has increased its Gini index between 2010 and 2013, from 0,532 to 0,549 (Observatorio de Desigualdad de Andalucia, 2017), and the local government is planning to breach the social gap for access to public spaces and services, employment, and digital technologies (DDH, 2020).

However, information regarding social participation has counterposed interests towards the environment, with some supporting groups for debated topics like Phosphogypsum Bay, marshlands, or industries' impact (Figure 3) (Mesa de la Ria, 2015).

Figure 3 Protest against Phosphogypsum Bay "'Thank you, Huelva, we are thousands. Phosphogypsum out! Justice for Huelva" (Mesa de la Ria, 2015).

[5] *Urban General Organizational Plan – PGOU, for its acronym in Spanish which is a land-use plan document*

Conversely, public surveys display a more profound preoccupation in employment, economy, politics and administration, and the health system as an overall perception. Nonetheless, specific environmental topics are forest fires, pollution, and sea and beaches deterioration (Figure 4) (Junta de Andalusia, 2018).

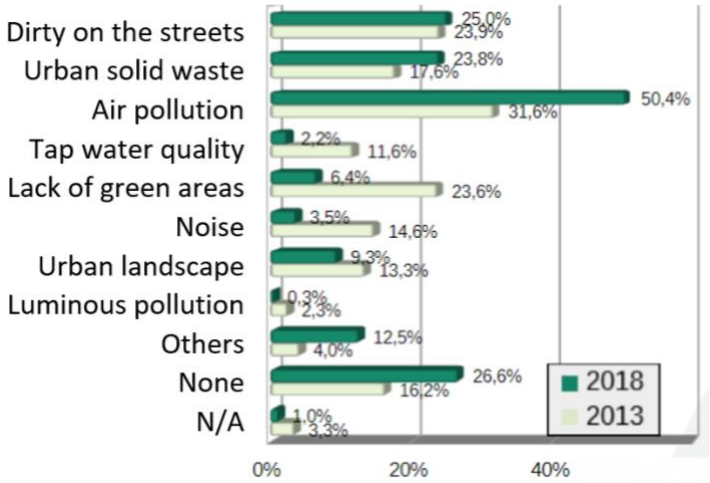

Figure 4. Province of Huelva's environmental problems – Society's perception (Junta de Andalucia, 2018).

In contrast, Huelva also presents positive political and technological aspects. The Municipality and the Andalusia Region are led by the same political party (PSOE) with a majority in their legislative levels, meaning high population representativeness (El Pais, 2019). Also, PSOE's agenda includes a vision to address climate change and environmental issues (PSEO Andalucia, 2020). Furthermore, the PGOU being developed by the city has opened public platforms to collect demands from people and organisations (Diario de Huelva, 2020).

In terms of technology, renewable energies present development opportunities. Local authorities embrace them with regulations that propose tax incentives and public investment for increasing its use, like electric charging for vehicles. Also, society is adopting electric scooters as an alternative form of transportation and solar panels for energy source (PMUS Huelva, 2020 & Huelva24, 2020).

Finally, a thorough review was conducted on the policies being implemented and cover many of the aspects presented so far, given in the next section. Likewise, more complex urban structure, temperature and heatwaves, and air pollution issues are discussed in sections 2.1.3, 2.1.4 and 2.1.5.

2.1.2. Policy Outlook

Huelva has multiple ongoing plans made by different authorities and entities; the present report's most relevant ones are shown in Table 3. Local Agenda 21 is the main framework for the following documents; hence, the city moves to a sustainable path. Overall, plans have focused on environmental issues, aligning those with the local economy's improvement and redevelopment. A participatory process has also been implemented in the decision-making stage. Although the plans have a cohesive explanation, the implementation phase is diffuse. For example, the Sustainable Energy Plan, which aimed to reduce CO_2 emissions by 20.25% by 2020 (Ayuntamiento de Huelva, 2012) has no information about its results. Therefore, there is a lack of monitoring and continuity of individual plans (Table 3).

Local Agenda 21 - Huelva

- Aproved in 2014, Huelva City Council
- A planning tool for sustainability. Reinforces the importance of stakeholders participating in the process. The plan is monitored by the Environment Delegation.
- Water, air quality and atmosphere, energy, natural areas, waste, economy and population, urban area, urban mobility, organization and municipal management, social development and poverty, education and environmental information, and health.

Land-use Plan (PGOU)

- 1999, modified in 2011, Huelva City Council
- Limits the urban land area, scheduled development, unscheduled development and non-development,
- Pedestrianisation of the city centre, Neighbourhood Plans, plans for Moret Park. Increased city footprint. The hills have been damaged: covered with concrete in some areas, building plans for high buildings have been approved next to the hills, and there have not been any important positive treatment. A new plan is being prepared.

Sustainable energy plan

- 2012, Huelva City Council
- Reduce the CO_2 emissions by 20,25% in 2020. It was made in the framework of Covenant od Mayors
- Economy with reduced CO_2 emissions, Actions in Municipal and private buildings; Planning of the territory; Transport; and Work with citizens and agents of interest.

Huelva Port – Strategic Plan 2012-2017 with 2022 vision

- 2013, Deloitte and Huelva Port Authority (Private)
- Becoming the main entrance point in the Atlantic, international reputation, addition of activities in products traffic, management improvement and specialization, becoming a constant cruises stop, becoming a green and sustainable port.

Sustainable mobility plan

- 2014, Huelva City Council
- Promote improvements in the conditions of circulation, parking, pedestrian movements, cycling, public transport, as well as the accessibility of the metropolitan area and design of urban roads.

The Air Quality Improvement Plan for the Industrial Zone of Huelva

- 2014, Huelva City Council
- Monitor, report and improve the air quality and emission generation from industries, guide and control the implementation ofair pollution abatement technologies.

Regeneration of Huelva's green and social lung *

- 2015-2022, Huelva City Council
- Create a plan that regenerates the city through the permeability, accessibility and integration. It is based in the Local Agenda 21
- Sustainable a decontaminated city. Huelva against the inequality and the poverty. Huelva technological and productive. Huelvawith a territorial and urban model. Huelva attractive and Creative.

Strategic Plan of Huelva Province *

- 2016-2026, Provincial Deputation of Huelva
- Encourage synergies and cooperation to promote the circular economy, Promote university-business cooperation, Environmental education, Protect and promote the exploitation and use of natural resources to guarantee sustainability, Sustainable movility plan, Production and comsumption of renewable energies

Huelva Smart City Route

- 2018, Huelva City Council
- Actions for the implementation of the Smart City Plan. Having a new sustainable model for the city.
- Integration of services with softwares and harwares, improve the traffic control system, use of GIS for certain services (events, water distribution, etc.), implementation of apps and interactive screens around the city for touristic information, opened and interactive information.

Tinto and Odiel Estuaries – Live your estuary! *

- 2020-2023, Provincial Deputation of Huelva
- Understand, articulate and promote the complementarity of these natural, cultural, social and productive landscapes linked tothe Estuaries of Tinto and Odiel.

*Urban Sustainable and integrated development strategy (EDUSI in Spanish): Urban plans that follow the national urban guidelines, which incorporate the EU interests (2020 Strategy). The plan will be executed with the co-financing with ERDF (EU funding).

Table 3. Summary of Ongoing plans in Huelva (Own elaboration, 2020).

Additionally, Figure 5 illustrates a timeline of this report's two main topics: the land-use plans (PGOU) and the air quality policy in Huelva. On the one hand, the city had its first PGOU in 1964, estimating a perimeter population of 250 000 inhabitants (Martinez, 1992). This plan and the reduced increase of people since that date are why the city is compact until today (Ayuntamiento de Huelva, 2020). It also concluded that the economic activities had jeopardised the landscape, with industry transforming from a priority to a problem. As mentioned before, the new PGOU is being conceived under a more sustainable framework. On the other hand, the Air Quality Improvement Plan is set in motion to manage and control industry-related pollutant emissions in Huelva in 2014, following the related EU and national decrees.

