Harmonious coexistence between industry and housing in **Haven-Stad**

Haven - Stad

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Abstract

This research analyses the integration of housing and industry in Haven-Stad, Amsterdam, with the aim of creating a harmonious coexistence.The central problem is the acute housing shortage in Amsterdam, while vacant industrial sites in Haven-Stad remain unused.The study presents concrete urban planning, architectural and technical solutions, such as green corridors, flexible housing typologies with double facades, and waste heat utilisation.The implementation is divided into five phases: inventory, area preparation, housing construction and cooperation/integration. The conclusion drawn is that harmonious integration is indeed feasible, provided that a number of factors are taken into consideration. These include minimising nuisances, exploiting synergies and ensuring that the needs of residents are central to the process. The approach developed in this study can serve as a model for other urban-industrial areas.

Keywords

Haven-Stad, housing shortage, industry and housing, mutualism, sustainability

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1. Introduction

1.1 Context

Amsterdam faces a housing shortage of more than 400,000 homes, while large parts of the city, including the western port zone, remain unused. Within this zone lies Haven-Stad, an area the municipality has designated as a key area for urban development. The aim is to realise 40,000 to 70,000 new homes and 58,000 jobs by 2040 in a healthy and easily accessible live/work environment (Municipality of Amsterdam, 2017). The premise here is that living and working go hand in hand.

Figure 1: Vision map oo Haven-Stad plan

A major obstacle in this transformation is the ‘pass-the-parcel’ policy, established in 2008 in However, the municipality's ambition to integrate living and working in Haven-Stad encounters considerable challenges. Initially, it was presented to the industry in this area that a mixed live/work function would be created, in which activity and living would coexist. This got the industry excited about the plans. However, the environmental impact assessment (EIA) shows that residential development in this area is only possible if industry is relocated and sites are donated (Antea Group, 2017). This contradicts the earlier promise and has led to friction between the industry and the municipality.

To address this friction, the ‘pas-op-de-plaats’ policy, laid down in the *Convenant Houthavens/NDSM-werf* (Provincie Noord-Holland, Gemeente Amsterdam, & Cargill B.V., ICL Fertilizers Europe C.V., Eggerding B.V., 2008), has been in place since 2008. This covenant stipulates that the industry has the right to continue operating in this area until 2040. This is problematic as these very areas have been designated by the municipality as the core locations for the realisation of a large part of the planned housing and workplaces in Haven-Stad. The policy, intended to reduce housing pressure and prevent disruption of industrial activities, has paradoxically led to stagnation in urban development at a time when housing pressure in Amsterdam is historically high.

figure 1: Pas-Op-De-Plaats area

This combination of problems - the need for large-scale housing development, the leasehold position of industry, the need to relocate activity, and stalled cooperation - lies at the heart of this research.

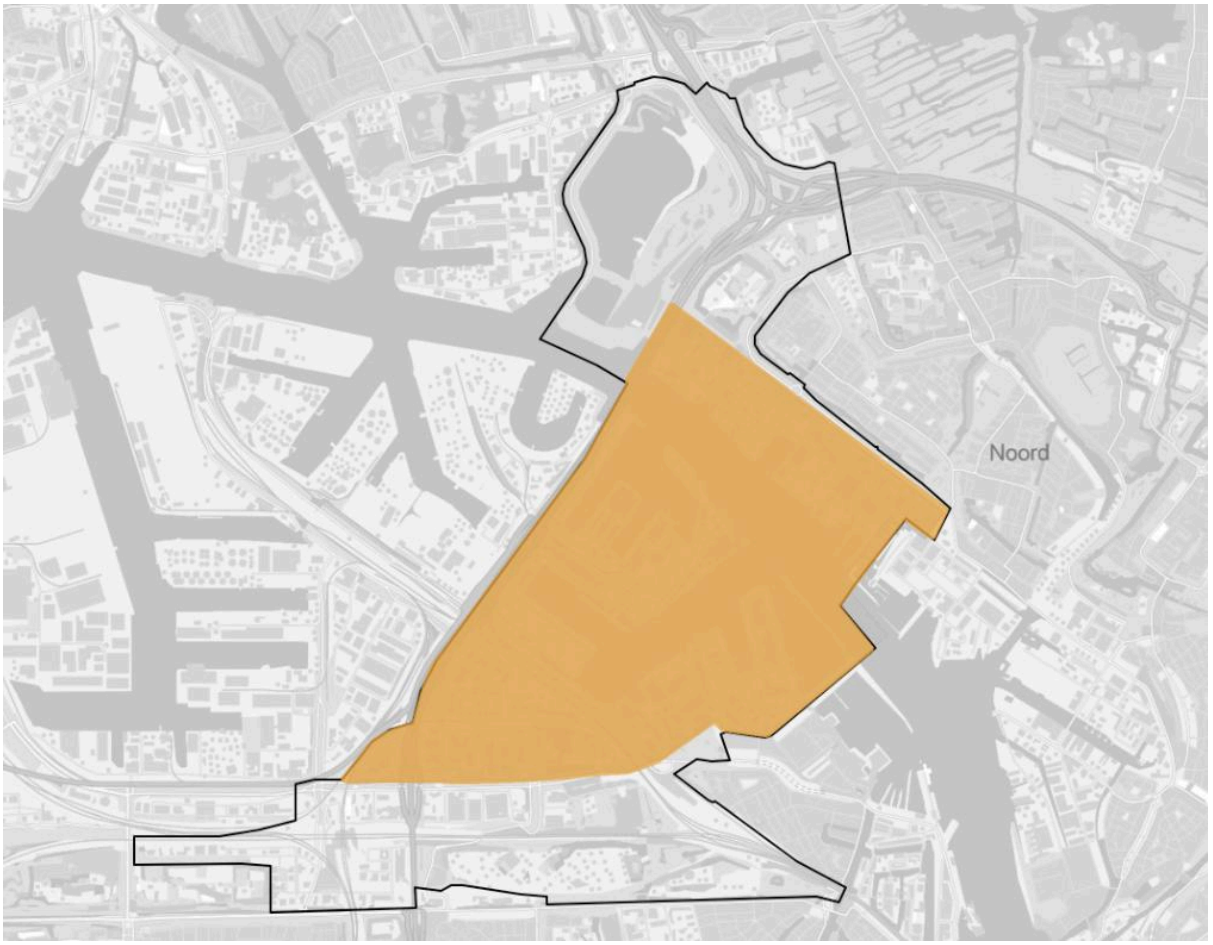

Figure 2: Pas-Op-De-Plaats area

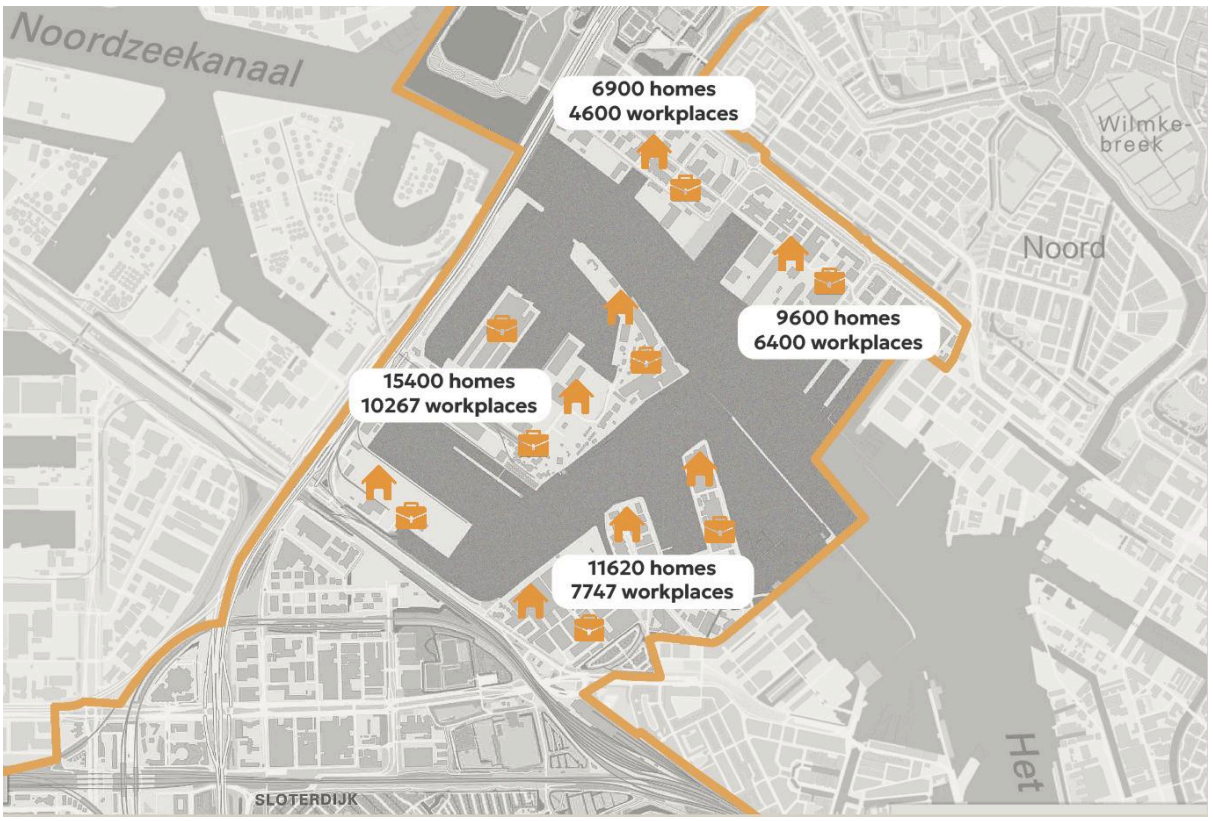

Figure 3: Number of housing and office spaces in the pas-op-de-plaats gebied

This research focuses on exploiting the opportunities arising from these complexities in Haven-Stad: how can living and working be sustainably integrated without relocating industrial functions? The aim is to discover how a harmonious coexistence between living and industry can be realised. To this end, technical, urban planning and architectural measures are examined to develop an integrated approach.

The research aims to provide a framework that balances both the needs of future residents and the interests of industry and housing. In doing so, it aims to break the stagnation in housing construction and contribute to future-proof urban development in Haven-Stad, and possibly in similar urban-industrial areas.

1.3 Main Question

How can housing and industry be harmoniously integrated in a heavy industrial area like Haven-Stad?

1.4 Sub Questions

1. What is the current state of industrial activities in Haven-Stad?
- Which industries operate there and why are they located here?
- What disruptions or environmental impacts do these industries cause?
- How does the industrial zone connect to Amsterdam's urban structure?

2. Who are the potential residents of this area and what are their needs and expectations?
- What are the attitudes of potential residents towards living in an industrial area?
- What are their preferences, lifestyles and expectations of a residential area?

3. What are the potential interactions and relationships between industry and residents in an industrial urban port such as Haven-Stad?
- Where do industrial and residential interests overlap, and what opportunities does this present?

- What conflicts and synergies emerge, and how can these be addressed?
- What elements are missing to make the area suitable for housing?

4. What urban planning, architectural and technical solutions can improve these interactions?
- Which urban planning measures can support coexistence?
- What architectural solutions can reduce conflicts and promote harmony?
- What technical solutions can address health, safety and sustainability challenges?

5. What strategies can be developed to promote mutualistic relationships between industry and housing?
- How can design strategies contribute to harmonious co-existence?
- In what ways can stakeholders implement these strategies?

6. How can these strategies, solutions and measures be combined in an overall approach to integrate housing in urban industrial areas?

1.5 Relevantie

This research is socially relevant because of the urgent housing shortage in Amsterdam and space constraints within the city. Integrating industry and housing can make efficient use of scarce space without disrupting industrial functions. Moreover, this research is relevant on a national level, as similar challenges exist in other urban areas in the Netherlands where housing and industry need to be developed side by side. Scientifically and technologically, this research offers new insights into sustainable urban design and technical solutions, such as noise reduction, air quality improvement and energy efficiency (Capital Value & ABF Research, 2023). These strategies can be applied not only locally and nationally, but also globally in urban industrial areas with similar challenges.

1.6 Method

This research follows a structured approach to answer the main and sub-questions. The methodology consists of the following steps:

1. Literature and policy research:
- An analysis of existing literature and municipal plans, such as ‘pass-the-parcel’ policies, to understand the context and challenges of Haven-Stad.

2. Site and context analysis:
- Visits to Haven-Stad to examine its industrial activities, environmental impacts, and spatial relationships with Amsterdam.

3. Stakeholder interviews:
- An analysis of existing interviews and data obtained from industrial parties, policymakers and residents to identify needs and expectations.

4. Analysis of interactions and relationships:
- Use of ecological concepts such as mutualism and parasitism to identify conflicts and synergies between industry and residents.

5. Development of solutions and strategies:
- Design of urban, architectural and technical solutions that contribute to harmonious coexistence.

6. Synthesis and validation:
- Combining the results into an overall approach and validation of strategies through stakeholder feedback.

This approach allows a thorough examination of both the current situation and possible solutions and practical recommendations.

1.7 Structure of the document

This research is composed of seven chapters that together provide a structured answer to the main question: How can housing and industry be harmoniously integrated in a heavy industrial area like Haven-Stad?

- Chapter 1: **Introduction** - Introduces the context, relevance, and objectives of the study, as well as the main and sub-questions and methodology.

- Chapter 2: **Analysis phase** - Explores the current situation in Haven-Stad. This includes an analysis of existing industrial activities and the needs and expectations of potential residents (subquestions 1 and 2).

- Chapter 3: **Relation phase** - Examines the interactions between industry and residents. It identifies both conflicts and synergies and discusses challenges to co-existence (sub-question 3).

- Chapter 4: **Solution phase** - Presents urban design, architectural, and technical solutions to improve industry-residents interactions (sub-question 4).

- Chapter 5: **Strategy phase** - Discusses strategies to promote mutual relationships and support the implementation of the proposed solutions (sub-question 5).

- Chapter 6: **Synthesis phase** - Combines the solutions and strategies into an integrated approach, reflects on feasibility and offers recommendations for further development (sub-question 6).

- Chapter 7: **Conclusion and recommendations** - Answers the main question by summarising the main findings of the study. It offers concrete recommendations for policymakers, designers and stakeholders and reflects on the wider applicability of the results in similar urban industrial areas.

2. Current Situation

Before thinking about solutions or opportunities for Haven-Stad, it is essential to consider what is already there. What are the characteristics of the current industrial area? What role do the existing companies play, and how do they influence their surroundings? And who are the people who might want to live here?

A good understanding of the existing situation is essential for developing solutions. The analysis phase answers questions and forms the basis for the rest of the research. It helps strike a balance between what is already there and what can be realised.

2.1 Industrial activities in Haven-Stad

2.1.1 Introduction

Haven-Stad is an important industrial hub within Amsterdam, where several industries play a key role in the local economy (Gemeente Amsterdam, 2020). To understand the potential for transformation of this area, it is important to identify the current situation of the industries. What types of businesses are located here, why have they concentrated here, and how do they affect their surroundings? This chapter focuses on answering these questions while also exploring the connections between the industries and the urban infrastructure.

2.1.2 Analysis

The analysis examines three key aspects of industrial activities in Haven-Stad:

1. Which industries operate in Haven-Stad and why are they located here?

To answer this question, I went to Haven-Stad several times and made a photo report of it (See Appendix).

My visits to Haven-Stad revealed that the area is home to a diversity of industries, with the number of chemical companies limited to four. These chemical companies are concentrated in a specific part of the area, which increases their logistical efficiency (see photo 1: Industrial Building). The character of this part is very different from the rest of Haven-Stad. Large plumes of smoke dominated the air, and the pungent smell of chemical processes was everywhere. As I cycled through here, it seemed I myself became part of the industry- surrounded by complex networks of pipes, the constant thump of machinery, and the constant hum of activities. There was little room for rest, but all the more to see and experience. This area was characterised by a significant degree of industrial activity that did not go unnoticed.

Photo 1: Industrial building with chemical plants in Port City.

Whereas the peak of industry can be found centred in one place, the rest of the area consists of storage and transhipment sites (see photo 2: storage and transhipment site). Big boxes, hundreds of metres long, with an imposing scale that feels almost abstract. From the outside, not much seems to be happening; it looks static and closed. Once inside, however, a different world reveals itself. Huge mountains of bulk goods lie there silently, untouched, waiting for their next destination. The huge halls offer a curious calm amid the bustle of Haven-Stad.

In this part of the area, it was remarkably quiet. No sounds of machinery, no activities visible. It gave an almost surreal feeling, as if the silence was the harbinger of something big or ominous about to happen. The absence of life made the experience both intriguing and uncomfortable, a stark contrast to the hectic nature of the industrial core.

Photo 2: Storage and transhipment spot in Haven-Stad.

And then it happened. Out of nowhere, a crane, at least 30 metres high, suddenly started making noise and moving. The massive hulk, equipped with a huge cargo scoop, plunged into a just-arrived ship to strip it of its bulk (see Photo 3). With precise, repetitive movements, the crane repeatedly scooped a huge amount of material from the ship's hold. Yet, despite the impressive size of the digging bucket, the ship hardly seemed to get emptier. The scale of the operation was vast, and it soon became clear that unloading the ship would take hours, if not days, to complete.

