Energy Improvement District – EID Strategy: Barmwisch – Bramfeld

A. Background information

Hamburg is conscious of its global responsibility and has continually promoted climate protection for many years now.

With its climate protection concepts and climate protection master plan adopted in 2013, Hamburg has already paved the way and considered both factors – climate protection and climate adaptation – in an integrated fashion. In 2015, these strategic papers were united for the first time in the so-called Hamburg climate plan. In this plan, Hamburg presents itself as the model of a modern city of the future where climate protection and climate adaptation are fundamental, closely interlinked components of social coexistence. Particularly given the impending challenges of a constantly growing metropolis, an increased focus will be placed on ecological responsibility. Therefore, the maintenance and sustainable development of environmental quality with urban green areas and the protection of nature and climate are fundamental guidelines for urban development.

Along with the urban development targets of the city as a whole, the climate plan particularly references the important role of individual districts in Hamburg's climate protection:

In Hamburg, districts are communal units, which gives them significant leverage and room for action when implementing Hamburg's climate goals. For this reason, integrating climate protection into district-focused urban development and implementing climate protection measures at the neighbourhood level are central elements of the Hamburg climate plan.

The development of communal climate protection concepts is an important strategic element for establishing climate protection in district administration and implementing regional requirements at the district level.

With the "Guideline for the promotion of climate protection projects in social, cultural and public establishments as part of the national climate protection initiative" (in short: "Communal Guideline"), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB) has created a promotional tool to support communities in their climate protection activities.

Based on the resolution of the District Assembly (Printed Matter 20/3076), the Wandsbek District Authority submitted a funding request for initial advice concerning a communal climate protection concept and took first steps in the direction of an integrated climate protection concept (IKK-W) in the period from September 2017 to February 2018.

With the development of the integrated climate protection concept from February 2019 to April 2020, the Wandsbek District Authority will further intensify its climate protection efforts and systematically analyse and develop the numerous opportunities and areas for action within the district jurisdictions. A fundamental goal will be the sustainable integration and anchoring of climate protection into the district administration structures, areas of responsibility and processes. The follow-up project will establish independent climate protection management in the district administration, also with the help of federal funds.

The EU project Area21 offers the opportunity of focusing district climate protection efforts more intensively at the level of neighbourhoods and existing buildings and to discover and establish economically beneficial and socially viable approaches for unified energy plans in new forms of cooperation between energy companies and housing associations as well as the public sector. The project will also contribute to closer networking of

internal administrative structures and departments, the integration of climate protection aspects into overarching urban planning and promoting the interdisciplinary collaboration required for future-oriented city development.

AREA 21 is co-financed by the European Union (European Fund for Regional Development and the European Neighbourhood and Partnership Instrument) as part of the Interreg programme for the Baltic Sea Region 2014-2020, Focus 2 "Natural Resources", Individual Goal 2.3 "Energy Efficiency".

Together with six other partner cities in the Baltic Sea region and under the guidance of the HCU, the Wandsbek District Authority has accepted the task of developing concepts for energy savings and energy efficiency at the district level as representative of the Free and Hanseatic City of Hamburg. Ultimately, these concepts will be developed and successfully reviewed in a model quarter in Bramfeld to serve as an example for comparable energy projects after the three-year project has been completed.

B. Local Context

The district of Wandsbek

The district of Wandsbek, located in the northeast part of Hamburg, is the most populous of Hamburg's seven districts. With 440,000 residents (as of 2018) distributed across 18 neighbourhoods, Wandsbek has the most inhabitants of any district in the Free and Hanseatic City of Hamburg.

The district exhibits varying characteristics and urban planning features and thus poses a variety of challenges.

The district extends from the southern quarter of Eilbek, a densely populated central area, to the core of Wandsbek including Jenfeld, Marienthal and Tonndorf with a mix of lively and calm residential areas, and north to Alstertal and the regional area of Bramfeld, Farmsen-Berne and Steilshoop with a juxtaposition of small detached houses and small and large-scale housing complexes, to the northeast with a diverse mix of late 19th century townhouses and post-war era housing complexes in Rahlstedt all the way to the more spacious rural structures in the "forest village" quarters. The neighbourhoods within Wandsbek are distinguished by their local identity, with unique quarter and district centres.

The housing networks are interspersed with a variety of green corridors along waterways such as the Alster banks and the Wandse green belt, as well as parks and garden areas. Wandsbek is also characterised by countless local recreation and forest areas as well as conservation areas and nature reserves, particularly towards the outskirts of the city. Various natural spaces in the district enhance the quality of the living and working environment, but also significantly restrict the area available for housing development.

In the so-called "Treaty for Hamburg" from 2011, yearly building permit figures of 1,100 housing units were stipulated for the district of Wandsbek. This figure was increased in 2016 with an agreement to approve an average of 1,800 housing units per year. From the year 2011 until August 2018, building permits were granted for nearly 16,000 housing units. Due to the sustained positive population development in recent years, expanding the number of existing housing units is a central topic, particularly for the district of Wandsbek. Such growth presents a major challenge, but in housing construction it is possible to effectively reduce climate-relevant emissions and resource consumption through strict energy standards, the use of sustainable materials and heat supply based on renewable energies. The maintenance and sustainable development of environmental quality with urban green areas and the protection of nature and climate should continue to be the guiding principles for urban development. This means that ecological and climate-related goals, for

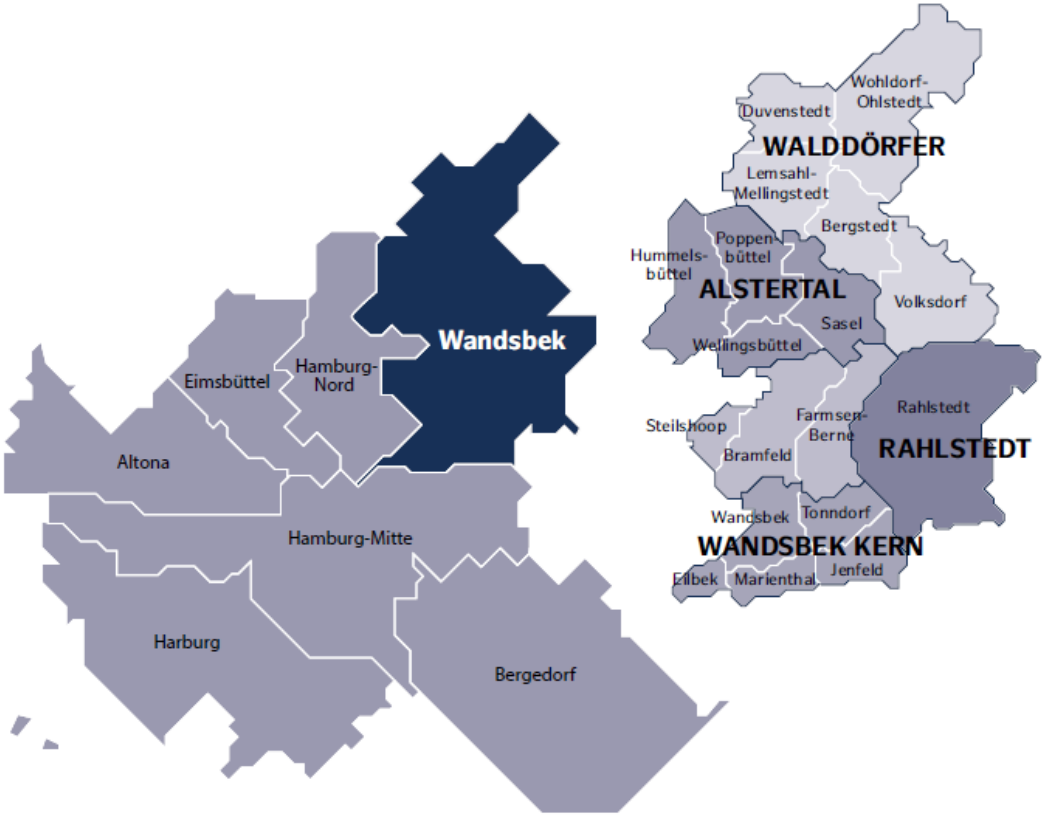

Figure 1 - Location of the Wandsbek district in the Free and Hanseatic City of Hamburg and its division into 18 quarters[1]

instance the developments in the pilot quarter Barmwisch – Bramfeld in the context of the Area21 project, must always be balanced with **social and economic responsibility**.

