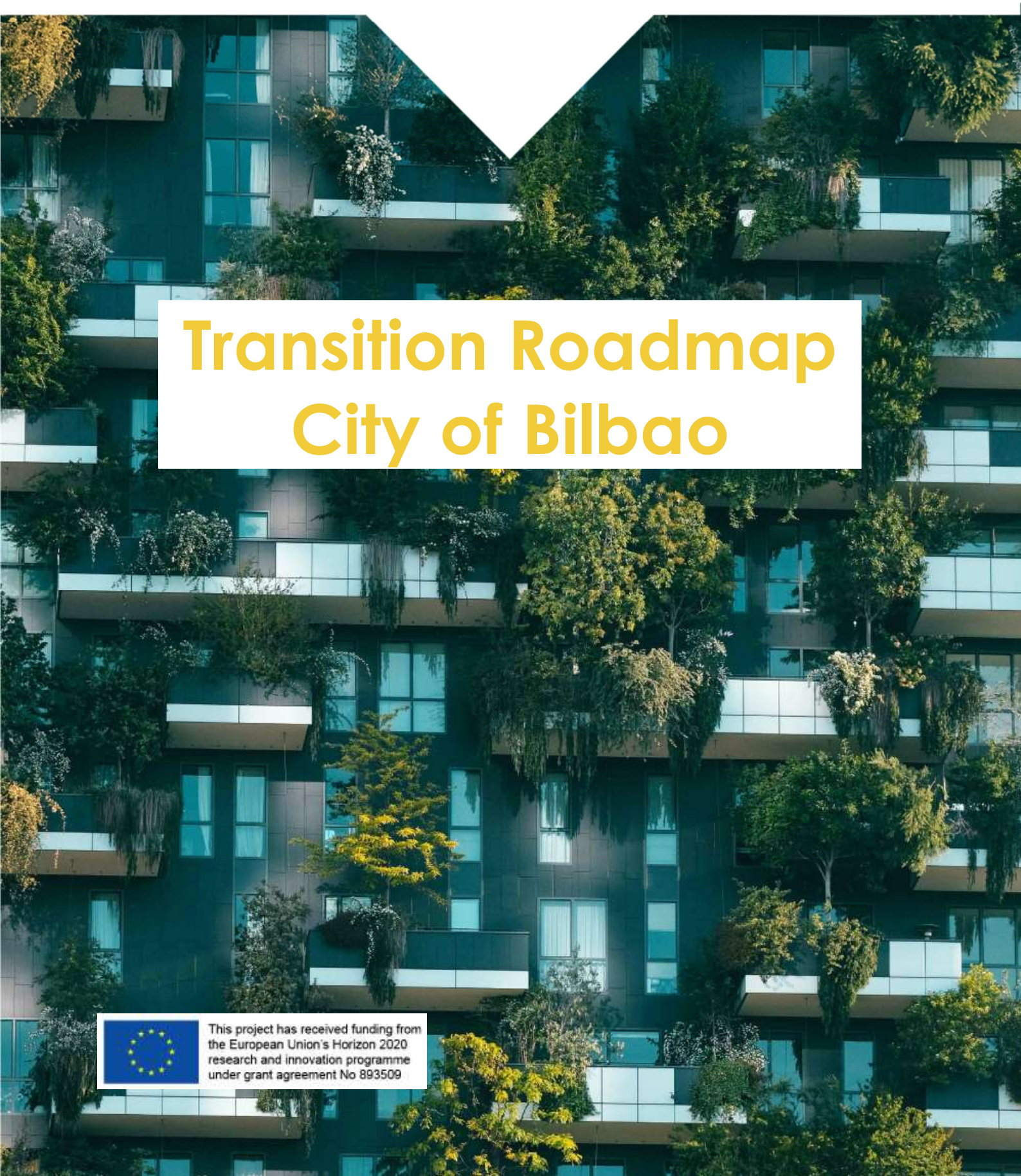
DECARB CITY PIPES 2050

Transition Roadmap City of Bilbao



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Transition Roadmap of Bilbao

Introduction

The city of Bilbao is a clear example of urban regeneration. Over the last 40 years, it has evolved from a totally industrial city with high levels of pollution to a city based on advanced services, technology and knowledge. Indeed, since the city started the restructuring of its industrial network by moving the harbour outside municipal limits, building a subway network, treating the sea inlet, and rebuilding a tram line, Bilbao has positioned itself at the forefront of the modernisation pathway.

As part of this path, the city also integrates sustainability and energy efficiency criteria in this process. Bilbao is clearly committed to meet climate neutrality by 2050, and the Bilbao Environmental Strategy 2050 dissects this ambitious plan into a compendium of strategic lines in order to handle the mitigation of CO_2 emissions and the adaptation to climate change.

Aligned with this environmental strategy, the city is subscribed to the Covenant of Mayors network. As part of that cooperation, Bilbao published in 2012 an Action Plan for Sustainable Energy (SEAP) which committed to reduce at least 20% of CO_2 emissions by 2020 with regard to 2005 levels. This milestone was surpassed by a wide margin and the city is strongly determined to develop a Sustainable Energy and Climate Action Plan 2030 (SECAP), which aims at a 55% GHG reduction.

The SECAP is still under development, and it will also underline the heating decarbonisation issue as a key factor for the city's transition. Cornerstone measures to be included are the reduction of energy use, promotion of building retrofitting, integration of renewable energies and extensive district heating networks analysis. In this sense, Bilbao has benefited from participating in Decarb City Pipes 2050 – being the first project dealing with decarbonising the heating and cooling sector for the municipality – to build up a strategic Heating and Cooling (H/C) 2050 vision and a data-extensive spatial mapping for the city's H/C Plan.

Bilbao's big urban transformation during the last decades was performed thanks to a very efficient and autonomous urban governance model through a public-private collaboration model which involved local and national administrations as well as private partners. This background and valuable experience can now be applied to carry out the heating transition. Nowadays, the city has almost complete autonomy over urban planning which presents as a clear advantage.

Bilbao's Transition Roadmap comprises essential information of the heating and cooling sector, identifies barriers and strengths of the city and elaborates on the most relevant instruments to accomplish an emission-free heating and cooling sector.