This activity highlights not only the activity in Haven-Stad, but also the crucial geographical location of this area. The direct interaction between water and road transport emphasises the operational character of Haven-Stad as a major logistics hub. This is exactly why companies settle here-the combination of its proximity to the water and its excellent connections to other parts of the Netherlands and beyond make this area an indispensable logistics centre.

Photo 3: Crane unloading bulk cargo from a ship.

Haven-Stad's strategic location is not only limited to its proximity to the water. Spacious roads and well-integrated rail infrastructure also contribute to the area's excellent accessibility. This combination makes Haven-Stad an attractive location for companies that depend on efficient transport and logistics processes. The proximity to both the water and the city of Amsterdam offers a unique combination of location factors that are important for industry in this area (see Photo 4).

Photo 4: Example of port operations with spacious infrastructure.

During field visits, it was noticeable that the roads and railway were relatively quiet and calm. This can possibly be explained by the focus on bulk goods, where continuous movement is less necessary. However, this calmness highlights the flexibility of the area, which is able to handle peak moments in logistics activities without overloading the infrastructure.

This analysis shows that Haven-Stad is an important logistics and industrial hub, with a concentrated presence of chemical companies and a dominant role for storage and transhipment sites. Its strategic location, with direct access to water, well-developed infrastructure and proximity to Amsterdam, are the main reason for the location of these companies. These factors contribute to Haven-Stad's efficiency and attractiveness as a crucial link in transport and logistics processes.

2. **What disruptions or environmental impacts do these industries cause?**

Industrial activities in Haven-Stad make an important contribution to the dynamics of the area, but are accompanied by various disruptions and environmental effects. During my visits to the area, these effects were evident, particularly in the form of odour and noise pollution in zones where chemical companies are concentrated. These challenges not only affect liveability, but also significantly hamper the planned transformation of Haven-Stad into a mixed residential-working area.

When developing the transformation plan for Haven-Stad, the City of Amsterdam (thoroughly) analysed these disruptions. In a so-called Environmental Impact Report (EIR), the risks of the industrial area were extensively investigated and recorded. An overview of these findings is available on the habitat map (https://maps.amsterdam.nl/havenstad_leefomgeving/) of Haven-Stad, available on the website of the municipality of Amsterdam (Gemeente Amsterdam, n.d.).

The Environmental Impact Report (EIR) defines environmental zoning as follows:

'Environmental zoning means that sufficient space should exist between environmentally harmful activities and sensitive functions, whereby the distance between the two is called environmental zoning. The aim here is that developments can be weighed up to see whether they can be realised with a sufficient quality of life.' (Antea Group, 2017, p. 75).

A total of six different environmental categories have been identified. (Antea Group, 2017, p. 75) For this study, however, the focus is on the subarea within the so-called "pas-op-de-plaats" areas. Within this subarea, three zones are distinguished, each with specific characteristics and associated environmental impacts (see Figure 3: Different zones in the "pas-op-de-plaats" areas).

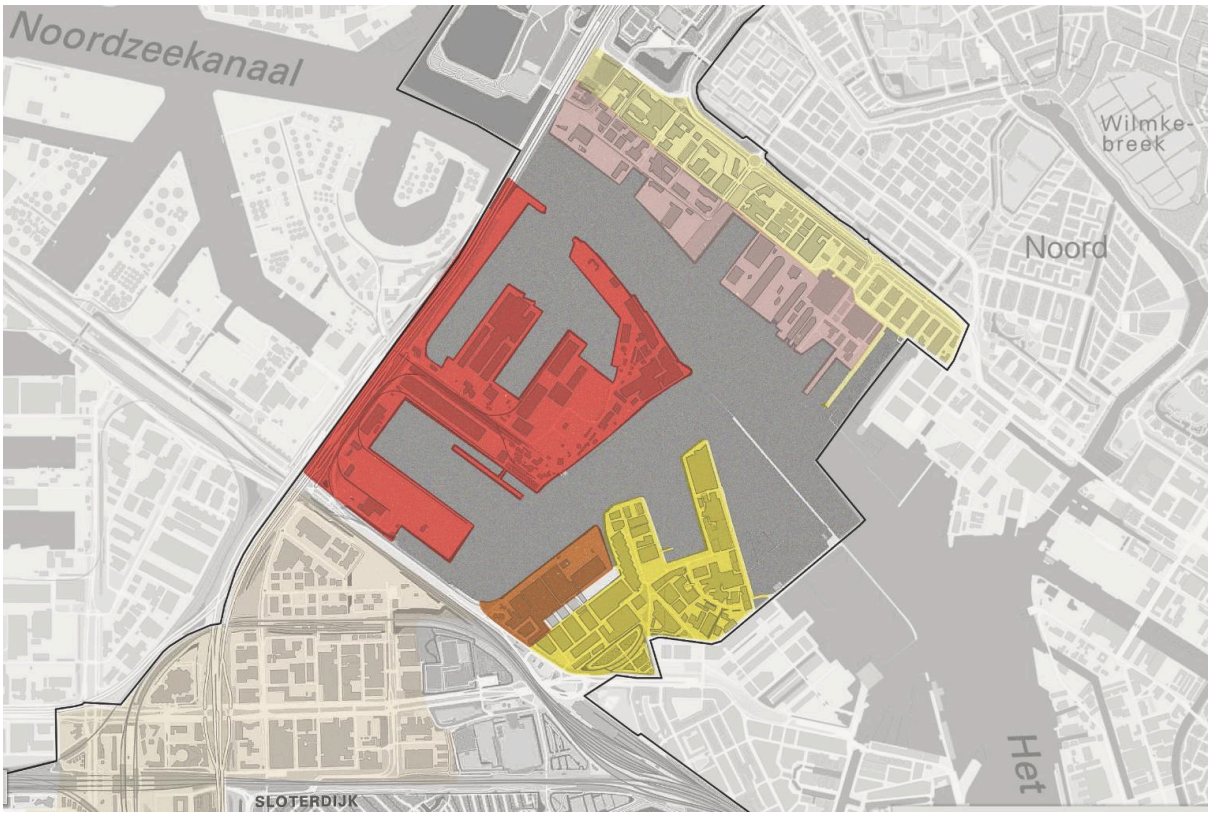

Figure 4: Different zones in the pas-op-de-plaats areas

The three zones shown in Figure 4 are defined as follows:
- 🟡 Zone 1: This zone is indicated by the colour yellow. This is the Minerva port
- 🟠 Zone 2: This zone is indicated by the colour orange. This is Mercuriushaven.
- 🔴 Zone 3: This zone is indicated by the colour red. These are Coenhaven and Vlothaven.

The zoning is based on the degree of nuisance the area experiences from industrial activities. In the yellow zone, nuisance is lowest, while it is highest in the red zone. To define the different environmental zones, various health aspects were considered. The main aspects relevant to this study are explained below.

Odour

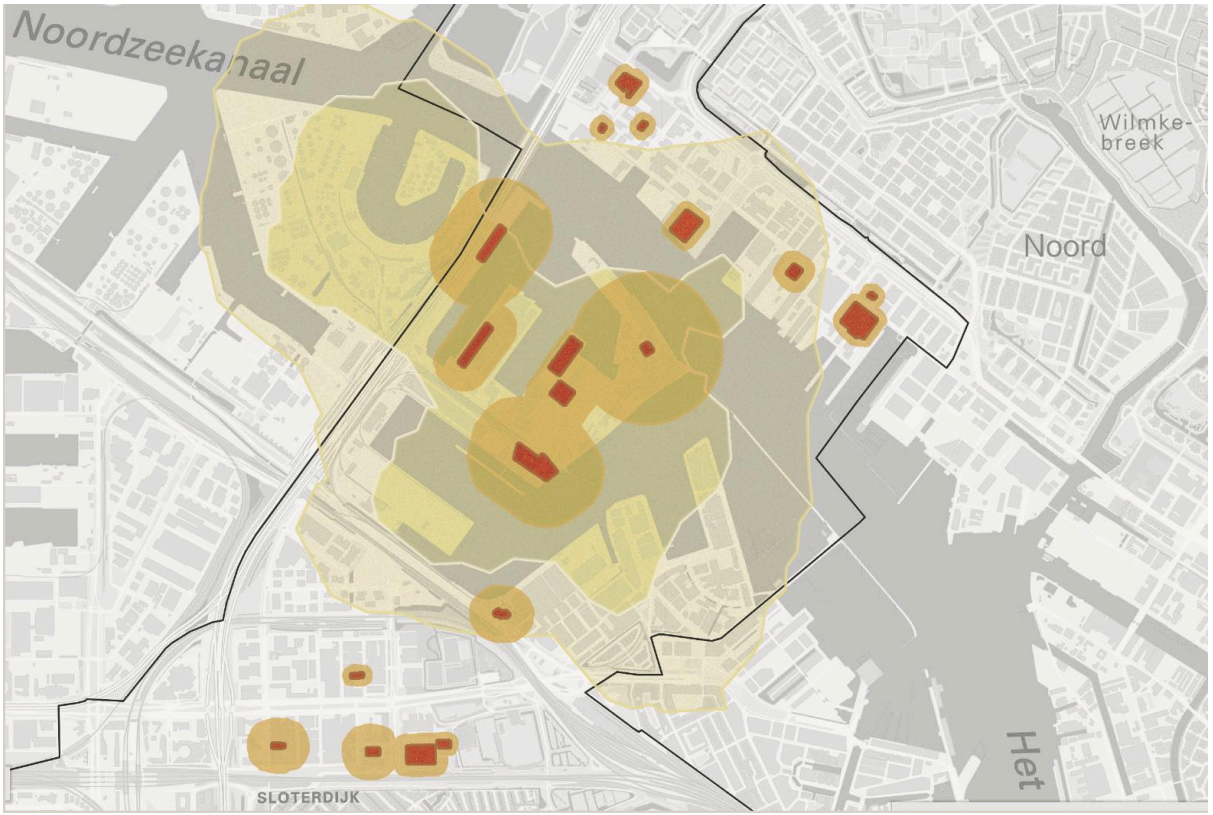

Figure 5: Indicative odour circles for individual farms

Figure 5 shows the indicative odour impact of individual companies in Haven-Stad. The contours show the areas within which odour impact may occur, based on target distances from the VNG brochure. These zones vary by company and reflect the intensity and scope of odour nuisance. (Antea Group, 2017, p. 77-79)

The map shows that odour contours are largely confined to the immediate vicinity of businesses and rarely overlap other sub-areas. This means that odour nuisance generally remains localised and has no wider impact on adjacent areas. However, in specific zones, such as Minervahaven-North, the odour contours are significant and would require additional measures to enable residential development.

Conclusion

In the western part (zone 3) of Haven-Stad, odour contours are significantly larger, indicating companies with intensive odour production, presumably chemical plants or similar industrial activities in Haven-Stad. In the central and southern parts of Haven-Stad, the contours are smaller and more manageable, making these areas more suitable for transformation to residential and work functions.

Noise

Figure 6: Indicative noise circles for individual companies

Westpoort, one of the largest industrial estates in the Netherlands, has a significant noise zone, as does the Cornelis Douwes industrial estate. Figure 6 shows the noise levels for the reference situation and the relevant phases. The map shows that the 55 dB(A) contour, the maximum permitted value when exempted, extends over almost the entire planning area of Haven-Stad.

This means that measures are required everywhere in Haven-Stad when developing new houses. The area-specific gaming framework, as drafted in the environmental impact report (EIA), provides the basis for this (Antea Group, 2017, p. 68-72). The map clearly shows that noise pollution is not limited to specific locations, but is an area-wide challenge.

Analysis of noise zones

- Coenhaven and Vlothaven (zone 3): This industrial estate generates the largest noise impact, with zones extending beyond its immediate surroundings. This is due to intensive logistics and industrial activities.
- Mercuriushaven (zone 2): This area has a smaller but still significant noise zone, mainly affecting adjacent residential and commercial areas.

Conclusion
Given the noise levels in the plan area, noise protection measures, such as façade insulation and adapted building techniques, are necessary to achieve a liveable living environment.

Dust

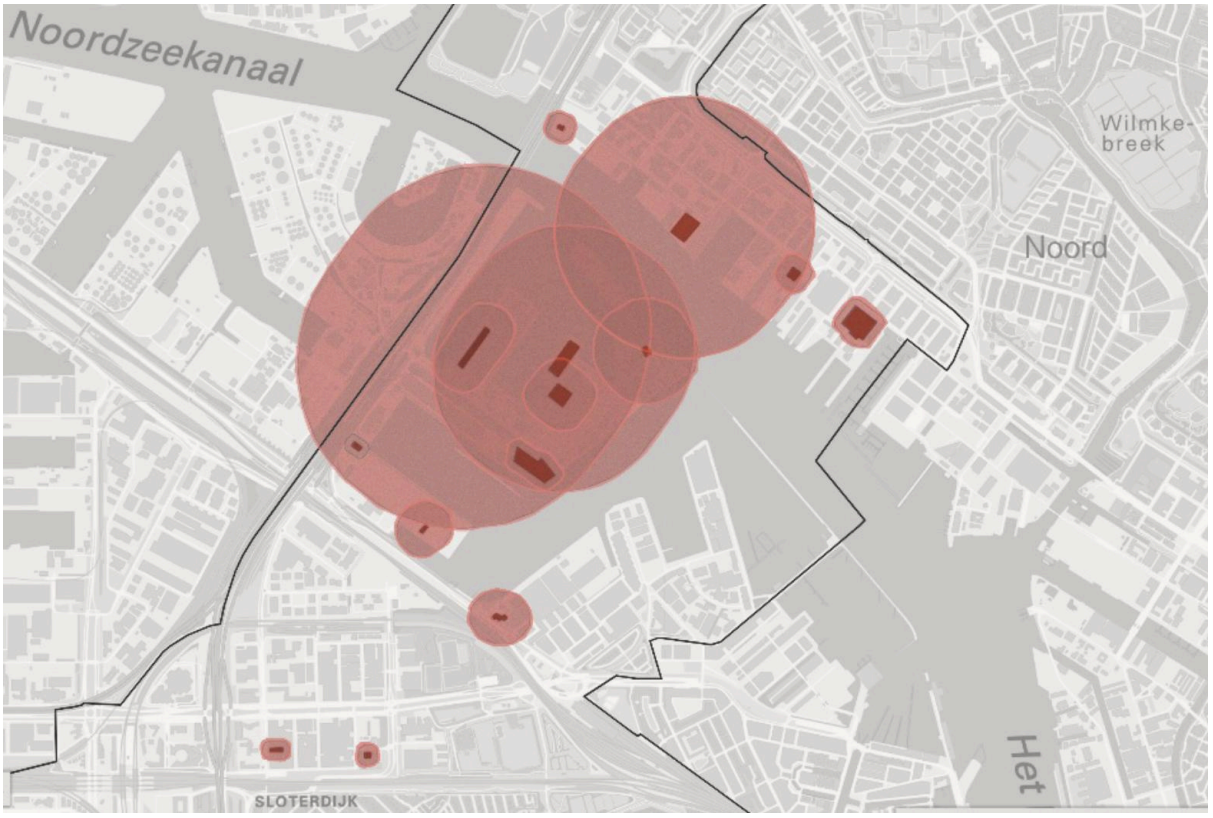

Figure 7: Indicative dust circles for individual farms

Figure 7 shows the dust contours of companies in Haven-Stad. The map shows that dust nuisance stays mainly within the boundaries of its own sub-areas and has little impact on surrounding areas. Strikingly, most nuisance is concentrated in zone 3, where environmental pressures are highest (Antea Group, 2017, p. 79-81).

Analysis of dust nuisance

- Limited impact: Dust nuisance remains largely localised, meaning surrounding areas remain relatively unaffected.
- Opportunities for transformation: Future developments within these subareas will require specific measures to minimise dust nuisance. These include creating buffer zones or applying technical solutions to reduce dust emissions at source.
- Practical reduction: In practice, actual dust contours are smaller than theoretically predicted, indicating effective internal measures by companies. This provides opportunities for further transformation and nuisance reduction.

Conclusion

The dust contours in Haven-Stad show that impacts remain mainly local and are largely concentrated in zone 3. This creates opportunities for residential development, provided dust nuisance is effectively controlled.

The analysis shows that the disturbances and environmental impacts caused by industries in Haven-Stad vary significantly between the three zones:

- 🟡 Zone 1: This is the least impacted zone within Haven-Stad. Disturbances caused by industries here are limited and mainly include occasional noise and minimal dust nuisance. This zone thus offers the most opportunities for transformation to live/work areas, with relatively few additional measures.
- 🟠 Zone 2: In this zone, nuisances are noticeably greater, mainly due to noise pollution from industrial activities and transport movements. Although these disturbances are greater than in Zone 1, they remain manageable with targeted measures, such as noise insulation and strategically placed buffer zones. Zone 2 offers good opportunities for transformation, provided the right measures are applied.
- 🔴Zone 3: This is the most stressed zone in Haven-Stad, where the heaviest industry is concentrated. This zone is characterised by a combination of odour, noise and dust nuisance. The high environmental pressure makes this area the least suitable for residential development without drastic measures. Transformation into a liveable residential and working area will require significant adjustments here, such as additional regulations and technical solutions.

In general terms, it can be concluded that the impact of industrial disturbances strongly depends on the location within Haven-Stad. While Zone 1 and 2 are relatively suitable for transformation, Zone 3 poses the greatest challenge. Implementing zone-specific measures is crucial to reduce environmental impacts and create a pleasant living environment.