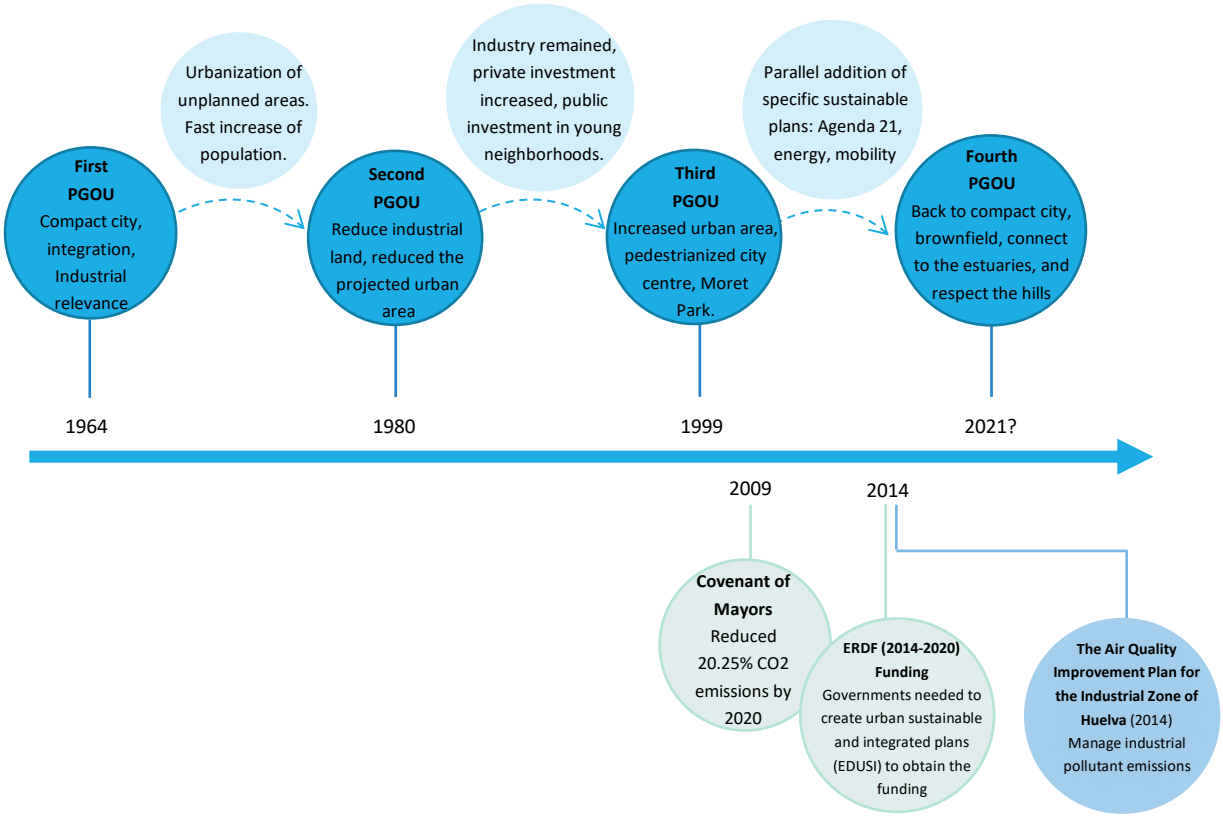

Figure 5. Evolution of Huelva's PGOUs, policies and other landmarks (Own elaboration, 2020).

2.1.3. Land-Use and Urban Characteristics

Huelva city is a palimpsest of eras, structured by three main natural components: the estuaries, the rivers, and the hills. It is possible to identify a city centre with an organic pattern with narrow streets as a heritage from its Muslim past. Martinez (1992) explains the evolution of Huelva (Figure 6) exposing key factors (industry, increase of population, railway) that generated a disconnection with the landscape and disordered development. The modern urban pattern became orthogonal and had wider streets, and the implementation of the main avenue called Andalusia. The phosphogypsum area locates in the southeast of the city, and it has around 100 million tons of toxic residues (Bocanegra, 2020).

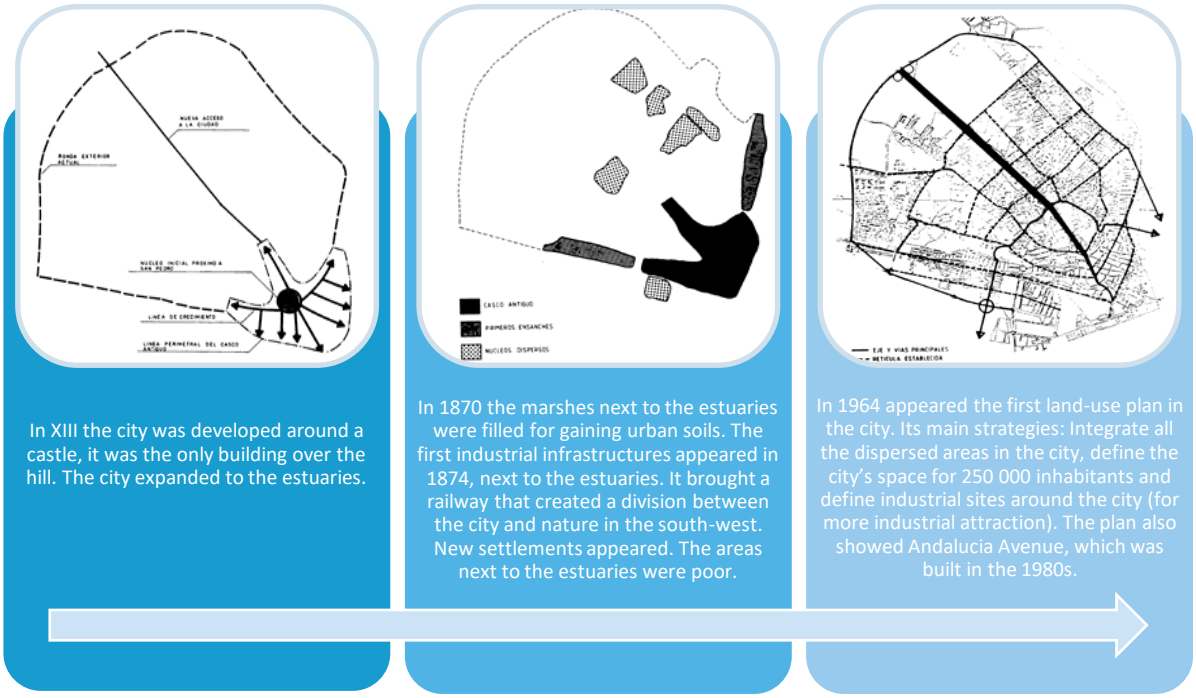

Figure 6. Summary of the urban evolution of Huelva (Own elaboration, 2020. Images and information: Martinez, 1992.)

The buildings' heights vary between areas, being Andalusia Ave. the one with the highest average of buildings, while the city centre is very heterogeneous (Figure 7). The city tends using light colour facades and roofs with red asphalt treatments or roof tiles. In terms of materials, the buildings are mainly built on concrete and brick; it is crucial to mention there are minimum curtain-wall type buildings.

Figure 7. Collage of Huelva's urban fabric and characteristics. (Own elaboration, 2020. Images: Pergeo, n.d, Andalucia informacion, 2020 and Dominguez, 2019.)

The urban area presents a significant green space in the central west side of the city composed by Moret Park and Conquero Hill (Figure 8). While the first has been developed progressively, the second remains without much treatment. Andalucia Ave Boulevard gives a continuous green space with high trees, flowers, fountains, etc. Many streets present mid-height trees along the pathways. In 2019, the city's green area was 1.317.000 m^2, and the area per inhabitant 8,8 m^2, which is inside the municipal regulations, but do not follow the WHO recommendation of 10m^2 (Lezameta, 2019).

Figure 8. Collage of Huelva's streets and avenues (Google Earth, 2020).

2.1.4. Urban Heat Island and Heatwaves

During this report's development, no Urban Heat Island (UHI) official Huelva studies were found. Nevertheless, there is information about heatwaves as a consequence of UHI. A document related to heatwaves' health effect prevention in Andalusia exposed (Direccion General de Salud Publica y Ordenacion Farmaceutica, 2020):

- Huelva has a reduced impact of heatwaves compared with other Andalusia's municipalities (Figure 9)
- In 2019 Huelva did not present any alert for excessive temperatures
- In 2018 people entered health centres for heatwaves (23 cases) or other related problems (28 patients).
- Huelva has not shown any death related to heatwaves since 2004.
- There is a program that tracks the population under risk by phone calls during summer.

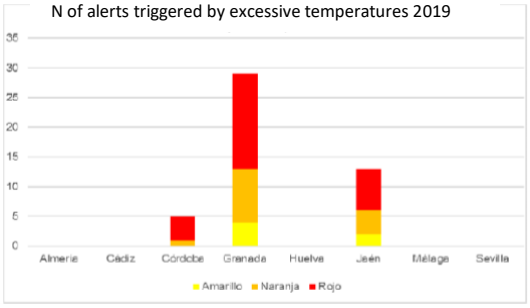

Figure 9. Number of alerts triggered by excessive temperatures in Andalusia 2019. (Direccion General de Salud Publica y Ordenacion Farmaceutica, 2020)

Therefore, heatwaves are not a significant problem in the city nowadays, as a consequence UHI is not a central topic in the municipal or regional plans. Heatwaves are also controlled with Huelva's urban characteristics. Some existing plans for summer seasons include health prevention plans for monitoring the risk population and the temporary canopy in pedestrian streets (Figure 10).

Figure 10. Street canopy in the City Centre. (Dominguez, 2020)

Nevertheless, Huelva will not be an exception from the global warming trends in the following years. RCP's show an increase in the duration of heatwaves and the maximum temperature (Figure 11 and Figure 12). Hence, it is necessary that the plans in Huelva, especially the new PGOU, implement strategies to prevent UHI and its effects.

