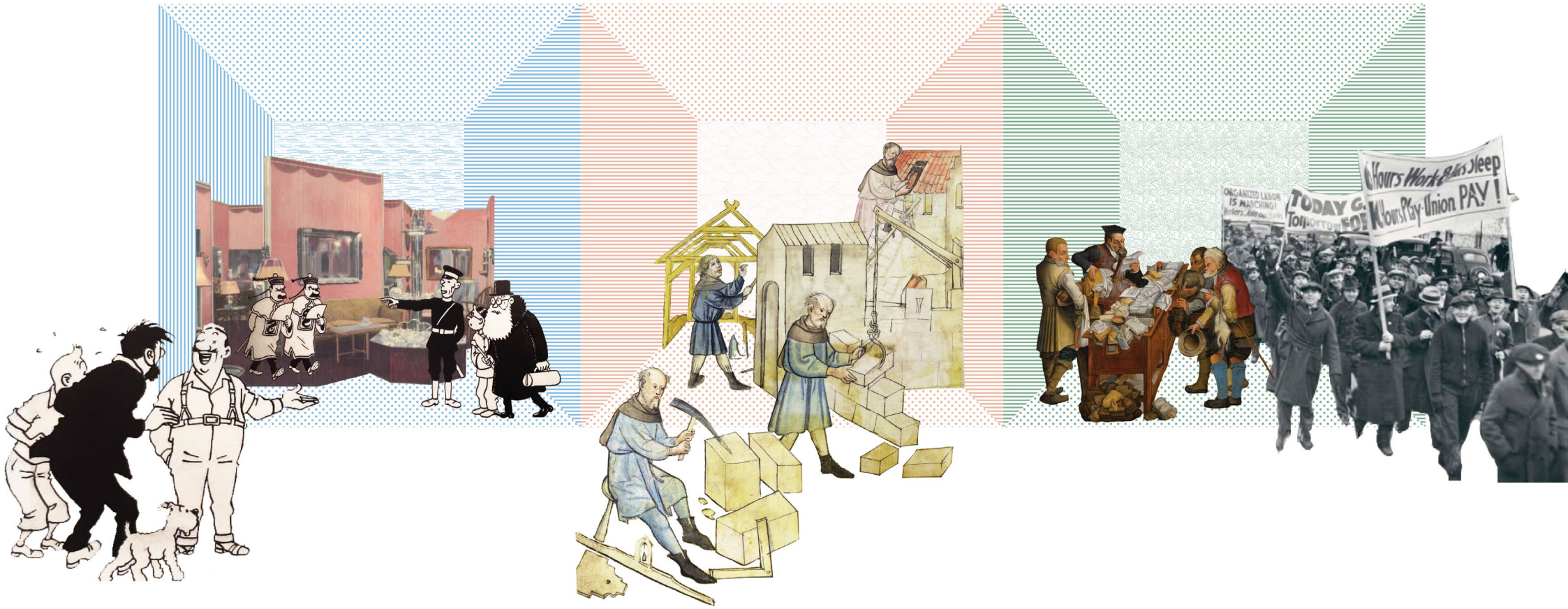
¡Open construction!

Envisioning a network for construction circularity in an urbanising landscape in the province of South Holland



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AR2U086 Spatial Strategies for the Global Metropolis
MSc Urbanism Q3
TU Delft Faculty of Architecture and the Built Environment

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Content

Preface

The project ¡Open construction! is a proposal for a circular model in the construction and demolition industry in the province of South Holland. This model is established by Nicolás Carvajal, Federico Carvajal Ruiz, Laura Conijn, Christiaan Hanse and YiXiáng Huang during the 2019/2020 Msc2 course AR2U086 R&D studio Spatial Strategies for the Global Metropolis. This is part of the Master of Urbanism at the Faculty of Architecture and the Built Environment at Delft University of Technology.

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Abstract

A nationwide program for building one million dwellings aims to relieve the Netherland's housing crisis: nearly a quarter of this construction will take place in South Holland. Currently, the construction industry needs a huge input of raw materials that is not only causing waste problems but is also decreasing environmental quality. A large part of construction and demolition waste (CDW) is being downcycled, losing economic and material value. This creates not only a need but an opportunity for a construction and demolition (C&D) industry based on circular flows and biobased materials. The goal of this project is to produce a vision with strategies for the implementation of circularity along with the resolution of spatial conflicts in different scales.

An overview of the spatial, technical and economic needs of the C&D industry and its externalities in urban environments was made. This resulted in the understanding of the spatial conflicts currently taking place between these two spheres of development and the potentials that circularity will have on jobs and consumption patterns. From this, a proposal for a circularity model with three components was formulated: an open network with a central production hub and peripheric logistic hubs, an open program for these hubs that adapts to current and future needs, and open edges that create interactions with their built and social environment.

Keywords: circularity, South Holland, construction and demolition waste, construction hubs, open scales, urbanisation

1 INTRODUCING ¡OPEN CONSTRUCTION!

1.1/Introduction

Open construction is a response to the goals of reaching a fully circular economy by 2050 and building 210.000 dwellings in the Dutch province of South Holland. The provision of dwellings creates a pressing conflict of resources, space and social cohesion.

South Holland, like the Netherlands, relies heavily on concrete for a wide array of construction activities. Such a demand for concrete and other construction materials makes the construction industry in the province produce the largest waste stream (around 4 Mton) causing relatively many negative environmental effects (Royal Haskoning, 2017). Although demand cannot be reduced, especially because of the need for additional dwellings, the province is searching for more circular input streams such as reusing, recycling and refurbishing.

Because of the new dwellings program, space for the construction industry and its corresponding housing projects compete for the same space. A factor that puts pressure on this land use competition is agglomeration as there is a conflict between growth and spatial equity because the peripheral region would be a loser when growth is boosted by the agglomeration of mobile activities (Keilbach, 2000). Industrial areas are enclosed urban spaces with no outside access that also largely contribute to emissions, therefore, are seen as dirty and off-limits.

For example, transportation alone was responsible for two thirds of the total consumption of energy of the construction sector in Rotterdam (Gladek et al., 2018). It is essential to be able to integrate both functions as industry is a spatial enclave in the present day.

Proposing to open up the construction industry to surrounding neighbourhoods not only creates discussions among existing home dwellers but also surfaces the current situation of construction workers. A large part (75%) of the migrant Construction and Demolition (C&D) workers in large construction sites, as those that the one million dwellings policy will produce, work under sub-standard conditions. The main reason for this is that these workers are not settled in the Netherlands, switching between different countries, companies and contracts in short periods of time (Berntsen, 2018). Under this circumstance, the role and status of hyper-mobile workers needs to be reconsidered in order to better integrate them into the society they are working for and in.

1.1.1/Problem statement

The Netherlands has a need for **one million new dwellings**, of which 150.000 still need to be located in the province of South Holland in the next decade. After this, an additional amount of 60.000 dwellings is needed. This will result in an **increased demand of materials** and create **waste from both construction and demolition processes**. To prevent further pressure on the limited availability of resources -including land- in the province of South Holland, there is a need to **define and apply circularity**. Achieving a circular model will require to formulate scenarios relating to material flows and their **social and spatial implications**.

Population in the South Holland province is expected to reach four million inhabitants by 2040. This means that the population will increase by around 300.000 inhabitants from 2018 to 2040. The Hague and Rotterdam are in the top three fastest growing municipalities in The Netherlands (CBS, 2016). Due to this, meeting housing needs is an urgent task that the province is currently facing. The demand for housing in the province originates from two developments: population increase and more residents living in single family dwellings (van Duin, te Riele, & Stoeldraijer, 2018). The graph below explains how these two developments interact to create a housing demand of one million dwellings.

The construction and demolition industry will be vital in terms of meeting the demand for new housing imposed by population growth. In order for a transition to happen, various strategies must be implemented to achieve a circular C&D industry. There is a need for multiple innovations and regulations to happen as “for each 100 houses being built in the region, 24 are demolished” (Gladek et al, 2018, pg. 76). This shows a deficit in terms of produced waste that has to be replaced with “new” raw materials. Currently construction materials released from demolition and renovation are not being reused with respect to their value. Because of this, contemporary methods of dealing with released materials are not only creating demand for more raw materials, but are also not taking advantage of the market value that can be generated.

one million new dwellings | increased demand of materials | more waste | apply circularity | social implications | spatial implications

1.1.2/Research questions

Main question

How can regional planning facilitate a circular model for the construction and demolition material industry in the case of urbanisation in South Holland?

Sub questions

1/**What are the spatial implications of a circular industry?**

2/**What are the scales of circularity with respect to the construction and demolition industry?**

3/**What are the social and technical implications of a circular industry in terms of job creation, public acceptance and cohesion?**

1.1.3/Conceptual framework

As shown in figure 1, the proposal for ¡Open construction! is encompassed by transitional and sustainability theories. These theories are used to develop a framework that defines how a circularity proposal can be achieved for the construction and demolition industry. This is realised through exploring relationships between the scales of open network, open program and open edges to the material flows, economic development and liveable urbanisation activities.