Bilbao's Status Quo and Climate Neutrality Target

GHG Emissions and Energy Consumption

Figure 7 outlines the evolution of annual CO_2 emissions between 2005 and 2018 in Bilbao. It is the most recent period for which representative data is available. During this time, emissions have been reduced by 38%, which is significantly higher than the original target. The municipality intends to continue this path and has committed itself to a 55% reduction by 2030 in the SECAP. These goals call for a series of measures and interventions in key sectors: transport, services, industry, waste and residential.

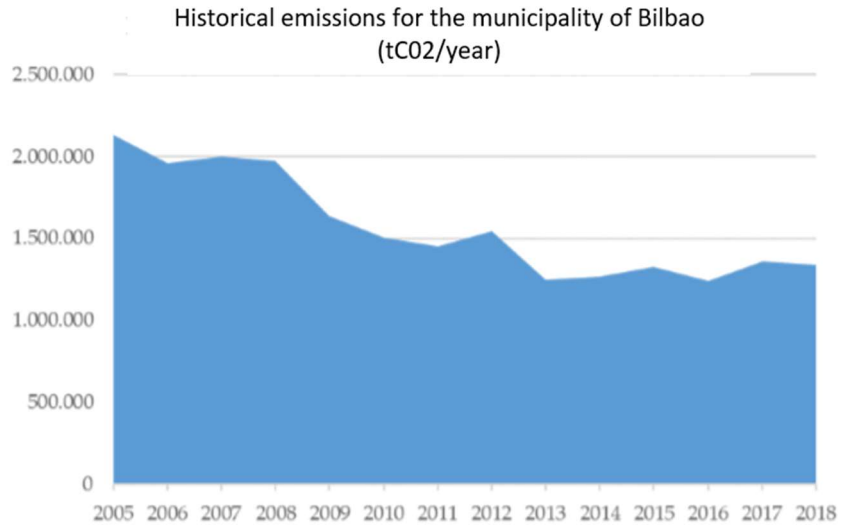

FIGURE 7: HISTORICAL EMISSIONS OF THE MUNICIPALITY OF BILBAO (tCO_2/YEAR)

Figure 8 shows that the transport sector is the largest contributor to GHG emissions, while the residential sector has recorded the highest GHG savings over the years. This is primarily due to the increasing share of renewables in the electricity grids, and to a lesser extent to the replacement of oil-fired boilers for other variants of heating systems.

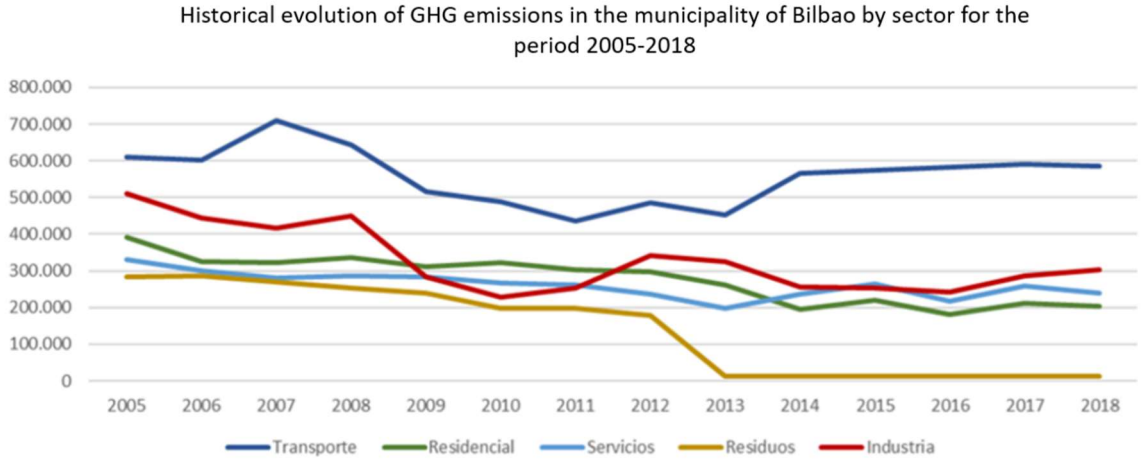

FIGURE 8: HISTORICAL EVOLUTION OF GHG EMISSIONS IN THE MUNICIPALITY OF BILBAO BY SECTOR FOR THE PERIOD 2005-2018

The evolution of the energy consumption over the years is a reliable indicator to analyse whether the municipality is reaching its targets and whether it is really becoming more energy-efficient. Figure 9 shows the total energy consumption by sector. The transport sector is the main consumer, with industry only responsible for a very small part, and the residential and service sectors are responsible for similar shares.

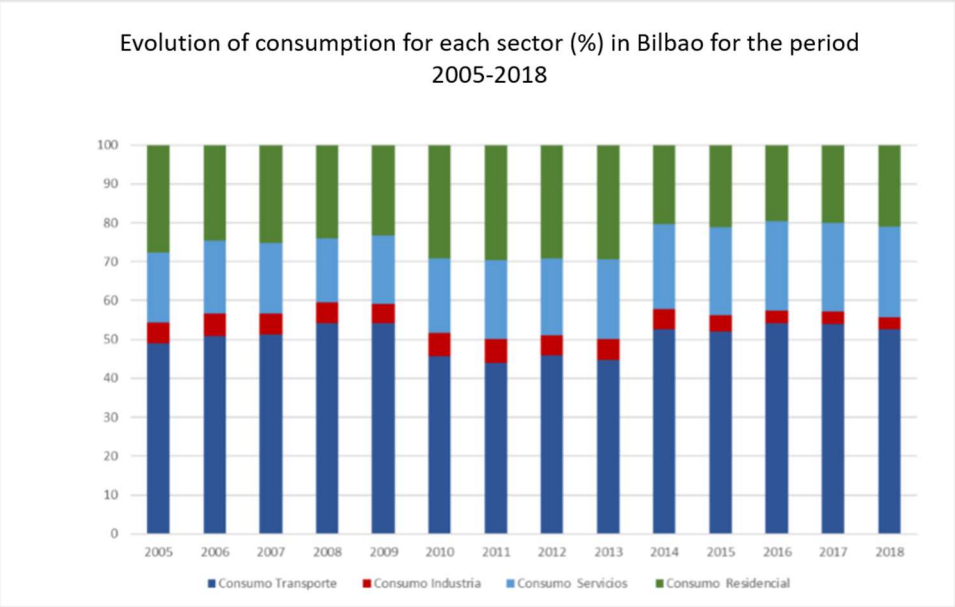

FIGURE 9: EVOLUTION OF CONSUMPTION FOR EACH SECTOR (%) IN BILBAO FOR THE PERIOD 2005-2018

Figure 10 displays the annual consumption in kWh for the service and residential sector for the whole municipality, differentiated by type of thermal or electrical energy (*there is a mismatch since heat pumps, for instance, are not considered for thermal energy).* Overall, there is a general reduction of 12% of total energy, but there is also a slight upturn in thermal energy during last years, mainly due to an increase of activities in the service sector.