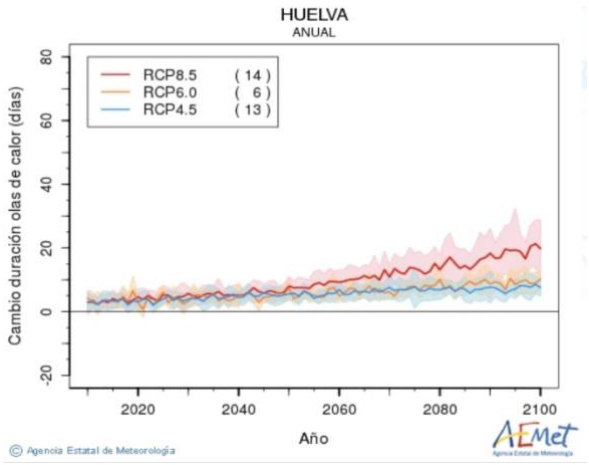

Figure 11. Maximum temperature (C °) with three RCP's scenarios in Huelva. (AEMET, n.d.)

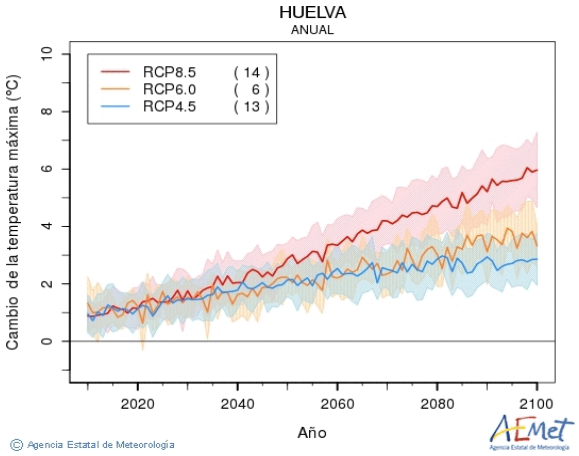

Figure 12. Duration of heatwaves (days) with three RCP's scenarios in Huelva. (AEMET, n.d.)

2.1.5.Air Pollution

Air pollution is a serious problem in Huelva for several decades. Huelva is prone to high particulate matter (PM) levels due to:	Industrial and traffic emissions,
	Low rate and frequency of rainfall events,
	Dry land surface,
	Proximity to North African desert storms,
	High photochemical activity that promotes generation of aerosols (Sanchez, 2007).

Huelva houses the second biggest copper smelter of Europe along with many petrochemical industries and petroleum refineries. Studies show the most significant contributor to air pollution in Huelva is the industrial activity, followed by traffic emissions (Tobias et al., 2018). The phosphogypsum stacks also contributed to air pollution with fugitive particles suspended in air and carried by the wind to the city (Macías et al., 2017). While the dominant wind direction is from the west, which is the opposite side from the industrial areas, eastern wind can also be seen from time to time, worsening its air quality (Figure 13).

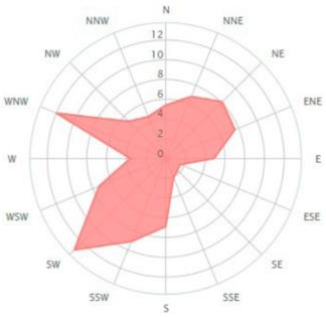

Figure 13 Dominant winds in Huelva (AEMET, 2020)

The trace elements that are found in the ambient air in Huelva are listed in Table 4 Trace elements found in ambient air in Huelva (Fernandez et al., 2012; Alastuey et al., 2006).

Punta del Sebo Industrial Area - Copper Smelting Activities	Punta del Sebo Industrial Area - Phosphoric Acid Production Activities	Nuevo Puerto Industrial Area - Petroleum Refinery Activities
• SO2 • As • Cd • Cu • Pb • Zn • Bi	• NH3 • Phosphate • PO4-3 • HF	• Volatile Hydrocarbons • SO2 • NOx • NH3 • Ni • V

Table 4 Trace elements found in ambient air in Huelva (Fernandez et al., 2012; Alastuey et al., 2006)

Huelva's air quality monitored between 2004 and 2011 is shown in Figure 14. Air quality is improved after 2008 by reducing traffic and implementing air pollution abatement techniques in industrial areas. The Municipality produced air quality improvement plans in 2011 following a national decree obliging it (Figure 15). However, the level of CO_2 emissions is still increasing in contrast with other emitters (DDH, 2020).

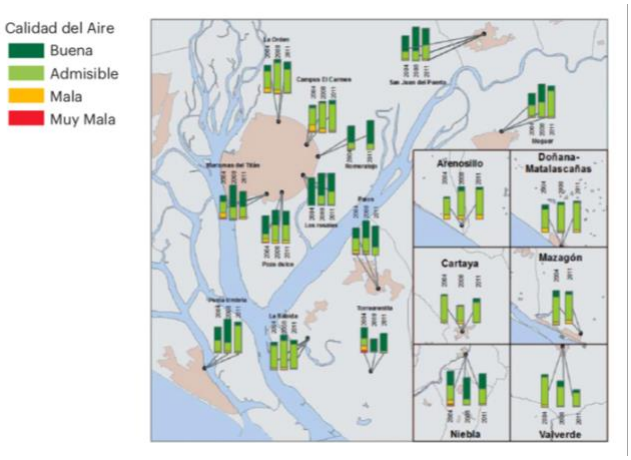

Figure 14. Air Quality in Huelva in 2004-2008-2011 (DDH, 2020)

PM is principally formed by metals which have adverse effect on human health (WHO, 2013). Furthermore, Ultrafine Particles (UFPs) are formed with the oxidation of SO_2 and H_2SO_4 and they are correlated with high cancer mortality. Studies reported air pollution related mortality coupled with environmental conditions and social factors is significant in Huelva (Benach et al., 2003; Lopez et al., 2006; Alguacil et al., 2014; Rodríguez et al., 2014). Figure 16 shows the cause of death for both sexes in Huelva within the last 10 years. Lung and bladder cancer mortality are very high in Huelva, as shown in Figure 17, which is linked with industrial activity in a study in 2006.

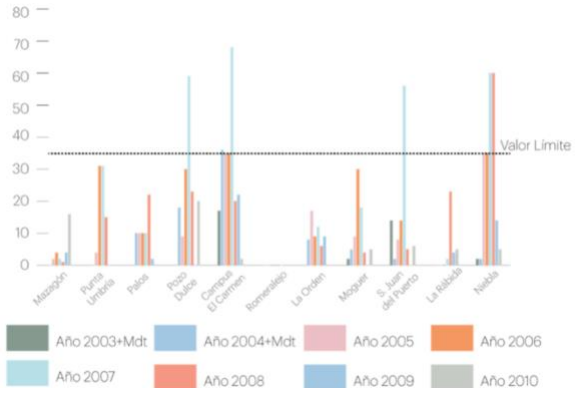

Figure 16. The number of days maximum emission limit is surpassed (DDH, 2020).

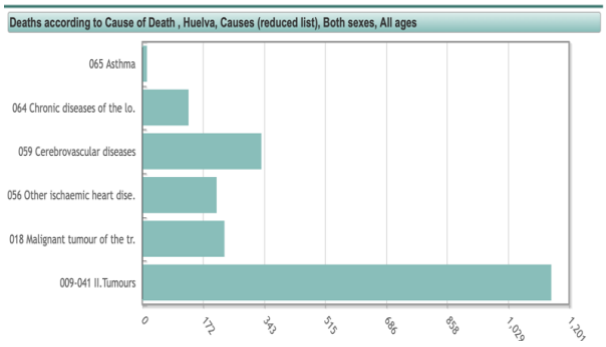

Figure 15. Air pollution induced cause of deaths in Huelva (INE, 2020)

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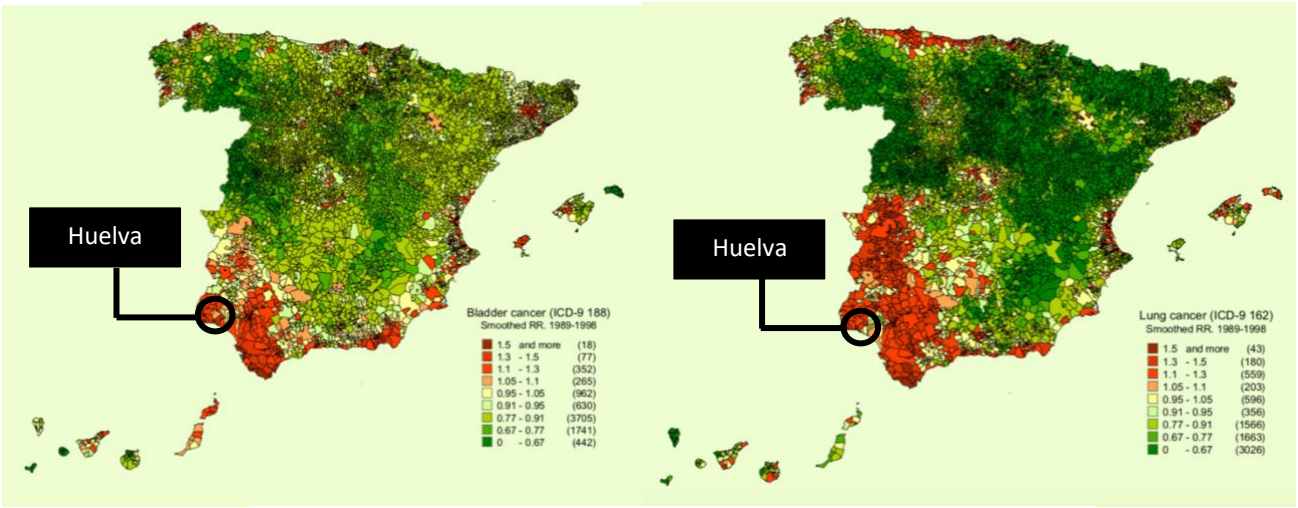


Figure 17. Lung and Bladder Cancer Mortality in Huelva (Lopez et al., 2006).