[1] Source: motum GmbH based on hamburg.de.

The pilot region of Barmwisch – Bramfeld

The pilot neighbourhood Barmwisch – Bramfeld is located in the Bramfeld quarter on the border with the Farmsen-Berne quarter to the east and Wandsbek to the south. This predominantly residential

Figure 2 - The pilot quarter and its defined borders[2]

area is conveniently located north of the U-Bahn metro line U1, not far from the Trabrennbahn station. In the north, the residential quarter in question is marked off by the street Turnierstieg and by the street Barmwisch in the west. The Hopfengraben tributary and part of the Osterbek canal form the eastern border of the region.

[2] Source: Geographical data infrastructure of the Hamburg metropolitan region – GDI-MRH
Map foundation: WebAtlasDE and aerial images © GeoBasis-DE/BKG

The urban construction of the quarter is characterised by lines of houses and free-standing, narrow housing rows with up to ten storeys. The existing buildings are predominantly owned by seven registered housing cooperatives. The buildings are predominantly prefabricated houses (industrial construction) that were built in the early 1970s and most of which have not been renovated.

The Elbkinder daycare centre is located centrally in the area in question. Only a small portion of the existing buildings are used commercially – a former supermarket in the northwest part of the quarter was destroyed by a fire in 2016 and has yet to be restored or recovered. Along Bengelsdorfstraße street in the eastern part of the quarter, there is also a row of houses with housing units privately owned by a total of 50 different parties.

In the areas between the buildings on the shore of the Osterbek and the Hopfengraben there are narrow green spaces and parking areas that are publicly owned. The playgrounds in the northeast and southwest of the quarter, also belonging to the city, were designed to be easily accessible from the residential areas without disrupting adjacent residential buildings. Finally, in order to meet the requirements of increased population density, various parking areas and parking spots were created. These are distributed evenly in the residential area.

Key stakeholders

The ownership structure was a significant criterion for identifying a pilot quarter. The aim was to choose a quarter with existing buildings predominantly owned by registered housing cooperatives.

Housing cooperatives are cooperative housing associations that take on responsibilities relating to housing and real estate on behalf of their member households that the members are generally unable to fulfil due to their economic situation. Thanks to their cooperative shares, the members are "co-owners" of the cooperative, which means that the existing housing is common property.

The main guiding principles of a housing cooperative are acquiring affordable housing, improving quality of housing and quality of life and promoting neighbourly cohabitation. In addition, housing cooperatives value the principles of self-help, self-responsibility and self-government. Each member has a vote regardless of the number of member shares involved. Instead of revenues and profits, the ethical pillars are solidarity, social responsibility and democratic decision-making. A housing cooperative is not just an economic enterprise but also a social community.

In Germany, housing cooperatives play an important role from a social and economic perspective. They make an important contribution to public welfare, which naturally enables close cooperation with community administrations.

Housing cooperatives demonstrate their significance in Hamburg as well, amounting to 20% of all existing housing units in Hamburg. Particularly in the context of growing demand for affordable housing and the correspondingly tight market, cooperation between the city and housing cooperatives is increasingly important. Around 70% of new buildings owned by cooperatives are already publicly co-financed by the housing subsidy programme of the city of Hamburg – proof of the close collaboration with city administration in the interest of welfare to establish affordable housing.

Given the background of urban climate protection efforts as well, cooperation with housing cooperatives should be expanded and intensified.

With the "Housing Alliance" (Bündnis für das Wohnen) established in 2011, housing associations including cooperative associations agreed with the city of Hamburg to integrate the climate goals of Hamburg more intensively into the ambitious core efforts towards socially responsible creation of housing. The neighbourhood approach will be an area of particular focus. Neighbourhood-level energy efficiency upgrades

should be considered as an integral part of planning for building upgrades and heat supply, with particular emphasis on renewable energies and heating grids. This should result in the establishment of sustainable networks even beyond these association partnerships and the growth of pilot projects for sustainable district development.

In the pilot quarter Barmwisch – Bramfeld, the majority of the existing buildings are represented by the following housing cooperatives:

- Housing cooperative Gartenstadt Wandsbek eG
- Housing cooperative Hamburg Wandsbek v. 1897 eG
- Gartenstadt Hamburg eG
- Hansa Baugenossenschaft eG
- Hanseatische Baugenossenschaft Hamburg eG (HBH)
- Deutsche Schiffszimmerer Genossenschaft eG
- Baugenossenschaft freier Gewerkschafter eG

For the Area21 projects, the housing cooperatives are the key stakeholders.

Policy

Climate, energy and urban development policy

Hamburg climate plan

The Hamburg climate plan approved by the Senate in 2015 created an overarching structure by bundling the targets and initiatives for a climate-conscious city adapted to climate change while further developing content and methods.

Time frame	**CO_2 reduction goals** (with respect to the polluter balance and the reference year 1990)	
	Previous goal (2015 climate plan)	New goal (2019 update)
2030	50% CO_2 reduction	**55% CO_2 reduction**
2050	At least 80% CO_2 reduction	**Climate neutral i.e. at least 95% CO_2 reduction**

Figure 3 - New CO2 reduction targets for 2030 and 2050 in Hamburg.[3]

The identified targets are oriented on both national and international requirements.

The Hamburg climate plan is prepared interdepartmentally and regularly adapted to current developments with the involvement of the districts (community level) and in collaboration with city stakeholders. The Climate Coordination Centre of the Ministry for the Environment and Energy (ministerial level) was engaged by the Senate to update, coordinate and manage the climate protection and adaptation measures. They also carry out tasks involved with resource allocation.

Transformation paths

The measures required to achieve CO_2 reduction targets are represented under the following transformation paths in the climate plan:

- **Transition to sustainable heating including building efficiency**
- **Transition to sustainable transport**

[3] Source: First update of the Hamburg climate plan

- **Economy**

In addition, the transformation path **Climate adaptation** outlines the process for developing and implementing initiatives to ensure quality of life, functionality of urban infrastructure and prevention of climate-related damages.