3. **How do these industries connect with urban infrastructure?**

Industries in Haven-Stad clearly interact with urban infrastructure. The strategic location of the area, between the A10 and the centre of Amsterdam, offers both opportunities and challenges in terms of mobility and accessibility. The existing infrastructure has a number of strengths, but at the same time it reveals limitations that could potentially create bottlenecks in the future. Below is an overview of the main connections and challenges, based on the traffic image and mobility network as described in the environmental impact report (Antea Group, 2017, p. 61-67).

Connections to urban infrastructure

Road traffic:

- The road network around Haven-Stad is heavily used, with regular traffic jams during morning and evening rush hours. This is especially true for the southern part of the area, where through traffic between the A10 and the centre of Amsterdam plays a major role.
- Despite the current volume of traffic, there is still some residual capacity available at several intersections and roads. However, the Transformatorweg, a crucial east-west connection, crosses areas that will be transformed in the future, which may pose potential complications for the development of Haven-Stad.

Public transport:

- Sloterdijk Station serves as a major public transport hub with excellent interregional train connections. At the local level, however, public transport accessibility falls short. Metro station Isolatorweg, as the terminus, does not offer a direct connection to the city centre, and the area does not have a finely-meshed bus or tram network.
- The northern part of Haven-Stad is even more limited in public transport options, with little to no (H)PT connections.

Bicycle network:

- The cycling network in Haven-Stad is relatively underdeveloped. There is no network of cycling routes that provide fast and safe connections to the city centre and other parts of the city. This limits the attractiveness of cycling as a mode of transport.

Regional impact:

- The northern part of Haven-Stad experiences a lot of influence from the A8, a major trunk road that is often congested during rush hour. This affects traffic from the Zaanstreek and Hoorn to the northern IJ bank.

Transformation challenges

The transformation of Haven-Stad into a mixed residential-working area requires far-reaching choices and investments in urban infrastructure.

- **Public transport:** The construction of new public transport connections, such as a metro connection between Haven-Stad and the city centre, is essential to improve accessibility.
- **Bicycle network:** Expanding and improving the bicycle network can contribute to sustainable mobility in the area.
- **Car traffic:** Limiting the growth of car traffic by unbundling through routes, such as Transformatorweg, is crucial to make future living and working areas attractive.
- **Regional cooperation:** Resolving traffic pressure on the A8 and developing better connections with surrounding regions will benefit regional mobility.

Conclusion

Industries in Haven-Stad are strongly connected to urban infrastructure, but the current situation has clear limitations. While the southern part mainly faces intensive traffic pressure, the northern part suffers from a lack of (H)PT and bicycle connections. For a successful transformation, investments in public transport, cycling networks and reducing car traffic are inevitable. Without these adjustments, the desired integration of industry and urban functions in Haven-Stad will not be optimally realised.

2.1.3 Conclusion

Haven-Stad forms an important industrial and logistics hub within Amsterdam, characterised by diverse industrial activities and a strategic location. The analysis of the area provides insight into the variety of industries, the associated environmental impacts, and their interaction with urban infrastructure.

Industrial activities are concentrated in specific zones, each with its own characteristics and challenges:

- 🟡 **Zone 1**: This is the least impactful zone, where limited odour, noise and dust nuisance is observed. The zone offers relatively high potential for transformation to live/work areas with minimal additional measures.
- 🟠**Zone 2**: This zone experiences an increase in noise pollution due to intensive logistics activities. Although the challenges here are greater, transformation remains feasible through strategic interventions such as noise insulation and buffer zones.
- 🔴 **Zone 3**: This is the most challenging zone, where heavy industry predominates and a combination of odour, noise and dust pollution is a major obstacle to transformation. Major measures are needed here to achieve a liveable environment.

Haven-Stad's strategic location on the water, with direct access to extensive transport and logistics networks, reinforces the area's attractiveness for companies. At the same time, this location brings significant challenges for urban infrastructure.

- The road network is congested, especially in the southern part, where through traffic contributes to regular traffic jams.
- Public transport is inadequate, with limited connections to the city centre and other parts of Amsterdam.
- The bicycle network is underdeveloped, making the transition to sustainable mobility difficult.

- Regional connections are hampered by congestion on the A8, affecting traffic between the Zaan region and the northern IJ bank.

In summary, this chapter shows that industrial activities in Haven-Stad interact with their surroundings in a complex way. Zones such as Zone 1 offer opportunities for transformation, while other areas, such as Zone 3, require significant adjustments. The existing infrastructure acts as both a strength and a constraint in this regard. Targeted investments in public transport, cycling networks and the unbundling of traffic flows are crucial to realise the transformation of Haven-Stad into a mixed living-working area.

2.2 Potential residents and their needs

2.2.1 Introduction

Understanding the target group that wants to live in Haven-Stad is essential for developing a strategy that enables the coexistence of residents and industry. Without a clear picture of the needs, expectations and lifestyles of potential residents, it is not possible to draw up an effective plan that both ensures quality of life and respects industrial functions in the area.

With the growing housing shortage in Amsterdam and the urgent need for affordable housing, Haven-Stad is becoming increasingly relevant as a residential location. But who are the people willing to live in an area with a strong industrial presence? Are these starters, families, or perhaps people who consciously choose urban living despite the challenges associated with proximity to industry?

This chapter focuses on analysing the demographic composition of potential residents, their lifestyles and expectations, and how their needs can be matched with the reality of living in an area such as Haven-Stad. By understanding these factors, a sustainable and attractive living environment can be created that takes into account both residents and existing industrial activities.

2.2.2 Analysis

The *Integraal Raamwerk Haven-Stad* of the Municipality of Amsterdam (2021) aims to create a diverse and inclusive community by creating a diverse housing stock. The plan provides housing for different target groups, such as young people, first-time buyers, people moving on and families with various incomes. The mix of social, medium and expensive housing, varying in size and in both the owner-occupied and rental sectors, should support this diversity. Gemeente Amsterdam, 2021, p. 54)

However, an opinion piece in Het Parool questions whether Haven-Stad will actually become the inclusive neighbourhood envisioned by the municipality. The article suggests that there are doubts about the feasibility of this inclusivity, given the challenges in realising such mixed residential areas in practice. (Licher, 2021)

Figure 8 gives a visual representation of the life cycle of housing needs in an urban context. The model illustrates the progression of housing types, starting with student housing, followed by starter homes, family homes, larger homes and finally senior housing. The circular layout underlines the cyclical nature of housing needs, with seniors releasing housing space for younger generations, such as students, through downsizing. The interrupted arrow between senior housing and student housing symbolises this reciprocal dynamic and emphasises the role of urban planning in facilitating generational change within the housing market.

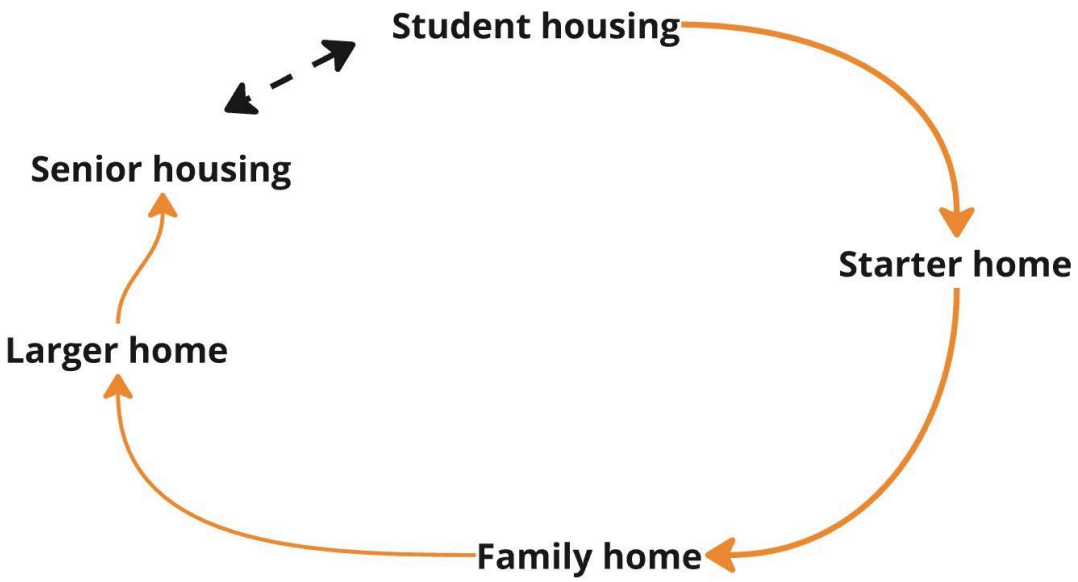

Figure 8: Lifecycle of housing needs: from student housing to senior housing

The figure highlights the challenge of a balanced housing stock that can support the diverse needs of residents at every stage of life. This requires not only a wide range of housing types, but also a strategy that avoids bottlenecks in the cycle, such as a shortage of affordable starter homes or appropriate senior housing.

This model is also criticised in an opinion piece in Het Parool (Licher, 2021). The article argues that inclusivity, as envisaged in the Integrated Framework, is difficult to achieve in practice. It highlights how previous projects often struggled to promote social cohesion and achieve a true mix of resident groups. This criticism calls for an in-depth analysis of the economic and social feasibility of the proposed strategies and a realistic evaluation of the inclusive housing cycle.

While this analysis is relevant, this depth goes beyond the scope of this study. For this study, the focus is more on potential residents' attitudes towards living in an area with heavy industry.

Attitudes towards living in an industrial area
Potential residents have varying attitudes towards living in an industrial area. For some, the industrial aesthetic, with its raw materials such as concrete and metal, is attractive because of its tough and unique look (BouwenWonen.net, 2021). Others, however, are reluctant, mainly due to concerns about environmental pollution, noise pollution and safety. A report by RIVM shows that residential satisfaction is strongly influenced by nuisance factors such as noise and odour often associated with industrial activity (RIVM, 2008).

Satisfaction with a living environment is determined by a combination of personal, experiential and environmental characteristics. According to RIVM, in addition to physical housing and neighbourhood characteristics, personal preferences and perceptions play an important role in how residents experience their living environment (RIVM, 2008, p.16).

Key insights:

1. **Residential satisfaction as an interplay of factors:** The living experience is influenced by both objective elements, such as house size and air quality, and subjective perceptions, such as personal preferences and sensitivities. This means that one universal solution will rarely be effective.
2. **Environmental quality is crucial:** Besides the dwelling itself, neighbourhood factors such as green spaces, air quality and noise levels play a key role in attracting potential residents. A high-quality environment can contribute a lot to the living experience.
3. **Personal characteristics are decisive**: Individual factors, such as age, health and lifestyle, have a relatively high influence on residential satisfaction. This underlines the importance of customisation in urban planning.
4. **Nuisance plays a role, but not the most important one:** Although noise and odour nuisance are important, research by RIVM shows that housing characteristics, such as form of ownership (buy or rent) and dwelling type, weigh more heavily in determining residential satisfaction (RIVM, 2008, p.16). This provides scope for partially compensating negative environmental factors with high-quality housing.

Residential satisfaction in industrial areas is determined by a wide range of factors. Housing type, ownership options and the quality of the environment appear to be at least as important as nuisance factors. This means that successful urban planning in Haven-Stad should focus not only on minimising nuisance, but also on creating attractive housing and neighbourhoods that meet the diverse needs of potential residents.

Residential preferences, lifestyles and expectations

Residents increasingly value factors beyond practical considerations such as price and location. An increasing focus on experiential aspects, such as aesthetics, atmosphere and sustainability, is influencing preferences for a residential environment (Arentze & Timmermans, 2009). This shift in priorities offers important insights when designing new residential areas, especially in complex environments such as Haven-Stad.

In addition, sustainability and biodiversity have become important themes in Dutch spatial planning. Projects such as the redevelopment of industrial heritage in Haaksbergen show that it is possible to create climate-adaptive residential areas with attention to nature and biodiversity (NL Adaptive, 2021).

Key insights:

1. **Experiential preferences:**
   Research shows that ‘soft’ factors, such as the aesthetic value of the environment and the atmosphere of a neighbourhood, play an increasing role in residents' living environment preferences (Arentze & Timmermans, 2009). This means that creating an attractive, characterful environment is essential to attract residents, even in areas with industrial influences.
2. **Sustainability and biodiversity:**
   Themes such as sustainability and biodiversity have become increasingly important in Dutch spatial planning. Examples such as the redevelopment of industrial heritage in Haaksbergen show that it is possible to create residential areas that are not only climate-adaptive, but also contribute to the restoration of biodiversity (NL Adaptive, 2021). Green roofs, natural drainage and green buffer zones are some of the measures that contribute to an attractive and sustainable living environment.
3. **Lifestyles and flexibility:**
   Modern living preferences are diverse and highly dependent on individual lifestyles. While some residents prefer quiet and space, others seek a lively urban environment. This diversity emphasises

the need for flexible and adaptable housing concepts that respond to different needs and expectations.

4. **Combination of living and working:**
   The growing popularity of hybrid forms of work has led to an increasing demand for residential environments that provide space for both living and working. This trend is also relevant to the development of Haven-Stad, where mixed living-working areas are an important starting point. While this development offers opportunities, there are still significant bottlenecks to overcome. Platform31's study (2023) shows that function blending on business parks brings challenges, such as noise pollution, safety requirements, and ensuring liveability. Successfully combining living and working therefore requires careful consideration of spatial and social factors, as well as innovative solutions to minimise conflicts between functions. (Platform31, 2023)

2.2.3 Conclusion

The analysis shows that the success of Haven-Stad depends heavily on its ability to meet the diverse preferences and needs of future residents. While the City of Amsterdam's inclusive housing vision is ambitious, criticism shows that the practical feasibility of a diverse and balanced housing stock is challenging. This calls for strategies that look beyond minimising nuisance from industry and instead focus on designing attractive, resilient and multifunctional residential environments.

A key lesson from this analysis is that residential satisfaction is influenced by a combination of objective factors and subjective perceptions:

- ⚖️ **Objective factors**: Measurable elements such as housing quality and environment amenities, including greenery and recreation.
- 👁️ **Subjective factors**: Personal and experiential aspects, such as aesthetics and the emotional connection to the environment.

The success of Haven-Stad depends on an integrated approach that combines living, working and nature in a cohesive way. Design strategies should not focus exclusively on functional aspects, but also on realising living environments that address both practical and socio-emotional needs of residents.

3. Interactions and relationships

3.1 Introduction

The interaction between industry and residents is a crucial theme within the Haven-Stad. This research aims to develop a strategy that not only allows industry and housing to coexist physically, but connects these functions harmoniously. This requires more than minimising negative impacts; it is about actively creating synergetic relationships between the two functions.

Industry and housing are traditionally often seen as conflicting functions, with conflicts arising from noise and odour pollution, safety risks and air quality. However, the transformation of Haven-Stad offers a unique opportunity to redefine this relationship. By examining how interactions between industry and residents currently take place and what potential they have, new strategies can be developed to make these functions work together. Examples include shared infrastructure, integration of industrial processes into the residential environment, and innovative solutions that benefit both residents and businesses.

Understanding these interactions is important to both recognise barriers and exploit opportunities. For example, good cooperation between industry and housing can contribute to shared sustainability efforts, job creation close to homes, and improved living environments through joint investments in green space and infrastructure.

This chapter builds on the findings of Chapter 2 where residents' needs became clear and focuses on identifying strategies to turn these interactions into opportunities. It thus provides the basis for a strategy that not only resolves the conflicts between housing and industry, but also enables new forms of cooperation and commonality in Haven-Stad.

3.2 Interests

To better understand the relationship between industry and residents, eight themes relevant to both urban planning and daily interactions between the two groups were examined. These themes include: location and space, logistics and mobility, nuisance and annoyance, cost and regulation, safety, flexibility and future, greenery and sustainability, and economy and employment. Each theme highlights specific tensions, opportunities and possible solutions that can contribute to balanced coexistence.

1. Location and space
Location and space form the basis of urban planning. Industry and housing often compete for the same scarce space, affecting proximity, liveability, and efficiency. While industry seeks operational advantages in strategic locations, residents value a stable, attractive residential environment.

This theme offers insight into how space claims of both parties affect each other and how they can be better aligned. It lays the foundation for a shared understanding of spatial conflicts and possible solutions for coexistence.

2. Logistics and mobility
Industry relies on logistics networks for an efficient flow of goods, while residents demand safe, easily accessible and car-free neighbourhoods. Both interests converge in urban infrastructure, where conflicts often arise.

Analysing this theme reveals how shared infrastructure can be used to create synergies, such as more efficient transport networks. At the same time, it offers solutions to reduce traffic congestion and safety risks.

3. Nuisance and annoyance
Noise, odour, and dust are direct sources of nuisance that have a strong impact on both residential satisfaction and industrial freedom. These factors represent a major area of tension between industry and residents.

The theme explores how technological and design-oriented solutions can reduce negative impacts. This helps to improve relations between industry and residents and enhance the quality of life in mixed-use areas.

4. Cost and regulation
Industry relies heavily on cost and regulation to sustain its operations. At the same time, residents demand affordable and sustainable housing. Both sides are affected by policies and investments, which present both opportunities and conflicts.

This theme explores how economic interests and regulations can reinforce each other. For example, shared costs for sustainability can benefit both industry and residents.

5. Safety
Safety is a fundamental need for both industry and residents. For industry, this means compliance with safety protocols, while residents demand a safe living environment, free of risks from industrial activities.