Arsenic (As) in PM is identified as the biggest problem in Huelva. It can only be found in another region in Spain apart from Huelva. Between 2001 and 2015, there was high daily As concentrations well above the EU limit, while after 2015, following the implementation of more efficient pollution abatement technologies, the concentrations reduced (Sanchez et al., 2018).

Another study reported a high concentration of Cu, Cd, As and Pb in the household dust in Huelva which are toxic for humans. As these particles typically found in industrial fumes and contaminated soil, their sources are linked with the industrial area and phosphogypsum stacks (Torres et al., 2017). These trace elements are found in urinary and hair samples, taken from children attending primary school and are associated with their cognitive behaviour (Aguilera et al., 2010; Rodríguez et al., 2014).

It is established that the trace element pollution reaches the city and mostly affects areas located less than 4 km from industrial zones. While the eastern part of the city has higher levels of trace elements, the western part (Figure 18) also experiences high mean concentrations for Cu, Zn, As, Cd and Sb (Parviainen, 2019).

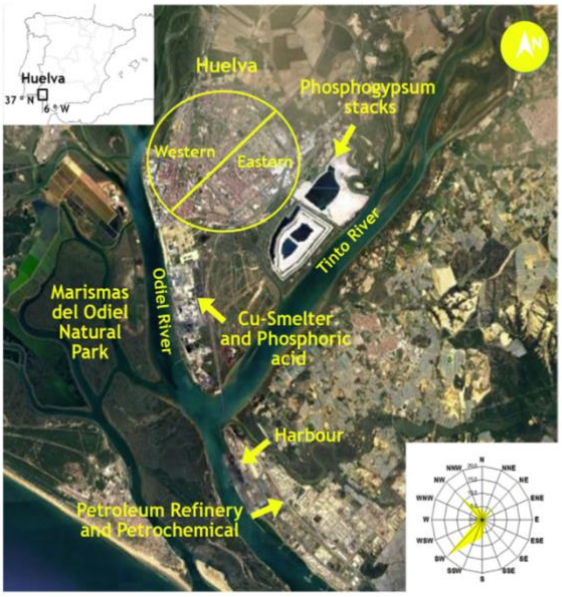


Figure 18. Huelva's layout according to air pollution factors (Torres et al. 2017)

Surface ozone is another threat to Huelva. Surface ozone is formed with NOx and VOC from industrial activities, high temperatures and solar radiation, and winds, making Huelva especially vulnerable. Surface ozone can cause asthma, reduced lung function and reduce nutrient uptake in humans and ecosystem degradation (Dominguez et al., 2014). Figure 19 shows the percentage of days where the maximum limit for surface ozone is exceeded.

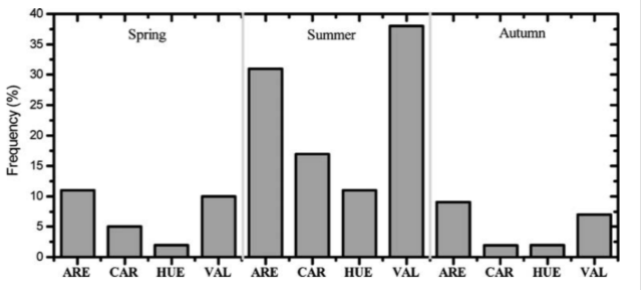
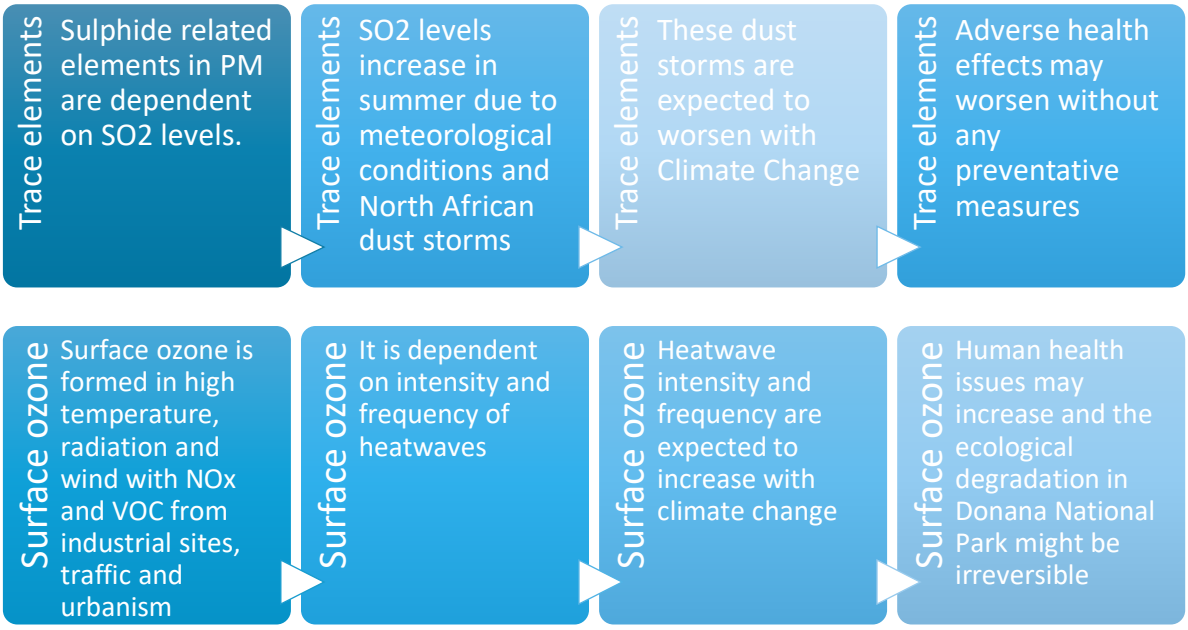


Figure 19. Percentage of days where maximum daily mean concentration of surface ozone is exceeded in Huelva (Dominguez et al., 2014)

The impact of climate change on air pollution can be detrimental based on following pollutant generation-climate change linkages:



3. Future Scenario Building

3.1. Key Drivers and Trends

Some crucial trends in the city of Huelva might determine its future to reach sustainability. Identifying these key drivers enables the analysis to elaborate on possible outcomes presented in the following section. Nonetheless, the spotted factors are:

	Drivers and Trends	Main Factors[6]
1.	*Increase in renewable energies utilisation.* Biomass and solar energy are gaining ground in the energy sector and support from different public and private groups (DDH, 2020)	P-Ec-T-L
2.	*Growth of personal transportation electric vehicles:* The use of electric scooters is more common now; however, they are personally owned and is not a service provided by public or private entities, diminishing availability for everyone. Also, neighbour city of Punta Umbria has already implemented regulations for its use, and Huelva is on the same path but not yet approved. There are political support and tax incentives for all-electric mobility types (Cumbrera, 2020 & Huelva24, 2020).	P-S-L
3.	*Reconnection with the environment.* Planning documents and public investment propel a reconnection with green areas, like Moret Park, and water bodies, like *Paseo de la Ria* on the left bank of the Odiel River (Ayuntamiento de Huelva, 2020 & Europe Press, 2016).	P-S-En
4.	*Circular economy in the extractive industries.* Public opinion, environmental groups, and academia support waste reuse as inputs to address pollution issues better. (Martin-Arroyo, 2020)	Ec-T-En
5.	*Deindustrialisation versus industrialisation forces.* Despite the regional down climb, local authorities and some stakeholders see a strong connection between development and industries.	P-Ec-L

Table 5 Drivers and Trends relation with PESTLE factors (Own elaboration, 2020)

Figure 20 Key Drivers/Trends identified. (Own elaboration,2020. Images: vectorstock.com, n.d.)