The transformation path **Transition to sustainable heating including building efficiency** stipulates the primary project-related recommendations for action as well as overarching measures to be implemented for energy planning at the district level:

- **Existing buildings:** Upgrading existing buildings for quality refurbishment with high refurbishment rates is an important cornerstone of climate protection. It must be ensured that the goals of affordable gross rents and restricting rent increases are not endangered in new constructions or existing buildings.
  According to the novel and innovative "Energiesprong" principle, pilot projects will be introduced in Hamburg for serial refurbishment using prefabricated components. The goal is to carry out refurbishment in accordance with the net-zero standard without affecting gross rents, such that buildings generate as much energy as needed for heating, warm water and electricity year-round. In Germany, the "Energiesprong" initiative is coordinated by dena, funded by BMWi and supported by the GdW Bundesverband deutscher Wohnungs- und Immobilienunternehmen (Federal Association of German Housing and Real Estate Enterprises).
- **Refurbishment rates and quality:** When replacing heating systems, future-oriented heat supply solutions should be selected and a refurbishment action plan should be created to consider the modernisation of system technology and refurbishment of building envelopes from a holistic perspective. One solution in this context could be a hybrid system consisting of efficient fossil fuel heating technology combined with the use of renewable energies and potentially a component to allow flexibility (such as thermal storage).
- **Share of grid-based heat in heat supply:** Establishing grid-based heat supply as the primary supply variant in the city. This can be accomplished by increasing the density of existing grids and constructing new heating grids. The goal is to cover at least 35 percent of the useful heat demand with grid-based heat supply by 2030. Repurchasing from heating companies offers significant potential for decarbonising the central and residual district heating systems by integrating industrial and commercial waste heat, near-surface and deep geothermal sources, solar thermal energy from open spaces, other environmental heat and heat from sustainably generated biomass.
- **Share of renewable energy in the heat supply:** The majority of useful heat demand will be provided via decentralised heat generation systems. To achieve the climate targets, two central measures are required in particular in this context. Firstly, when replacing heating systems, suitable measures should be adopted to increase the use of renewable energies, where relevant using hybrid heat systems. Secondly, energy efficiency refurbishment should be pursued on the building side to ensure optimal integration of renewable heat sources by reducing the heating load of a building or installing heating elements with large heat transfer surfaces. Low heating temperatures are generally required to this end to efficiently implement generation systems such as heat pumps or solar thermal energy, as well as to use waste heat sources and environmental heat. The high heating temperature required in buildings that have not been upgrade is the largest restriction on the use of renewable energies. Efficiency and the increased use of renewable energies are interdependent.

Cross-sectoral approach

The transformation to a climate-conscious city requires holistic, interdisciplinary and cross-sectoral approaches to coordinate the activities of public and private stakeholders. For the neighbourhood approach, this means that the sectors of mobility, social and economic infrastructure and climate adaptation always need to be considered along with building-specific areas of activity in order to establish meaningful synergies. This should generate a leverage effect for economically justifiable implementation of climate protection that can overcome investment obstacles.

The principal strategic measures for implementing the cross-sectoral approach are outlined briefly in the following:

- **Climate protection and energy efficiency in the "Bündnis für das Wohnen" housing alliance in Hamburg:** Climate protection, climate adaptation and affordable housing are equally important for the future of Hamburg and are high political priorities. For this reason, the partners in the housing alliance expressed a mutual interest in active climate protection and agreed to develop joint solutions for new constructions and existing buildings. The goal is to reduce the energy consumption of buildings, increase energy efficiency and increase the share of renewable energies. In technical discussions, the alliance partners have engaged with questions of energy-efficient district development, transport and the implementation of climate adaptation measures.
- **Energy-efficient district planning:** To tap the potential of heat grids, the "neighbourhood approach" is pursued for new constructions as well as existing buildings. This means a holistic perspective within the neighbourhood, rather than considering individual buildings. The goal of the federal subsidy for energy-efficient neighbourhood concepts (KfW programme 432) is to prepare and implement integrated district concepts that include measures for energy savings and the integration of renewable energies into energy supply. Implementation relies on energy efficiency upgrade management. Measures at the neighbourhood level can achieve greater CO_2 reductions than energy measures implemented at the building level.
  Area21 and the project's central idea of a holistic approach to achieving an Energy Improvement District (EID) adopts nearly all the points stipulated in the Hamburg neighbourhood approach and the approach of the federal subsidy programme. For the pilot project in the identified area of Wandsbek, the building-related focus was expanded to include the relevant areas of mobility, social and economic infrastructure and climate adaptation.
- **Aids for climate change considerations in urban development:** Under a Senate order, action guidelines were prepared by the responsible authorities in collaboration with the districts to consider climate protection and adaptation to climate change. This indicates the possible actions in the specific urban planning phases – starting from urban planning competitions for the development of open spaces down to the tendering process for concepts – in order to consider climate requirements in planning. The approach is interdisciplinary: topics such as quality of life, higher densities with the increase of housing, maintaining and developing green areas and open spaces, integrated rainwater management, sustainable transport, transitions to sustainable energy and heat must be brought together in integrated urban planning along with many other considerations.
  For new construction projects, an energy-efficiency technical review, a **technical energy plan**, will be introduced. This will be prepared for projects that encompass more than 150 housing units or an equivalent housing need as well as a floor area ratio of more than 0.8. Above this size and density, the fundamental requirements for efficient heat supply are provided by a heat grid. The technical energy plan examines the efficiency of the heat supply solutions that are viable locally with the lowest possible CO_2 emissions.

- **Climate protection concepts and climate protection management in the districts:** The Senate aims to employ climate managers in all districts by the end of 2020 to create and implement climate protection concepts and to engage additional caretakers for urban development planning or mobility concepts.
  Another goal is for each district to have a neighbourhood energy efficiency management division for the preparation and implementation of an energy-efficient neighbourhood concept by 2021.

Climate protection concepts and climate protection management in the districts:

The goals of the Hamburg climate plan are specified at the district level by the district authorities.
The Wandsbek District Authority launched the process for developing its own climate protection potential with the *Initial advice for community climate protection* in 2017 and further developed this with the integrated climate protection concept. District efforts are funded by the national climate protection initiative and co-financed by the Ministry for Environment and Energy of the City of Hamburg.
By implementing this concept, the Wandsbek District Authority is actively committed to future-oriented and climate-friendly development in the district. In this process, the district authority is incorporating the requirements of climate protection and adaptation to climate change within its responsibilities and leading by example. At the same time, the district authority informs the residents of Wandsbek and the numerous stakeholders about their options and assists them with climate-friendly actions. The district authority will make visible and reinforce the commitment of the stakeholders who have been involved with climate protection and sustainable living for years or even decades.
Climate protection management in Wandsbek is focused on more efficient energy use and more renewable energy production, as well as making climate-friendly conduct easier overall. The citizens and initiatives of Wandsbek are sources for ideas, while the numerous small-scale and large-scale urban development projects are specific starting points for action.
The climate protection measures of the Wandsbek District Authority are divided into five areas of activity:

- Building energy,
- Transport,
- Urban spaces,
- Nutrition, consumption and recycling,
- Communication and stakeholder involvement.

The category of *Building energy* brings together measures and approaches targeting the efficient generation, distribution and use of energy as well as the integration of renewable energy sources into new constructions and existing buildings while creating synergies with the considerations of the Area21-related pilot project.
The *Urban spaces* category includes measures that demonstrate how climate protection can be achieved during the maintenance and new design of street spaces, public green areas and open spaces as well as Wandsbek town squares. The integration of climate protection requirements into the established planning and coordination processes of the district authority and other public stakeholders is of crucial importance. For neighbourhoods that are part of integrated district development (RISE), there are numerous potentials and additional financial incentives that can be used by the district authority in the future. By defining the *Wandsbek climate protection standards*, all new buildings constructed in the district in the future will exceed the legal requirements in terms of energy efficiency and energy supply, climate-friendly transport, sustainable construction materials and design of open spaces. In existing neighbourhoods, grid-based heat supply concepts and energy efficiency upgrades will be implemented to confront the central challenges of reducing energy needs and achieving climate-friendly energy supply for existing buildings.