This theme offers insight into how safety measures can be improved and shared. Through cooperation, conflicts can be minimised and joint solutions developed.

6. Flexibility and the future
The dynamics of urban areas require both industry and housing to be flexible and adaptable to future changes, such as growth, technological innovation, or transformations.

This theme emphasises adaptive designs and strategies that anticipate future needs. This will enable harmonious coexistence in a changing environment.

7. Green and sustainability
Access to green space and sustainability is essential for the liveability and image of urban areas. For residents, green spaces and biodiversity are crucial, while industry faces stricter environmental requirements.

By analysing this theme, opportunities for synergies arise, such as green buffer zones and joint investments in sustainability. These improvements benefit both industry and residents.

8. Economy and employment
Industry is an important driver of the local economy and employment. At the same time, residents expect employment to be accessible and not negatively affect their living environment.

This theme explores how to maximise the economic benefits of co-existence, for example by creating employment close to homes. At the same time, negative impacts on housing quality are mitigated.

3.2.1 Interests of the industry

Outlined below are the main industry interests related to the eight themes of this study.

1. Location and space
Industries are often highly dependent on their location due to specific logistical connections, proximity to markets, and available infrastructure. Relocating industrial activities is usually costly and complex, making the preservation of the current location a key concern. Moreover, companies need sufficient space for growth, storage, and production activities to ensure their operational continuity.

2. Logistics and mobility
Efficient logistics infrastructure, such as roads, waterways and rail links, is vital for industry. This enables companies to transport raw materials and finished products in a timely manner. Obstacles in mobility, such as traffic congestion or access restrictions, can not only disrupt business processes but also lead to increased operational costs.

3. Nuisance and inconvenience
Industries need protection from complaints from residential areas, especially about noise, odour, and dust. Such complaints can lead to stricter regulations or restrictions on operations. Buffer zones or technological solutions are therefore important to reduce nuisances without compromising business productivity.

4. Cost and regulation
Cost control is a priority for industries, especially when investing in new technologies or modifications needed to comply with urban and environmental regulations. Regulations should be feasible and predictable to ensure business continuity and avoid unexpected investments.

5. Safety
Safety protocols and clearances are essential for industry to minimise risks from their operations. This not only protects workers, but also prevents legal liability and possible restrictions by government agencies. Thus, a safe operational environment is crucial for business operations.

6. Flexibility and future
Industries value flexibility and room for future expansion or adjustments in their operations. This allows them to respond to technological changes, market developments, and new regulations. The lack of such flexibility can lead to obstacles in competitiveness and innovation.

7. Green and sustainability
Sustainability is becoming increasingly important for the industry, both because of societal pressure and stricter environmental legislation. Adhering to clear and achievable sustainability guidelines, as well as investing in green technologies, helps companies strengthen their image while meeting environmental targets.

8. Economy and employment
Industries play an important role in creating and maintaining local jobs. This helps them attract and retain workers and contributes to the legitimacy of their presence in urban areas. In addition, businesses support the local economy, which can be mutually beneficial for both the industry and the community.

Conclusion
The industry's interests focus on security, efficiency and continuity. Ensuring operational freedom,

minimising risks, and optimising resources are key. These interests must be carefully balanced with the needs of residents to enable mutual benefits and synergies.

3.2.2 Interests of the residents

Below, residents' interests are structured by research theme.

1. Location and space
For residents, the stability and livability of their living environment is of great importance. They value long-term prospects that provide certainty about the quality of the environment and the preservation of home value. In addition, residents desire an environment that is well-designed, with sufficient space for greenery, tranquillity, and social interaction.

2. Logistics and mobility
Residents need safe and accessible mobility. Car-free and easily accessible streets contribute to a pleasant living environment. In addition, proximity to essential facilities, such as schools, shops and public transport, is important to ensure a high quality of life. Road safety and the absence of industrial transport nuisances are also key issues.

3. Nuisance and annoyance
Health and living environment are key issues for residents. They expect noise, air pollution, odour nuisance, and dust, often associated with industrial activities, to be reduced. Residents desire measures such as noise insulation, air filtration systems, and green buffer zones to ensure a healthy and comfortable living environment.

4. Cost and regulation
Affordability is an important issue for residents. They value sustainable and energy-efficient homes that not only contribute to lower energy costs, but are also environmentally friendly. Regulations that increase living comfort, such as requirements on air quality and noise levels, are highly valued by residents.

5. Safety
Physical and psychological safety is essential for residents. They want to be sure that their living environment is free of risks from industrial activities, such as explosions, leaks or environmental pollution. In addition, the feeling of safety plays a major role: residents want to feel protected by clear safety distances and visible measures.

6. Flexibility and future
Residents expect their homes and surroundings to be adaptable to changes, such as family expansion or ageing. Flexible designs that are future-proof provide assurance that the home and neighbourhood will remain pleasant and functional in the long term.

7. Greenery and sustainability
Green spaces and biodiversity are crucial for residents. Access to parks, gardens, and green roofs contributes to physical and mental health, while sustainable initiatives such as renewable energy and climate-adaptive designs enhance the liveability and future-proofing of their surroundings.

8. Economy and employment
Proximity to employment is important for residents. This increases efficiency in commuting and strengthens the local community. In addition, residents want nearby economic activities to contribute to the

social and physical infrastructure of the neighbourhood, such as schools, sports facilities, and public transport.

Conclusion
Residents' interests focus on creating a healthy, safe, and sustainable living environment. They desire homes and neighbourhoods that are not only affordable and future-proof, but also provide sufficient green space and amenities.

3.2.3 Matrix of interests

Below is the matrix of interests between industry and residents.

Themes	Importance for industry	Importance for residents
Location and space	Availability of sufficient space for production and storage	Proximity to work and amenities
Logistics and mobility	Efficient transport routes for goods and raw materials	Accessibility to public transport and roads
Nuisance and disturbance	Minimizing complaints to avoid operational delays	Reducing noise, air, and traffic pollution
Costs and regulations	Compliance with affordable and realistic regulations	Affordable living and clear regulations
Safety	Secure operations and minimizing risks to surroundings	Safe living environment
Flexibility and future	Adapting to technological and market changes	Long-term livability and adaptability
Green and sustainability	Energy efficiency and sustainable processes	Green spaces and sustainable energy sources
Economy and employment	Contribution to the local economy and job creation	Access to job opportunities

Matrix 1: interest matrix industry and residents

3.2.4 Priority matrix of interests

Themes	Importance for industry (Priority)	Importance for residents (Priority)
Location and space	1. Availability of sufficient space for production and storage	8. Proximity to work and amenities
Logistics and mobility	2. Efficient transport routes for goods and raw materials	6. Accessibility to public transport and roads
Nuisance and disturbance	3. Minimizing complaints to avoid operational delays	1. Reducing noise, air, and traffic pollution
Costs and regulations	4. Compliance with affordable and realistic regulations	3. Affordable living and clear regulations
Safety	5. Secure operations and minimizing risks to surroundings	2. Safe living environment
Flexibility and future	6. Adapting to technological and market changes	7. Long-term livability and adaptability
Green and sustainability	7. Energy efficiency and sustainable processes	4. Green spaces and sustainable energy sources
Economy and employment	8. Contribution to the local economy and job creation	5. Access to job opportunities

Matrix 2: interest matrix industry and residents with priorities

The interest matrix above shows the priorities of both industry and residents. It clearly shows that the interests of both groups have different emphases and priorities.

1. **Location and space**: Industry bases its choice of location on functional and economic considerations, while residents are guided by social and environmental aspects.
2. **Logistics and mobility**: Industry looks at economic efficiency, while residents focus on safety and comfort in their daily lives.
3. **Nuisance and annoyance**: Industry focuses on minimum cost and regulatory compliance, while residents see nuisance as a primary threat to their well-being.
4. **Cost and regulation**: Industry sees regulation as limiting efficiency, while residents see it as ensuring protection.
5. **Safety**: Industry focuses on internal operational safety, while residents emphasise external (residential) safety.
6. **Flexibility and future**: Industry sees flexibility as a strategic advantage, while residents see it as a guarantee of continuity and stability.
7. **Green and sustainability**: Industry looks at economic motives, while residents see sustainability as essential to their well-being and future.
8. **Economy and employment**: Industry has direct economic interests, while residents see indirect benefits, as long as it is not at the expense of their living environment.

3.3 Analysis using ecological models

The synergy between industry and residents can be compared to a biological phenomenon known as symbiosis. In biology, symbiosis describes a long-term interaction between two different organisms, where this interaction can take place in different ways. Symbiosis is a model that is also applicable to complex relationships between industry and the surrounding habitat of residents.

Symbiosis is defined as '*a close and long-term interaction between two different biological species*' (Begon, Townsend, & Harper, 2006). This interaction can be beneficial, detrimental or neutral for the parties involved, depending on the nature of their relationship. This concept provides a useful framework to analyse and categorise the relationships between industry and residents based on their mutual impact.

❌ **Parasitism**
In parasitism, one party, often industry, benefits at the expense of the other, in this case residents. This type of relationship occurs when industrial activities directly harm the environment and health of residents, without any benefits to them.

Characteristics:
- Negative impact on residents through pollution, noise, or safety hazards.
- Industry operates without regard to the environment.

Example:
Air pollution from a factory causing emissions of pollutants. Residents are exposed to increased health risks, while industry reaps economic benefits.

⚡**Commensalism**
In commensalism, one party benefits from the relationship without the other party experiencing benefit or harm. This type of relationship can occur when industrial activities contribute indirectly to the quality of the living environment without explicitly affecting residents.

Characteristics:
- Neutral relationship for the non-benefiting party.
- No direct benefits or disadvantages for residents.

Example:
A factory implements new technologies to produce faster and more efficiently. This increases the productivity of the factory without directly benefiting or harming nearby residents, as the technological improvement has no noticeable impact on their living environment.

🌱 **Mutualism**
In a mutualistic relationship, both industry and residents benefit. This synergy occurs when there is cooperation that benefits both parties. Mutualism forms the basis for sustainable and mutually beneficial developments.

Characteristics:
- Mutual benefit through cooperation.
- Focus on shared goals such as sustainability or energy efficiency.

Example:

An industrial estate supplying waste heat to surrounding homes. Residents benefit from affordable energy, while industry saves costs and reduces emissions.

By analysing the relationship between industry and residents using ecological models such as parasitism, commensalism and mutualism, it becomes clear how these interactions occur and what consequences they have. This not only provides insight into the nature of the relationship, but also helps identify opportunities for more mutualistic collaborations, where industry and residents jointly benefit from sustainable and innovative solutions.

3.4 Parasitism

Parasitism in the current situation is often visible in urban areas where industry and housing exist in close proximity. This manifests itself mainly in factors such as noise pollution, air pollution, traffic congestion, and a lack of attention to the housing quality of surrounding residents. While industrial activities maintain their profits and efficiency, the negative externalities are transferred directly to the living environment and well-being of residents.

Themes	Parasitism
Location and space	Dependency on shared space reducing efficiency
Logistics and mobility	Traffic congestion caused by industrial and residential overlap
Nuisance and disturbance	Increased noise, pollution, and complaints
Costs and regulations	Shared costs creating unfair burdens
Safety	Higher risks due to conflicting activities
Flexibility and future	Limited adaptability due to competition for resources
Green and sustainability	Compromised sustainability goals
Economy and employment	Negative economic impact due to conflicts in land use

Matrix 3: The parasitic interactions in the Haven-Stad.

The ambition is to transform parasitic relationships into more balanced forms of interaction, such as commensalism and mutualism. This allows residents to benefit from the proximity of industry, for example through employment and shared infrastructure, without compromising their well-being and living environment.

Strategy to reduce parasitism:

1. **Minimise nuisance**: Invest in technologies that reduce noise, odour and pollution.
2. **Buffer zones**: Create green and functional zones between industry and housing.
3. **Increase safety**: Introduce strict protocols and safety distances.
4. **Regulation**: Establish and enforce clear rules to ensure responsible industrial behaviour.

Limiting parasitism is an important step towards a harmonious relationship between housing and industry in Haven-Stad. This transition contributes not only to a better living environment for residents, but also to a future-proof and socially responsible position of industry.

3.5 Commensalism

Commensalism is visible in Haven-Stad in situations where industry provides indirect benefits to residents, without providing adverse or direct benefits to the industry itself. This manifests itself, for example, in the form of industrial investments in infrastructure, such as improved roads or logistics networks, which are also used by residents. Industrial greening, such as green buffer zones or energy-efficient buildings, contributes to an improved living environment without explicitly targeting residents. Although these interactions are not aimed at cooperation, in some cases residents benefit indirectly from the presence of industry.

Themes	Commensalism
Location and space	Shared space utilization benefits one without harming the other
Logistics and mobility	Improved transport infrastructure benefiting residents
Nuisance and disturbance	Minimal disturbance from industry while benefiting residents
Costs and regulations	Balanced regulations accommodating both parties

Matrix 4: The commensal interactions in the Haven-Stad.

Strategy to exploit commensalism:

1. **Encourage indirect benefits**: Develop projects in which industrial initiatives, such as infrastructure or greening, contribute indirectly to the living environment.
2. **Improve communication**: Make sure residents are aware of the benefits of industrial measures to increase mutual understanding.
3. **Minimise drawbacks**: Ensure that potential side effects of commensalist relationships, such as traffic congestion or aesthetic considerations, are minimised.

The aim is to strengthen commensalist interactions by making unintended benefits of industrial activities more consciously available to residents, without putting additional pressure on industry. This turnsto a more balancedrelationship and is a step towards mutualism, where both parties actively benefit from each other.

3.6 Mutualism

Mutualism is visible in Haven-Stad in places where industry and residents both actively benefit from their interaction. These mutually beneficial interactions provide a strong basis for promoting a harmonious relationship between living and working in Haven-Stad.

Themes	Mutualism
Location and space	Optimal shared use of space benefiting both parties
Logistics and mobility	Coordinated transport solutions improve efficiency for both
Nuisance and disturbance	Collaborative efforts reduce disturbances for all
Costs and regulations	Shared investments and streamlined regulations benefit both
Safety	Joint safety measures enhance security for everyone
Flexibility and future	Mutual planning ensures adaptability and long-term success
Green and sustainability	Joint sustainability initiatives benefit environment and stakeholders
Economy and employment	Shared economic growth and job opportunities

Matrix 5: The mutualistic interactions in the Haven-Stad.

Strategy to exploit mutualism:

1. **Strengthen shared benefits**: Ensure that shared infrastructure, such as roads and public transport, is used optimally by both industrial logistics and residents. Through joint investment and smart design, both parties can benefit from improved mobility and accessibility.
2. **Utilise industrial residual flows**: Expand the use of industrial waste heat and other residual products to support housing and urban facilities. This increases the energy efficiency of industry and reduces energy costs for residents.
3. **Optimise green buffer zones**: Develop multifunctional green zones that reduce air pollution, provide recreation for residents, and create a positive image for industry. Encourage collaboration in the design and management of these areas.

The aim is to strengthen mutualistic interactions by deliberately maximising benefits for both parties. This creates a balanced relationship in which both industry and residents actively contribute to each other's well-being and efficiency. This makes Haven-Stad an area where cooperation between living and working leads to sustainable and mutually beneficial development.

3.7 Conclusion

The analysis of interactions between industry and residents in Haven-Stad shows that achieving a harmonious relationship between the two functions is possible by striving for mutualism. This requires

redefining the traditional, often conflictual relationship between living and working. The aim is to minimise negative, parasitic interactions, characterised by nuisance and harm to residents, and to transform them into relationships in which industry and residents actively reinforce each other.

A harmonious relationship requires more than limiting noise, odour, or safety risks. It is about developing synergies where both industry and residents benefit. This can be achieved through strategies such as sharing infrastructure, utilising industrial residual flows for energy and heat, and creating multifunctional green buffer zones. These measures not only improve the living environment for residents, but also contribute to more efficient and sustainable operations for industries.

The shift towards mutualism is supported by embracing innovative solutions that offer shared benefits. Examples include integrating industrial processes into the residential environment, for instance by using residual streams for district heating or by using green areas as noise buffers and recreational space. In addition, shared responsibility for sustainability, such as investments in circular systems or energy efficiency, promotes a shared vision of the future.

Mapping the conditions for this transformation, as explored in this chapter, lays the foundation for a strategy that not only allows living and working to coexist, but actually connects these functions. By minimising parasitism, harnessing commensalism and enhancing mutualism, Haven-Stad can become an area where industry and housing blend harmoniously, with benefits for both parties.

4. Urban, architectural and technical solutions

4.1 Introduction

This chapter presents solutions derived from the findings in Chapter 2 and the strategic approach in Chapter 3. The proposed solutions focus on:
Urban planning interventions: Improving the physical structure of the area and solving spatial challenges.
Architectural strategies: Minimising nuisance and promoting an attractive living environment.
Technical innovations: Making use of industrial waste streams and increasing energy efficiency.

In transforming Haven-Stad into a mixed living-working area, it is important not only to formulate solutions, but also to organise them according to their application and impact. To make the proposed solutions easier to understand, they are structured using three core scales derived from the analyses in the previous chapters.

Scales from Chapter 2.1: zones of adaptation
Each solution is linked to one or more zones in Haven-Stad, based on the degree of adaptation required to achieve liveability and transformation:

- 🟡 **Zone 1**: Least impact zone, minimal adaptations, with a focus on maintaining and enhancing quality of life.
- 🟠 **Zone 2**: Moderate adaptations, focusing on reducing nuisance and optimising the environment.
- 🔴 **Zone 3**: Heavily impacted zone, where drastic measures are necessary to create a liveable living and working environment.