3.2. Scenario Building and SWOT Analysis

The industrial inheritance constitutes as one of the most influential factors for the economic and social development of Huelva due to its strategic position along the Tinto and Odiel Rivers with its neighbouring cities and has had enormous impacts not only on the formation of the urban fabric but also on the environment. The urban settlements with land use and population shown in Figure 21 and Figure 22 graphically explain its impacts on industry location and population density. Hence, the team inferred the industry's preponderant position and role for the coming decades, reason for which a called *industrial engine* presents at the core of three scenarios which are explained as follows:

[6] *Referring to PESTLE components where P: Political; Ec: Economic; S: Social; T: Technological; L: Legal; and En: Environmental*

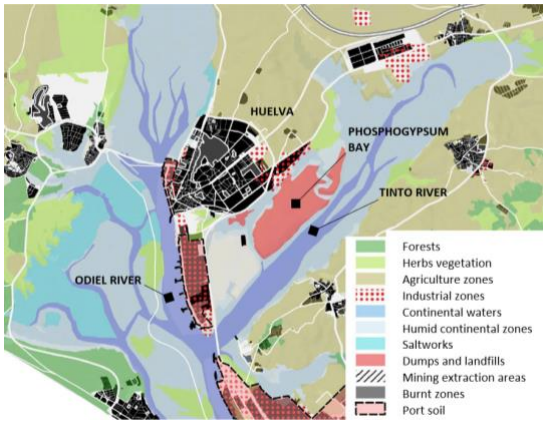


Figure 21 Huelva's land use map (DDH, 2020).

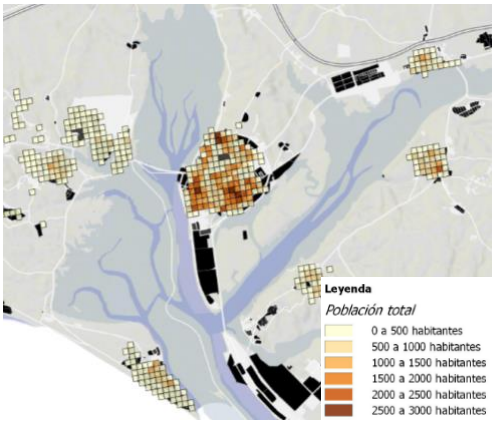


Figure 22 Huelva's population density map (DDH, 2020).

Scenario A – The industrial engine follows the current path

One of the leading environmental concerns is Phosphogypsum Bay. It is treated under Fertiberia's remediation plan, with a capping method covering the area with a soil layer. After its approval, an opportunity for improvement is lost, and disables enhancing other industries. Industrial and brownfield areas reclamation is not possible. The situation influences urban development, following the current trend of unemployment, decrease of population, air quality (complying regulations but with more emissions), adaptation of renewable energies (solar and electric sources), and a partial increase of green infrastructure due to public budget limitations. Under this scenario, which is closer to "*business as usual*", the stakeholders maintained a more passive but less intertwined position and pushed their agendas without much integration. Public administration and society adopted electric mobility, while industries relied on their usual practices and management models.

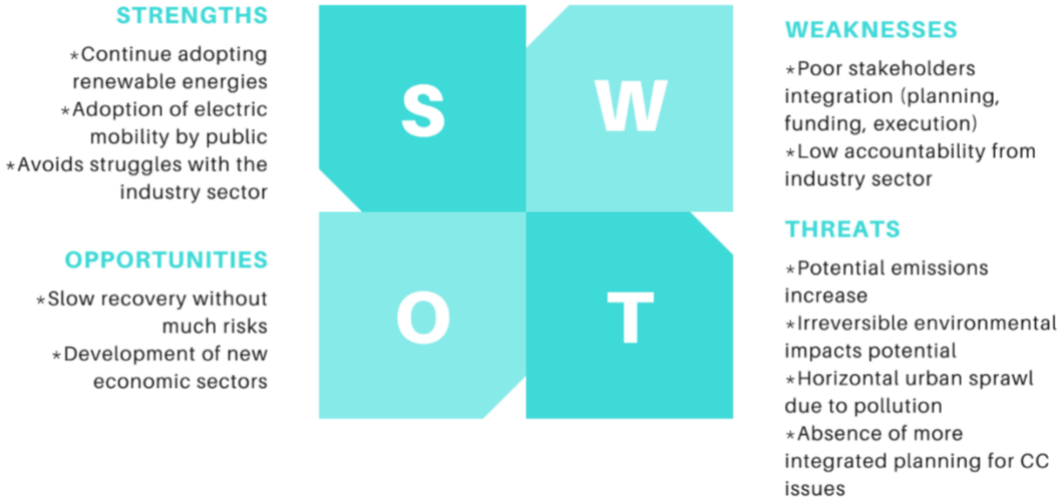


Figure 23 SWOT Analysis for Scenario A (Own elaboration, 2020).

Scenario B – The industrial engine collapses the environment.

A more catastrophic vision involves this scenario. The public administration support to the industrial sector attracts more investment and permits to slowly recover with SMEs support while fostering the economy. In general, society encounters a problematic situation due to the economic recession and pandemic effects, so adapts to government position privileging economic results over opposing to the industry's expansion. However,

environmental negative impacts increase compromising natural areas and inciting air pollution. Still, industry complies with regulations, but indicators worsen. Despite these results, popular measures are supported by society with a growing energy sector (electric mobility and energy sources). However, other sectors like urban growth, industry waste, and social inequality are not adequately addressed.

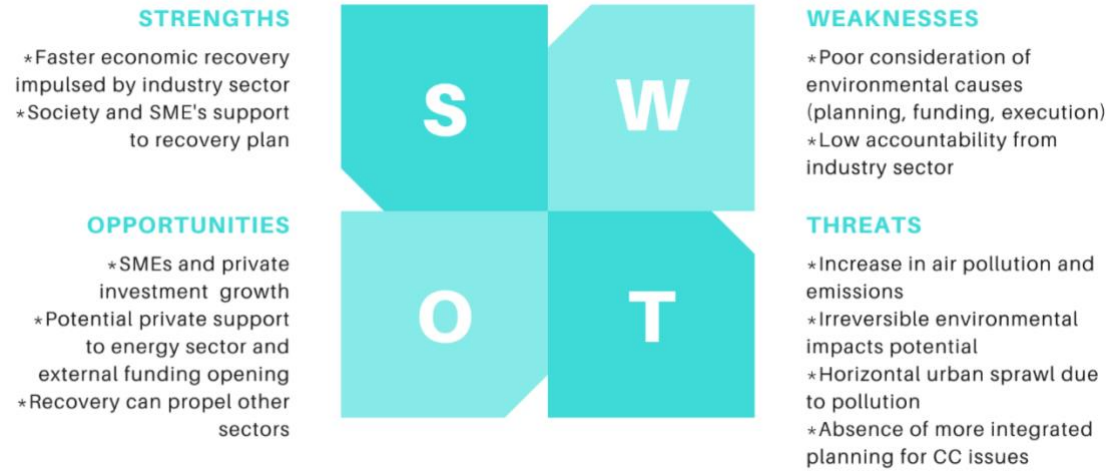


Figure 24 SWOT Analysis for Scenario B (Own elaboration, 2020).

Scenario C – An industrial symbiosis propels sustainability.

In this case, a more challenging but rewarding position is taken amongst stakeholders. Public administration and industry work on a circular economy framework with academia and society's support in a synergy that comprehends the Phosphogypsum Bay, mining and marshlands as pillar in the short and medium term. The Green Capital Foundation is also created, which becomes a crucial organisation for funding, organising, and prioritising projects and programs. The circular industry approach, emission goals, and sustainability measures ameliorate adverse effects imposed on ecosystems and air and subsequent urban structure. In general, society and administrators embrace the industrial heritage with this new vision since it is allowing to enhance development.

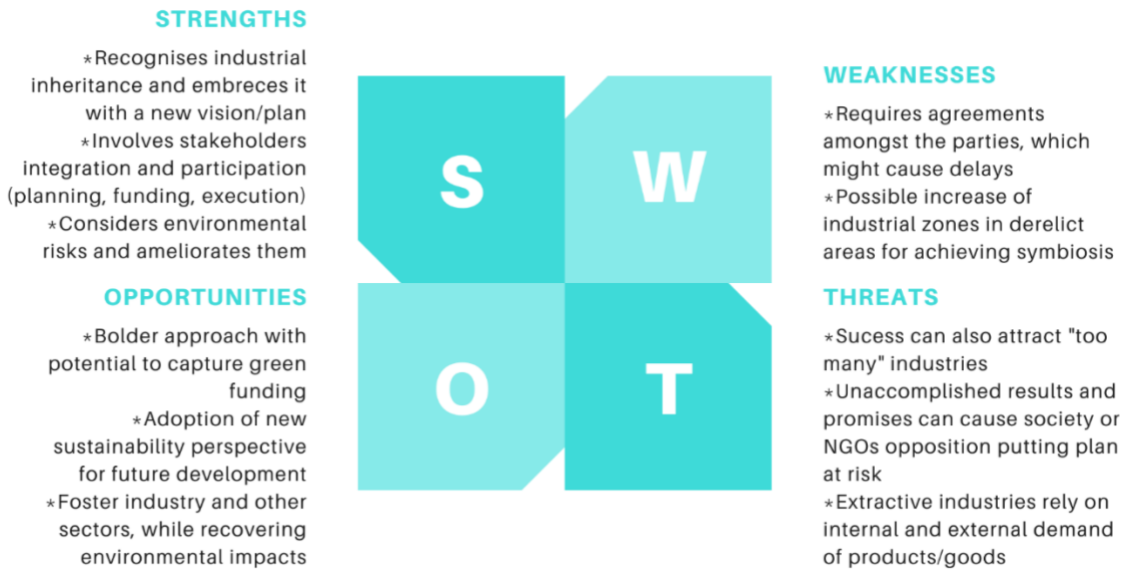


Figure 25 SWOT Analysis for Scenario C (Own elaboration, 2020).