The district authority will also implement these plans in its own buildings wherever feasible. In this way, the district has its sights set on the target of achieving a climate-neutral building stock by 2050, without neglecting the fact that further efforts will be required in the future.

Hamburg's climate protection law

In order to anchor the goals and tools of climate policy and other significant provisions under law, a new climate protection law for Hamburg was passed in February 2020 parallel to the continuation of the Hamburg climate plan. This draft law aims in part to provide a legal foundation for the climate plan and establish a regulatory framework.

A central element of the climate protection law is phasing out fossil fuels in heat grids, compulsory connection and usage, and decarbonisation action plans for existing heat grids (Section 8). Concerning buildings, the law stipulates a prohibition on electric space heating (Section 11) and oil heating (Section 12). Paragraph 16 obligates building owners to use all suitable roof surfaces for solar power generation either themselves or by third parties. For the replacement or subsequent installation of heating systems, owners of buildings constructed before 01 January 2009 are obliged to integrate renewable energies. They should cover at least 15% of their annual heat energy requirement with renewable energies (Section 17). Some of the corresponding legislative decrees and exceptions must still be stipulated by the Senate. In Part 4, the climate protection law emphasises the exemplary role of public buildings. This includes application of the 'Effizienzhaus 40' efficient building standard, inspecting roof spaces for the generation and use of renewable energies and the use of climate-friendly construction materials. Paragraph 23 also stipulates that the regional and district administration must maintain a climate-neutral vehicle fleet by 2030. In the area of transport, the climate protection law describes the targets of sustainable and low-emission transport in the Hanseatic city, particularly by means of:

- Improving and optimising the offers of local public transportation with the aim of increasing use rates for public transportation,
- Gradual replacement of vehicles with fossil fuel engines by other climate-friendly forms of engines, along with an unrestricted openness to technological ideas,
- Increase of cycling and walking as transport options,
- Suitable measures to quieten and reduce traffic.

In part, the changes and effects resulting from the climate protection law cannot yet be estimated due to impending legal regulations. With the climate plan combined with the climate protection law, the City of Hamburg has established a solid foundation for climate protection at the regional and district level.

Energy efficiency potential

To achieve significant potential for improved energy efficiency and more sustainable energy supply in the Barmwisch – Bramfeld neighbourhood, the ICT tool Hamburg Heat Demand Cadastre (Wärmekataster) was used as an aid.

The heat demand cadastre is an interactive map that displays aggregated (for data protection reasons) information about heat demand, generation and distribution as well as potentials for the use of renewable energy solutions in a geographical distribution.

This made it possible to identify territorial spatial units in Wandsbek with respect to potential improvements in energy technology, and to select a specific area for implementing an EID considering other relevant criteria such as ownership and building structure.

The following technical data concerning energy collected for the heat demand cadastre was considered in detail and used as a foundation for holistic integrated strategy development in the selected pilot quarter:

I. Energy need and consumption
    a. Absolute useful heat demand
        i. unrenovated
        ii. renovated
    b. Electricity consumption
II. Heat distribution
    a. Heat density
        i. unrenovated
        ii. renovated
    b. Existing heat grid
    c. Hypothetical heat grid
        i. unrenovated
        ii. renovated
III. Potential solar power areas

The technical data was supplemented by collecting energy-related data concerning buildings and information about the individual needs and plans of the owners in the existing buildings within the quarter who are participating in the project.

Finally, the data was situated in a holistic context in line with the action recommendations of the updated Hamburg climate plan and cross-sector synergies were worked out according to the integrated approach.

The individual demand analysis in particular demonstrated that creating new housing in the examined quarter can generate a leverage effect for many owners, helping investment activities to become economically justifiable in line with climate protection and energy efficiency.

Energy efficiency upgrade of building envelopes

The existing buildings in the examined quarter are characterised by a uniform industrial construction style of multi-dwelling buildings with up to 10 storeys. The buildings were constructed in the early 1970s and thus before the first Ordinance on Thermal Insulation (Wärmeschutzverordnung), which only entered into force in 1977 following the Energy Savings Act passed by the Bundestag in 1976. Buildings in this construction year category are particularly inefficient in terms of energy unless they have been thoroughly refurbished. Due to lacking or insufficient façade insulation, these buildings have high heating energy requirements, often associated with the risk of mould formation.

This is also clearly demonstrated by the useful heat demand values for the building clusters. According to the data stored in the heat demand cadastre, the average specific useful heat demand of the existing buildings owned by the housing cooperatives is 130 kWh/m^2/a. Useful heat demand is composed of the demand for heat and warm water and constitutes the amount of energy required for the thermal conditioning of a building when considering defined requirements. The useful heat demand is thus the total of heat sinks (transmission heat losses, ventilation heat losses etc.) minus heat sources (usable solar gains, gains from devices, people, etc.).

Accordingly, the useful heat demand is a good reflection of the energy efficiency of the building or cluster, and the examined quarter currently demonstrates significant potential for energy savings and energy optimisation through refurbishment of building envelopes. The few renovated properties, like the existing buildings owned by the Hanseatische Baugenossenschaft Hamburg eG in the northeast part of the quarter, are the exception.

The actual energy consumption data submitted for the existing building owners also confirms the high overall potential and is only slightly below the values for useful heat demand, somewhat lower for renovated buildings (~ 100 kWh/m²/a).

The potential suitability of the "Energiesprong" principle for energy-efficient refurbishment of building envelopes can be reviewed for the project as part of the overarching initiative programme "Serial Refurbishment". Due to the high specific energy consumption and architecturally simple and uniform constructions with simple and homogeneous façades, the examined existing buildings would be well suited for the implementation of serial refurbishment. Additional criteria such as the potential combination of building upgrades with modern power generation systems such as PV or thermal pumps, would have to be reviewed in detail.

Heat optimisation in the existing building
Energy efficiency upgrades of building envelopes achieve particularly high savings of energy and greenhouse gases, making them particularly beneficial from the perspective of climate protection. The technical potential would make it possible to cut the current useful heat demand at least in half by upgrading building envelopes. At the same time, these measures are very elaborate and associated with high costs for the housing cooperatives, who do not benefit from the energy savings enjoyed by the tenants.

Ideally, an energy efficiency upgrade of the building envelope would be implemented along with replacement or optimisation of the heating system to bring the heat output and heating control in line with the reduced demand for thermal energy, thereby achieving further savings. Older heating systems in particular are probably poorly configured and potentially in excess of demand. Overall, this causes high greenhouse gas emissions and affects tenants with high energy costs and an unpleasant room atmosphere (cold and draughty in the winter, hot in summer, mould caused by cold bridges). Optimal configuration of a heating system can lower the energy consumption for room heating by 10 to 15% without requiring the replacement of components.

Energy savings through user behaviour
User behaviour has a significant influence on a building's energy consumption. Up to 15% of energy costs can be spared by modifying behaviours. This requires all parties involved to be informed and motivated. Building users and administrations must also work together towards rational energy use, in order to prevent potential rebound effects caused by comprehensive energy efficiency upgrades. A great deal of information is already available for convenient access online (e.g. www.co2online.de). The Hamburg Consumer Advocacy Centre also offers free advice on-site (www.vzhh.de).