Theories

Transition

Transition is the main theory used since for a transition to occur, many interactions must happen which involve multi-level interactions of different social groups (Geels, 2005). By framing relationships between scales with multi-level interactions, an understanding of distinct societal dimensions is gained. The open construction proposal calls for the transition of the C&D industry into a circular model that not only takes into account industrial components but also integrates society into it. Therefore, the importance of structuring a proposal based on scales aligns the notion of transitions.

Sustainability

Before transitioning into a circular model for the industry, sustainability must be understood as it can be used to better describe how such a circular system works. Sustainability demands for the integration of social, economic and environmental dimensions as for sustainability to be achieved it “must occur in these three dimensions simultaneously” (Larsen, 2012, pg. 48). Relating these dimensions with respect to the established scales results in actively integrating the dimensions into our scope of work.

Circularity

A circular C&D industry means understanding how transitions can be managed and integrating sustainability dimensions into our scales. With a circular C&D industry we aim for more conscious development to take place in terms of resource consumption and living standards. Integration is achieved by analysing the different scales of shifting an industry to one based on a circular hubs system. The circular hubs are evaluated with respect to the system using three scales: open network, open program and open edges. Scaling the main production hub and its seven satellite material hubs allowed us to make relationships with material flows (environmental), economic development (economic) and liveable urbanisation (social) in order to materialise a tangible C&D industry.

Activities

Material flows

This activity within the proposal refers to the efficient tracking and monitoring of all materials used for the realisation of 210.000 dwellings in the province. Efficient tracking and monitoring activities are assessed in all the three mentioned scales to ensure practicing circularity in construction projects

Economic development

Shifting an industry into a circular model entails many changes and improvements to take place in different scales. Within such changes and improvements, job creation and replacement have to be considered through the (re)education and transparency of the transition taking place.

Liveable urbanisation

Future development requires for the full consideration of sustainability dimensions especially the social one as urbanisation in the past has had a negative connotation. Achieving liveable urbanisation is done through assessing such developments whether densification or expansion thoroughly in each of the defined scales.

Open Scales

How can planners create spaces where contrast is not a synonym of segregation, and productivity does not come at the cost of liveability? In The Open City (2006), Richard Sennet discusses the idea of the Open system as a possible solution to these situations, defining it as “one in which growth admits conflict and dissonance”, and its product, the Open city, as

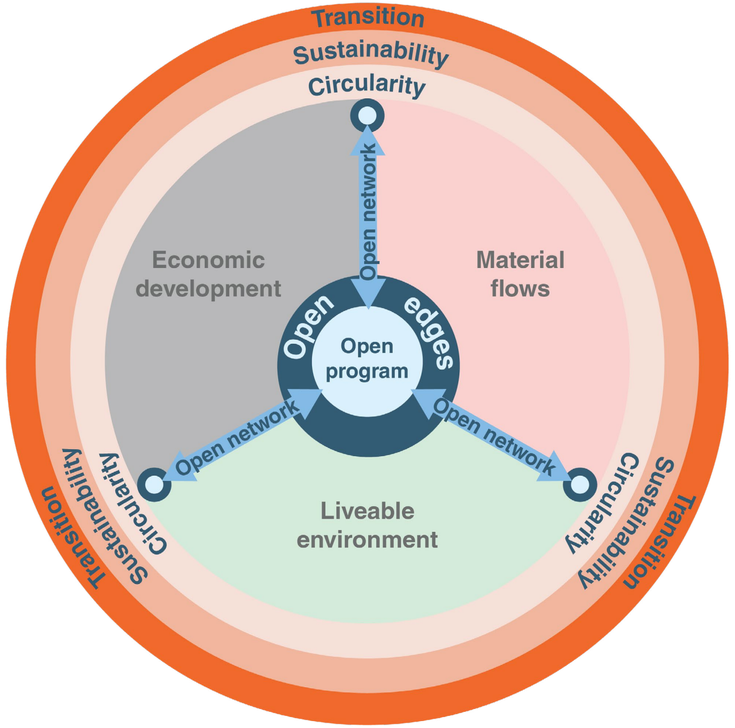


Figure 1. Conceptual Framework

one where “as in the natural world, social and visual forms mutate through chance variation; [and] people can best absorb, participate, and adapt to change if it happens step-by-lived-step.” In this situation, both the competition for resources between the C&D industry and residential areas and their tendency to become enclaves can produce negative impacts on residents and workers. Therefore, the spatial realisation of an open system is desirable and pertinent, thus becoming the guiding principle of our proposal. Given the complex and unique nature of the material and social dimensions of the C&D industry, and the opportunities that circularity presents, the project is structured in three different open scales: network, program and edges.

Open Network

An open network entails distributing material flows and economic development through a defined area of the province. This study area is chosen based on conflicts between industrial and residential land uses as well as sufficient connections for transportation. The hubs, in this network scale, work together in a provincial manner through the distribution of materials and knowledge. At this scale, distribution of said services is a focus in order to ensure efficient cooperation between the hubs. This cooperation allows for conscious development to take place in the form of liveable urbanisation. Achieving liveability for the province’s goal of 210.000 dwellings is met through a complete network of cooperation between environmental, economic and social agendas.

Open Program

Within the defined study area, several cities are selected for the planning and execution of a circular C&D industry. Cities are chosen based on their urbanisation needs, such as densification and expansion, and locations of C&D industrial agglomeration. The open program scope represents the distinct functions of the hubs that make up the network. These cities must develop relations through support and collaboration with other stakeholders for liveable urbanisation to take place.

Open Edges

Open edges illustrate the smallest scale in the open system in which industrial areas are opened up to the surrounding residential areas. This scale is very important as future urbanisation needs to be inviting from industrial to residential areas in order to use space purposefully. Opening up the C&D industry allows for the interaction of public, private and social sectors and creates more inviting spaces.

1.1.4/Methodology

The methodology is composed of answering the sub research questions below through qualitative and quantitative research methods. Depending on the question, either one or a mix of the research methods are applied to achieve a complete understanding of the problem at hand.

> What are the spatial implications of a circular industry?
>
> What are the scales of circularity with respect to the construction and demolition industry?
>
> What are the social and technical implications of a circular industry in terms of job creation, public acceptance and cohesion?

The qualitative research method includes a site visit to the Binckhorst transformation area in The Hague, a greenport in De Lier and the transformation area in the former harbour of M4H in Rotterdam. This site visit established an understanding of the context of reclaiming industrial space for more mixed use purposes. After this a literature review was done to understand the current material flow situation in the province as well as spatial and economic impacts of shifting industries into circular models. Qualitative research creates a better understanding of the current situation of the defined problem in terms of human interaction and development.

Quantitative research was made through the use of GIS with governmental data from PDOK statistical data CBS and data from the governmental LISA system. These programs and databases were used in order to understand relationships between the province's municipalities with construction activities, job creation and urbanisation projects. Quantitative research was done in order to understand the province in terms of the construction industry in a subjective and a scientific manner. This is needed for an understanding of the industry as a network system within the boundaries of South Holland.

1.1.5/Ethics

In the ¡Open construction! vision, the groups that could be negatively affected are current workers of industries that would need to be relocated in order to transform certain areas into construction hubs. Drivers and employees in the transportation sector ,that could be rendered unnecessary by autonomous vehicles, would also be affected.

Hyper-mobile C&D workers, who currently avoid any involvement with authorities and organisations, are also the main silent stakeholder that is taken into account by giving new chances for settling down under proper conditions. Access to spaces for training and legal counseling are created as part of the hubs. Together with regular C&D workers and former freight truck drivers, they could also be educated in circular professions.

The areas where the hubs are located are spaces in which industry and residential function already compete with each other. That is why the group that is currently negatively affected by the C&D industry, are mainly people living around these areas. The need for 210.000 dwellings that are to be built by 2050 will only increase the pressure on land and the negative externalities that come with it. Along with neighbouring residents, children, local business owners and people passing by the hubs might experience increases in air and noise pollution. The proposal is to deal with this by opening up the construction industries' edges and the concentration of all production in only one point in the province.

Even if the vision intends to not deepen already existing inequalities, the social reaction generated by our interventions should be taken as the main indicator for validating our intentions.

2 ANALYSIS
UNDERSTANDING THE CURRENT SITUATION

2.1/Current situation in South Holland

In order to understand the impact that circularity could have on the province of South Holland, the current state in terms of construction and demolition is researched. This research allows us to perform analysis of different topics concerning the C&D industry. Therefore, the current state of jobs, material situation and flows, potential areas and potential of a circular materials industry is analysed in the following sections.