3.3. Scenario Analysis

The development of the previous scenarios determined the need for a vision of Huelva's future 30 years from now, in which the consulting team's aim points to use the Backcasting method for Scenario C (Figure 26). This method permits to treat complex issues in which trends form part of these problems (Holmberg & Robèrt, 2000). Moreover, under the current situation, opportunities for change, and drivers explained in the previous sections, the identification of the following elements backed the decision approach:

- *Embracing and enhancing industrial heritage and moving towards a circular economy:* Current perspectives of development from the public and private sectors, supported by investment and policies, cannot deny the importance of industry in its citizens' lives. Nonetheless, the negative impacts recognised by all parties involved can now be addressed under a sustainable approach with overall good results. Industrial symbiosis and clustering will be initiated with vigorous stakeholder engagement.

- *Improving natural elements in the city:* The recovery of marshlands is possible thanks to reducing gypsum and ecologic actions supported by regional Government, Port authority and NGOs. Moreover, after the recession, the economic recovery allowed to invest in public spaces completing the previous attempts like Park Moret, or the *Green Lung* proposed in the Regenerations of Huelva's Plan. The Green Buffer situated in the city's Eastside will be connected with the Green Lung and serve as a barrier between the industry and the residential area.

- *Cleaning air:* One of the principal concerns at the public's opinion can be fully integrated into policies and actions with industries' commitment and the establishment of higher quality standards. Also, the consolidation of green spaces will lessen air pollution. Gypsum reuse options will be tapped through symbiotic links with alumina, cement and fertiliser production facilities. Soil remediation can begin, leading to less fugitive materials, hence PM in the air.

- *Creating a green growth hub:* This hub consists of a pollution abatement technology, a circle and renewable energy facilitation centre. Issues in ecosystems, water, soil, and air can be solved under a broader and active role. Incentives for renewable energy is more accessible.

- *Generating a service-based economy and tourism:* The overall improvement of life quality and urban structure can impulse the hostelry and gastronomy sector, supported by an increase in tourism.

- *Building resilience to heatwaves and dust storms:* The inclusion of RPC, UHI, and greenery in planning, strengthens the city's position to confront these issues.

- *A more analytical approach for the city development:* An integrated and participative tactic, backed by technical and information tools, allows enhanced progress.

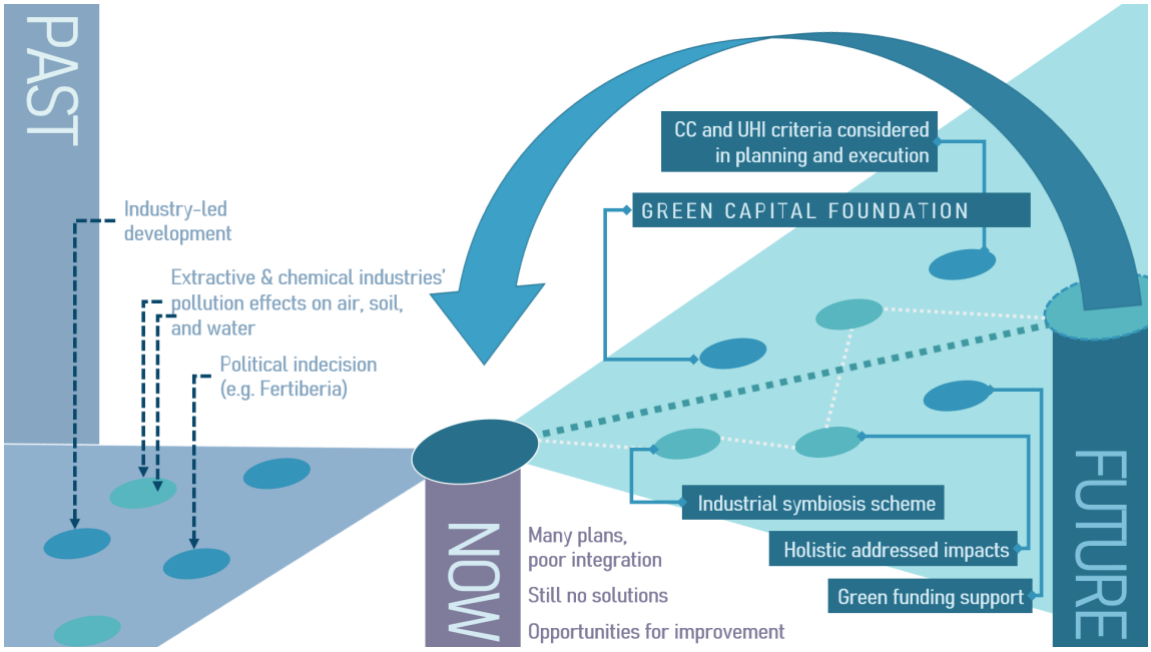


Figure 26 Vision cone and backcasting for Scenario C – Industrial symbiosis propels sustainability (Own elaboration, 2020)

4. Action Plan and Goals

The action plan is prepared according to the identified vision and future scenario for urban climate in Huelva:

Establishing Green Capital Foundation	• Facilitator and mediator between stakeholders and in charge of the RGC 2030 Application • Initially it will be part of the Municipality, in the Environment Department • KPI and current situation analysis to establish where Huelva is for being Green Capital
Linking Existing and Future Plans with Funding Mechanisms	• Applying for modern financing options • Using EU Taxonomy and Green Deal classification for planning projects and secure funding • Apply for medium and long term funding.
Stakeholder Engagement - Technical, Financial and Social Coverage	• Cohesion between governance, citizens, industries, businesses and academia with the support of Green Capital Foundation
Implementing UHI and RCP's analysis in the new plans	• The city is developing its new PGOU, which can be the first plan that includes a deep climate change adaptation/mitigation analysis. • Includes use of Envimet, GIS, and other softwares for decision-making.
Forming Pollution Abatement Technology Circle	• First steps for Green Growth Hub, Advisor, facilitator, research services, control/monitor • Takes national and EU air quality policies, but considers higher standards. • Inserted in the Environmental Department of the Municipality of Huelva.
SMEs and Start-ups Support Centre	• Transition to a world vulnerable to pandemics like Covid-19 and for the declining industry: Business diversification. Propels circular economy enterprises. • Opens job opportunities, it becomes an attraction for inmigration to Huelva. • Facilitator/advisor to funding alternatives.
Industrial Symbiosis Links and Formation of Clusters	• Phosphogypsum recovery and reuse, air pollution abatement through soil remediation • More efficient waste management. • Find opportunities for new enterprises.
Green Lung, Green Wall, Green Roofs and Rehabilitation of Marshland	• Mitigation for UHI effect and air pollution • City life quality improvements • Increase of public spaces
Brownfield Regeneration and Adaptive reuse buildings	• Remanent Industrial buildings and areas inside the city borders will be prioritized for new projects. Uses can vary depending on the city needs. • It will enhance the compact city, the recycle of structures, maintain the city's industrial identity /heritage.
Open and interactive information	• New platforms for the environment (air pollution, heatwaves alert) and projects/plans. • Interactive platforms, universal and of easy understanding: Apps, websites, interactive panels. • Additional GIS information in platforms, benefits: awareness and engagement.
Renewable Energy Facilitation Centre	• Lessen the relience on petroleum and gas • Leveraging the potential of solar radiation
Active Travel Infrastructure and low carbon emission vehicles	• Managing the effects of traffic on air pollution and promoting healthier citizen habits • Government programs for bycicles and scooters renting • Implementation of electric charging points for vehicles and credits for electric cars
Monitoring	• Importance of having updated data for future plans so a starting point for future projects • Evaluation of the effects of previous plans • Setting suitable KPIs and ensuring their monitoring /reporting to follow up with implementation.