By applying this scale, it becomes immediately clear for which zones a solution is suitable. Solutions may be relevant to multiple zones, but solutions for Zone 3 will rarely be applicable in Zone 1 due to their intensive nature.

Scales from Chapter 2.2: residents' needs
Solutions are further assessed in terms of their contribution to the needs of future residents, divided into two categories:

- ⚖️ **Objective factors:** Measurable elements such as housing quality and environment amenities, including green space and recreation.
- 👁️ **Subjective factors:** Personal and experiential aspects, such as aesthetics and emotional connection to the environment.

This scale indicates whether a solution responds to tangible (objective) or emotional (subjective) needs, or a combination of both. This helps to provide insight into how a solution contributes to attractiveness and liveability for residents.

Scales from Chapter 3: relationships between industry and residents
The relationship between industry and residents is a crucial aspect of transformation. Solutions are assessed for their impact on this relationship:

- ❌ **Parasitism**: The solution addresses a situation where one party is significantly disadvantaged by the other.
- ⚡ **Commensalism:** The solution favours one party without disadvantaging the other.
- 🌱 **Mutualism:** The solution creates mutual benefits for both residents and industry.

Solutions will mainly focus on transforming a parasitic relationship ❌to a mutualistic 🌱 or commensalistic⚡ relationship. This is visually represented as: ❌ > 🌱, where a negative relationship is transformed into a positive mutual interaction.

This classification provides an orderly structure that not only presents the solutions, but also links them directly to the main challenges and goals of Haven-Stad. The combination of zones, residents' needs and relationships between industry and residents makes it possible to evaluate the proposed measures for their suitability, impact and effectiveness. This bridges the gap between the analyses from the previous chapters and the practical application of solutions.

4.2 Urban planning solutions

The urban planning solutions form the basis for transforming Haven-Stad into a mixed living-working area. These measures focus on improving the physical structure of the area, solving spatial challenges and creating an attractive living environment for both residents and industry. They lay the foundations for harmonious coexistence by rearranging and optimising the area.

4.2.1 Natural boundaries and green buffers

What is the problem?

The proximity of industrial activities causes significant visual and physical nuisances, such as noise pollution, air pollution and lack of green spaces. These factors reduce the liveability of adjacent residential areas and make it difficult to create a healthy living environment.

What is the solution?

1. **Natural boundary:** Green buffers, such as trees, shrubs and dense vegetation, serve as visual and noise barriers between industrial and residential areas. These natural boundaries improve air quality and attenuate industrial noise (Tzoulas et al., 2007). An analysis of the Ruhr region, conducted in 2024, shows that such buffers are effective in minimising industrial impacts and creating a healthier living environment (see Annex Analysis Ruhr region).
2. **Integration into design:** Green zones can be designed as multifunctional parks, green corridors or roof gardens, adding both aesthetic and functional value. This concept has been successfully applied in several urban settings, with green infrastructure improving liveability and reducing urban heat islands (Benedict & McMahon, 2006).

What is this solution relevant for?

- **Zones:**
  - 🟡 **Zone 1:** Green buffers improve quality of life by providing visual separation and additional green spaces.
  - 🟠 **Zone 2:** Reduce noise and air pollution through strategically placed green zones.
  - 🔴 **Zone 3:** Intervention buffer zones and multi-purpose green areas are essential to separate heavy industries and residential areas.
- **Residents' needs:**
  - ⚖️ **Objective:** Improvement of environmental amenities such as greenery, clean air, and noise attenuation.
  - 👁️ **Subjective:** Increasing the aesthetic value and well-being of residents through the addition of attractive green spaces.
- **Relationship:**
  - ❌ > 🌱 Adding green buffers reduces the negative effects of industry on residents. Besides increasing the quality of life for residents, the added greenery also provides industry employees with a relaxation space, contributing to a healthier and more pleasant

working environment. This creates a mutually beneficial situation where both residents and workers benefit from an improved environment.

Integrating natural boundaries and green buffers contributes to the livability and attractiveness of urban-industrial areas such as Haven-Stad. It reduces nuisance, increases aesthetic value and creates a balance between industry and housing.

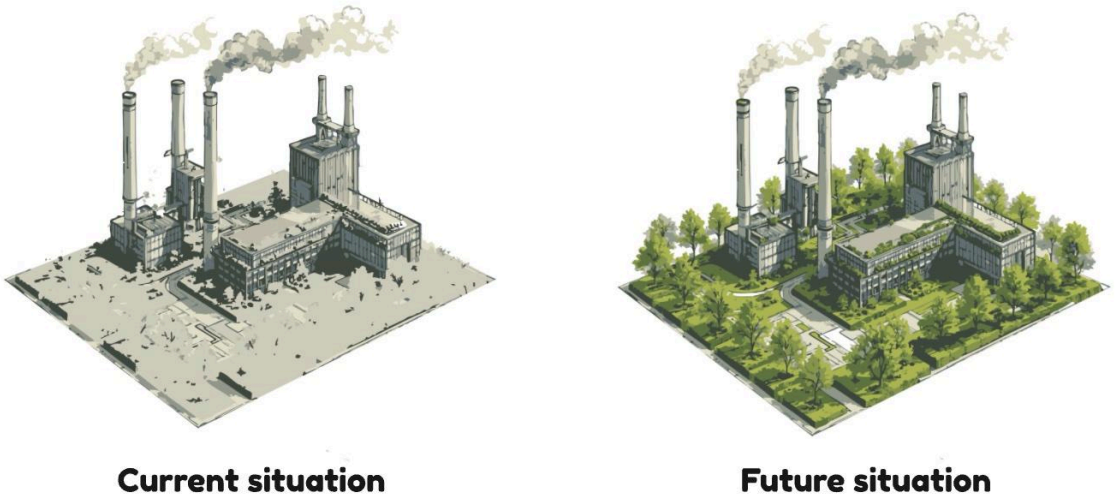

Illustration 1: The current situation compared to the future situation of industry in the Haven-Stad. (Own illustration)

4.2.2 Smart rearrangement of infrastructure

What is the problem?

The existing infrastructure in Haven-Stad is outdated and not designed for the combination of intensive industrial activities and residential areas. This leads to congestion, dangerous traffic situations and a lack of segregated traffic flows. The lack of sustainable mobility options, such as bicycle and pedestrian paths, limits liveability and accessibility for residents.

What is the solution?

1. **Smart supply routes:** Improving infrastructure in Haven-Stad requires further research on how to optimally combine industrial and residential traffic flows. Designing specific logistics corridors for heavy freight traffic and separating them from residential mobility can increase safety and reduce inconvenience and congestion. This approach offers opportunities to maintain the efficiency of industrial supply while adding new infrastructure that provides residents with sustainable and accessible mobility options. Further analysis is needed to determine how this balance can be achieved within the unique context of Haven-Stad.

2. **Floating storage:** Floating storage sites on the water offer an innovative solution to free up valuable land for housing and recreation. This concept takes advantage of Haven-Stad's unique waterfront location and offers logistical flexibility for industries. By placing bulk goods and tank storage on floating platforms, land becomes available for urban functions such as housing and recreational spaces.

The benefits of floating storage have been proven by examples such as the services of Interrijn ARA Bulk Floating Storage, which uses barges for bulk storage in ports such as Amsterdam and Rotterdam. This solution combines flexibility with cost efficiency, while simultaneously reducing space pressure on land (Interrijn, s.d.).

In addition, Floating Storage Company B.V. demonstrates that floating storage is a sustainable and scalable option for tank storage and shipping logistics, focusing on efficient use of waterways for urban port areas (Floating Storage Company, s.d.).

3. **Green corridors:** Developing green connecting routes for cyclists and pedestrians promotes sustainable mobility and connects residential areas with recreational and urban facilities. These corridors not only promote a healthy living environment, but also act as visual and physical buffers against industrial activities.

   Examples from urban contexts support this approach. Cities like Hamburg and Copenhagen, with their respective ‘Featherplan’ and ‘Fingerplan’, have proven that green corridors not only improve mobility, but also contribute to the health and well-being of residents and workers by bringing nature closer and creating space for relaxation and recreation (TU Delft, s.d.).

   Green corridors are also essential for promoting biodiversity in urban areas. They connect green zones, allowing animals to migrate safely and ecosystems to become stronger. This idea is widely supported within urban greening initiatives, as described in the Climate Coalition's strategies (Climate Coalition, s.d.).

   Another benefit of green corridors is their contribution to sustainable mobility. Redesigning cities with a focus on cyclists and pedestrians improves quality of life and reduces dependence on private cars. This is illustrated in projects such as the redevelopment of the Spoorzone Hoofddorp, where a finely-meshed network of cycle routes focuses pedestrians and cyclists and minimises car traffic (De Zwarte Hond, s.d.).

Illustration 2: Illustration of a green corridor in Haven-Stad, where a canopy with green spaces serves as a visual and physical buffer between industry and residential areas. (Own illustration)

illustration 3: Illustration of the interior of such a green corridor with the purple light of a Vertical Farm on the left (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2:** Optimising traffic flows is crucial in medium-heavy industrial areas, where both logistics activities and habitation take place.
  - 🔴 **Zone 3:** In heavy industrial areas, a smart infrastructure layout helps create safe and liveable conditions despite intensive industrial activities.
- **Residents' needs:**
  - ⚖️ **Objective:** Efficient and separated mobility facilities reduce inconvenience and improve accessibility for residents.
- **Relationship:**
  - ❌ > ⚡ > 🌱: Smart supply routes and floating storage not only reduce nuisance for residents, but also offer potential benefits for industry. A more efficient logistics system and better spatial layout support industrial activities, while residents benefit from an improved living environment without nuisance. This ultimately leads to a mutually beneficial situation.
  - ❌ > 🌱: Green corridors contribute directly to a mutualistic relationship. They not only improve the living environment for residents, but also provide workers from industry with safe and pleasant routes to move around. This not only promotes a healthier living environment, but also strengthens the integration between industry and housing.

Smart supply routes and floating storage form the basis for more efficient logistics solutions that reduce the impact of industrial activities on the living environment. These measures not only free up space for urban development, but also support the continuity and growth of industrial functions.

In this transformation, green corridors occupy a central position as meeting and connection places. These corridors not only act as mobility solutions, but also provide a shared space where residents and industry come together. Workers benefit from safe, attractive routes, while residents get direct access to nature and recreation. By emphasising these shared functions, green corridors strengthen social integration and promote a reciprocal relationship between living and working.

This integrated approach to infrastructure and space use creates a situation where industry and residents not only coexist peacefully, but actually support and reinforce each other.

4.2.3 Flexible zoning

What is the problem?

The current rigid division of urban areas into fixed zones for housing, industry and recreation hinders the integration of different functions. This often leads to conflicts, such as noise or air pollution nuisance, and limits the possibilities of developing housing in industrial areas. In Haven-Stad, fixed zoning makes it difficult to provide sufficient flexibility to accommodate both industrial activities and housing needs.

What is the solution?

1. **Tailored zoning**
    - Develop dynamic zoning that takes into account the intensity of industrial activities and the measures needed to ensure liveability.
    - Lightly impacted zones (such as Zone 1) can be more easily transformed into live/work areas, while heavily impacted zones (such as Zone 3) require additional measures such as noise insulation or advanced ventilation systems.
    - Regular review of zoning allows areas to adapt to changing urban needs and economic developments.
2. **Transition zones**
    - Design shared areas between industry and housing where the two functions can reinforce each other.
    - These zones can consist of flexible functions, such as temporary workplaces, pop-up parks, markets, or recreational spaces.
    - Transition zones act as a buffer and create space for interaction between residents and industrial workers, promoting social cohesion.

What is this solution relevant to?

- **Zones:**
    - 🟡 **Zone 1:** In these zones, the integration of living and working can be applied directly by using light industrial functions that cause minimal nuisance.
    - 🟠 **Zone 2:** Transition zones in medium-loaded areas offer the opportunity to encourage interaction between residents and industry, while additional measures limit nuisance.
- **Residents' needs:**
    - ⚖️ **Objective:** Spatial quality through more efficient and flexible use of space, in which conflicts between functions are reduced.
    - 👁️ **Subjective:** Transition zones contribute to the vibrancy of the area and promote a sense of community by creating spaces that attract both residents and workers.
- **Relationship:**
    - ⚡ > 🌱: The introduction of transition zones changes the relationship between industry and housing from a neutral (commensalistic) to a mutually beneficial (mutualistic) one. Sharing space and cleverly combining functions creates a situation where both residents and industry benefit.

The implementation of flexible zoning in Haven-Stad offers an approach to enable the integration of residential and industrial. By allocating customised zones and introducing transitional zones, a dynamic urban structure is created in which both liveability and economic functions are optimised. This approach not only contributes to spatial quality and social cohesion, but also stimulates mutual benefits between residents and industry.

4.2.4 Climate adaptation measures

What is the problem?

Haven-Stad's urbanisation and proximity to intensive industrial activities make the area especially vulnerable to the effects of climate change. Climate-related challenges, such as heat stress, flooding and air pollution, are exacerbated by the lack of green infrastructure and the large amount of paving in urban and industrial zones. Without adaptations, the livability and functioning of Haven-Stad will be limited.

What is the solution?

1. **Green infrastructure**
    - Add stormwater buffers, such as wadis and retention basins, to prevent flooding and infiltrate rainwater locally.
    - Implement green roofs and facades to retain water, reduce the urban heat island effect and improve air quality.
    - Use permeable paving to drain rainwater more efficiently and reduce the risk of flooding.
2. **Microclimate optimisation**
    - Integrate greenery and water features, such as urban parks and ponds, to reduce heat stress and provide natural cooling.
    - Plant trees and create shaded walkways in residential and commercial areas to increase the comfort of residents and workers.
    - Develop green corridors that not only support biodiversity but also improve the microclimate in the immediate vicinity.

What is this solution relevant to?

- **Zones:**
    - 🟡 **Zone 1**: Green infrastructure offers a direct improvement of the living environment in less intensive zones.
    - 🟠 **Zone 2**: Climate adaptive measures are essential in areas where industrial activities coexist with habitation to reduce heat and water nuisance.
    - 🔴 **Zone 3**: Intensive adaptations, such as large rainwater buffers and shaded green spaces, are needed in heavily-used areas to offset the impact of industrial activities and climate change.
- **Residents' needs:**
    - ⚖️ **Objective:** Climate resilience through water management and heat stress reduction.
    - 👁️ **Subjective:** The addition of greenery and water features improves the experience of nature and contributes to a more pleasant living environment.
- **Relationship:**
    - ⚡ > 🌱: Climate-adaptive measures can both improve the living environment for residents and contribute to more sustainable management of the area. While these measures are primarily aimed at increasing climate resilience, they can also indirectly benefit industry by mitigating flood risks, for example. This creates opportunities for a balanced relationship in which both residents and industry benefit from a climate-resilient and resilient area.

Climate-adaptive measures offer a solution to the challenges of urbanisation and industrial activities in Haven-Stad. Green infrastructure, such as rainwater buffers and green roofs, reduces heat stress and flooding, while making the area more climate resilient. This approach improves liveability for residents

and supports industry by reducing risks such as flooding, creating a better balance between urban and industrial functions.

4.2.5 Sustainable area development

What is the problem?

The current spatial layout of Haven-Stad falls short of providing a coherent strategy for sustainable development and economic resilience. While initiatives exist to make parts of the area more sustainable, integrated solutions that benefit both residents and industry are lacking. This results in inefficient energy and waste flows, a lack of sustainable economic activities and insufficient use of available space.

What is the solution?

1. **Circular economy**
    - **Shared waste streams:** Implement a system where industry and residents process waste jointly, with a focus on recycling and reuse. For example, composting organic waste from homes and businesses and using it in local agricultural projects or green spaces.
    - **Energy sharing:** Facilitate a shared energy network in which residual heat from industry heats homes and excess solar energy from residents is fed back into industrial processes. The technical elaboration of this energy sharing is discussed further in the Technical Solutions section.
2. **Green as an economic carrier**
    - **Recreation and nature:** Develop parks and green spaces that not only serve as recreational facilities but also house economic functions, such as small-scale hospitality, event spaces and markets.
    - **Urban agriculture and small-scale production:** Use green spaces for urban agricultural projects, such as kitchen gardens or vertical farms, which provide residents with locally produced food and strengthen the local economy.
    - **Link to tourism:** Integrate green and economic functions with tourism initiatives, such as hiking trails, cycle paths and cultural events, to make the area more attractive to visitors.

What is this solution relevant to?

- **Zones:**
    - 🟠 **Zone 2:** This zone offers opportunities for shared flows and multifunctional green spaces due to the mix of industry and habitation.
    - 🔴 **Zone 3:** In heavily stressed industrial areas, a circular approach is necessary to reduce environmental impact and strengthen economic resilience.
- **Residents' needs:**
    - ⚖️ **Objective:** Sustainability in energy and waste management, complemented by the availability of multifunctional facilities that improve the quality and functionality of public spaces.
- **Relationship:**
    - ❌ > 🌱: By introducing shared energy and waste streams, both residents and industry benefit from more efficient and sustainable processes. Combining nature, recreation and economic functions creates a mutualistic relationship in which both parties benefit from an integrated sustainable approach.