2.1.1/Jobs

In total, the current number of jobs in the Netherlands reaches over 10 million (10.767.000). In which 6% of this total accounts for the construction industry. When focusing on South Holland, 7% of the nearly two million jobs (1.922.400), are jobs in the construction industry (CBS, 2019). Assuming this, a quick calculation shows that around 130.000 jobs in South Holland are construction industry based. This number is equal to 20% of the total construction jobs in the whole country. The province of South Holland is, therefore, responsible for 20% of the total jobs in the construction industry.

A circular economy can provide up to 54.000 additional jobs in all sectors (Bastein et al., 2013). However, it is unknown what this will mean for the construction sector in South-Holland specifically. Based on the total number of jobs in South Holland compared to the rest of the Netherlands, 13.000 of these 54.000 jobs could be provided in South Holland in all sectors (Drift & Metabolic, 2018).

The many companies providing these 130.000 jobs can be seen in figure 3. Small companies can consist of 10 employees while bigger companies can reach up to over a 1000 employees. These big companies are usually located in urban areas that are accessible by waterways and highways. This accessibility in combination with the location in the urban areas is important as the companies need to be accessible by many people and products.

Also wet concrete production locations can be found near the urban areas in the figure. These can usually be found near agglomerations of construction companies as these companies will be collaborating with these wet concrete production locations.

These 130.000 jobs are partly filled by migrant, hyper-mobile workers. These workers travel between different jobs, have contracts for short periods of time and can, therefore, easily be relocated to different locations and even countries. These hyper-mobile workers are hired as companies are in a need for cheap and disposable labor from contractors and take advantage of the lack of close attachments in the immediate environment. This brings some problems, as these workers receive underpayment and insufficient healthcare. This is caused by the lower living and working standards of these workers, and their lack of involvement with authorities and trade unions. Another problem could be the segregation of nationalities, which is created to favor efficient communication (Berntsen, 2016).

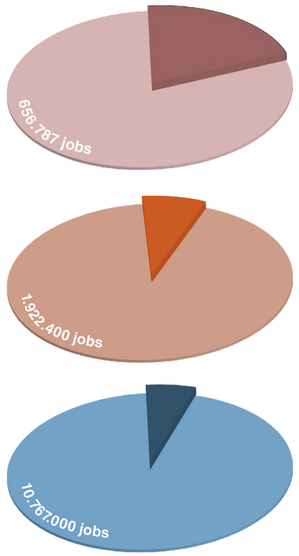


Figure 2. C&D industry jobs in the Netherlands and South Holland (CBS, 2019)

Figure 3. Construction companies and their sizes in terms of employment. Added to this are the selected wet concrete plants in the Province of South Holland.

2.1.2/Current material situation

Today, more than 2.5 million tonnes of construction and demolition waste (CDW) are produced in the province of South Holland, mostly as a consequence of demolition works. This waste consists of several materials in which the processing for each one of them is different: recycling, downcycling and incinerating. Nearly half of materials that are released consist of stony rubble of which 97% in figure 4 is reused but for low-value applications such as foundation material for roads. The remaining 3% is actually reused in the concrete production phase. Even though metals represent a small portion of waste, they are not being handled properly after demolition and renovation while metal is of high quality and value. As these materials are losing a large part of their original value, this process is considered as downcycling rather than recycling (Drift & Metabolic, 2018). The rest of stony rubble that is being reused, is in non-structural applications such as low grade materials. These materials are mainly used for road foundations, in a process known as backfilling (Kenai, 2018). For asphalt, which is the most abundant type of waste, a large part is already being recycled.

Due to downcycling being a monofunctional construction activity, its use in civil engineering is expected to decrease. There is an increasing amount of material used in civil engineering that is made of a material released elsewhere.

This “saturation” of the material industry in civil engineering creates an incentive to develop more circular applications of building materials for other purposes (Ministry of Infrastructure and Environment, 2016). This downcycling happens because of a lack of confidence and experience from C&D producers and construction companies, the need for further research on applications for C&D waste and the inexistence of a clear regulation for reused and recycled materials (Ng & Engelsen, 2018, Icibaci, 2019).

A special mention should be made on reused items. Currently, the Do It Yourself (DIY) market represents the main consumer group of reusable CDW recovered by large companies. This means that demolition companies privilege variety and direct availability for small scale retail over large scale operations of recovery and commercialisation. Therefore, “this fact indicates that commercial projects could apply used products, but the current market structure is not able to support a supply-demand balance on a larger scale” (Icibaci, 2019, p.130). The lack of guarantees and change in building standards and laws that will be explained later in section 2.2.3, are other factors that prevent the market of reused materials to reach larger scales: research and development would be needed in order to make that transition.

South Holland produces

2’581.840 ton

of construction and demolition waste

- **Asphalt** 49%
- **Stony** 42%
- **Others** 4%
- **Wood** 3%
- **Steel + Iron** 1%
- **Glass** 0.2%
- **Plastic** 0.2%
- **Other metals** 0.2%

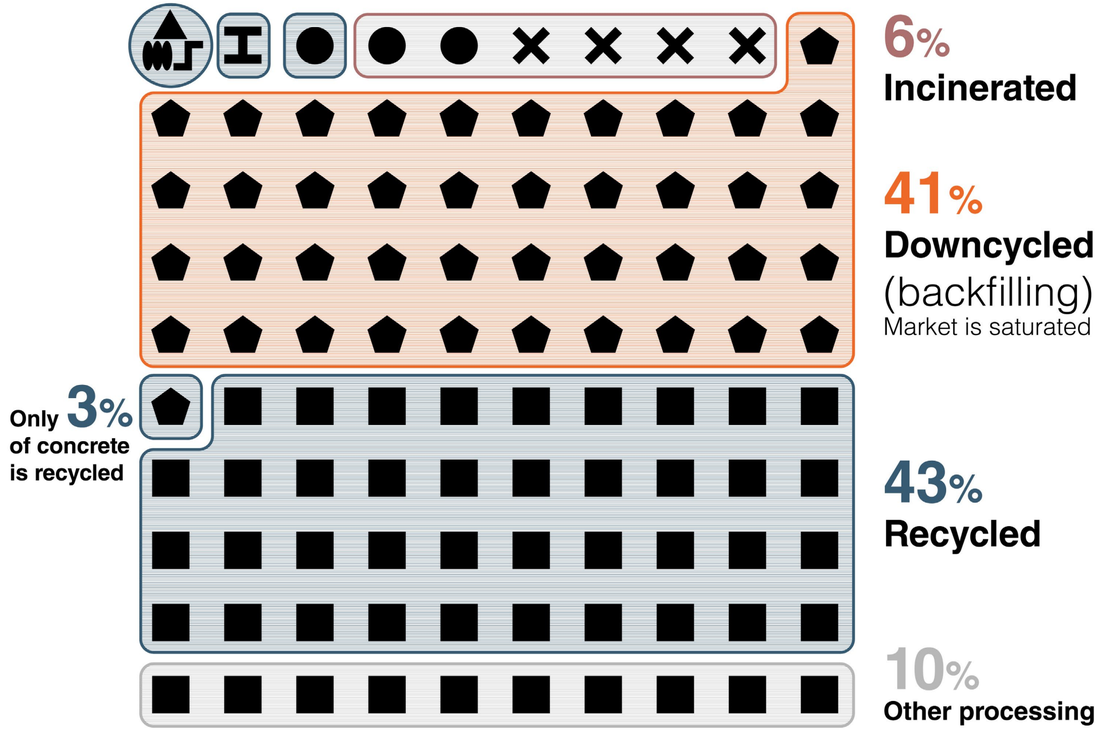


Figure 4. Current material situation in South Holland (based on Drift & Metabolic, 2018).

2.1.3/Current flows & amounts

As of 2018, 6.8 Mton entered the construction chain annually while the total outflow totalled to 3.9 Mton in South Holland (Drift & Metabolic, 2018). Because of this imbalance, the construction sector cannot reach full circularity based on the total outflow that the province produces. The province also heavily relies on the import of raw materials that are required for the processing of concrete, asphalt and steel. The construction material flow in the province is the largest material flow within the region after the chemical sector and container handling (Drift & Metabolic, 2018). Therefore, the importance of the construction sector needs to be addressed, with multiple strategies at different scales, in order for the transition towards a circular system to be realised.

Figure 6 depicts the current flow of materials in which there exists a huge import of raw materials, whether sourced nationally or abroad. Cirkelstad (in Drift & Metabolic, 2018) estimates that around 40% of all raw material flows are driven by construction. When these raw materials are processed in manufacturing centers, they still have to be manipulated at construction sites in the form of casting and welding. This represents a challenge when the building reaches its life cycle as the used materials are harder to deconstruct. This will result in extensive demolition activities.