Table 6 Action Plan Scheme (Own elaboration, 2020)

After envisioning the future scenario, incremental goals are set to achieve it. Short-term goals are designed to take Huelva towards medium and long-term goals. The initial targets are setting up the Green Capital Foundation to start with stakeholder engagement, finding financing mechanisms and having a thorough analysis of what's happening now in terms of the identified problems, challenges and opportunities.

The action plan and individual strategies are designed to bring each goal to life and carry Huelva to the next chapter in the plan. The Green Capital Foundation and stakeholder engagement, green capital award application, setting KPIs and current situation analysis, funding research and UHI and RCP minded new planning are the first steps to achieve industrial symbiosis to tackle gypsum problem, building the green growth hub, making green spaces consolidated, diversifying business and create a more resilient Huelva.

Then, Green Lung and Green Buffer Zone project, designed as a crucial for city integration, air pollution management and making a barrier between the city and the industry follows the actions. Founding the pollution abatement hub, RE Facilitation Centre and SMEs and start-ups support centre will be initial steps for Green growth hub in Huelva. Active travel framework will consider limiting air pollution as a priority, bringing other benefits as well. Interactive platforms will be set for acceptance and adoption of these mechanisms.

Long-term, monitoring and reporting with appropriate KPIs are emphasized. Symbiosis goals are carried further by eliminating the geographic barrier. Green growth hub will generate new sustainability projects and the stakeholders will be engaged regularly for feedback. The city will develop on brownfield reuse with our UHI and RCP minded design.

In light of this, long, medium and short-term goals to align Huelva's climate and air quality with sustainability principles and changing it into an inspirational green capital are identified in Table 7.

Longterm Goals - 30 years	Medium Term Goals - 15 years	Short Term Goals - 5 years
Reduced phosphogypsum by industrial symbiosis	Initiating Green Lung, Green Wall and Marsh Rehabilitation	Founding the Green Capital Foundation
Improved air quality	Bringing in industrial symbiosis links	Starting wide stakeholder engagement
Increased resilience for UHI and climate change induced air pollution	Starting with the formation of Green Growth and Pollution Abatement Hub	Finding financing mechanisms
Business Diversity and Circular economy	Renewable Energy Facilitation	Evaluation of environmental current conditions.
Consolidated green spaces	Open and interactive information	Climate change and RCPs analysis for plans
Walkable-bikeable-scooter safe city		

Table 7 Incremental Goals (Own elaboration, 2020)

5. Change Management Plan

5.1. Stakeholder Plan

The stakeholder plan is formed following stakeholder identification, categorisation and mapping. The engagement plan considers the alignment of action plan and goals with categories of stakeholders. The activities are planned to assess cultural appropriateness, interest and knowledge of stakeholders, and financing potential.

5.1.1.Stakeholder Identification

The stakeholders are identified based on the considerations in Table 8 (Land, 2017):

Who is directly responsible for the decisions on the issues?	Who is influential in the area?	Who will be affected by any decisions on the issue?	Who runs organisations with relevant interests?	Who is influential on this issue?	Who can obstruct a decision if not involved?	Who has been involved in this issue in the past in the decision making?	Who has not been involved, but should have been in the decision making?
National Government	EU	Citizens	EU	EU	Mining and petrochemical industry	Public Governance Organizations	Citizens
Andalucia Regional Council	Industry	Industry	NGOs	National Government	Public Governance Organizations	Industry	EU
Huelva City Council	Financing Organizations	Financing Organizations	Public governance organizations	Huelva City Council	EU		Academia - UHU
Provincial Deputation of Huelva			Industry Shareholders	NGOs	Financing Organizations		Banking Sector
			Financing Organizations	Traditional and Social Media			Environmental Consultants
							Business Sector

Table 8 Stakeholders Identification (Own elaboration, 2020).

According to "Level of Interest and Power Matrix" (Mendelow, 1991; Newcombe, 2003) as shown in Figure 27, their categorisation follows the major stakeholder groups' initial identification.

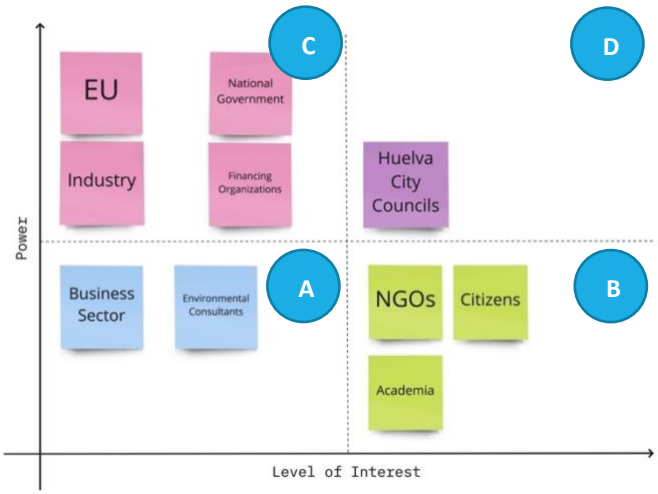


Figure 27 Stakeholders' position in the Interest / Power Matrix (Own elaboration, 2020).

Under the scheme of the previous matrix, it is noticeable that the Municipality has the highest power and interest to improve the situation, not only for its responsibility but also for its potential to capitalise public support. However, the crucial stakeholder to bring into quadrant D is the industry sector. Currently, the Phosphogypsum Bay contamination struggle is signifying a vital landmark for driving change. Nonetheless, public opinion, academia, and NGOs' pressure counterbalance Fertiberia's intentions with its remediation proposal. Therefore, economic incentives and agreements with the public administrators can bring industries into the quadrant D, carrying Fertiberia into that group. Hence, supporting ideas for this engagement are presented in the next section.

A more detailed stakeholder analysis is conducted after categorisation, and key players from each category are grouped, as shown in Figure 28.

Figure 28 Identified Stakeholders (Own elaboration, 2020).

5.1.2.Stakeholder Engagement

Stakeholder engagement is instrumental in achieving specific goals. Normative, it provides co-benefits apart from reaching the said goals, and substantive as it improves the decision-making process regardless of the goals (Florino, 1989). The proposed action plan aligns with this stakeholder engagement strategy. The links between approaches, targets and projects planned to reach the targets are summarised below:

Instrumental	Sustainable Development	Business Diversification
		Industrial Symbiosis
	Environmental Protection	Urban Green and Marshes
		Cohesion with new EU regulations
	Improvement of urban climate	Pollution Abatement Centre
		Renewable Energy Centre
		Active Travel
		Analysis in Planning process
Normative	Citizen Empowerment	Social research through Citizen Juries
		Open and interactive information
	Improved social capital	Awareness and knowledge building through workshops and media
Substantive	Business and industry diversity	SME and start-up support
		Incentives for bringing in symbiotic industries
	Technology and science generation	Pollution abatement and renewable energy centres
		Collaboration with academia

Table 9. Stakeholders Engagement Plan (Own elaboration, 2020).

The participatory processes to initiate change towards long-term goals and widen its acceptance and adoption among stakeholders will involve interactive working rather than reactive working. As shown in Figure 29, involving more stakeholders from the start and in the decision-making phase by creating an environment where they can give their input and iterate decisions several times can shorten the time needed for participation. Furthermore, the interaction between the stakeholders will improve the sense of ownership of stakeholders and increase commitment.

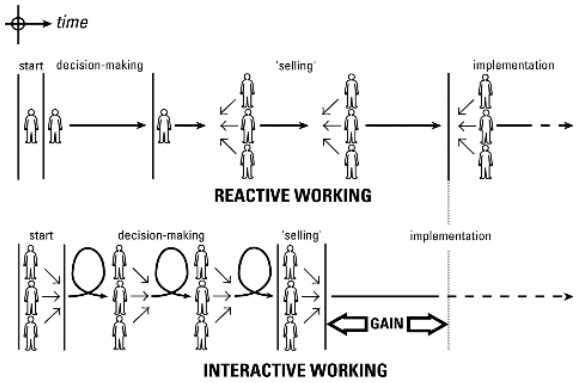


Figure 29. Interactive Stakeholder Participation (Ozkan, Personal communication, 2018)

This process ensures multiple interrelated issues are discussed with diverse opinions from different stakeholders. Building the environment for effective interaction can be difficult, so Green Capital Foundation's involvement as a mediator and connector is crucial. The Foundation will initiate the process and take the lead for active communication for stakeholders. The interaction will also serve to promote downstream projects and create opportunities for establishing symbiotic links between them.

Effective communication is the baseline for the stakeholder engagement plan. It depends on understanding the audience, which means each stakeholder group and keeps a flexible communication approach (Figure 30).