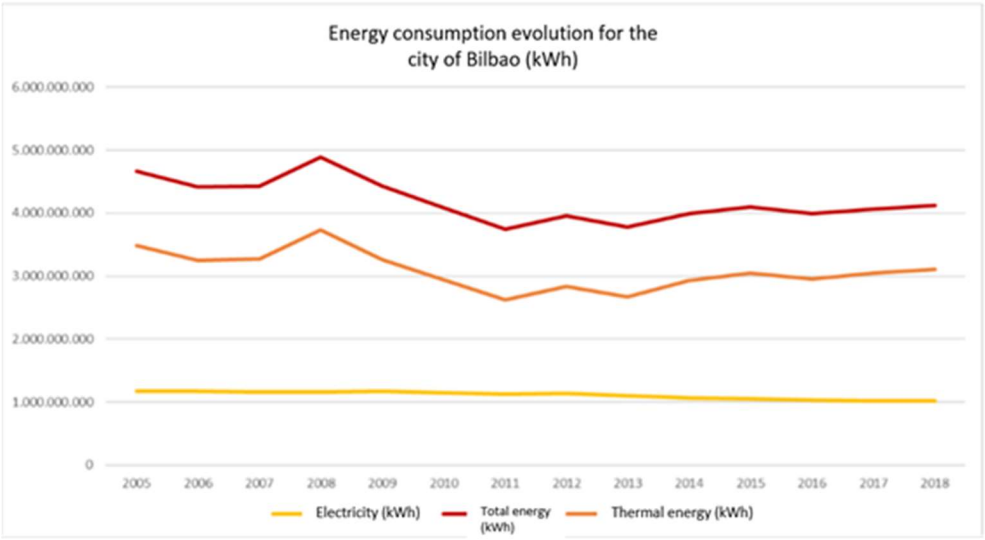

FIGURE 10: ENERGY CONSUMPTION EVOLUTION FOR THE CITY OF BILBAO (KWH)

Building sector

When analysing the building sector, it represented almost a 50% of the total energy consumption in the city in 2018 and was responsible for approximately 33% of CO_2

emissions. Electricity for lighting and auxiliary equipment, and natural gas for heating are the main energy carriers. Due to the mild climatic conditions in Bilbao, there are not very high heating demands as compared to other northern European countries. Regional and national strategies have generally prioritized the decarbonisation of the electricity production, and heating supply has not been studied in detail. Despite that, Decarb City Pipes 2050 states the relevance of cutting down fossil fuels in the thermal sector by a step-by-step heat roadmap.

Natural gas is by a wide margin – around 80% – the most used energy source for heating, cooling and hot sanitary water supply in Bilbao. More than half of that amount corresponds to heating while cooling has a very low impact. Figure 11 shows the distribution of different equipment and types of heating in the residential sector. Remarkable is the low penetration of individual heat pumps (below 1%), the considerable direct use of electricity (15%) and the extensive use of individual gas boilers (50%), which are the most common heating infrastructures in the city.

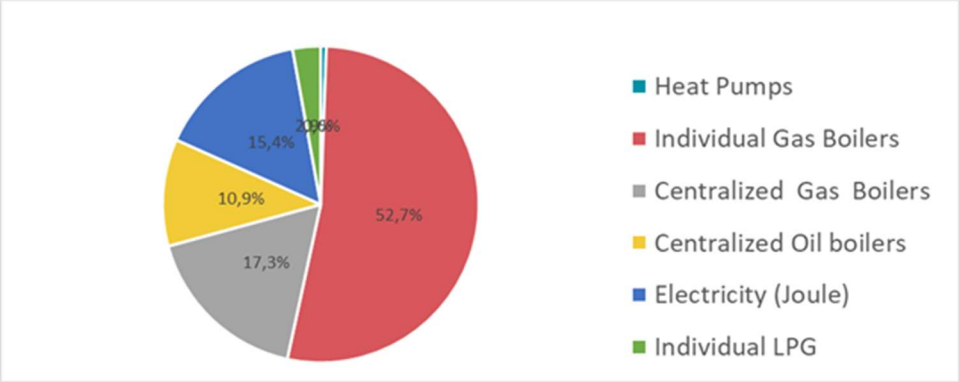

FIGURE 11: DISTRIBUTION OF DIFFERENT EQUIPMENT AND TYPES OF HEATING IN THE RESIDENTIAL SECTOR

Figure 12 depicts the distribution of heating systems per use of building in the non-residential sector. For tertiary commercial buildings, natural gas boilers are still the most common systems but there is a noticeable 30% of use of heat pumps.