Potential for climate-friendly heat and power supply in existing buildings
The supply of heat to the buildings in question is primarily accomplished using natural gas. In some of the existing buildings, old boilers are used that have low efficiency and generate high emissions. Power generation using cogeneration units is a more climate-friendly alternative to the currently predominant gas heating. Combined production of heat and electricity results in significant primary energy savings when compared with separated production, and reductions of up to 60% in CO_2 emissions depending on the compared variant.

In addition, in part due to the above-average thermal density in the quarter, there is also high potential for implementing economically beneficial common heat supply for multiple buildings by constructing new heat grids or expanding the existing grid on the western border of the quarter (Hanse Werk Natur GmbH). Due to the spatial proximity between the non-refurbished multi-storey housing buildings and the antiquated heating technology still used in some buildings, grid-based energy supply is a promising and climate-friendly holistic approach for an EID. Including the daycare centre and possibly the secondary school north of the quarter as

additional consumers would generate a time-staggered demand for power and heat compared with the existing residential buildings and provide optimal utilisation of system capacities.

At the technical data level "Hypothetical heat grid" in the heat demand cadastre, the heat grid potential for the examined quarter can be displayed to provide initial orientation for economically feasible implementation of a heat grid solution. This hypothetical grid includes all buildings that are currently outside an existing grid. The buildings are connected to a hypothetical heat grid in the street using the shortest paths. The increased density of the structure involves additional obstacles when laying heating lines, which would incur higher costs. For this reason, heat grids are only considered to be economically feasible starting from a linear heat density of > 2 MWh/m/year. The hypothetical local heat grid for the examined area is depicted in Figure 4. The linear heat densities for a hypothetical heat grid with non-refurbished existing buildings fall in the range of 3.4 – 8.3 Mwh/m/year. For refurbished buildings, according to the minimum standards of EnEv 2014, the linear heat densities fall between 2.2 – 5.4 Mwh/m/year and thus always in the feasible range.

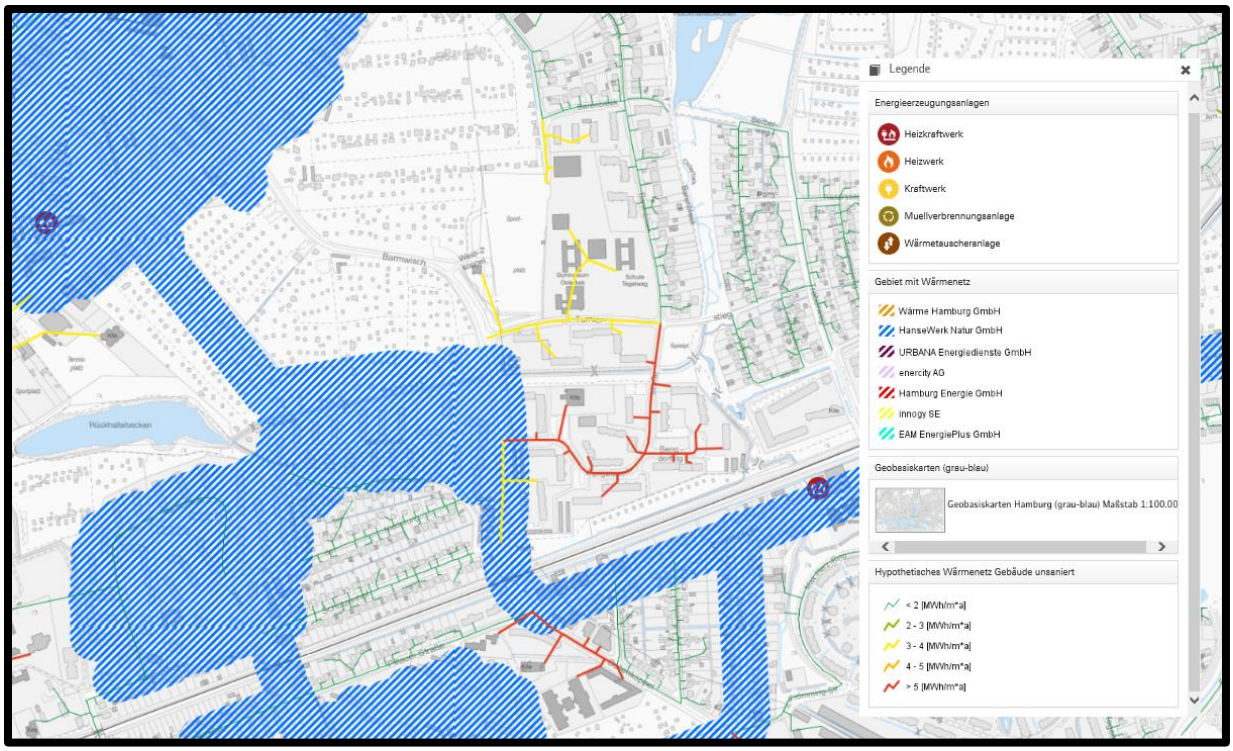

Figure 4 – Excerpt from the Hamburg Heat Demand Cadastre: Existing and hypothetical heat grid in the pilot quarter[4]

During the workshop series carried out with the representatives of the housing cooperatives, the connection options with the existing heat network in the western part of the quarter were roughly assessed by grid operator Hanse Werk Natur GmbH with the aid of the local heat demands and the capacity of the integrated grid. The result was a proposed grid expansion in line with the representation in Figure XYZ; however, this is unable to include all existing buildings in the quarter due to the limited capacity of the heat grid.

The eastern integrated grid is supplied in part with thermal energy from the Stapelfeld incineration plant, 19 thermal power and cogeneration plants as well as by multi-function storage systems and hybrid systems. As part of energy contracting, the proposed heat concept would be subjected to the Heating Supply Ordinance to guarantee cost-neutral implementation. Accordingly, no additional costs would arise for the tenants. For a

[4] Source: ©Wärmekataster-Portal Hamburg

detailed examination of the connection and implementation options as well as additional technical, logistical (cable routing, line installation approval) and economic framework conditions, a more extensive potential study must be commissioned by agreement with the owners of the existing buildings.