After materials are manufactured in their respective concrete and steel plants, they are sent to construction sites. However, materials such as concrete and asphalt are sent to construction sites in “wet”, not ready to use forms. This means that the mentioned materials must be poured, unlike its prefab counterparts. When a building is completed, waste is not only created during the construction of the building but also during its use phase. During its lifespan, the building is subject to maintenance and renovations that generate excess material that can be used for recycling or renovation (Drift & Metabolic, 2018). This demonstrates an opportunity and need for the application of a circular system in the construction and demolition industry.

After reaching its lifespan, the building is demolished. This is the phase that creates the most waste. This is because most materials cannot be deconstructed easily. Therefore, 50% of the materials flows released from demolition and renovation consist of stony rubble (1.1 Mton) (Drift & Metabolic, 2018). Demolition represents the end of the current linear flow of the construction industry as demolition material is mostly either downcycled or sent to a waste facility. A more detailed description on construction and demolition waste will be given in the next section.

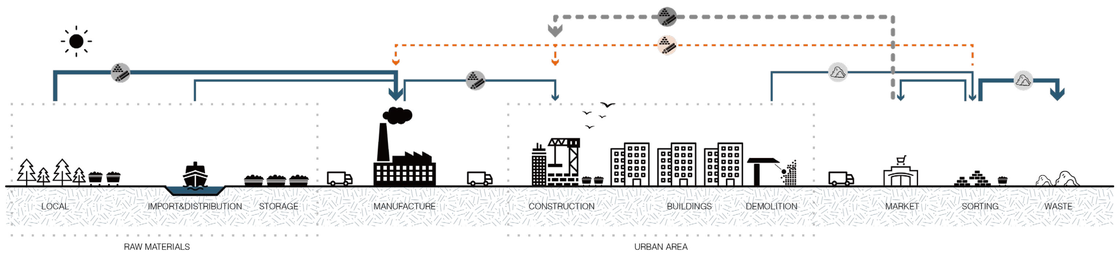


Figure 5. Current section of the C&D industry in South Holland

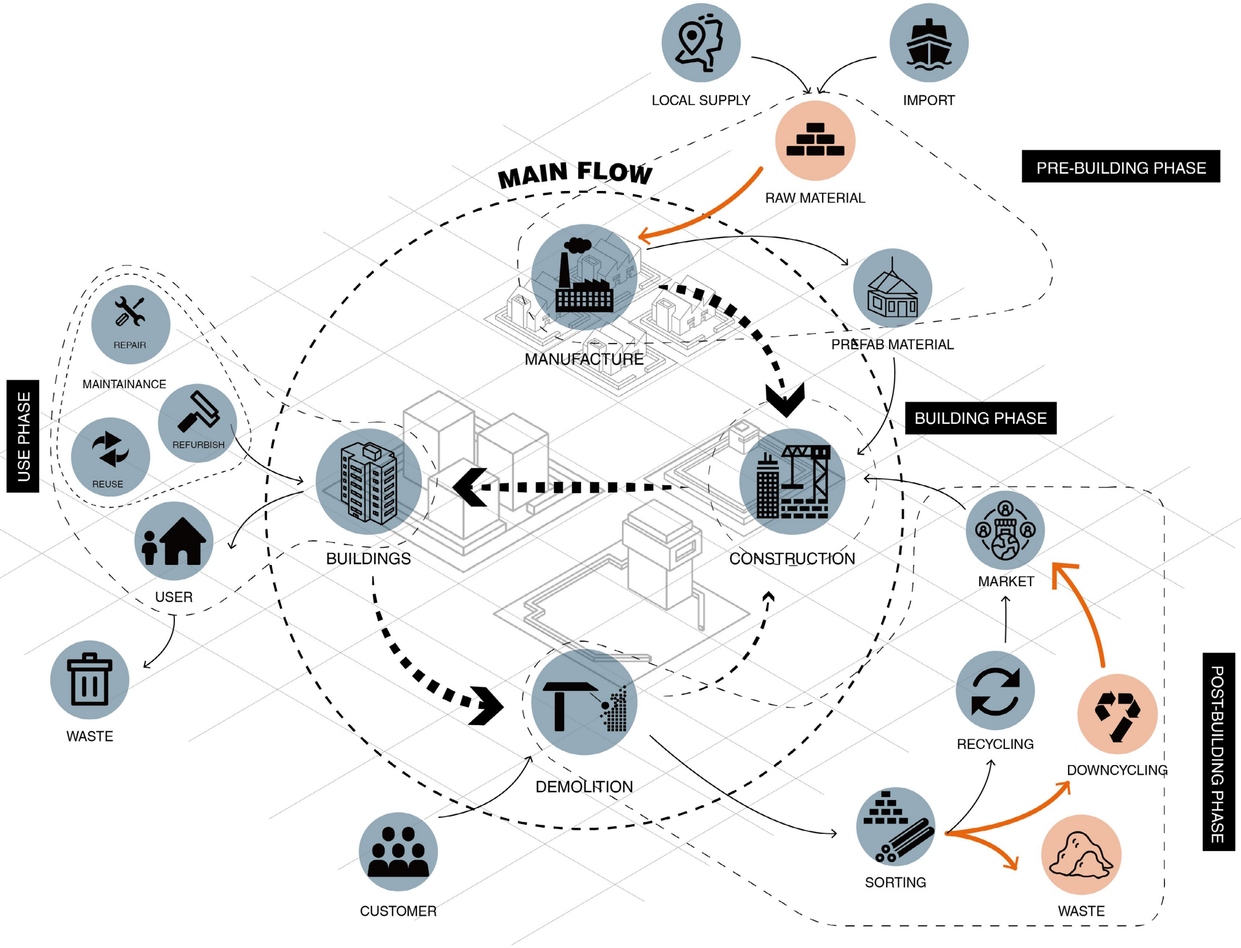


Figure 6. Current flows of the C&D industry in South Holland

2.1.4/Landuse analysis: a sandwich approach

For this project, a sandwich of functionality is defined. This sandwich is showing how construction industry facilities and housing areas compete for the same areas (Kort, 2017). Water and access to main roads are attractive to both of these functions. Conflict is present as there is a competition for locations that are most accessible. Housing is in need of quiet, peaceful areas with natural qualities, while industry depends on transportation and factories which generate polluting industrial factors. These factors are the reason why it is not common for these two functions to be combined. In many areas of conflict, buffers are created to overcome such clashes, creating distant industrial areas.

These conflict areas in the province of South Holland can be indicated when understanding the sandwich principle. In figure 7, areas with direct connectivity to and from traffic and waterways infrastructure are defined. Based on the sandwich principle, we have defined a study area using the transportation connectivity factor. In the defined study area, the land use consists of residential areas (**34%**), industrial areas (**21%**) and green areas (**30%**) as shown in figure 8. These predominant land use types, residential and industrial, which are the functions competing for land in the sandwich model, are indeed present in areas with good transportation connectivity.