Sustainable area development offers an integral solution to Haven-Stad's spatial and economic challenges. By implementing shared energy and waste flows and combining nature with economic functions, a

resilient urban-industrial area is created. This approach not only enhances liveability for residents, but also supports industry in making processes more sustainable and increasing economic opportunities.

4.2.6 Training and employment programmes

What is the problem?

The transformation of Haven-Stad requires not only physical adjustments but also a socio-economic strategy. Currently, the area offers limited opportunities for local employment and training linked to industry. This leaves both employment opportunities and the economic potential of the transformation underutilised. At the same time, the sustainability and modernisation of the industry requires new skills and specialised personnel.

What is the solution?

MBO training:
Setting up an MBO training programme focused on technical and industrial professions, such as energy management, sustainable construction techniques and process optimisation, can structurally strengthen the labour market in Haven-Stad. Technical MBO courses play a crucial role in training professionals needed for urban transformation. Research shows that enrolment in technical courses is increasing, partly due to better links to the labour market and transfer opportunities between vmbo, mbo and hbo (Bureau Techniek, s.d.; ECBO, 2022).

This programme can be linked to industry in Haven-Stad through practical internships and close cooperation with companies. Initiatives such as Bouwend Nederland's programme show that cooperation between educational institutions and industry significantly increases the outflow of qualified technicians (Bouwend Nederland, s.d.).

Inclusive employment strategies:
Employment programmes targeting both the highly and low-skilled contribute to social cohesion and economic stability in Haven-Stad. This includes positions in logistics, maintenance, administrative support and innovative manufacturing. An effective tool is the use of work-learning pathways, where residents are not only trained but also actively contribute to the transformation of their own residential area. The programme ‘Urban Transformation: more space for living’ shows how such pathways not only increase employment, but also create support for urban transformation projects (‘Stedelijke Transformatie’, s.d.).

Stakeholder cooperation:
The success of these training and employment programmes depends on close cooperation between educational institutions, companies and local authorities. Policy programmes such as that of Bouwend Nederland emphasise the importance of public-private partnerships to set up training and employment projects that meet the needs of both employers and employees (Bouwend Nederland, s.d.). In addition, subsidies and tax breaks can encourage employers to invest in training and guidance.

What is this solution relevant to?

- **Zones:**
  - 🟡 **Zone 1**: Opportunities for light industry and small-scale operations.
  - 🟠 **Zone 2**: Medium-sized industrial operations requiring additional skilled staff.
  - 🔴 **Zone 3**: Complex industries with high demand for specialised knowledge.
- **Residents' needs:**

    - ⚖️ **Objective**: Employment and economic security.
    - 👁️ **Subjective**: A sense of belonging and pride in the residential area, enhanced by social connections and the opportunity to actively contribute to the transformation of Haven-Stad through training and employment programmes.
- **Relationship:**
    - ❌ > 🌱 Introducing training and employment programmes creates a mutualistic relationship in which both industry and residents benefit. Industry gains access to a well-trained workforce, while residents benefit from new opportunities and economic stability.

Establishing an MBO and inclusive employment strategies strengthens the socio-economic structure of Haven-Stad. Involving residents directly in the industrial transformation not only creates opportunities but also increases support for the transformation. Moreover, a close connection between education and industry ensures a future-proof Haven-Stad, where living and working truly go hand in hand.

4.3 Architectural solutions

The architectural solutions build on the urban planning basis and focus on improving the quality of life and functionality in Haven-Stad. They include building-specific interventions that minimise nuisance, promote energy efficiency and enhance the aesthetic value of the area. Here, architecture provides concrete solutions to optimise the interaction between residential and industrial functions and create an attractive living environment.

Reference projects were used for various architectural solutions. These projects offer practical insights into proven strategies and show how innovative designs can contribute to the integration of housing and industry. By integrating these insights with the specific context and needs of Haven-Stad, the proposed architectural solutions provide a foundation for development of the area.

4.3.1 Double façade systems

What is the problem?

The proximity of heavy industries in Haven-Stad causes noise and air pollution, seriously affecting residents' quality of life. Noise pollution can cause stress and sleep disturbance, while air pollution poses health risks. These challenges limit the possibilities of successfully combining residential and work functions in the same area.

What is the solution?

Double façade systems offer an innovative architectural solution by creating an additional layer on the outside of the building, consisting of glass or another soundproofing and ventilating structure. This system works as follows:

- **Noise reduction**: The air layer between the inner and outer skin absorbs and dampens sound waves, significantly reducing noise pollution.
- **Air purification**: Ventilation systems in the double walls are equipped with filters that remove pollutants from the air before they reach the interior.
- **Energy saving**: The air layer acts as insulation, reducing heat loss and promoting energy efficiency.

illustration 3: Illustration of the benefits of a double façade (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2:** Double façade systems provide protection against medium industrial activities with moderate noise and air pollution.
  - 🔴 **Zone 3:** In heavy industrial areas, these systems are essential to create a liveable environment despite high levels of nuisance.
- **Resident needs:**
  - ⚖️ **Objective:** Improved air quality and noise reduction contribute to a healthy and comfortable living environment.
  - 👁️ **Subjective:** The transparent design of the facades preserves natural light and visual connection with the outdoor environment, contributing to the aesthetics and experience.
- **Relationship:**
  - ❌ > ⚡**:** Currently, the solution mainly reduces disruption to residents without direct benefits to industry.
  - Transformation towards mutualism 🌱: A mutually beneficial relationship can be fostered by implementing double-frontage systems with integrated energy-generating technologies, such as solar cells or heat exchangers. The energy generated can be used directly in industrial processes, contributing to cost savings and more efficient energy use for industry. At the same time, residents benefit from an improved living environment through better insulation and noise reduction.

Double façade systems offer an effective solution to liveability problems in industrial residential areas. Although the relationship is currently mainly commensalistic (⚡), a mutualistic relationship can be achieved through further innovation and cooperation between industry and residents (🌱).

4.3.2 Vertical and roof gardens

What is the problem?

In Haven-Stad, industrial activities in Haven-Stad create a lack of green space, resulting in reduced air quality, heat stress and a less attractive living environment. Moreover, there is a lack of space for traditional green spaces such as parks and public gardens, which complicates the integration of nature in industrial areas.

What is the solution?

Vertical gardens and roof gardens transform the look and experience of Haven-Stad through architectural interventions that go beyond mere functionality. Vertical gardens, applied to both residential and industrial buildings, literally bring nature to facades. For residents, they offer a calming and visually appealing environment. Seeing greenery has proven calming effects, contributing not only to mental health but also to neighbourhood social cohesion. Industrial buildings, often perceived as bleak and unattractive, are softened by green facades, making them better integrated into the urban context. An example is CopenHill (Amager Bakke) in Copenhagen, a waste treatment plant with a green roof that acts as a ski slope and recreational park. This project combines functionality with recreation and contributes to the integration of industrial infrastructure into the urban environment, while at the same time improving the image of the industry. Such applications can also create greater acceptance and engagement with residents in Haven-Stad.

Roof gardens add a new layer to urban infrastructure. For residents and workers, they provide places to relax, congregate and enjoy nature. In densely built-up environments, where space is scarce, roof gardens act as an oasis of tranquillity. They not only offer recreational value, but also enhance the sense of community by bringing people together in an inspiring location. Industrial buildings benefit from green roofs by not only being less conspicuous in the landscape, but also by the practical benefits, such as better insulation and improved microclimate.

The combination of vertical gardens and roof gardens is not only visually appealing, but also forms a bridge between people, nature and building. They enhance the well-being of residents, humanise the industrial landscape and provide a communal space that fosters a sense of belonging.

illustration 4: Architectural design with integrated vertical gardens and roof gardens in the Haven-Stad (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🟡 **Zone 1**: Vertical gardens and roof gardens improve the living environment by adding aesthetic value and integrating climate-adaptive measures, such as reducing heat stress and promoting biodiversity, into this least stressed zone.
  - 🟠 **Zone 2**: In areas with moderate industrial activity, vertical and roof gardens act as buffers against noise and air pollution. They also support residents' well-being by providing clean air and visual separation.
  - 🔴 **Zone 3**: In the most heavily polluted areas, these solutions help minimise the negative impact of heavy industry, such as air and noise pollution. At the same time, they contribute to a more pleasant microclimate in the immediate vicinity.
- **Residents' needs:**
  - ⚖️ **Objective**: By improving air quality and reducing heat stress, vertical gardens and roof gardens contribute to a healthier living environment.
  - 👁️ **Subjective**: The visual appeal of green facades and roofs strengthens residents' emotional connection to their living environment. They increase appreciation for the area.
- **Relationship:**
  - ❌ > 🌱: Vertical gardens and roof gardens create a mutualistic relationship between industry and residents. They reduce the negative effects of industrial activities, such as pollution and noise pollution, while creating a more attractive and healthier environment for residents. For industry, these solutions enhance image and support energy efficiency by improving thermal insulation and air quality.

Vertical gardens and roof gardens are an important architectural strategy for the transformation of Haven-Stad into a sustainable and liveable urban-industrial area. These green spaces combine aesthetic, ecological and functional benefits, including improved air quality, reduction of heat stress and enhancement of the visual quality of the environment. By realising shared benefits, they promote interaction between industry and residents and contribute to a harmonious urban context where mutual interests are supported.

4.3.3 Flexible housing typologies

What is the problem?

The growing need for hybrid home-work environments is not adequately supported by traditional housing designs. Many homes in urban areas are not adapted to changing lifestyles and functions, such as working from home, limiting residents' use of space. Moreover, the proximity of industrial activities in areas such as Haven-Stad leads to challenges such as noise and air pollution, which require extra attention in housing design.

What is the solution?

Flexible housing typologies offer an innovative approach to housing design, focusing on adaptive and multifunctional spaces. These homes are designed with adaptable modules, such as movable walls, that can transform living spaces into workspaces or extra bedrooms. In addition, the facades and layouts of these homes optimise natural ventilation, daylighting and noise reduction, which is essential in urban areas with industrial activities such as Haven-Stad.

Practical examples illustrate how these housing typologies can be realised:

- **Elements in Amsterdam** shows an integrated approach with flexible housing types, collective spaces and sustainable additions such as a rooftop park and winter garden. These amenities promote not only sustainability but also social cohesion.
- **Adapteo's modular homes** offer a scalable and adaptable solution for both temporary and permanent housing needs. They combine comfort and sustainability with the ability to respond quickly to changing circumstances.
- **COA's flexible housing solutions** address diverse target groups and demonstrate that high-quality, relocatable housing offers an effective solution for areas with high pressure on the housing market.

In the context of Haven-Stad, these housing typologies can be equipped with hybrid air purification and thermal insulation systems, making them more resistant to environmental influences from nearby industry. Moreover, shared facilities such as shared workspaces and roof gardens encourage social interaction and make the houses attractive to both residents and industry workers. However, the effectiveness and feasibility of these systems and facilities require further research to fully understand their practical application and contribution to a sustainable and liveable environment.

What is this solution relevant to?

- **Zones:**
  - 🟡 **Zone 1:** Flexible housing typologies support the integration of small-scale industry and housing by making housing adaptable to changing needs.
  - 🟠 **Zone 2:** In areas with moderate industrial activity, these houses can serve as buffers against noise and air pollution, while allowing residents to combine work and living functions.
  - 🔴 **Zone 3:** In heavy industrial zones, flexible housing provides protection from industrial impacts and enhances livability by integrating sound attenuation and air-purifying technologies.
- **Residents' needs:**
  - ⚖️ **Objective:** The adaptive designs offer practical solutions to the challenges of hybrid working, while protecting against external factors such as noise and pollution.

    - 👁️ **Subjective:** By providing a sense of control and freedom in the use of living spaces, flexible housing typologies contribute to residents' satisfaction and well-being.
- **Relationship:**
    - ❌ > ⚡ > 🌱**:** Flexible housing typologies not only minimise the negative impact of industrial activities, but also create opportunities for interaction and collaboration. By integrating shared spaces and facilities, they strengthen the bond between residents and industry, resulting in a harmonious and mutually beneficial relationship.

Flexible housing typologies offer a future-proof solution to the challenges of living in an urban-industrial area such as Haven-Stad. By introducing adaptable and multifunctional spaces, they support both the changing needs of residents and coexistence with industrial activities. These homes not only enhance liveability, but also encourage innovation and collaboration, creating a sustainable and inclusive urban environment.

4.3.4 Membrane domes

What is the problem?

In heavy industrial areas, such as the intensively polluted areas of Haven-Stad, air pollution, noise pollution and extreme weather conditions pose major challenges to the living environment. These problems not only limit living comfort, but also make the use of outdoor spaces and public facilities unattractive or even impossible. The lack of a controlled microclimate in these areas also hampers social cohesion and residents' sense of safety and well-being.

What is the solution?

In heavily polluted industrial areas such as Zone 3 in Haven-Stad, where the impact of air pollution, heat and noise is challenging for both residents and industry, innovative membrane domes offer a unique architectural solution. Manufactured from materials such as ETFE, these lightweight, transparent structures create a controlled and protected environment where air quality, temperature and noise levels are effectively regulated.

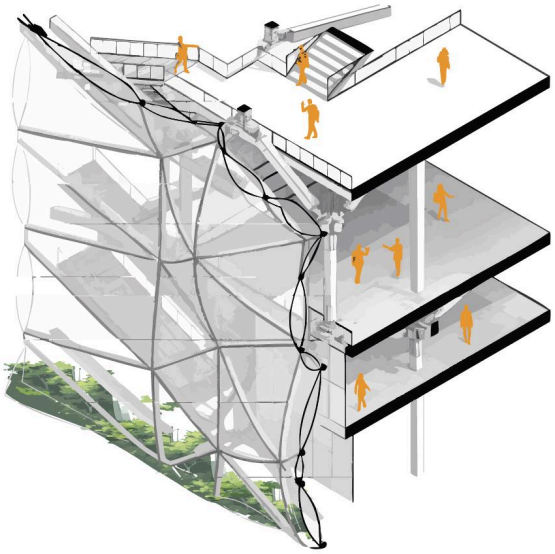

illustration 5: Architectural cross-section of such a membrane structure attached to an existing building (Own illustration).

The strength of these domes lies in their multifunctionality. They act as physical barriers against pollutants such as particulate matter and CO_2 from industrial activities, while at the same time creating a pleasant microclimate. Thanks to their transparency, they allow sufficient daylight, which not only promotes the well-being of occupants and users, but also creates a sense of openness and connection with the outside world. These properties make the domes not only functional, but also aesthetically pleasing.

A special feature of the membrane structures is the interstitial space they provide. Inspired by projects such as the *Mars Ice House*, designed for the extreme conditions on Mars, this space becomes more than just a buffer zone. In Haven-Stad, this in-between space could be used as a place for meeting and interaction between residents and industry workers. It provides an environment where recreation, relaxation and social cohesion come together, while limiting the spread of pollutants. This shared space strengthens the relationship between industry and residents and contributes to harmonious coexistence.

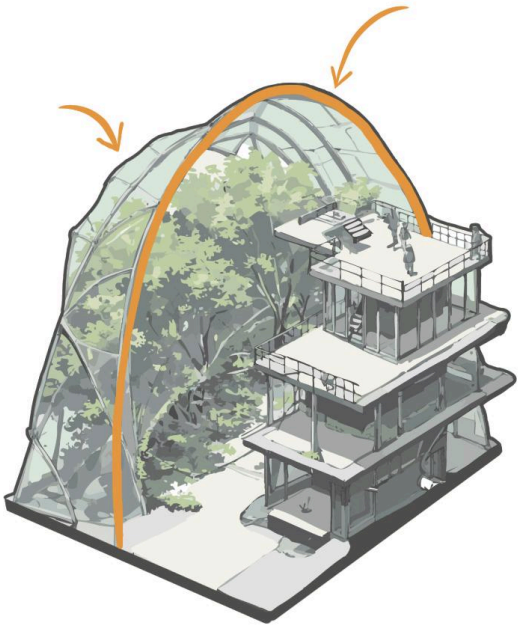

illustration 6: Architectural sketch showing the gap created when using such a membrane structure (Own illustration).

A variety of functions can be realised under the domes. From markets and sports facilities to green community zones, the domes provide a versatile and flexible space to suit the needs of different users. These functions make the domes relevant not only for residents, but also for industry workers, who benefit from pleasant and accessible spaces in their working environment.

Inspiration for this application comes from existing reference projects such as *The Eden Project* in Cornwall and the *Biosphere* in Potsdam. Both projects show that such structures can impressively combine ecological and social functions. In addition, they underline the potential of innovative membranes to address complex challenges in extreme environments.

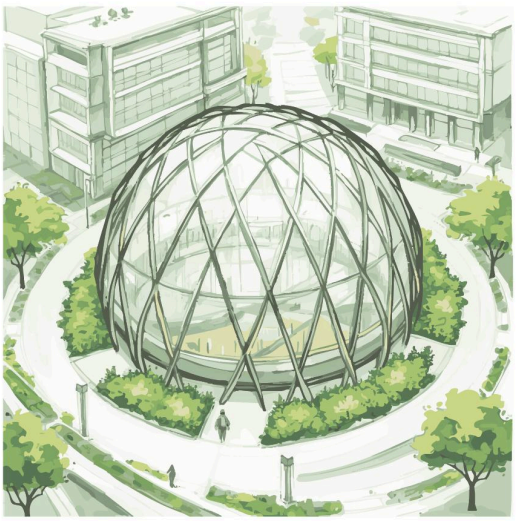

Illustration 7: Architectural sketch of a membrane dome applied in an urban setting (Own illustration).