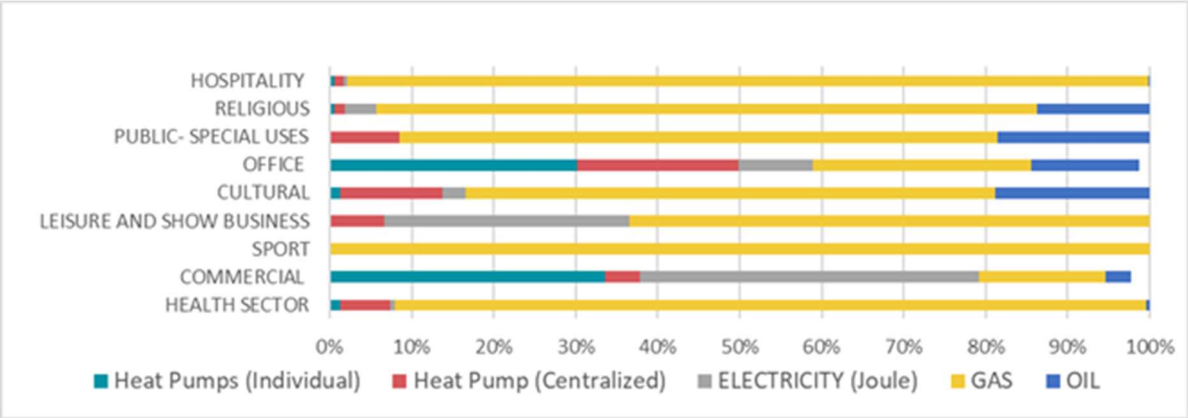

FIGURE 12: ENERGY MIX IN DIFFERENT BUILDING TYPES

The building sector in Bilbao is confronted with the following circumstances:

Promotion of refurbishment rate: Hundreds of buildings in Bilbao are even older than 100 years and their envelopes do not meet high energy efficiency criteria. Their renovation is a priority task for the city, and very efficient or 'passive buildings' are to be reached in those areas where district heating networks are unlikely to be developed. The current

refurbishment ratio is rather low – around 0,5% -, and it needs to grow exponentially next years to reach the agreed objectives for decarbonisation.

Energy efficiency: An improvement of overall energy performance of the building stock, including decarbonisation of the heating system and new requirements for the building envelope, are required by different standards and regulations. The national Technical Building Code prescribes that a minimum annual contribution of renewable energy must cover the domestic hot water (DHW) needs of buildings with at least 100l/d demand. (60% RE when the DHW demand is lower than 5000l/d and 70% if it is higher). This directive is applicable to residential, private and public buildings. Solar power, biomass boilers or heat pumps are the most suiting renewable source systems in this regard. In addition, buildings with more than 1000m^2 of constructed area are forced to install PV energy to produce electricity.

Exemplarity of public administrations: the most ambitious goals must be set for the public buildings. A better insulation of the facade of buildings as well as behavioural changes in habits for users are key factors for the reduction of energy consumption. As an example, the national government has set a directive that limits the interior temperature of heated and cooled spaces to 19 degrees in winter and 27 degrees in summer. That measure is also applicable for tertiary buildings.

In addition, a progressive replacement of heating systems towards renewable energies must be considered. The Basque Sustainability Law enacts the inclusion of renewable energies, stipulating that public administration buildings must cover their electricity and heat demand at least by 32% through on-site renewable energy generation. For example, when implementing a district heating network, and particularly if the investment comes from a private party, reliable initial potential consumers such as public buildings with high energy demands allow for planning certainty and reduces investment risks.

Citizenship engagement and affordable financial schemes: Whatever the alternative to fossil fuels needs an adequate sustainable business model to thrive. Social sustainability and affordability are key parameters in the energy transition. Bilbao tackles an extra-challenge: most of the buildings are privately owned by multifamily housing and every decision for the buildings must be endorsed by 2/3 of the co-owners. Only 4.000 buildings are municipally-owned, which is a 1/85 ratio. Additionally, Bilbao has a relatively elderly population which hampers the acceptance of changes, such as for heating systems. The initiation of public-private collaboration projects is considered fundamental.

There is a need of launching incentives or subsidies promoting energy efficiency measures in the private sector. The National Institute for Diversification and Saving of Energy, for example, has established an annually updated funding programme (implemented in the Basque Country through the Basque Energy Agency) to support energy rehabilitation of existing buildings, covering i.e. thermal renovation, energy efficiency improvements of heating systems (e.g. the replacement of conventional energy for solar thermal) or lighting installations. This funding also covers the switch from a fossil-based heating system or switch to a renewable heating system based on e.g. biomass, aerothermal or geothermal energy.

Legal framework: No direct measures with regard to total decarbonisation of the thermal sector at regional and national level are in force currently and, unfortunately, none are expected to enter into force in the short term. There is no ban or limitation on gas or on gas heaters planned and there are still no plans or discussions about the decommissioning of gas infrastructure. However, coal heating systems are indeed forbidden to be installed in new and refurbished buildings since 2007, while oil heaters are not prohibited at national level, but the Basque Sustainability Law of 2019 has taken the strong commitment to abandon them by 2030. Existing oil boilers, which are mostly old and inefficient, are generally being replaced by gas boilers.

Gas network and supply operation and management: Unlike other European cities, thermal energy suppliers and natural gas network operators in the city of Bilbao are private, which creates a challenge for the implementation of a district heating or other individual solutions. Additionally, the gas network was constructed in Bilbao only around 35-40 years ago (being not very old) and meant a high investment for the municipality, making it difficult to think about substantial remodelling and decommissioning in the short-term. The ideal strategy consists of engaging existing gas network companies in the deployment of big-scale renewable heating systems, since they already have a high knowledge and expertise on the exploitation of energy sources.

Renewable energies

Waste heat from companies, data centres etc. are not considered a major energy source in Bilbao, as there are no large industries or computing centres within the municipality. Biomass is also rejected due to the emission of particles and logistics issues. Individual solutions (e.g. air source heat pumps) and centralized DH networks based on geothermal energy or hydrothermal exchange are considered the most favourable solutions for decarbonisation.

Heat pumps

The deployment of individual air-source heat pumps (HP) may be the least intrusive pathway for the administration, as existing gas boilers can be progressively replaced by HPs once their life cycle finishes. In certain areas of the city, however, heat pump installation is currently hampered through local heritage protection laws, such as in the old town of Bilbao (e.g. attachment to the roof prohibited). The high upfront investment costs, and generally the lack of knowledge, expertise and experience of installing heat pumps to substitute centralized boilers in multifamily buildings are also an obstacle. New buildings are likely to be equipped with HP, but it is not very common in already existing buildings yet.

District Heating (DH) systems

Although they currently are the more efficient system, there are no laws in place that favour DH over individual heating systems. Only the Basque Sustainability Law mentions it in a specific article for local administrations, requiring them to foster studies for centralized energy systems in order to improve energy efficiency of the existing building stock. For new developments, it requires them to consider centralized energy systems for energy supply, and the use of renewable energies.