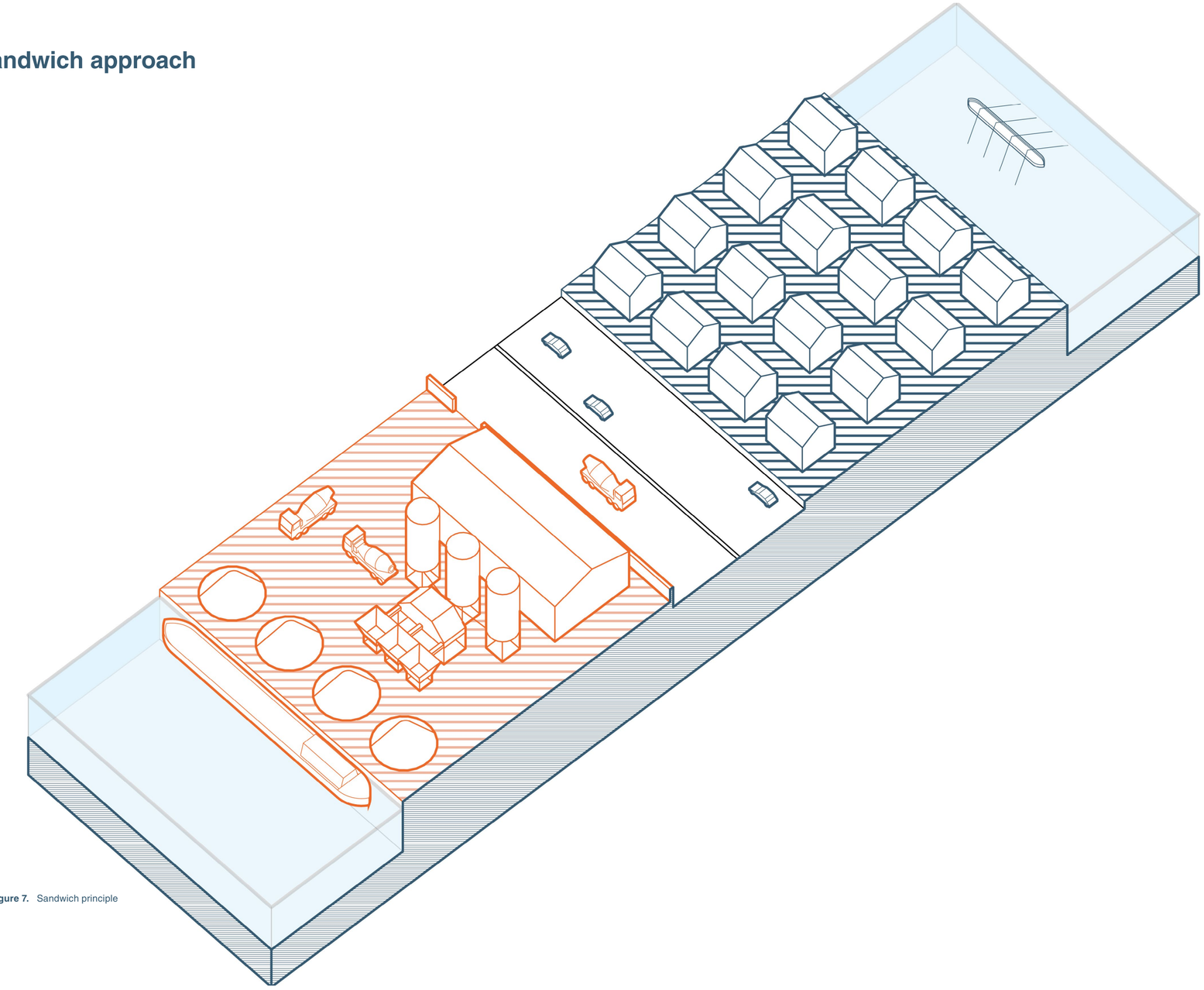


Figure 7. Sandwich principle

The conflict in functions can also be seen when looking at maps that represent the number of construction, renovation and demolition activities per municipality as shown in figure 10. In figure 11, it is evident that the majority of industrial locations are found within the study area and are formed around the port of Rotterdam. The construction and demolition industries are found in the same locations where these different urbanisation activities are happening. This also means that residential areas are located in areas where construction production companies are active.

As concrete is the main material used in construction in South Holland, understanding its spatial requirements explains a considerable part of the spatial dynamics of the C&D industry in South Holland, such as concentration and closeness. There are two different sorts of concrete production, one of them is wet concrete production and the other is precast concrete production. The biggest difference between these two types of concrete is their service areas. Wet concrete plants need to be less than 25 kilometers away from construction sites, while precast concrete plants can be up to 90 kilometers away from construction sites. This means that, to cover the same distance, there is a need for three times more wet concrete plants compared to precast plants. This means these wet concrete plants will more often be located in urban areas than these prefab plants. In figure 12 the effect of this 25 kilometer radius is

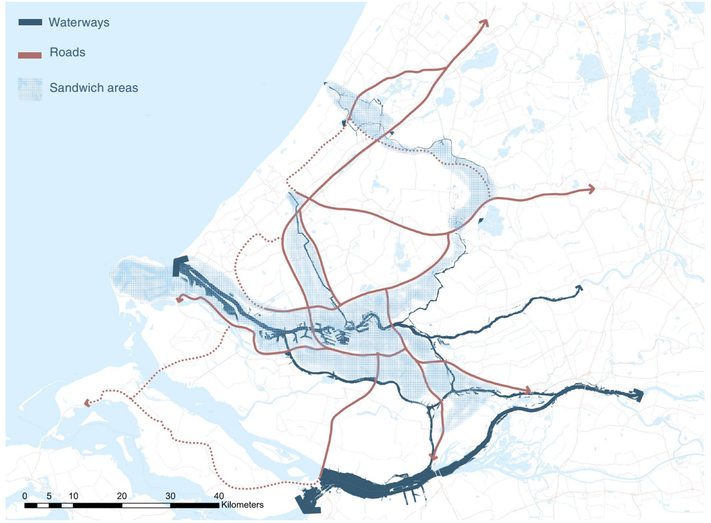


Figure 9. *Sandwich* areas in between highways and waterways

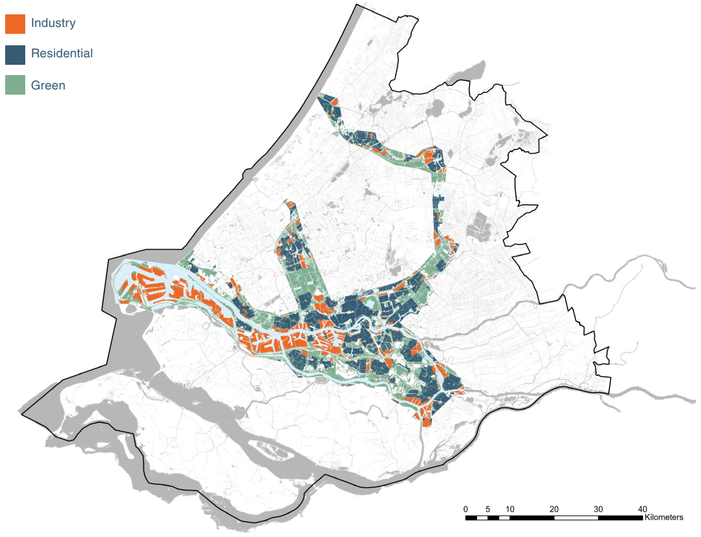


Figure 8. Land use for defined area (based on OSM, 2018)

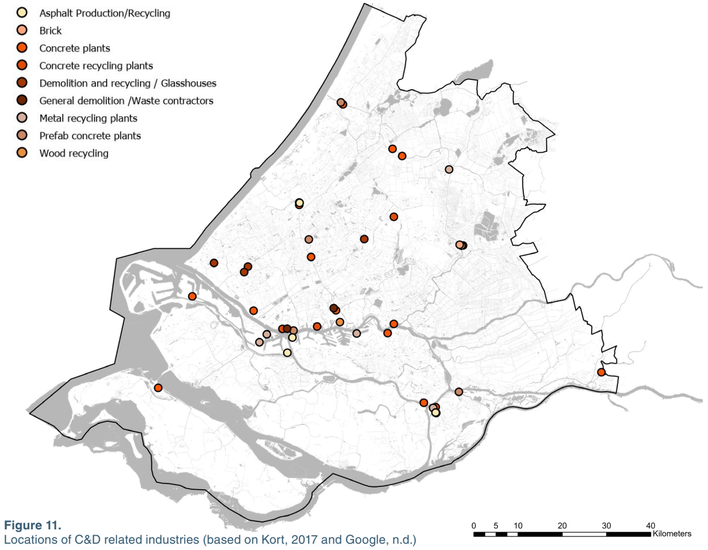


Figure 11.
Locations of C&D related industries (based on Kort, 2017 and Google, n.d.)

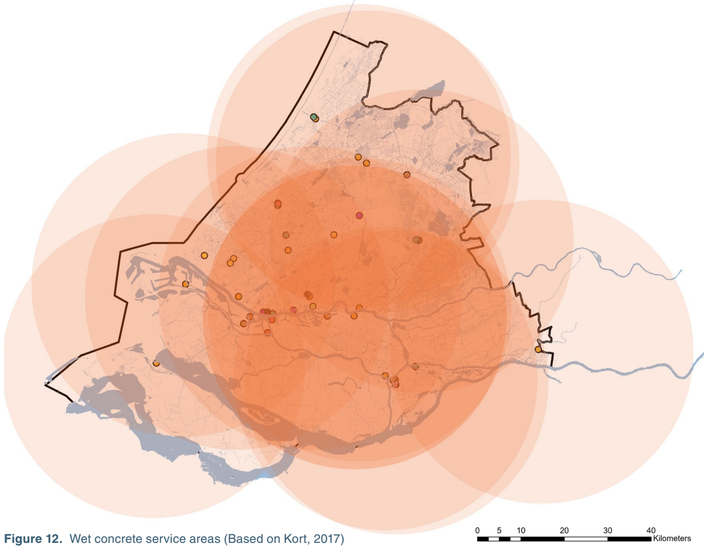


Figure 12. Wet concrete service areas (Based on Kort, 2017)

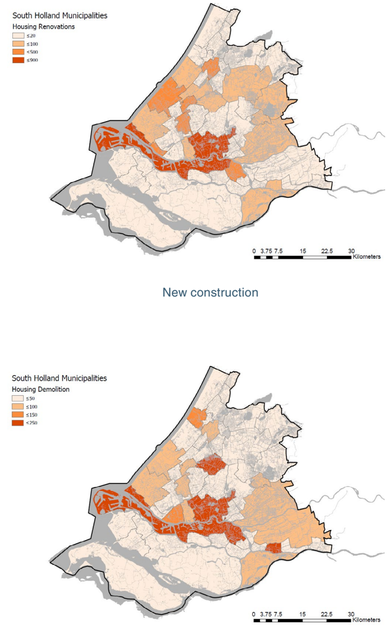


Figure 10. Construction activities per municipality (based on CBS, 2019)

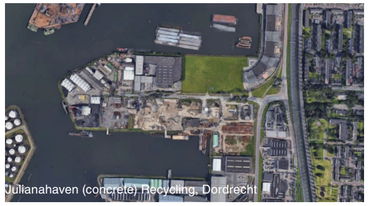
2.1.5/Current example areas of CDW industries

Production areas

When taking a closer look in the industrial areas that include these concrete plants, a quick look will show that these areas are not at all attractive to live near. Large buildings with only walls are typical for these industrial areas. Fences, and inactive facades are also not unusual. The freight trucks that are needed to provide services and materials for these industrial companies are also consistently present in the area. In these examples, houses are located near this industry.