Figure 30. Communication Strategy (Ozkan, Personal communication, 2018)

Our engagement approach is based on the below actions to initiate and sustain a solid change management:

Figure 31. Categorical stakeholder activities (Ozkan, Personal communication, 2018)

While we want to achieve all these targeted approaches (Figure 31) with each group, we emphasise some for specific stakeholders according to the analysis. For example, we want to inform and empower the public while attempting more collaboration with industry and academia. NGOs and academia are consulted, and government bodies will continue to be involved in every project phase. Therefore, the proposed engagement activities are shown in Table 10:

Public Participation	Governance Bodies and Politics	Industries and Businesses	Academia	NGOs
• Citizen Juries • Citizen Summits • e-petitions • Social Networking • Social Media • Surveys • World Café • Open Space • Design/Projects Contests	• Best Practice Panels • Periodic Forums with citizens • Live decision making sessions • Progress Reports • Open Coffee/Tapas Days	• Bilateral Meetings • Multilateral Meetings • Sectoral Fairs • Technology Update Conventions • Periodic Newsletters - accesible to public • Open Coffee Days	• Science Update Meetings • Multidicipline Meetings • Brainstorming Meetings • Periodic Newsletters - accesible to public	• View Sharing Panels • Case-by case Awareness Raising Meetings • Industrial Heritage Panels

Table 10 Stakeholders' Engagement Activities (Own elaboration, 2020)

Our stakeholder engagement approach emphasises the division between engagement during planning and implementation. The activities should continue proactively during the execution of our action plan. The engagement activities work through the loop and reliable feedback, allowing a revision of procedures in an agile process. This scheme is also correct for project planning, where stakeholder feedback will be considered in project revisions (Figure 32).

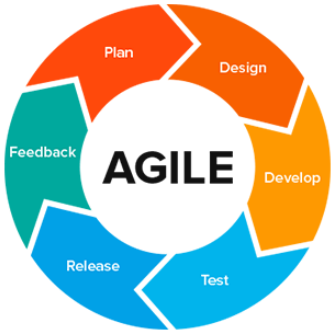


Figure 32. Agile process for engagement activities and project planning (Ozkan, Personal communication, 2018).

5.1.3. Funding Mechanisms

Financing mechanisms are essential for our proposal in terms of project planning and implementation. Providing means of financing is crucial for the sustainability of the transition and ensuring its security economically, socially and environmentally. The possible funding for the proposal has been divided into three groups (Figure 33).

On the one hand, the EU currently presents multiple programmes that aligns with our proposal and gives support to different topics and stakeholders.

- ERFD funding gives support/credit to SMEs and governments (EU, 2020).
- ESF funds supports employment-related projects (EU, 2020)
- Next Generation EU responds to the COVID 19 crisis by give loans and grants to mitigate projects' economic and social impact with a sustainability and resilience framework (EU, 2020)
- EU Green Deal aims to supply clean, affordable and secure energy, biodiversity, zero pollution and a circular economy (EU, 2020).
- EU Taxonomy is a tool to support investors, companies, issuers, and project promoters managing their transition to low carbon and resource-efficient economies (EU, 2020).

One other leg for financing is Spanish private banks, providing low-interest loans for sustainability, climate change adaptation and mitigation, clean energy projects. Employing banks for this type of funding can be used to boost sustainable development activity in line with our proposed action plan. The local government or private companies can apply for these loans. They can be used to complement some EU partial funding.

Finally, the Spanish government supports the air quality improvement with the programme FES-CO2 where the project will receive a determined quantity per ton of CO2 equivalent reduced and verified. It applies in the following relevant sectors: transportation, residential, commercial and institutional, waste management, fluorinated gases, small industry and mining (Miteco, 2020).

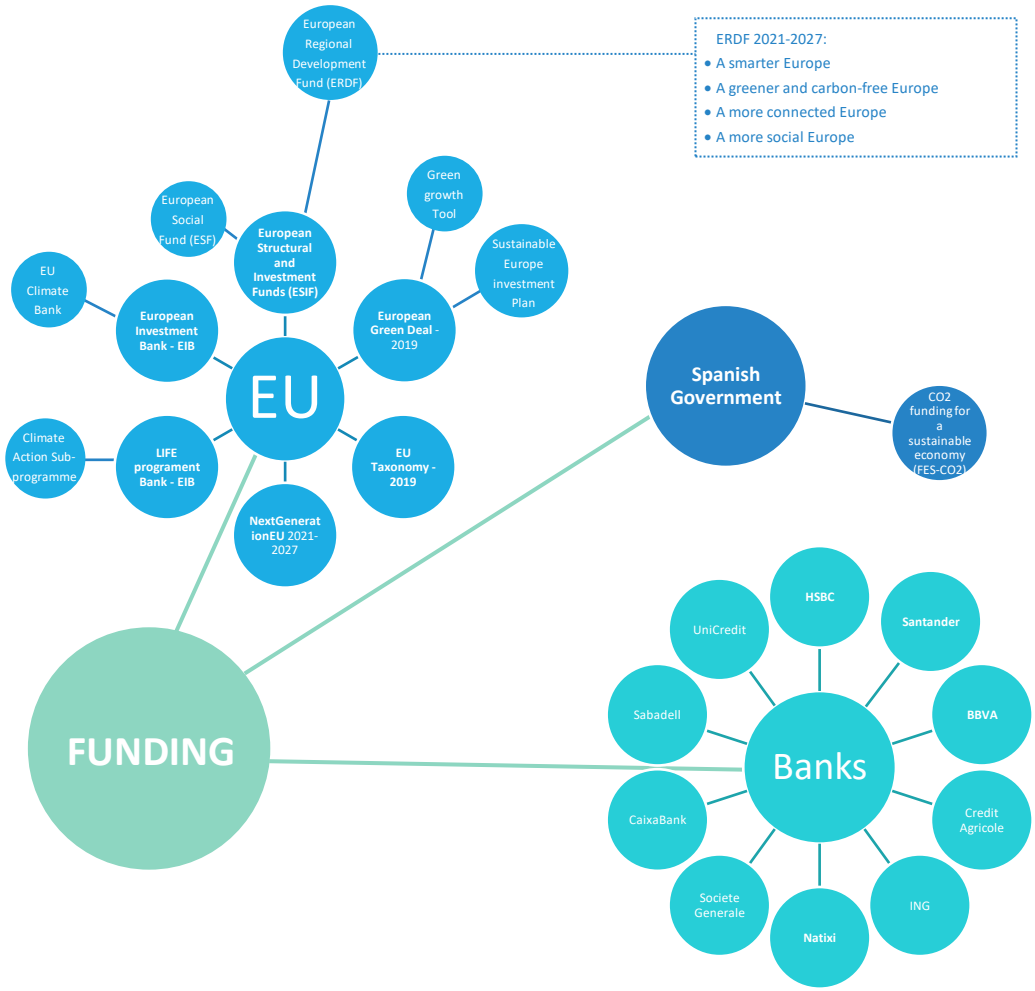


Figure 33. Identified Funding Sources. (Own elaboration, 2020).

6. Application for European Green Capital Award

The European Green Capital Award (EGCA) aims to initiate change towards sustainability in Europe by interactively engaging European Cities and create inspirational cases from problems and challenges (EU, 2020).

Reinventing Huelva will tackle many complex issues integrated and deep-rooted in its history, like the impact of industrialisation on the environment and citizens. The holistic proposals joint with proper implementation will be very poignant for other European cities looking for ways to overcome integrated problems cities usually face and to achieve modern sustainability goals.

Along with the proposal, the city needs to think in the EGCA application and how to over stand from its competitors. Huelva's "Green Capital Foundation" will need to work in a proper strategy. For starting, the proposal will require an exciting slogan but also a memorable logo (Figure 34). Additionally, it needs to highlight specific topics that make "Reinventing Huelva" inspirational, with added value and unique (Figure 35). Aside from the application and the technical information, it will require quality photographs and graphic design that exposes the data creatively and comprehensively.

Figure 34. Reinventing Huelva logo. (Own elaboration, 2020).

Figure 35. Summary of strongest points of "Reinventing Huelva". (Own elaboration, 2020).

7. Conclusion

Our proposal takes Huelva's problems and challenges with its current economic, social and environmental state on climate-related topics and built an opportunistic scenario to achieve a sustainable future in Huelva. Towards that aim, the utilisation of different tools supports our proposal. The PESTLE analysis showcased the most urgent, urgent and climate change sensitive problems. Additionally, the study of three future scenarios determined the selection of a radical change, where an industrial symbiosis propels sustainability. Our vision is projected to the present with a backcasting method which incremental goals and an action plan are set. Finally, a combination of holistic stakeholders and change management activities are proposed to initiate acceptance, adoption and sustainability of the action plan. Therefore, winning the EGCA will be just a consequence of having a realistic bold sustainable plan.

Overall, our vision emphasizes the convergence of the stakeholders' efforts under our proposed design, considering key features of Huelva, as are the hills or "cabezos", the industrial engine with a sustainable approach and propelling the social and economic development, and the public's concern and participation that enabled the reclamation of its natural beauties (Figure 36). Overall, with a fully complemented synergy we found that a reinvented Huelva is possible.

Figure 36 Reinventing Huelva, proposal visual. (Own elaboration, 2020.)

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