What is this solution relevant to?

- **Zones**
  - 🟠 **Zone 2**: The domes can serve as partial canopies for specific functions, such as community markets or sports fields, to protect residents from moderate industrial impacts, such as noise and particulate matter.
  - 🔴 **Zone 3**: In heavily polluted industrial areas, membrane domes provide a safe and liveable micro-environment by minimising harmful environmental factors, such as extreme noise, air pollution and temperature variations.
- **Residents' needs**
  - ⚖️ **Objective**: The domes improve air quality and create a stable microclimate, significantly improving physical living conditions. They also help reduce odour and noise pollution, essential factors for residents' health and well-being.
  - 👁️ **Subjective**: The open, light and transparent architecture of the domes provides a visually appealing living environment. The multifunctional interstitial spaces, inspired by projects such as Mars Ice House, create places that invite meeting, recreation and contemplation, enhancing social cohesion.
- **Relationship**
  - ❌ > 🌱: Membrane domes foster a two-way relationship by neutralising the negative effects of industrial activities on residents, while industries benefit from an improved image and greater involvement in the urban community. The shared interstitial spaces under the domes provide a unique meeting place for residents and workers, encouraging cooperation and mutual understanding.

Membrane domes offer an advanced solution to the complex challenges in heavily polluted industrial zones, such as Haven-Stad. These domes protect against harmful environmental factors, such as air and noise pollution, while creating a high-quality and functional living environment. In doing so, they contribute to a balanced coexistence between industry and residents.

The architectural design of the domes, inspired by iconic projects such as the *Mars Ice House* and *The Eden Project*, combines aesthetics, functionality and sustainability. Using advanced materials and technologies, these structures not only provide a safe environment, but also promote social interaction and

collaboration by introducing shared spaces. These interspaces function as meeting points and contribute to social cohesion within mixed-use urban areas.

4.3.5 Orientation and zoning of buildings

What is the problem?

In Haven-Stad, the proximity of industry and housing and associated nuisances such as noise and air pollution pose major challenges to the liveability of the area. Residents experience limited access to daylight, fresh air and privacy when homes are directly adjacent to industrial areas. This can lead to an unpleasant living experience and increased stress levels, while at the same time industry may be inconvenienced by complaints or restrictions imposed by residents.

What is the solution?

Building orientation and zoning provides an architectural strategy to address these challenges. By placing closed facades on the side of industrial activities and facing open facades towards green areas and recreational areas, a barrier is created that minimises noise and air pollution. At the same time, this layout optimises the entry of daylight and ventilation, which is essential for a healthy and pleasant living environment.

The closed facades on the industrial side are designed with materials that absorb and insulate noise, such as acoustic glass or soundproof panels. These facades can also serve as space for vertical gardens or energy-saving features such as solar cells. On the open side, large windows, balconies and terraces overlook green areas, allowing residents to benefit from a natural and relaxing environment. This design balances the interests of residents and industry by creating an architectural buffer.

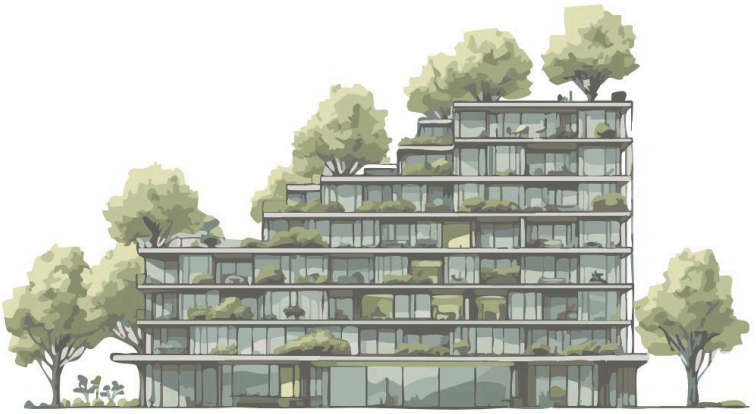

Illustration 8: Architectural design with integrated roof gardens in the Haven-Stad (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2:** In areas with moderate industrial activity, strategically placed closed facades and optimised open facades are crucial to reduce nuisance and create a pleasant living environment.
  - 🔴 **Zone 3:** In heavy industrial zones, this solution plays an essential role in minimising the impact of industrial activities on residential areas.
- **Residents' needs:**

    - ⚖️ **Objective:** The orientation and zoning improve air quality and reduce noise pollution, contributing to a healthier living environment.
    - 👁️ **Subjective:** Directing open façades towards green areas enhances the aesthetic appeal and well-being of residents.
- **Relationship:**
    - ❌ > 🌱: This approach minimises the negative impact of industrial activities by creating physical buffers, while residents benefit from an improved living environment. This fosters a reciprocal relationship in which both industry and residents benefit from building zoning and orientation.

The orientation and zoning of buildings provides a practical and effective architectural solution for harmonising housing and industry in Haven-Stad. Strategic placement of closed and open facades not only improves liveability but also minimises the impact of industry on residents. This contributes to the development of a sustainable and pleasant urban area, where the interests of residents and industry are balanced.

4.4 Technical solutions

Technical solutions are an important part of the transformation of Haven-Stad, as they enable housing in areas with heavy industrial activities in Haven-Stad. Where urban planning and architectural measures improve spatial and visual quality of life, technical solutions focus on directly reducing the impact of industrial processes.

By deploying innovative technologies such as air filters, noise insulation and waste heat utilisation, a liveable environment is created even in the most challenging areas. These solutions not only make it possible to reduce nuisances such as air and noise pollution, but also provide opportunities for mutual benefit between residents and industry. Examples include shared energy solutions or carbon capture and recycling systems. Technological innovations play an essential role in facilitating the integration of living and working in a heavily polluted industrial environment. They contribute to the feasibility of a sustainable and liveable development of Haven-Stad.

4.4.1 Raised chimneys and exhaust pipes

What is the problem?

In Haven-Stad, industrial emissions and odour cause significant nuisance to residents. Harmful substances such as particulate matter, nitrogen oxides and odour components accumulate in densely populated areas, affecting not only liveability but also the health of residents. The proximity of residential areas to industrial activities exacerbates these effects, and existing emission systems are insufficiently designed to minimise this impact.

What is the solution?

Raising chimneys and emission pipes offers an approach to reduce the negative effects of industrial emissions on nearby residential areas. This measure focuses on diluting pollutants, such as particulate matter and nitrogen oxides, by dispersing them higher in the atmosphere. This reduces the direct impact on homes, while allowing industrial activities to continue undisturbed (LineOne, s.d.).

The effectiveness of raised chimneys was already demonstrated in the Ruhr region of Germany in the 1960s and 1970s. Here, the ‘policy of high chimneys’ was introduced, in which industrial chimneys were

raised to dilute air pollution and improve the living environment. Although this policy provided temporary relief, it became clear that it was only a respite from environmental problems, as pollution eventually spread to larger areas (LineOne, s.d.; Appendix 2, 2024).

Annex 2 shows that chimneys in the Ruhr region are significantly higher than in Haven-Stad. This difference highlights the potential of raised chimneys as a temporary measure in urban transformations.

Besides dispersing emissions, raising chimneys offers other technical advantages. Higher chimneys create a stronger chimney effect, leading to more efficient air circulation and better removal of industrial heat and gases (ScienceSpace, s.d.). This not only contributes to cleaner air, but can also have a passive cooling effect on industrial systems, increasing operational efficiency.

Moreover, modern chimneys can be equipped with advanced filtration systems, such as electro-filters and catalysts, to further purify emissions before they reach the atmosphere

While raised chimneys are a temporary solution, it is important to realise that this measure is not enough to improve air quality in the long term. Integrated environmental strategies, such as the implementation of carbon capture and storage, and the transition to clean energy sources are essential to structurally reduce the impact of industrial emissions (Vion, 2021).

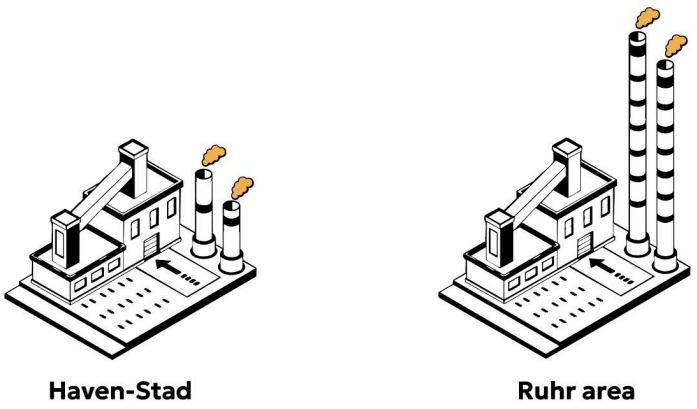

Illustration 8: Comparison of chimney heights between the Haven-Stad and the Ruhr (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🔴 **Zone 3:** In heavily polluted areas, this solution provides immediate relief by reducing local concentrations of pollution and achieving better air quality.
- **Bewoners behoeften:**
  - ⚖️ **Objective:** Improved air quality directly contributes to a healthier and liveable environment for residents.
  - 👁️ **Subjective:** By reducing odour and visual nuisance, negative associations with nearby industry are reduced.
- **Relatie:**
  - ❌ > ⚡: By dispersing emissions, negative impacts on residents are reduced without interfering with industrial activities. This results in a commensal relationship in which residents benefit from reduced nuisance and industry can continue to operate undisturbed.

Raising chimneys and emission pipes in Haven-Stad offers a pragmatic solution for reducing air pollution and odour nuisance in nearby residential areas. Although this measure is a temporary solution, it represents

an important first step in creating a more liveable urban-industrial area. By combining this approach with other technical innovations and environmental strategies, a sustainable transformation of Haven-Stad can be achieved.

4.4.2 Residual heat utilisation

What is the problem?

In Haven-Stad, residual heat released from industrial processes is not yet sufficiently utilised. This leads to wasted energy and a missed opportunity to sustainably heat homes and other functions, such as greenhouses. Although the City of Amsterdam has now integrated residual heat from data centres into heat networks, this valuable energy source is still hardly used in other industrial sectors. This inefficiency hampers the transition to a sustainable energy supply and increases dependence on fossil fuels (Gemeente Amsterdam, z.d.).

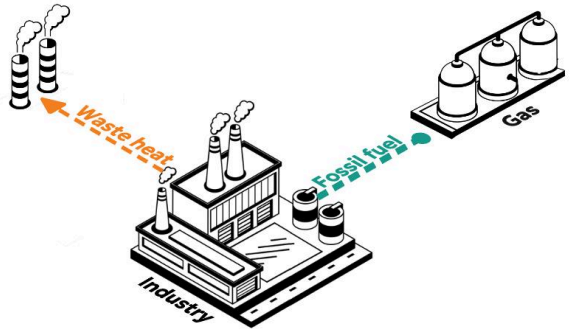

Illustration 9: Illustration of current energy flows in the Haven-Stad (Own illustration).

What is the solution?

Waste heat utilisation offers a sustainable and practical solution by using the heat released from industrial processes to heat homes and greenhouses. This not only increases energy efficiency, but also reduces energy costs for both residents and businesses. Heat networks such as Warmtelinq demonstrate how infrastructure can be effectively used to distribute waste heat from industrial sources to urban areas (Warmtelinq, s.d.).

The proximity of homes and industry in Haven-Stad makes setting up a waste heat network relatively easy and cost-effective. Through a network of pipelines, heat can be transported directly from industrial sources to homes and greenhouses. A good example is the heat network in Hoek van Holland, where residual heat from industry is used for both homes and greenhouses (Restwarmtenet Hoek van Holland, s.d.).

Adding greenhouse horticulture as an additional function in Haven-Stad can further strengthen this solution. Greenhouse horticulture companies can use residual heat to heat greenhouses, which not only increases the efficiency of the network, but also contributes to local employment and sustainable food production. This is similar to initiatives such as that of Dutch Heat Now (NWN), in which residual heat is used for sustainable agriculture and energy efficiency (NWN, s.d.). Through this synergy, Haven-Stad can create a circular energy system that integrates urban and industrial functions in a sustainable way.

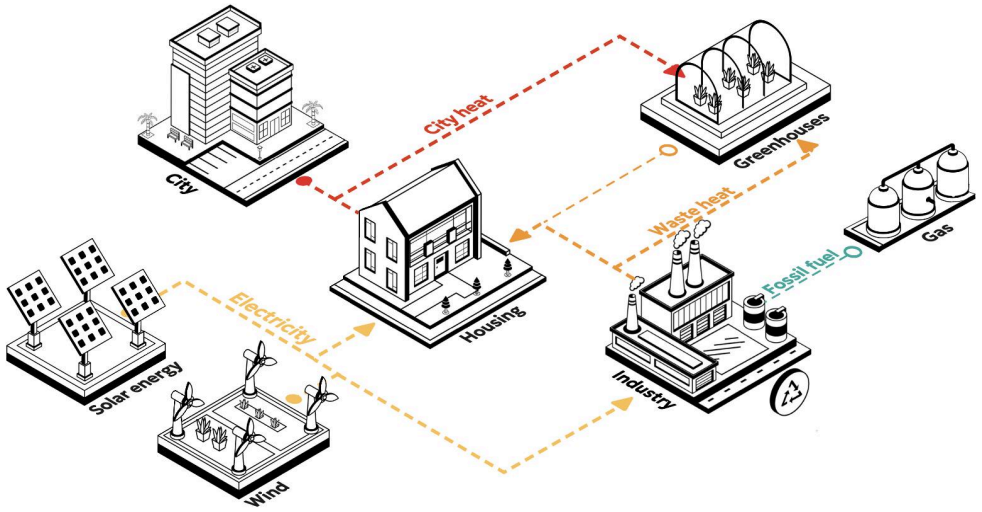

illustration 10: Illustration of future energy flows in the Haven-Stad (Own illustration).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2:** Here, waste heat utilisation makes it possible to provide heat to both homes and small-scale greenhouses.
  - 🔴 **Zone 3:** In these heavily utilised industrial areas, waste heat can be widely used for both urban functions and industrial cooperation, maximising energy efficiency.
- **Residents' needs:**
  - ⚖️ **Objective:** Waste heat increases energy efficiency and reduces energy costs, providing direct economic and environmental benefits for residents.
  - 👁️ **Subjective:** The use of waste heat contributes to an eco-friendly image of the area, making it more attractive to both residents and businesses.
- **Relationship:**
  - ❌ > 🌱**:** By utilising waste heat, the relationship between industry and residents transforms into mutualism. Industries reduce their negative impact on the environment and actively contribute to improving the living environment. Residents benefit from lower energy costs and a more sustainable living area.

Residual heat utilisation is a feasible and sustainable solution for Haven-Stad, connecting homes, greenhouses and industry through a circular energy system. Utilising industrial residual heat not only provides an efficient way to heat homes and greenhouses, but also strengthens the economic and ecological integration of functions in the area. With examples such as the heat network in Hoek van Holland and the use of greenhouse horticulture, Haven-Stad can serve as a model for sustainable urban development.

4.4.3 CO_2 capture and recycling

What is the problem?

Industrial processes in Haven-Stad contribute significantly to emissions of CO_2, a major contributor to climate change. To meet the national target of a CO_2-neutral industry by 2050, it is essential to implement innovative solutions that not only reduce emissions, but also create value. Currently, CO_2 is often sent into the atmosphere without recycling, while these emissions have potential as feedstock for green applications in the area, such as feeding plants in vertical farms and green spaces.

What is the solution?

CO_2 capture and reuse offer a progressive solution to reduce emissions from industrial processes while creating a valuable resource. By capturing CO_2 with technologies such as chemical absorption or membranes, emissions can be effectively reduced and reused.

An inspiring example of this is the AVR waste-to-energy plant in Duiven, where 60,000 tonnes of CO_2 are captured annually and supplied to horticulturists for use in greenhouses. This application increases crop yields and reduces dependence on fossil fuels. A similar system can be applied in Haven-Stad to use the captured CO_2 for vertical farms and urban greenery, such as green corridors and parks. This makes it possible to strengthen the circular economy in the area by directly linking industrial emissions to green urban functions (AVR, s.d.).

With the support of research and innovation from TNO, the implementation of CO_2 capture can be further optimised. Their expertise in capture and storage technologies provides solutions to not only reuse CO_2 locally, but also transport it to other locations where demand for CO_2 exists, such as greenhouses in the region (TNO, s.d.).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2**: CO_2-afvang en hergebruik ondersteunen de transitie naar een duurzamere omgeving in middelzware industriële gebieden.
  - 🔴 **Zone 3:** In zware industriële gebieden is CO_2-afvang essentieel om de uitstoot drastisch te verminderen en bij te dragen aan een leefbare omgeving.
- **Residents' needs:**
  - ⚖️ **Objective**: Vermindering van CO_2-uitstoot draagt bij aan een schonere lucht en een gezonder leefklimaat.
  - 👁️ **Subjective:** Het hergebruik van CO_2 voor stedelijk groen en vertical farms versterkt het imago van Haven-Stad als een innovatieve en duurzame leefomgeving.
- **Relationship:**
  - ❌ > 🌱: CO_2 capture and reuse transform the relationship between industry and the environment from a harmful to a mutually beneficial interaction. Industry reduces its negative impact, while urban functions benefit from the captured CO_2.