Recycling plants

Jansen (demolition) Recycling, Rotterdam



Jullanahaven (concrete) Recycling, Dordrecht

Concrete production plants

Dyckerhoff Basal, Delft

Dyckerhoff Basal, Dordrecht

Figure 13. Current situation of C&D industrial areas (Google, 2020)

Buffers

There are many examples where a buffer is present to create distance between these two functions. However, distancing can also have a negative effect if the buffer becomes a barrier, as there is no social control from residents in the example of a physical buffer with no active function.

Figure 14, shows the possibility of using an active buffer such as the Rotterdam Dakpark where there is a shopping area inside of a physical buffer. Other than that, natural buffers can be used in the form of parks. However, these only create a physical buffer, but allow both areas to be visible. More often, is a buffer by waterways. Waterway buffers also create physical distance between the residential and industrial areas. Residents are able to see the industry, but are not able to visit it. A third buffer that can be used, as shown in figure 16, is a buffer by train tracks. This is similar to the waterways buffer as it is also using infrastructure to create a distance between the two areas but in most cases is not desirable as it also create noise pollution.

Figure 14. Active buffer

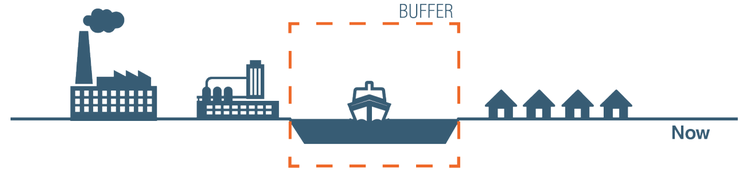


Figure 15. Buffer by waterway

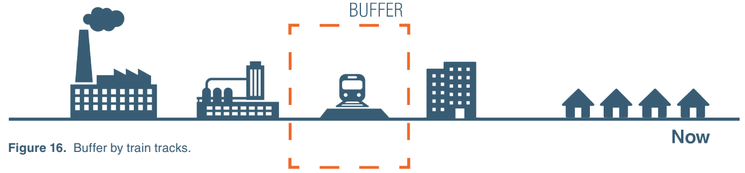


Figure 16. Buffer by train tracks.

2.1.6/Liveability regarding current C&D companies in urban areas

Figure 17 shows the areas with the lowest rates of liveability in combination with the current C&D industry related companies in a map. Liveability is determined by several indicators, divided into five dimensions: dwellings, inhabitants, safety, facilities and physical environment. The map shows that areas with the least liveability rates are often within proximity of companies related to the C&D industry. The map also shows that most wet-concrete production plants are in the proximity of the areas with the worst liveability. Even though it is unknown if this is due to the negative externalities that these companies might produce, like pollution and noise (as can be seen in figure 18), it becomes clear that liveability in these areas needs to be improved.

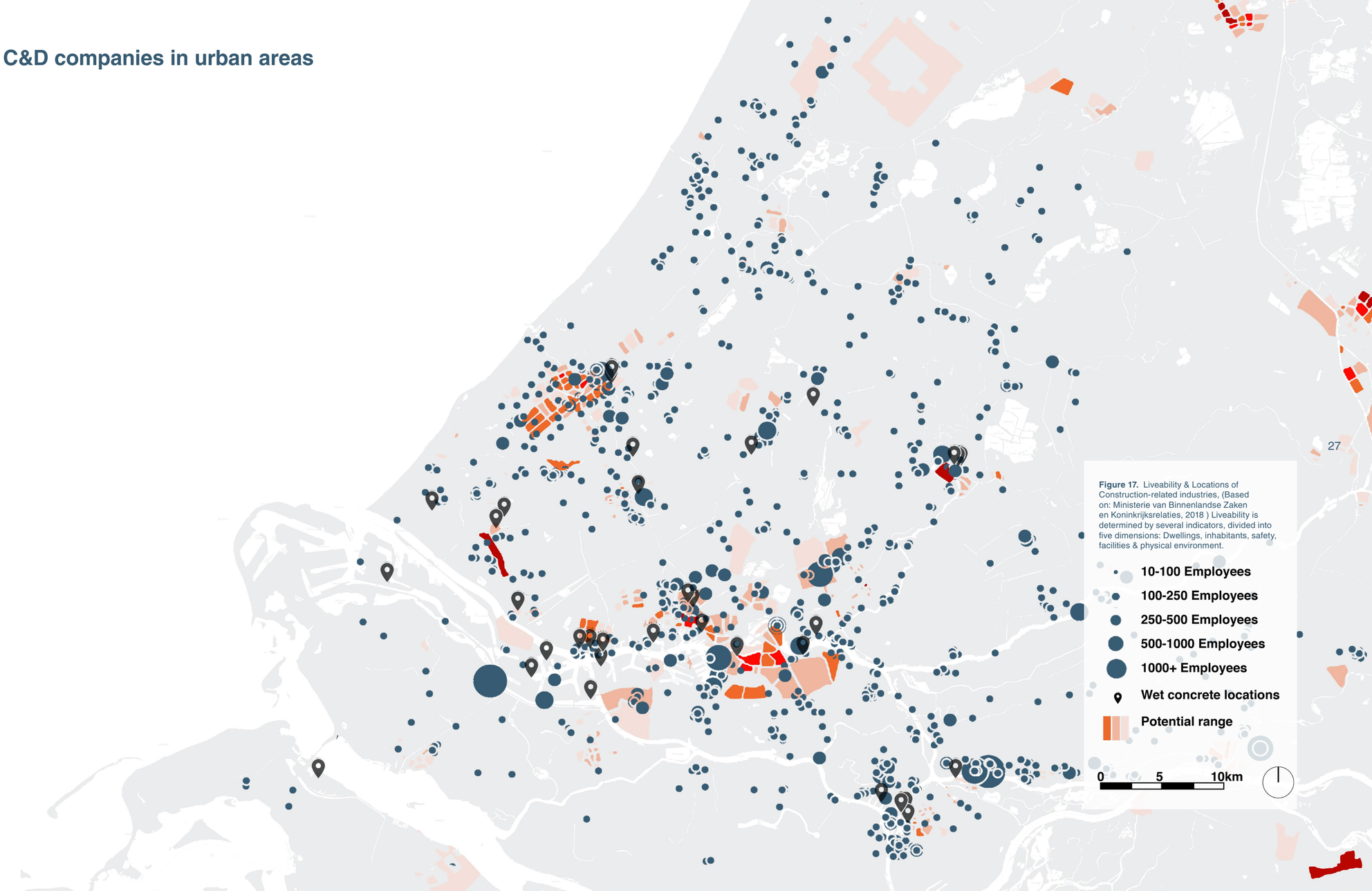


Figure 17. Liveability & Locations of Construction-related industries, (Based on: Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018) Liveability is determined by several indicators, divided into five dimensions: Dwellings, inhabitants, safety, facilities & physical environment.