The only existing operative DH in Bilbao is a small network that supplies heating and cooling to the hospital buildings of Basurto and is based on biomass and natural gas. A DH pilot based on a geoexchange low-temperature network is being implemented in the still non-urban developed area of Zorrozaurre, and it is planned that residential, tertiary and industrial buildings will be able to connect to the grid.

Stakeholders: Besides the municipality, there are other crucial actors for the energy transition: the Basque Energy Agency is a very important entity that has led the decarbonisation of the region over the last 40 years. Nevertheless, the decommissioning of the natural gas network is currently not a priority since old oil boilers are still being replaced by natural gas boilers and subsidies are being granted for that. Also, representatives from the industry such as Tecnalia are important in this process through their knowledge and experience in the sector. Indeed, the Basque Country has a very powerful auxiliary industry in the energy and electricity sector, including companies with great expertise such as Iberdrola and Telur.

City Planning: The collection of a robust data basis at the building and apartment level is essential for the gradual spatial mapping analysis. It is a key tool for the decision-making process and specifically for identifying the most suitable fossil heating replacement strategies for each area of the city. While there are not yet any local legislations that require municipalities to develop these plans, Decarb City Pipes 2050 offers Bilbao the perfect ecosystem to build up this mapping.

Pathway to climate neutrality and Heating & Cooling Outlook

Introduction

The heating and cooling pathways the city of Bilbao is exploring have been constructed around the city vision of a fully electrified heating and cooling of buildings by 2050. As described in the city's heating and cooling plan, this transformation will require the substitution of all fossil fuel combustion systems for other sources of heat, driven by electricity. These sources will vary from individual electric heating devices (Joule effect) to individual aerothermal heat pumps, to collective systems based on geothermal exchange or connection to heating and cooling networks with diverse sources for heating and cooling (e.g. waste heat, hydrothermal, geothermal, etc.).

This heating and cooling roadmap for 2050 will contribute to this goal of electrification and ensure high efficiency of the overall heating and cooling strategy, for example by trying to avoid the deployment of direct electric heating devices and promoting low-temperature heating and cooling networks in certain areas of the city. A shorter-term action plan for the building sector is being currently developed for the SECAP, with actions being detailed for the next years and up to the 2030, further contributing to the reduction of the heating and cooling demand, and the substitution of fossil fuel boilers.

The detailed characterization of the buildings stock performed within the Decarb City Pipes 2050 project has provided a good basis for both these short and long-term strategies, and to define potential solutions in different parts of the city.

Heating and Cooling in 2050

The current rate of building energy refurbishment is very slow, covering below 0,5% of the building area annually. Even if this rate is increasing to 1%, 1,5% and even 2% in the coming years, about half of the building stock will likely remain without deep renovation interventions by 2050. The overall demand for space heating is therefore expected to be reduced until 2050 by around 20-30%, which is not so significant. Hot water demand, which currently accounts for about 40% of the heat demand in residential buildings, is expected to keep stable and become progressively the larger final use of heat. The cooling demand, on the contrary, is likely to increase. From being currently practically inexistent in the residential sector, it will start being required due to factors such as expected climate change and increased insulation levels in buildings.

Overall, total energy demand for heating and cooling is therefore not expected to change dramatically. The energy sources and technical building systems to supply the demand will be therefore key for the heating and cooling transition.

Final Energy Use for Heating and Cooling by 2050

The SECAP 2030 includes various actions aligned with this heating and cooling roadmap, including promotion of electrification of thermal loads and the development of pilots for highly

efficient thermal networks. In this line and considering a longer-term vision, the Heating and Cooling Outlook envisages the following final energy uses for the residential and tertiary sectors.

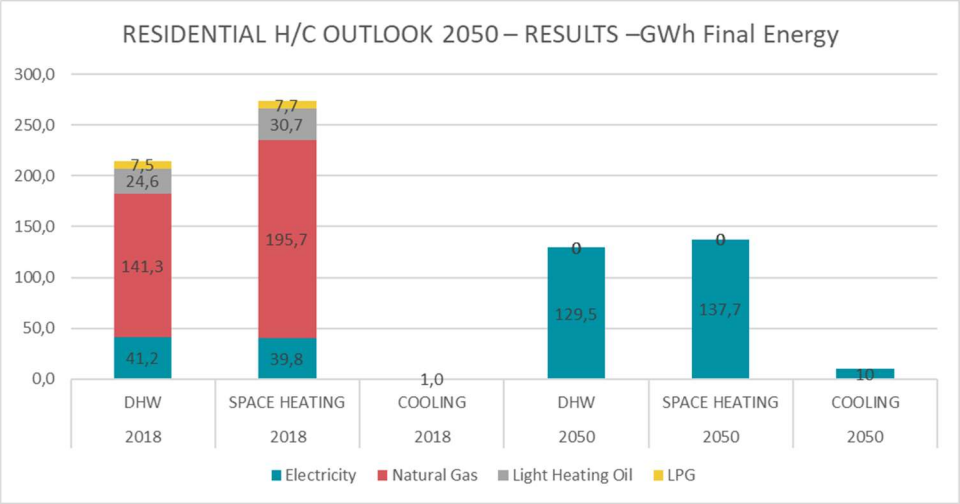

FIGURE 13: RESIDENTIAL H/C OUTLOOK 2050

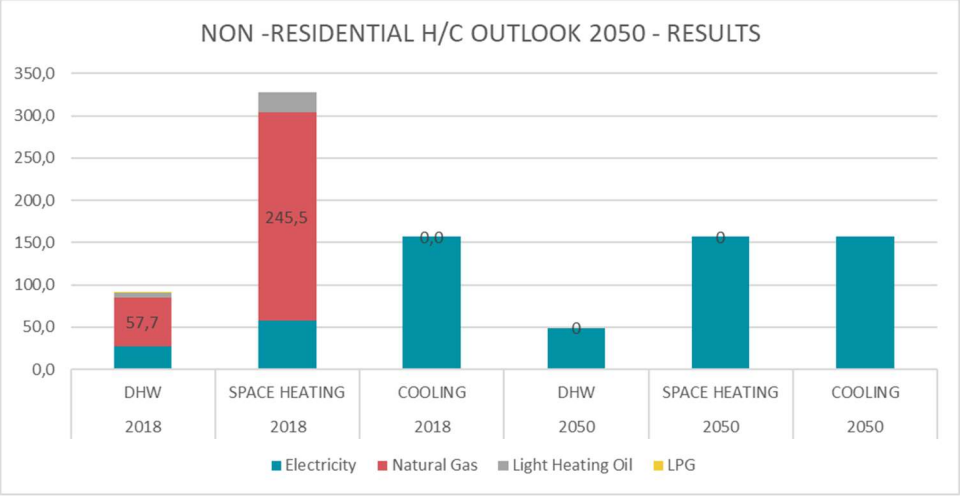

FIGURE 14: NON-RESIDENTIAL H/C OUTLOOK 2050

As can be observed in Figure 13 and Figure 14, the aim is to have an all-electric heating and cooling supply in buildings by 2050, supplied by highly efficient heat pumps, both at building or apartment level, and through heating and cooling networks.