CO_2 capture and reuse are an innovative and sustainable solution to the challenges of industrial emissions in Haven-Stad. Utilising CO_2 as a raw material for urban functions such as vertical farms and green facilities not only reduces emissions, but also creates a valuable contribution to the living environment. In the context of Haven-Stad, this technology can play a key role in the transition to a circular and sustainable urban environment. Linking industry's CO_2 emissions to urban functions creates a mutually beneficial relationship in which industry and residents reinforce each other.

4.4.4 Energy production

What is the problem?

The transformation of Haven-Stad into a sustainable mixed residential-work area requires a significant reduction in dependence on fossil fuels. Both the industrial sector and the new housing in the area need a stable and green energy supply. Currently, an integrated approach to large-scale renewable energy

generation is lacking, hampering the electrification of industry and making housing more sustainable. Without structural solutions, Haven-Stad remains dependent on traditional energy sources, delaying the transition to a carbon-neutral future in 2050 (TNO, s.d.).

What is the solution?
Energy generation offers an innovative and integrated approach by integrating renewable energy sources, such as solar panels and wind turbines, into both residential and industrial buildings. For homes, solar panels can be installed on roofs and facades, which not only contributes to sustainable power generation, but also covers residents' energy needs locally (Platform31, 2023).
In industrial zones, large areas, such as roofs of factories and warehouses, can be used for solar energy. In addition, wind turbines designed for urban areas can be deployed. These turbines produce green power without causing significant space occupation or noise pollution (TNO, s.d.). The combination of solar and wind power provides a stable energy mix that supports both industrial and residential needs.

The energy generated can be used directly to electrify industrial processes. Examples include electrically powered machinery and heat generation through electric boilers. Surplus energy can be stored in batteries or used for residential purposes, creating a fully integrated and circular energy system (TNO, s.d.).

What is this solution relevant to?

- **Zones:**
  - 🟠 **Zone 2:** Both industry and homes can benefit from integrated energy generation technologies.
  - 🔴 **Zone 3:** Large-scale industrial rooftops provide an ideal location for solar panels, and wind turbines can help make heavy industry more sustainable.
- **Residents' needs:**
  - ⚖️ **Objective:** Access to sustainable and affordable energy sources increases energy efficiency and reduces energy costs for residents.
  - 👁️ **Subjective:** The visible presence of renewable energy sources, such as solar panels and wind turbines, strengthens the sustainable identity of the area and contributes to a sense of pride among residents.
- **Relationship:**
  - ❌ > 🌱: By integrating energy generation technologies, both industry and residents benefit from a shared infrastructure. This fosters a mutual relationship in which industrial processes are made sustainable and residents have access to clean energy.

Energy generation from renewable sources is an essential pillar for the transformation of Haven-Stad. It not only provides a solution to the electrification of industry, but also contributes to making homes more sustainable and creating a circular energy system. Integrating solar and wind energy creates a stable, green energy supply that meets the needs of both residents and businesses. This makes Haven-Stad an example of how renewable energy solutions can contribute to a carbon-neutral future.

4.5 Conclusion

The solutions presented in this chapter provide a basis for transforming Haven-Stad into a sustainable, liveable and integrated live/work area. Through an integrated approach of urban planning, architectural and technical strategies, both the physical and functional challenges of the area are addressed. In addition, these solutions provide a framework for encouraging mutual interactions between industry and residents, contributing to a balanced and future-proof development.

Quantification and analysis of solutions

The solutions presented in this chapter have been analysed according to their relevance to the different zones, the needs of residents and their impact on the relationship between industry and residents. Below is a quantitative overview:

Zones
The distribution of solutions across zones shows how they contribute to the transformation of Haven-Stad:

- 🟡 **Zone 1:**
  - **5 solutions** aimed at aesthetic improvements and climate adaptation, such as green buffers, vertical gardens, and flexible housing typologies.
- 🟠 **Zone 2:**
  - **7 solutions,** including double façade systems, residual heat utilisation, and smart rearrangement of infrastructure, which reduce disruption and promote social interaction.
- 🔴 **Zone 3 :**
  - **6 solutions,** such as membrane domes, raised chimneys and energy generation, which aim at intensive adaptations to ensure livability.

Residents' needs
The solutions address both objective and subjective needs of residents:

- ⚖️ **Objective needs** (health, safety, energy efficiency):
  - **10 solutions**, with a focus on improvements in air quality, noise reduction, and energy efficiency.
- 👁️ **Subjective needs** (aesthetics, well-being, pride):
  - **8 solutions**, such as vertical gardens and green corridors, which contribute to the well-being and aesthetic attractiveness of the environment.

Relationship between industry and residents
The impact of the solutions on the relationship between industry and residents was classified as follows:

- ❌ **Parasitism (negative impact on residents):**
  - **0 solutions.** All proposed measures reduce parasitic interactions.
- ⚡ **Commensalism (benefit to one party, no harm to the other):**
  - **5 solutions,** such as raised chimneys and emission pipes, which mainly reduce nuisance for residents without direct benefits for industry.
- 🌱 **Mutualism (mutual benefits):**
  - **9 solutions,** including waste heat utilisation, carbon capture and reuse, and shared energy networks, offering benefits for both residents and industry.

The combined approach of urban planning, architectural and technical solutions provides a solid basis to address the challenges of Haven-Stad. The quantification of the solutions shows that most of the measures target Zone 3, the most heavily impacted area, with a strong emphasis on meeting objective residents' needs such as air quality, noise reduction and climate resilience. In addition, the analysis shows that a large proportion of the solutions create a mutualistic relationship in which both residents and industry benefit.

These solutions not only focus on reducing nuisance, but also promote social cohesion and sustainability. By combining smart infrastructure, green architecture and innovative technologies, it is possible to transform the interaction between industry and housing in Haven-Stad into a mutually beneficial relationship. This effectively achieves the goal in Chapter 3 of realising mutualism.

The transformation of Haven-Stad thus functions as a model for urban development in which mutual interests are central. The approach emphasises that a harmonious relationship between industry and residents is feasible, provided investment is made in solutions that are both functionally and socially relevant.

The next chapter discusses how these solutions can be practically implemented, supported by strategies that further optimise the interaction between industry and residents. As a result, the transformation of Haven-Stad can succeed not only in theory, but also in practice.

5. Implementation of solutions

5.1 Introduction

The transformation of Haven-Stad into a mixed residential-working area is a challenging process that requires a coherent and strategic approach. The previous chapters have analysed the challenges, opportunities and solutions. These solutions focus on minimising disruption, promoting sustainability and encouraging positive interaction between industry and residents.

This chapter presents a roadmap to enable the transformation of Haven-Stad. The roadmap consists of a series of integrated phases, focusing on policy, stakeholder cooperation, technical measures and social integration. Arranging this approach chronologically provides a clear path from vision to realisation.

The roadmap emphasises not only the need for a structured approach, but also the flexibility to respond to future developments in Haven-Stad. These phases are intended to transform theoretical solutions into practical actions.

5.2 The roadmap to harmonious coexistence

Phase 1: Inventory and analyse current situation 🔍📝

- **Compile a detailed map** of industrial zones, their environmental impacts and infrastructure present. See Chapter *2.1 industrial activities in Haven-Stad*.
- **Identify companies with the greatest impact** on odour, noise and dust, and determine their specific impact on the surrounding area. See Chapter *2.1 industrial activities in Haven-Stad*.
- **Develop policies for function mixing:** See Chapter *2.2 Potential residents and their needs* and Chapter *3: Interactions and relationships*. Establish new regulations that allow safe combinations of residential and industrial. Introduce specific ground rules for emission standards, noise and nuisance abatement in mixed zones.
- **Define clear zones** (light, medium, heavy) with corresponding guidelines for transformation.

Phase 2: Prepare area for housing 📋🏠

- **Realise green buffer zones:** See Chapter *4.2.1: Natural boundaries and green buffers*. Create natural boundaries between industry and housing through green areas. Use greenery to improve air quality, dampen noise and create visual barriers.
- **Raise industrial chimneys:** See Chapter *4.4.1: Raised chimneys and exhaust pipes*. Minimise air pollution and odour nuisance by dispersing emissions higher in the atmosphere. Implement filters and technologies to further reduce emissions.
- Modernise industrial infrastructure: See Chapter 4.2.2: *Smart rearrangement of infrastructure.* Develop smart supply routes to minimise the logistical impact on residents. Introduce separate transport networks for heavy goods traffic and residential mobility.
- **Create a green corridor through the area:** See Chapter *4.2.1: Natural boundaries and green buffers*. Design green corridors as connecting elements between residential and commercial areas.
- **Design shared areas between industry and housing** See Chapter *4.2.3: Flexible zoning*. Develop transitional zones where residents and workers can come together and benefit from shared functions.

- Flexible functions: Introduce temporary workplaces, pop-up parks, markets or recreational spaces to encourage interaction.

- Buffer and interaction: Make these zones function as physical and social buffers, where residents and workers can come together safely and enjoyably.

- Spatial quality: Design attractive public spaces that contribute to social cohesion and a sense of community within the area.

Phase 3: Phased residential constructions 🏗️🌳

- **Stimuleer duurzame energie:** Zie *Hoofdstuk 4.4.4: Energieopwekking*. Introduceer groene energiebronnen zoals zonnepanelen en windmolens in het gebied. Ontwikkel systemen om industriële restwarmte te benutten voor het verwarmen van woningen.
- **Bouw adaptieve woningtypologieën:** Zie Hoofdstuk 4.3: Architectonische oplossingen. Pas architectonische oplossingen zoals dubbele gevels, daktuinen, oriëntatie en membraanstructuren toe, afgestemd op de specifieke uitdagingen per zone.
- **Start pilotprojecten voor functiemenging:** Voer kleinschalige experimenten uit met woningen in lichte industriezones. Gebruik de resultaten van deze pilots om de plannen verder te optimaliseren en op te schalen.

Phase 4: Promote cooperation and integration 🤝🔗

- **Encourage collaboration between stakeholders:** Create a partnership between the municipality, industry, housing associations and residents. Involve all parties in the design process to increase support and commitment.
- **Facilitate local training and employment:** See Chapter *4.2.6: Training and employment programmes*. Start MBO programmes aimed at technical occupations in industry. Encourage industries to provide employment opportunities for residents of the new residential areas.
- **Integrate smart mobility solutions:** See Chapter *4.2.2: Smart rearrangement of infrastructure*. Strengthen public transport in Haven-Stad and create bike lanes and shared transport options. Make plans to separate freight traffic and residential mobility for greater safety and comfort.

Fase 5: Monitor, evaluate and adjust ✅📊

- **Establish clear KPIs:** Define measurable indicators for sustainability, liveability and economic impact.
- **Evaluate progress:** Use collected data to analyse progress and make improvements where necessary.
- **Adjust where necessary:** Implement flexible strategies and adjust measures to respond to new insights or changing circumstances.

5.3 Conclusion

Implementing solutions in Haven-Stad requires a phased and integrated approach that takes into account the (complex) relationship between industrial activities and residential functions. The proposed roadmap provides a structured framework for the transformation.

The success of the transformation depends on the coherence between measures, such as modernising infrastructure, introducing green buffers and deploying renewable energy solutions. The plan also emphasises the importance of adaptive implementation, so that new insights and changing circumstances can be integrated.

The roadmap constitutes a practical and scientifically based start for the transition of Haven-Stad to a mixed living-working area. Through this approach, a harmonious coexistence between industry and residential will be enabled. See Annex 3 for this roadmap.

6. General approach to housing integration in urban industrial areas

6.1 Introduction

The strategies and solutions developed in this research have been tested within the specific context of Haven-Stad. This industrial area serves as a case study to examine whether housing and industry can be integrated. However, the question remains whether this approach is more widely applicable. Can similar areas, such as port and post-industrial sites worldwide, also benefit from this methodology? This chapter explores how the insights from Haven-Stad can be scaled up to other areas and what adjustments are needed to do so.

The focus is on translating the strategies and solutions into a generic approach that can be adapted to diverse geographical, economic and policy contexts. This analysis not only highlights the potential of scaling up, but also identifies limitations and challenges.

6.2 Evaluation of applicability

1. Key lessons from Haven-Stad
The Haven-Stad case study offers a series of valuable lessons:

- **Zoning:** Classifying areas according to industrial intensity (light, medium and heavy zones) helps focus solutions.
- **Mutualism:** Developing mutually beneficial relationships between industry and residents is crucial to reduce conflict.
- **Flexible strategies:** A mix of urban planning, architectural and technical solutions provides the necessary space to provide locally tailored solutions.
- **Residents' needs:** Both objective factors, such as housing quality, and subjective aspects, such as aesthetics, should be considered in the design of residential environments.

2. Opportunities for scaling up
The approach can be applied in other areas with similar characteristics:

- **Port areas:** Where logistics and heavy industry are at the core.
- **Post-industrial sites:** Areas with declining industrial function that are transforming into mixed residential-working zones.
- **Urban expansion sites:** Where lack of space and urban pressures call for innovative integration of living and working.

3. Adapting to local context
When scaling up, strategies should be adapted to local conditions:

- **Policy:** Local and national regulations influence the feasibility of solution**s.**
- **Economic resources:** The availability of funding determines the scale and speed of implementation.
- **Environmental characteristics:** Climate, infrastructure and population density require context-specific approaches.

6.3 Generic approach for urban transformation

Om de inzichten uit Haven-Stad te vertalen naar andere gebieden, wordt een generieke aanpak voorgesteld:

1. Context analysis

- Analyse the industrial intensity, resident needs and infrastructure of the area.
- Use the zoning of light, medium and heavy zones as a basis for tailor-made solutions.

2. Modular strategies

- **Zoning:** Offer solutions that fit the specific challenges of each zone.
- **Mutualism:** Encourage shared benefits, such as energy exchange and green buffers.
- **Resident-centred design:** Develop flexible housing models that meet objective and subjective needs.

3. Cooperation models

- **Public-private partnerships:** Encourage cooperation between industry, government and housing associations.
- **Financing:** Create subsidies and tax breaks for sustainability and housing construction.
- **Participation:** Involve residents in decision-making to increase support.

6.4 Constraints and challenges

Some limitations need to be overcome when scaling up this approach:

- **Financial resources:** Not all regions have access to sufficient budget for large-scale transformations.
- **Policy frameworks:** Variations in regulations between countries and regions can complicate implementation.
- **Support:** Integrating housing and industry requires convincing evidence that liveability and sustainability can go hand in hand.

6.5 Conclusion

The strategies and solutions developed in this research are not only relevant to Haven-Stad, but also provide a basis for urban transformations elsewhere. Combining zoning, mutualistic relationships and resident-centred designs, it forms a generic framework that can be adapted to various urban and industrial contexts.

Although local adjustments are necessary, this approach provides a tool to future-proof urban areas. Translating the insights from Haven-Stad to a broader context paves the way for innovative transformation projects that promote the balance between living, working and sustainability.

7. Conclusion and discussion

7.1 Conclusion

This study focused on the question: *How can housing and industry be harmoniously integrated in a heavy industrial area like Haven-Stad?* Answering this question required an analysis of the specific challenges and opportunities involved in combining housing and work. The findings show that successful integration is possible, provided a coherent and area-specific approach is taken.

The study ‘Harmonious society between industry and living in Haven-Stad’ concludes that the integration of living and industry in an area like Haven-Stad is feasible, provided a well-thought-out strategy is followed. By acting on three pillars, harmonious coexistence can be achieved:

- **Zone-oriented solutions:** Classifying areas according to industrial intensity (light, medium and heavy industry) makes it possible to specify measures. Lighter zones require simpler adaptations, while heavier zones require radical and innovative solutions, such as membrane structures and raised chimneys.
- **Mutual relationships:** By encouraging synergies, such as shared infrastructure and energy exchange, industry and housing can reinforce each other. This approach not only minimises nuisance, but transforms the interaction between the two functions into a mutually beneficial collaboration.
- **Resident-centred design:** residents' needs, both objective (such as air quality and safety) and subjective (such as aesthetics and experience), are at the heart of the process. This results in a living environment that is not only functional but also attractive.

The study offers concrete strategies, including urban planning measures (green buffers, smart infrastructure), architectural innovations (flexible housing typologies, double facades) and technical solutions (waste heat utilisation, carbon capture). Implementing these requires a phased approach and close cooperation between all stakeholders.

Using Haven-Stad as an example, this project shows that the integration of housing and industry can be feasible. The findings provide a framework that is applicable in Amsterdam and, with attention to local context, can also inspire urban-industrial transformations elsewhere. Harmonious coexistence is possible through a smart combination of strategy, collaboration and innovation.

7.2 Reflection

Haven-Stad shows that the integration of housing and industry is not only a complex challenge, but also offers opportunities for more sustainable and inclusive urban development. This research provides policymakers with a practical framework, offers designers inspiration for innovative solutions, and forms a solid basis for further academic studies.

The focus on Haven-Stad provides valuable insights, but limits the generalisability of the results. For wider application, additional research is needed on similar urban-industrial areas. This can help refine the developed framework and adapt it to diverse contexts and challenges.

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9. Appendix

I. Photo report of field visits to Haven-Stad

II. Ruhr region analysis:

https://earth.google.com/earth/d/1CKhH159qgKBqS3Eip7KSyGLxPxrTWR1F?usp=sharing

III. The roadmap to a harmonious coexistence

Harmonious coexistence between industry and housing in **Haven-Stad**