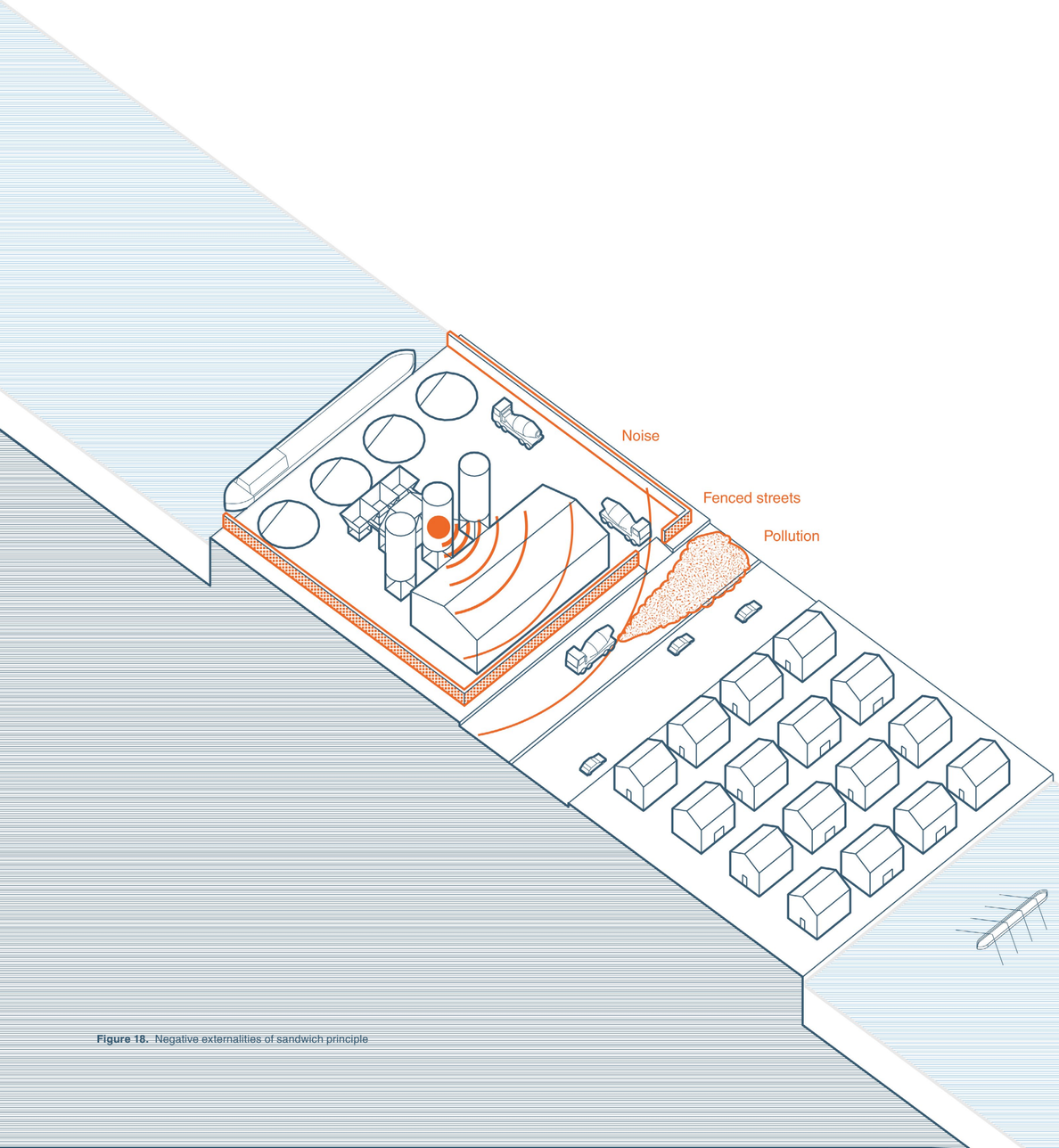


Figure 18. Negative externalities of sandwich principle

2.1.7/Current Examples of CDW Hubs

Construction hubs do already exist in the Netherlands. Current examples do mostly have a logistic function for inner-city development due to the limited availability of space at building sites.

The Amsterdam construction hub, Bouwhub Amsterdam, is mainly focused on logistics and saving space on building sites by temporarily storing materials in a central hub. Materials and deliveries are monitored in order to transport them from hubs to the building sites in time, without having them to be stored at the building sites before use.

'De Trip' in Utrecht was also studied as an example of a hub by De Bes et al., (2018) has shown that the amounts of traffic movements to construction sites can be reduced by up to 69%. This is not only for supplying materials, but also includes transport mobility of employees. The benefit in terms of CO_2 emissions can increase to 68%. Next to this, about 5% less construction waste is produced and the time needed for the final phase of construction can be reduced by approximately 25%. In total, transport costs can be reduced by roughly 71%.

Furthermore, the establishment of construction hubs generates positive externalities for residents of cities, as the C&D industry is currently responsible for 20% of inner city commercial traffic. The examples studied in the report show less complaints from surrounding neighbourhoods when a construction hub is located in the area. The total benefit in terms of costs can be up to 3-5%, as almost 15% of the total costs of construction is due to transport.

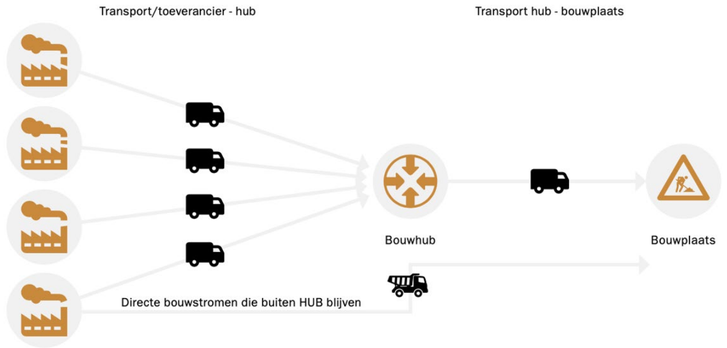


Figure 19. Chain of logistics with BouwHub. (de Bes et al., 2018, p.27). This example shows the way the example hub in Utrecht is functioning. In here, the hub is only for inner city developments because of limited availability of space at the building site.

2.1.8/Potential areas for urbanisation and C&D hubs

Urbanisation trends in the province of South Holland consist of two forms: expansion and densification. It is important to note a distinction between these two types of urbanisation as they have different needs in terms of area and materials. Expansion consists of new developments located in formerly open tracts of land whereas densification refers to the construction of housing in existing developed areas (Broitman & Koomen, 2015). In terms of materials, both expansion and densification requires the implementation of “new” material, however, refurbishing and renovation activities can also be used in densification projects.

Developing 210.000 dwellings using circular economy principles in the province of South Holland, requires for the selection of locations for urbanisation. Figure 21 shows the possible locations for urban expansion in combinations with C&D companies. In the potential map in figure 25 the selected locations for urban expansion are shown. As can be seen in this map and as explained before, both urban areas and CDW companies compete for the same land.

As not all of the 210.000 dwellings can be built outside the current urban areas (Boelhouwer, 2017), densification in existing urban areas is needed. One of the possibilities for urban densification is the renewal, restructuring or renovation of urban areas built in the 1950’s. These buildings are often in need of renewal as they do not always meet current living standards. Urban densification could possibly take place at these locations, providing both spaces for new developments as well as improvements of the current built environment in these neighbourhoods. Based on the map in (figure 23), we selected the larger possible locations for urban densification as can be seen in the potential map (figure 25).

Agglomeration of C&D industry locations can be found throughout our defined study area. As shown on the figures 22 (OpenStreetMap, 2018) & 24 (Ministry of Infrastructure & Water man-agement, n.d.), an agglomeration of industrial companies can create noise that exceeds the 75dB level, which is two categories over the level of ‘very bad’. Combining the problems of noise pollution with the earlier mentioned buffer zones, a big amount of space is needed to just separate these two functions. The more industry locations there are, the more buffers are need-ed. This space is also needed for urbanisation, therefore, a minimum of these heavy industrial areas should be aimed for in order to decrease the amount of perimeter. Therefore an agglom-eration of companies would be beneficial in this case.

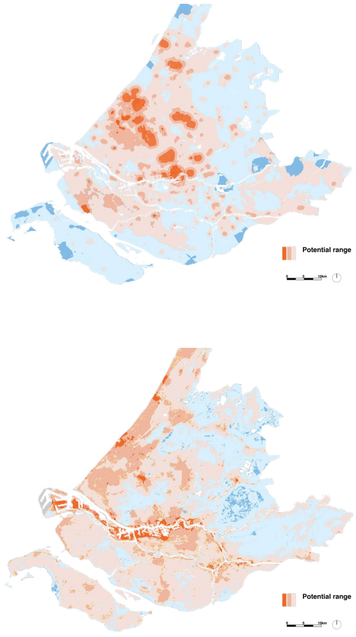


Figure 20. Urban potential (above) and resilience (below) Based on (Province of South-Holland Discussienota verstedelijking, 2017)

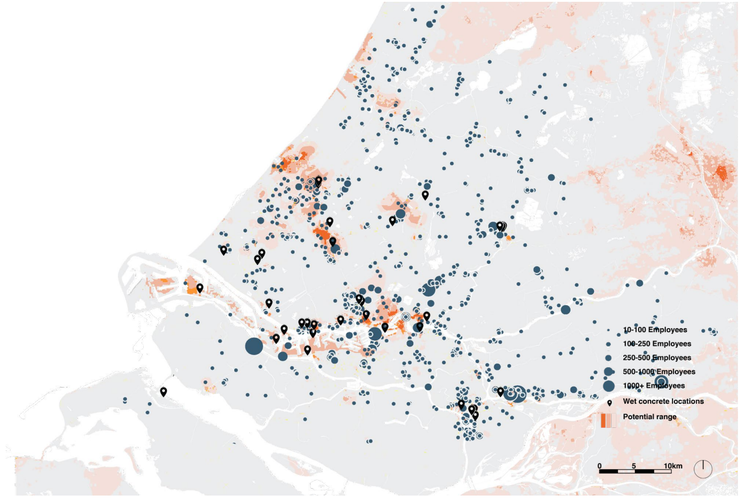


Figure 21. Potential areas for urban expansion based on urbanisation potential and climate resilience.Urbanisation potential is based on accessibility, possibilities for a multi-core metropole, new economies, renewable energy possibilities, services & facilities and the best economic locations. Based on (Province of South-Holland, Discussienota verstedelijking, 2017)