This electrification of heating, which will result in an overall reduction of final energy use of more than 50%, will represent, however, a large increase of the total electricity energy use by circa 200GWh, which is around an additional 20% of Bilbao's total electricity use in 2022.

This highlights the need of integrated planning for heating and cooling together with electricity infrastructure, particularly considering that electric mobility, the other large electricity user besides electrified heat, will also lead to higher electricity demand.

Heating and Cooling (H/C) Plan 2050

An initial geospatial analysis of the heating and cooling requirements in the city of Bilbao has been developed as part of Bilbao's Heating and Cooling Plan.

For the development of the H/C Plan, different sources of information were used. As a base GIS layer, the energy demand calculated per square meter, as well as the configuration of the heating distribution within buildings (centralised or individual) and the current energy source were mapped. This information was extracted from a model developed using basic information from the cadastre as input data, from which building characterising and heating and cooling schedules are inferred. Hourly heating and cooling demands are calculated, and fuel consumption and its associated costs and emissions can also be deducted using data from energy certificates regarding the installation type and fuel. After these calculations from the building stock energy model, results have been adjusted using real data regarding total energy consumption of the city, provided by the energy distribution companies.

Figure 15 shows the calculated heat demand for each of the buildings in the city of Bilbao.

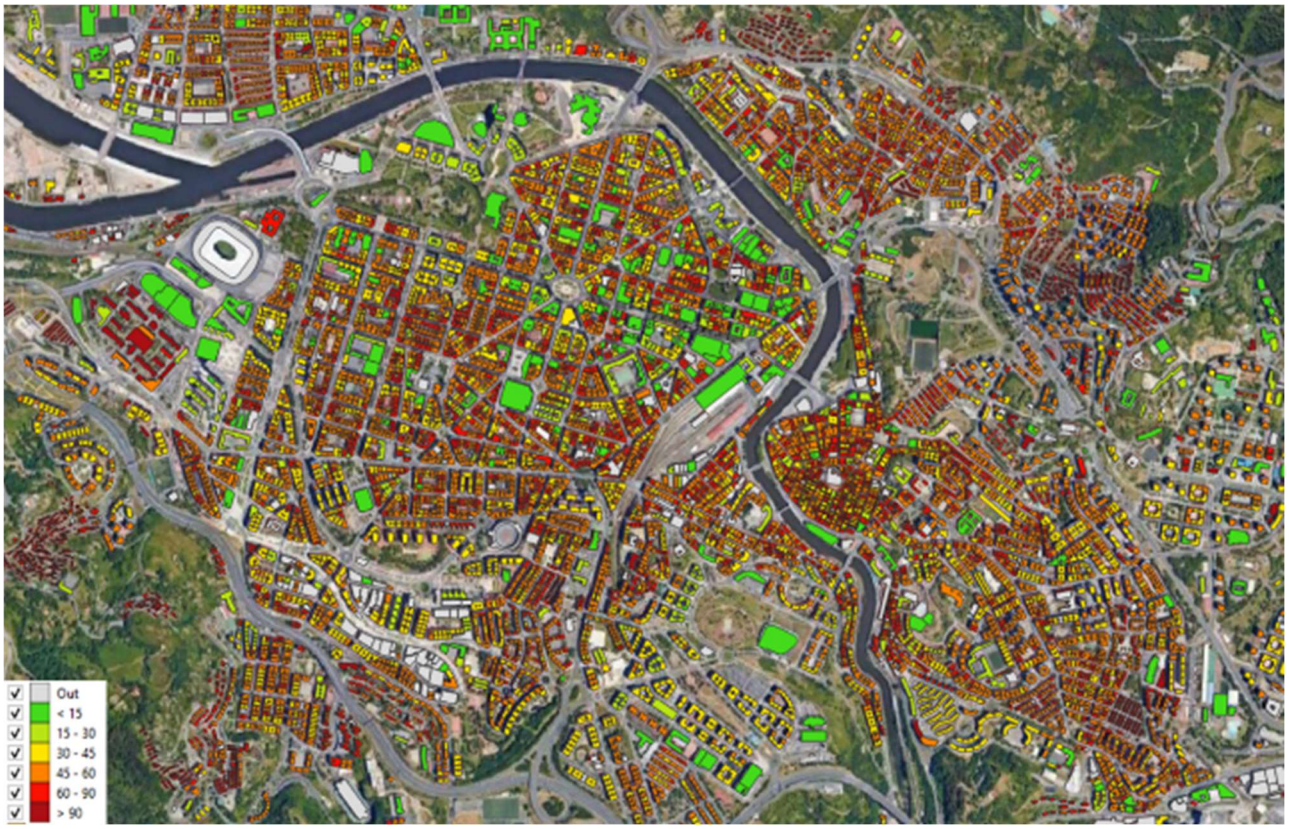

FIGURE 15: HEATING DEMAND [KWH/M2] FOR THE BUILDINGS IN THE CITY OF BILBAO

In addition to these data layers on heating and cooling use, energy source and heating system configuration, further layers were considered in the analysis, which are relevant to inform decisions about where to implement different types of solutions for decarbonising the heating and cooling systems:

- **Potential Heating/Cooling Energy Sources**: Proximity to available heating or cooling sources, which could exchange heat with a district network. The availability of waste heat, geothermal or hydrothermal sources for heat exchange, can improve the economic viability of district heating or cooling networks.