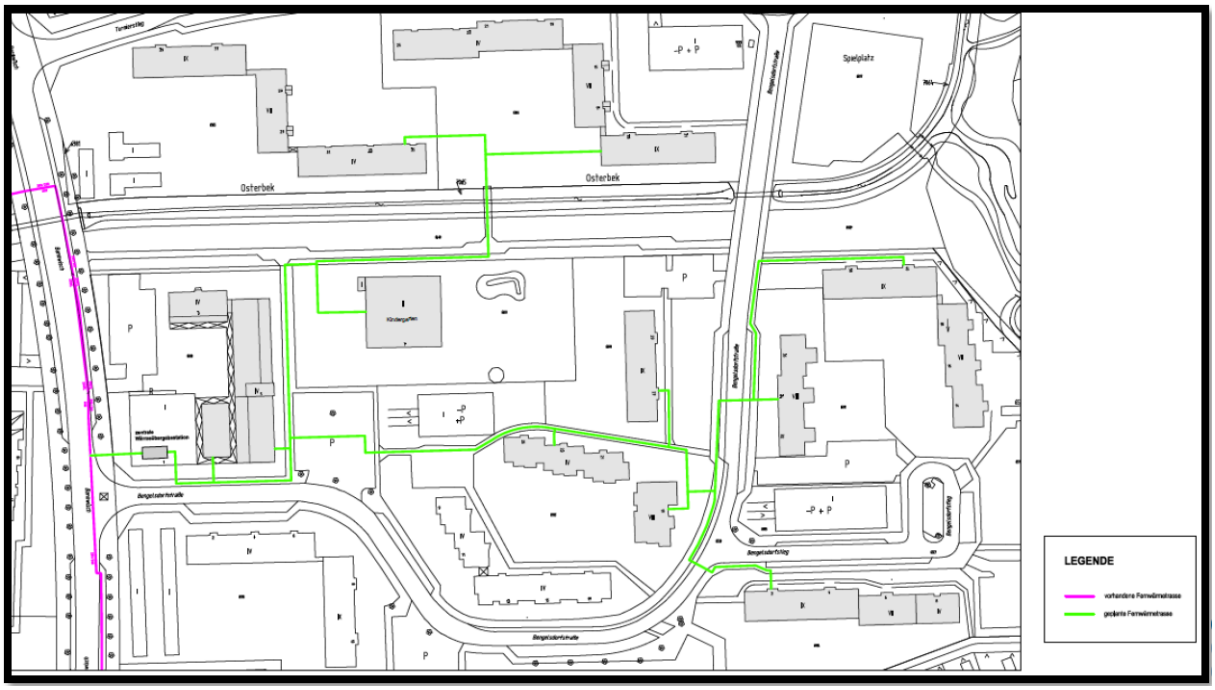

Figure 5 – Hypothetical connection to the eastern integrated grid of HanseWerk Natur GmbH[7]

If a new local heat grid is constructed, it will offer improved flexibility compared with heating systems in individual existing buildings along with the required infrastructure to efficiently integrate renewable energies into the heat supply to a large extent or to enable combined technologies (CHP, solar thermal energy, heat pump, seasonal storage) and sector coupling (e.g. power-to-heat systems). For instance, it is possible to expand a system with heat-only production into a system with combined power and heat production or to integrate the use of thermal solar energy (including the required storage systems) without intervention in the heat customer's building solely by renovating a single heating centre.

Concentrating system technology in a heating centre also offers very good conditions for professional operation, maintenance and upkeep. This is a considerable advantage especially with respect to the growing technical diversity of systems and components when using renewable energies and CHP.

Use of renewable energies

In connection with the potential to expand and use the adjacent heat grid or to construct a new independent heat grid for the quarter, there are additional possibilities to integrate technologies that generate renewable energies for decentralised supply into energy efficiency plans.

Using the heat demand cadastre, enormous potential was identified for all examined existing buildings especially for the use of solar power technologies. Potentials for the use of PV systems for power generation and for the use of solar thermal systems for heat generation can be identified down to the individual housing blocks using the available roof spaces and the average amount of radiation, taking into account the specific degree of shading. Across the existing buildings, at least good conditions and predominantly very good conditions were identified for the use of solar energy.

Models such as neighbourhood-based or tenant-based electricity supply are interesting to consider in this regard, for example to enable the use of self-generated solar power. Part of the motivation for implementing these business models lies in integrating tenants as stakeholders. Using local, decentralised generation, these models can gain widespread acceptance for the transition to sustainable energies and encourage adjustments to energy behaviour.

Since on-site generation with PV systems is not technically capable of ensuring full, economically efficient supply at all times in nearly all cases, even when combined with co-generation units (CHP) and storage systems, users relying on tenant's electricity will also be provided with power from the grid by their suppliers (the provider of the tenant's electricity rate).

Locally generated power can then be sold to the tenants and marketed as an independent brand: *"Barmwisch Power"*. In case of high energy turnover (that is, if multiple households participate), the power can be offered at competitive prices. The consent of the relevant housing cooperatives must be obtained before implementation. In addition, collaboration with the energy cooperative Energienetz Hamburg eG can be pursued in order to lower investment costs.

Finally, projects using solar energy technology can be combined with the implementation of green roofs. This would not only improve the micro-climate but also achieve optimal energy-efficient utilisation of the installed solar cells.

Synergy effects in connection with infill development potential
Creating new housing and expanding the number of existing buildings in the examined area is of particular interest to the housing cooperatives from an economic perspective and could create decisive leverage to ensure that investment activities in climate protection remain economically viable.

An expert review could be commissioned to identify potentials for housing construction in the examined area. New housing construction would be carried out in locations that are well-connected to local public transportation through the U-Bahn metro station Trabrennbahn and various bus stations, with access to existing services such as daycare centres, schools and suppliers for daily needs. Planned new housing construction within the existing building structures examined would contribute to climate protection as a viable alternative to car-friendly new housing construction in suburban locations. The development costs and follow-up costs would be comparably low compared with new construction projects outside the city. Such urban infill development contributes significantly to inner-city development and offers a great deal of potential for climate-resilient urban development with respect to land usage.

This context also generates synergy effects in terms of unified and integrated energy efficiency planning at the neighbourhood level.

Dismantling the garages and parking spaces dispersed across the quarter would create the required open space for constructing new residential buildings with up to approx. 142 housing units. The eliminated parking spaces could be compensated by constructing a central garage for the quarter. In connection with such a new construction project, services and measures to facilitate climate-friendly transport could also be considered. For instance, bicycle parking options and charging infrastructures for various electric vehicles could be included in the garage plans for the quarter. Future-oriented strategies for parcel delivery would also open up significant potential for climate-friendly development of the quarter. In this context, a parcel hub or cargo bicycle station could also be integrated in the central garage for the quarter.

With respect to implementing a communal grid-based heat supply, the option of integrating the required heat centre into the planned neighbourhood garage could be reviewed as a way of logistically pooling operation, maintenance and upkeep at a central location.

Hamburg technical energy plan and Wandsbek climate protection standard for new construction projects

Due to the high demand for new housing, urban infill development constitutes a high-priority field of political action in the Free and Hanseatic City of Hamburg.

To reinforce interaction between the fields of climate protection and housing creation, the so-called technical energy plan was developed at the ministerial level along with the update of the Hamburg climate plan. This consists of a technical energy efficiency review for new construction projects that examines the local potential for renewable energies, unavoidable waste heat, existing heat grids and synergy with existing buildings. In this manner, when considering the various power generation options and the three variants of the building energy standard (legal standard pursuant to EnEv, KfW 55, KfW 40), it should be possible to identify the optimal combination of variants with the lowest CO_2 emissions while maintaining economic viability.

In the future, such technical reviews will be mandatory in all of Hamburg for projects that encompass more than 150 housing units or an equivalent housing need as well as a floor area ratio of more than 0.8. For the examined quarter, the assessment estimated infill development potential of new constructions with at least 142 housing units with a floor area ratio of 0.89. The technical energy plan thus presents a promising tool for unified energy efficiency development in the quarter of Barmwisch that also includes the potential for creating new housing.

By introducing the Wandsbek climate protection standard in the course of implementing the integrated climate protection concept (IKK-W), the Wandsbek District Authority aims to ensure that new buildings in the district are future-oriented and climate-friendly above and beyond the legal minimum requirements. The standard takes up the technical energy plan outlined above, introduced by the Ministry for the Environment and Energy (BUE) and expands on it (CO_2 indicators, monitoring). It continues to refer to the Guidelines for Sustainable Construction by the Federal Ministry of the Interior, Construction and Homeland Security (BMI). Within the three topic areas 1) Energy production, 2) Climate-friendly transport and 3) Sustainable construction materials, a catalogue of criteria will be applied to assess new construction projects during the planning phase. During future consultation and negotiation with investors while developing project-specific development plans and urban planning contracts (Section 11, 12 BauGB) and for exemptions and special cases in the context of building permits (Section 31 BauGB), the standard will be coordinated and implemented with investors and developers at the district level in order to further promote the integrated approach to energy efficiency planning.

Climate adaptation and landscape planning considerations

There are points of interaction between infill development, climate change adaptation and climate protection where synergies can be used as described above, but also where there are differences that need to be resolved.

In particular, intervening and sealing off existing green spaces has negative impacts on the urban micro-climate (temperature and wind flow conditions) and causes increased problems for rainwater seepage.

Targeted adaptation of urban districts to climate change requires a comprehensive examination of the links between urban infill development and climate change that must be integrated into energy efficiency planning at the neighbourhood level.

To prevent and reduce potential impacts of infill development, the following compensatory measures can be implemented:

- Creating green roofs and façades
- Increasing water surfaces

- Maintaining existing vegetation; increasing green areas
- Reducing the degree of sealing
- Bright surface design
- Increasing shaded areas

Ultimately, the crucial factor is housing development oriented on user quality of life that accounts for ecological, economical, social and cultural aspects.

Significant challenges on the path to energy efficiency

A crucial foundation for a successful transition to sustainable heating and Hamburg's transformation into a climate-resilient city adapted to climate change is to upgrade the existing buildings and ensure their heat supply at the neighbourhood level.

In this regard, a viable energy efficiency concept at the neighbourhood level will pursue a unified approach in line with the AREA21 project idea and also integrate the areas of transport, social and economic infrastructure and climate adaptation considerations into planning to deliver needs-based measures that interconnect while mutually supporting and complementing each other.

Needs-based concept design is also a decisive factor for guaranteeing implementation by the stakeholders involved. Especially when developing a unified bundle of measures across all existing buildings, the challenge is to make use of synergies in the various building-specific and upgrade-specific demands among the numerous owners. There is still considerable need for action and investigation in order to coordinate the individual action plans of the housing associations and to expand them appropriately following a unified strategy.

To accomplish the EID concept, it must be ensured that the owners are willing to continue and intensify their cooperative interactions with other housing cooperatives. The Wandsbek District Authority and a future climate protection management for the district, along with a potential district upgrade management division, could provide assistance and support to propel the process of exchange and cooperation after the project phase, especially for the procurement of sufficient funds and additional technical services. In the course of upgrade management, federal funds could be used to readopt, further specify the ideas and measures that have already been collected, and implement them as needed. In this case, the upgrade management division would also function as a caretaker and driving force for implementing the project idea and act as a liaison between economic stakeholders and the public service.

To increase willingness and interest in continuing the joint collaboration of all housing cooperatives in the neighbourhood, it is important to ensure an economically attractive district solution that also benefits the tenants in the existing buildings owned by the cooperatives.

The costs for upgrading (including new power generation systems) can be distributed among the rents. Modernisation allocations according to rental law were recently lowered to 8 percent of the modernisation costs (full costs minus maintenance share). Nevertheless, excessive financial burden to the tenants must be prevented if the resulting basic rent increases cannot be compensated by the savings in utility costs. At the moment, housing cooperatives are focusing their extensive planning on other existing buildings outside the examined quarter. This is due to various reasons. Because of the limited capital resources available, it is thus essential to fall back on appropriate funding instruments and coordinate them practically for legally permissible cross-financing to achieve optimal cost reductions for housing cooperatives and members. For all measures, it must always be ensured that no one is excessively burdened and that targets such as affordable housing are not endangered.

Another effective financial point of leverage could be infill development. To initiate unified energy efficiency development at the neighbourhood level, it is therefore recommended to launch an extensive study to examine how the overarching goals of climate-resilient urban development can be brought in line with district-level acceptance, social, environmental and economic viability during urban infill development according to the potentials outlined above.

Apart from purely financial considerations, energy efficiency and climate protection measures are often not attractive enough on their own, and there is not sufficient acceptance for change among the general population in terms of energy-efficient optimisation of existing buildings. Upgrading and renovation measures in line with energy efficiency are always associated with prolonged disorder and disturbance in everyday life. Accordingly, another challenge for implementing an EID is to address other fundamental needs of tenants such as improving the attractiveness of outdoor spaces or availability of cultural and everyday services, and to adopt corresponding measures in a unified neighbourhood development concept. In this way, tenant acceptance of more extensive neighbourhood development can be increased and the necessary measures can generate greater appreciation on a broader scale.

C. Vision

Attractive climate-friendly and socially responsible housing in Barmwisch

The examined quarter of Barmwisch in Bramfeld is a large, monostructural housing estate. The existing buildings exhibit the characteristic multi-story industrial prefabricated construction of the early 70s and are predominantly in non-refurbished condition with high overall useful heat demand as a result. There are terraced rows of buildings and free-standing linear developments with separate courtyards or semi-public communal spaces. Additional public open spaces that are currently unattractive to use are located along the Wandse and Osterbek rivers.

The focus when establishing an EID in the quarter of Barmwisch – Bramfeld must not rely solely on implementing energy efficiency measures. There is enormous potential for energy efficiency improvements. The key to implementing the numerous potentials described above in a unified strategy is the economic justifiability for tenants and landlords and the commitment among residents for energy efficient neighbourhood development using an integrated approach involving additional actions required for general improvement of the area's attractiveness.

The vision of attractive, climate-friendly and socially responsible housing in Barmwisch involves ongoing cooperative interaction of all housing cooperatives with the district. The considerable energy efficiency potentials have already been discussed jointly, while targets and measures have been specified. When establishing an upgrade and climate protection management unit in the district administration, cooperation between the administration and the housing cooperatives should continue, gradually bringing in additional relevant stakeholders and ultimately implementing a jointly resolved concept in the form of a committee that meets regularly.

A central component of the jointly resolved concept will be connecting the infill development demand with a unified climate-resilient heat supply solution for the neighbourhood. To ensure effective implementation, upgrade measures to the existing building envelopes will be considered and integrated simultaneously along with renovation based on construction year, green space expansion measures and measures to change user behaviour. The integration of renewable technologies for power and heat generation will be reviewed extensively but only stipulated to the extent permitted by the economic situation of the housing cooperatives as required for rent-neutral implementation.

To increase widespread acceptance, the energy efficiency measures will be accompanied by general improvements to the quality of the locations and spaces. The energy efficiency concept will also be accompanied by a district transport concept. A central component of the transport concept will be the district garage planned in the course of infill development. This new construction process will result in additional energy efficiency potentials that are not related to residential buildings, enriching the location and making it more attractive for residents.