- **Available public space**: Availability of public space for the construction of necessary infrastructure.
- **Protected buildings**: Historic buildings or protected parts of the envelope that do not allow for retrofitting or rooftop installation of elements such as photovoltaic panels or external units for heat pumps.
- **Public buildings**: Buildings owned by public bodies such as the municipality or the Basque government. These are buildings which have a specific requirement for decarbonization under the Basque Energy Sustainability Law 4/2019, and where implementation of low-carbon strategies has become a priority.
- **Degraded areas**: geographical delimitation of degraded areas. These areas have access to subsidies for the implementation of energy efficiency and refurbishment strategies, and integral regeneration projects are more likely to be developed.
- **City plans** (future and incorporated): Plans for new developments or urban regeneration currently incorporated in urban planning or defined future plans.

The consideration of all these layers has served to explore where in the city of Bilbao different strategies could be more relevant, giving a first overview of where heating and cooling networks could be more feasible, or indicating areas more suitable for individual solutions (heat pumps) or for deep refurbishment.

Figure 16 shows and example of a “hotspot” analysis for heating and cooling networks. Areas in red indicate locations in the city where networks could be more viable, based on the weighting and aggregation of all the geospatial information previously gathered.

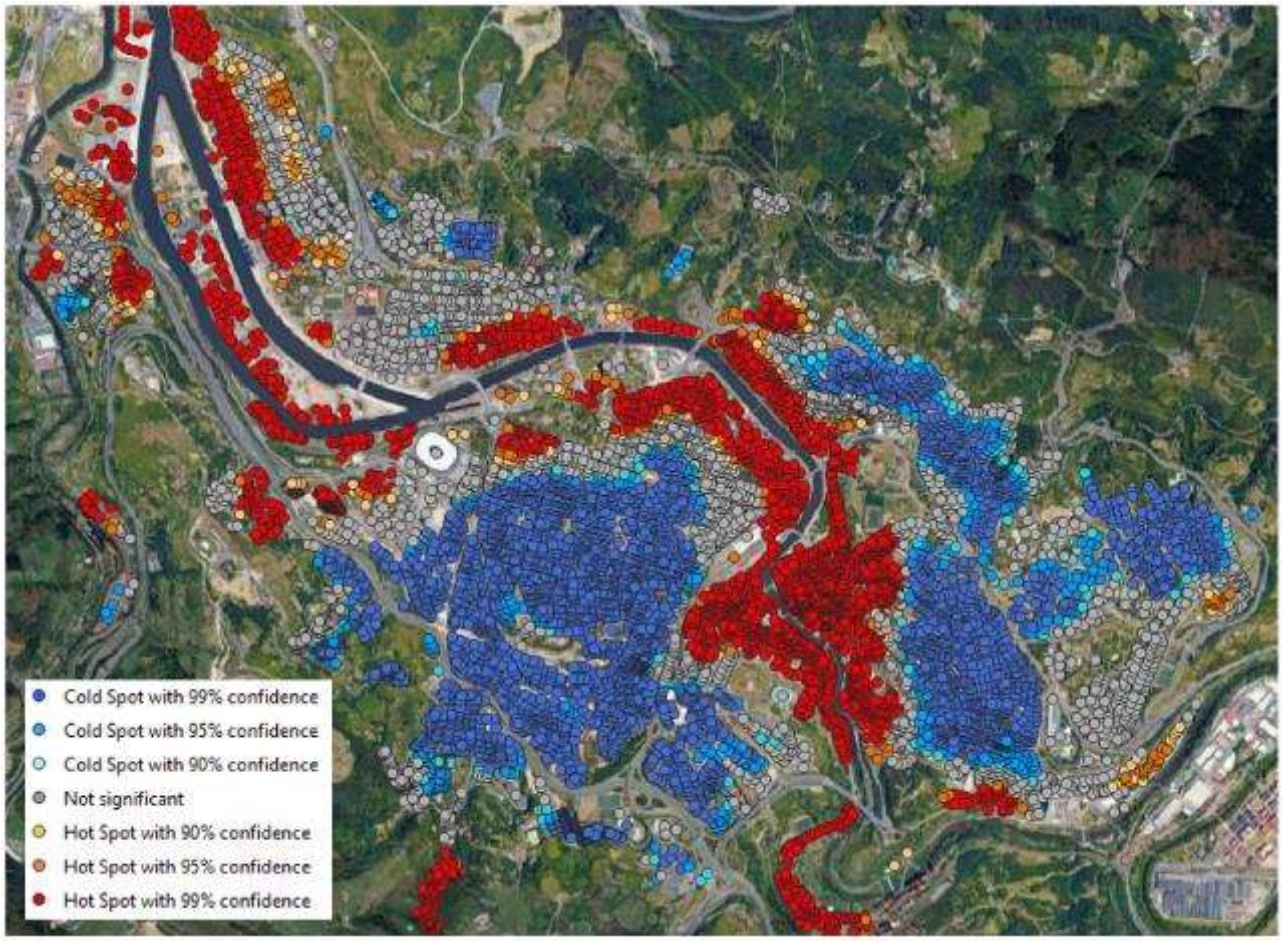

FIGURE 16: HOTSPOT ANALYSIS FOR DISTRICT HEATING AND COOLING NETWORKS

This geospatial analysis will contribute to the decisions about which technologies for electrification of heat (building level heat pumps or district networks) are used within different areas in the city, to be able to reach the vision of an electrified heating and cooling system.

Levers and Instruments

What is the basis to advance towards the decarbonisation of thermal sector? It is a very complex question and perhaps difficult to answer categorically at the moment for the city of Bilbao. It requires an elaborate and meticulous study that tackles the situation from different angles: technically, economically, socially.

This section includes a first description of the identified exploitable instruments or levers in order to achieve GHG emission reductions at city level and the substitution of fossil fuels by renewable energies.

Instrument 1: Energy Spatial Plan

As described in the previous section, the city of Bilbao has a geospatial energy map referenced at building level, which is particularly valuable for the selection of most suitable decarbonisation strategies in each area of the city. There are still new layers of additional data to be incorporated in order to provide an added value to the tool and enrich the decision-making process.