D. Goals for achieving this vision

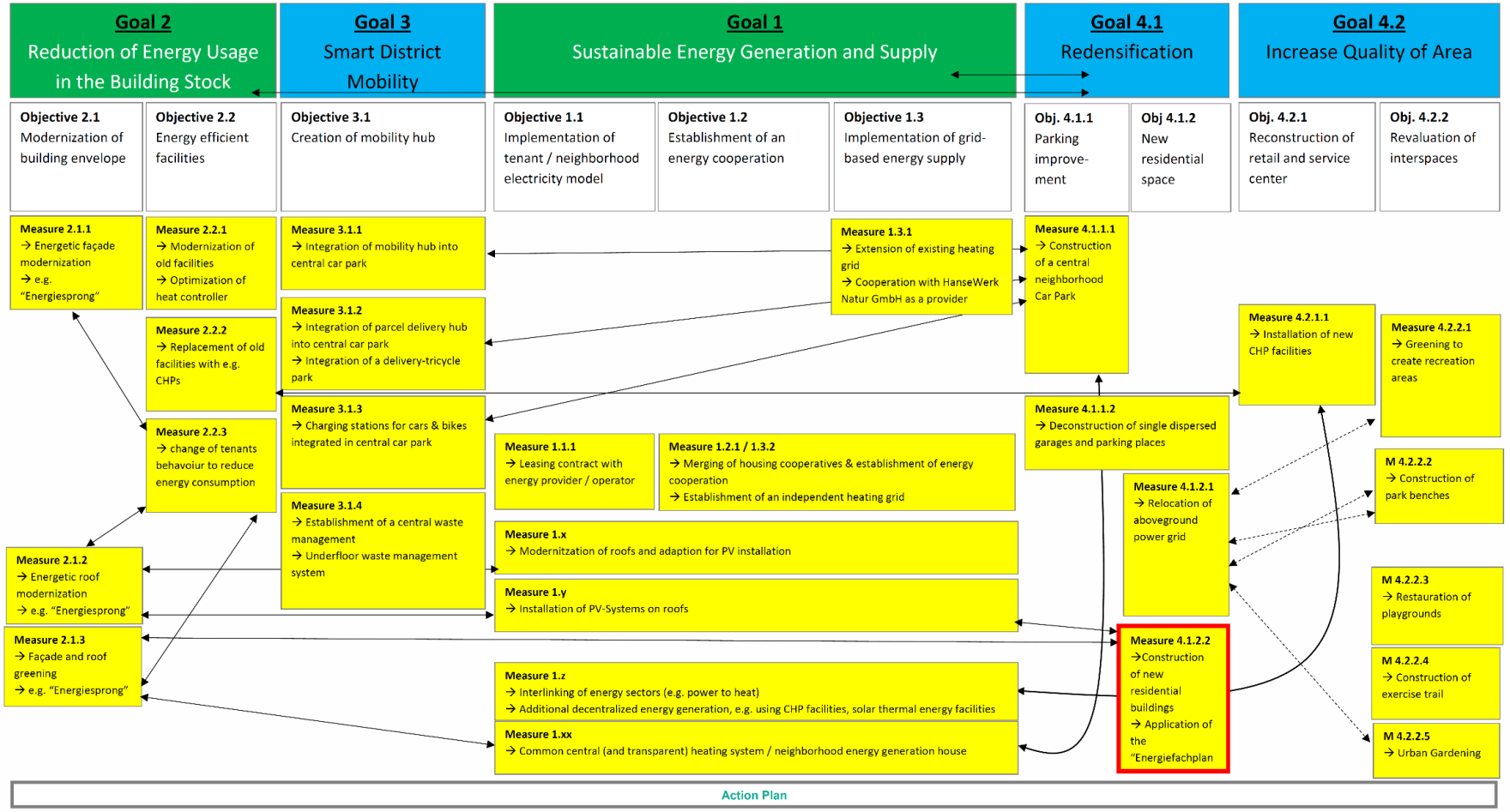

Figure 6 – EID goals and measures for the pilot quarter of Barmwisch – Bramfeld

E. SWOT Analysis

	FACILITATE the achievement of EID goals	HINDER the achievement of EID goals

INTERNAL ORIGIN (attributes of the area) *You have some control over & can change strengths and weaknesses.*	**Strength**
	▪ *Manageable area size and homogeneous ownership structure*
	▪ *High technical potential, e.g.*
	  ○ *PV capacities,*
	  ○ *Potential for an economical / ecological sensible network based heat supply due to the above-average heat density and the spatial proximity of non-renovated stocks (e.g. connection to the Verbundnetz Ost of HanseWerk Natur GmbH)*
	  ○ *High renovation potential of the building envelope and technology*
	▪ *Experiences in energy planning among some housing cooperatives*
	▪ *Extensive renovation of the neighborhood stocks of the Hanseatische Baugenossenschaft Hamburg eG*
	▪ *Housing cooperatives as strong partners in the sense of general care*
	▪ *Good public transport connection via U1 Trabrennbahn and bus stations*
	▪ *Narrow green and park areas along the Osterbek*
	▪ *Children's playgrounds in the neighborhood*
		Weaknesses
		▪ *Image and attractiveness weakness*
		▪ *Partly inadequate maintenance of the public space and the green areas*
		▪ *Bicycle parking facilities only partially available in the area of multi-storey apartment buildings*
		▪ *Dispersed garage courtyards and parking areas reduce the quality of the room*
		▪ *Above-ground power line prevents intentions for redensification or alternative use of space*
		▪ *Supply center (small EKZ) in need of restoration*
		▪ *The state and needs of renovation differ*
		▪ *Limited financial and human resources*
		▪ *Different prioritization of building stocks within Hamburg*
		▪ *Realization of a rent-neutral renovation*
		▪ *Continuation of the tasks open after the end of the funding period*

EXTERNAL ORIGIN (attributes of the environment) *You can take advantage of opportunities & protect against threats, but you cannot change them.*	**Opportunities** ▪ *redensification potential in connection with the construction of a neighborhood garage as an economic lever* ▪ *Increase of value of the building stock and the public spaces* ▪ *Political will (Hamburg climate plan, Integrated climate concept Wandsbek - IKK-W)* ▪ *Application of the energy plan (possible technical and financial support by the city)* ▪ *Synergies in connection with the establishment of climate protection management in the district office* ▪ *Financial and personnel support through funding programs such as KfW 432* ▪ *Integrated approach: consideration of non-technical aspects (socio-cultural offer, public space, etc.)* ▪ *General willingness to test new cooperation formats*	**Threats** ▪ *Possible rent increases* ▪ *Limited financial and human resources* ▪ *Pilot area not attractive enough for housing cooperatives, prioritization* ▪ *High bureaucratic effort in the application / implementation of funding programs* ▪ *Tight time frame when applying funding programs*

Figure 7 – SWOT Analysis

F. Definition of EID-specific goals

The needs-based objectives were formulated in collaboration with the key stakeholders. The core of deliberations and the visualisation under D was the target of "sustainable generation and supply of power". This core target is divided into three different objectives that will be technically reviewed on an individual basis to determine their feasibility and which are not mutually exclusive for implementation. To achieve communal, unified heat supply, the feasibility of grid-based heat supply should be investigated. The possibility of connecting to the existing heat grid of HanseWerk Natur GmbH or constructing an independent grid should be reviewed. If an independent heat grid is to be implemented, the options and advantages of establishing an independent energy association should also be assessed. The business concept of tenant's electricity and/or district electricity must be harmonised with heat supply options. Options for meaningful cross-sector links must be considered. The idea is to develop an energy concept that encourages optimal energy independence while ensuring maximum cost savings for owners and tenants along with optimal utilisation of renewable technologies.

In the course of reviewing the potential for economically and ecologically viable infill development, the ideal combination of variants should be identified with respect to CO_2 reduction potential and economic justifiability for heat supply and insulation standards according to the "Technical Energy Plan". The preferred variant for economic, optimally reduced CO_2 heat supply for the new construction project as determined in the technical energy plan should be bindingly laid down for all parties involved through energy stipulations in the development plan or regulations in urban building contracts.

These energy efficiency goals are accompanied by considerations to improve district transport and open spaces or landscape areas that should increase the attractiveness of the neighbourhood. At the same time, these considerations should involve energy-efficient and climate-resilient factors and expand energy efficiency concepts beyond the individual building approach.