Firstly, it would be advisable to automate the aggregation of data received from the electricity distribution companies and the natural gas network operators through a periodical input in order to keep the map up-to-date. In addition, the current tool needs to be merged with the existing GIS platforms of the local administration which include urban planning infrastructure data. Additional new layers will be beneficial and refine the map, i.e. existing sources of waste heat in the city such as server centres, underground vents, supermarkets because of their need for cooling, or the sewage network. Besides that, collecting data on the electricity grid, as well as on the current renewable production and the potential of generation, on the points of streetlights and their consumption will also be beneficial for completing the mapping.

In fact, the more detailed the map is, the higher the accuracy that can be achieved for determining the prioritisation of strategies by district. In short, the mapping should result in more specific feasibility studies of diverse decarbonisation solutions. As an example, in the areas where centralised thermal systems have been found to be highly viable, the intention is to develop not only a thorough technical report (on pipelines, energy sources, etc.), but also an economical evaluation, defining potential sustainable business models. It is particularly relevant to explore the role of the administration as well as the possible involvement of energy companies or even natural gas network operators. It is also of course important to analyse the case studies of individual solutions (building level, house level) that can be undertaken through heat pumps.

Instrument 2: Municipal Work Structure

A solid and robust working group specifically devoted to the phase-out of fossil fuels is required at municipalities to drive the process. Decarb City Pipes 2050 is a starting point

project in this field for the Bilbao City Council and does not involve the participation of many relevant departments yet. Until now, the Sustainability Commission has been leading the Local Working Group, but its task is limited to fulfil the Sustainability Commission targets.

In this regard, the recent foundation of the BioArtigas energy agency is a key milestone for the city since energy efficiency issues will acquire higher relevance. BioArtigas is a public-private partnership constituted by the City Council and the Basque Energy Agency, which will be responsible of defining the city's long-term Environmental Strategy, cooperating transversally with all City Council departments and establishing the energy-related interventions in the city. It is then decisive that the agency takes over more responsibility and that more resources in terms of budget and workers are added in the following years. Training sessions for workers are also planned in order to increase the agency’s capacities.

Instrument 3: Legal framework

There is no national, regional or local legislation specifically prohibiting the use of fossil fuels for heating and that is highly unlikely to change in the short term. The intention is to take advantage of the project learnings and disseminate the outcomes in order to raise the awareness of authorities for setting a regulatory framework enabling the heating transition. This is the only way to speed up the process. As a result of the project, the municipality intends to set a closer coordination with regional and state regulations to assess the benefits of heat networking and to try to suggest legislative changes. At the same time, it is also important to review local regulations that hinder the implementation of alternatives to fossil fuels (e.g. prohibition of the use of roofs for installing aerothermal equipment).

Instrument 4: Social awareness

Public awareness and capacity-building sessions are crucial elements to achieve the goals set. The City Council has to think about innovative channels to inform the general public about alternatives to fossil fuels, and about taking energy efficiency actions. However, it is not an easy task to reach out to citizens. Incentivising measures, such as subsidies or grants, are potential strategies in order to promote energy savings interventions among residents. On the other hand, in some cases, "one-stop-shop" offices can be helpful due to their proximity to residents. Several big-scale retrofitting projects in Bilbao used this option with a high level of satisfaction and it could be replicated especially for those areas where DH is to be implemented.

Instrument 5: Training sessions for workers

Nowadays, there is a clear lack of knowledge and expertise in the heating sector about renewable solutions. With the aim of closing that gap, regular training courses for professionals (installers, architects etc.) could be given by the Basque Energy Agency.

The Road Ahead

The City of Bilbao has undertaken a great transformation over the last decades from a fully industrial area to a city focused on tourism, services and knowledge. All the construction works and interventions developed along the years have been based on an urban sustainable planning context and with the purpose of attaining a better quality of life for residents. In line with that strategy, the city has recently also started several energy and sustainability projects, submitting the Bilbao 2050 Environmental Strategy or by being part of the Covenant of Mayors.

Nevertheless, regarding the heating and cooling sector, the Decarb City Pipes 2050 project has been the trigger point for focusing on the impact of space heating, cooling and domestic hot water consumption. Due to the mild climate in southern Europe, “decarbonisation” is usually linked to decarbonising electricity production. This project has, however, highlighted the relevance of the heating and cooling sector and explored ways for replacing the widely used natural gas boilers in the city as well as old oil boilers with other renewable solutions. In a first approach, the city assumed that massive retrofitting would be a practical measure to lower the energy demand and reduce the dependence of fossil fuels. However, given the low renovation rate for residential buildings, the fact that domestic hot water represents a significant ratio of total heat demand, and considering the expected increase demand for cooling, the city is committed to proactively adopt other measures to decarbonise heating and cooling.

The final goal is to achieve high energy efficiency performances and emission-free standards at building level through sustainable business models and affordable schemes for citizens, and by involving the adequate stakeholders. Local circumstances are also critical to design a tailoring plan. Most of the buildings in Bilbao are privately owned condominiums (multifamily properties), with a rather aged population and with a private operator of the gas network and that context determines the rhythm of the actions.

The H/C Plan developed in the project is a first conceptual valuable tool to select the most suitable strategies (individual solutions such as heat pumps, centralised district heating…) depending on the features of each district. The main outcome of that plan is a mapping that aggregates diverse layers of data: urban planning data, energy data and potential renewable production, buildings characteristics. The GIS developed gives a comprehensive overview of the convenience of renewable solutions in each area. Further analysis including additional information and a cost-benefit evaluation will be needed to advance towards heating and cooling decarbonization in the city.

The City of Bilbao is aware that there is a lot of work ahead and that more resources are necessary. In this regard, the recent creation of the BioArtigas energy agency is a key milestone for the city since energy efficiency issues will acquire a higher relevance. It will shape the city's long-term Environmental Strategy and ensure transversal cooperation across all City Council departments.

Upcoming steps will include the improvement of the mapping exercise, integrating new additional layers of data, such as the existing sources of waste heat or the electricity grid data. More accurate conclusions will be then be possible and certain specific analyses for

business cases are expected to be undertaken. As an example, Halmstadt University in cooperation with Tecnalia is working on a technical and economic study of a centralised district heating in an area of the city with appropriate conditions. While these reports need to be carefully evaluated by the local administration, they will be in line with and support the efforts laid out in the city's SECAP.

DECARB CITY PIPES 2050

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