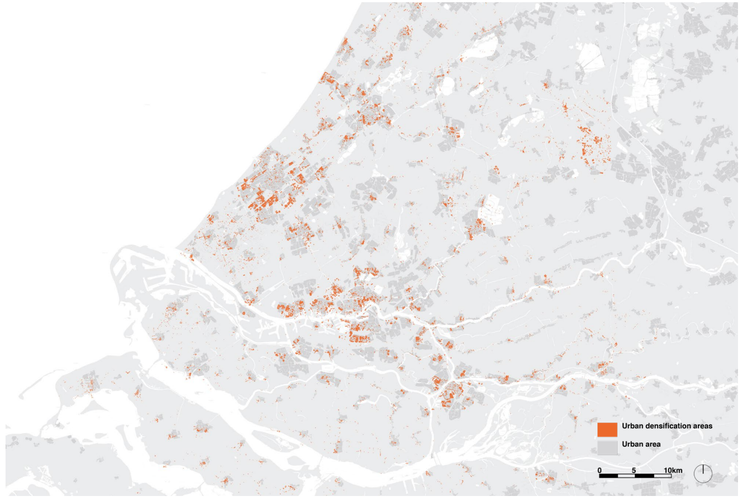


Figure 23. Map showing areas in the Province of South Holland built in the period of 1945-1960. Based on (Kadaster, Basisregistraties Adressen en Gebouwen, 2013).

Figure 22. Agglomeration in the port of Rotterdam (Based on OSM)

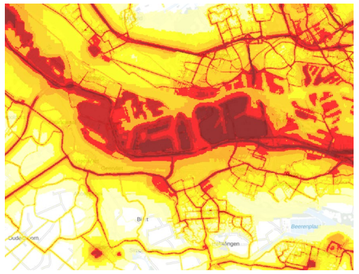


Figure 24. Noise pollution for agglomeraion area in the port of Rotterdam (Based on: Ministerie van infrastructuur en Waterstaat, Geluid in Nederland (Lden), n.d.)

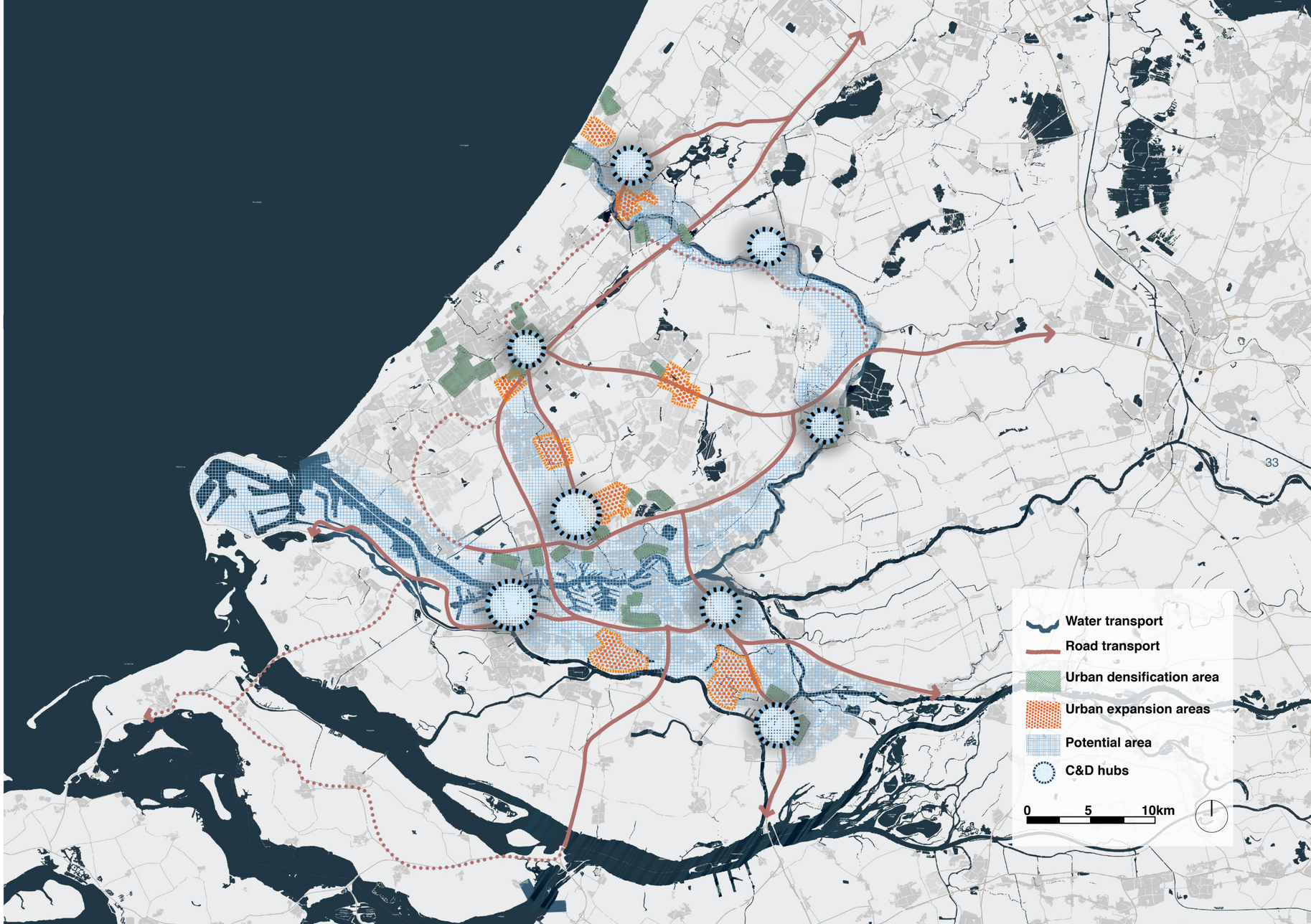


Figure 25. Potential map

Conclusions

The current situation in South Holland shows a lot of potential in order to reach circularity. Job opportunities are expected to grow in this industry through circularity, however, the status for construction workers needs to be improved. The C&D industry produces the third largest material flow in the province mainly because of demolition and renovation projects. Materials released from demolition represent an end point in the current linear system as these materials are either downcycled or sent to a waste facility. However, downcycling through backfilling is saturating the current monofunctional need for released stony rubble materials. In terms of land use, industrial and residential areas compete for access to highways and waterways creating conflicts. Since both land uses have distinct functions, this creates a clash mostly because of negative externalities of industry. Such a clash offers an opportunity to revamp the C&D industry and improve the current situation. Applying a network of hubs would allow for a positive interaction between both land uses. This concept of hubs has not only been tested but also proven in Amsterdam and Utrecht.

2.2/Circularity in the C&D industry

In this section the possibilities of applying circularity in the construction and demolition industry are explored. Several circular activities are defined to achieve this circular model. Also, the impact of the C&D industry on its surroundings is researched on different scales. Next to this, research is included on current thresholds regarding the legal implementation and bottlenecks in institutional procedures. Finally, social challenges regarding circularity in C&D and drivers and potentials for implementations have been elaborated on.

2.2.1/Circular activities

In order to explore the possibilities offered by circularity to the C&D industry of South Holland, it is important to first understand which kind of activities define a circular management of waste and what are the priorities and hierarchies inside those activities.

After checking some general definitions on waste management given by national and international governmental bodies (European Parliament and Council, 2008 and UK Government, 2011), it is evident that the two extremes of waste management in terms of environmental costs, prevention (lower impact) and disposal (higher impact), as well as the concept of “recycling”, are clear and undisputed. On the other hand, other terms as recycle, reuse, repair, recondition, refurbishment or remanufacture, seem to be less clear and even interchangeable (Gharfalkar, Ali, & Hillier, 2016).

Therefore, after a review of current circular projects and initiatives (Ellen MacArthur Foundation, 2016; Climate-KIC & C40 cities, 2018; Gladek et al.; 2018 Icibaci, 2019; Beelen, 2020), as well as the local conditions and specific challenges for the C&D sector in the Netherlands, five circular activities are defined (figure 26). They are shown in their order of precedence, defined by their environmental cost.

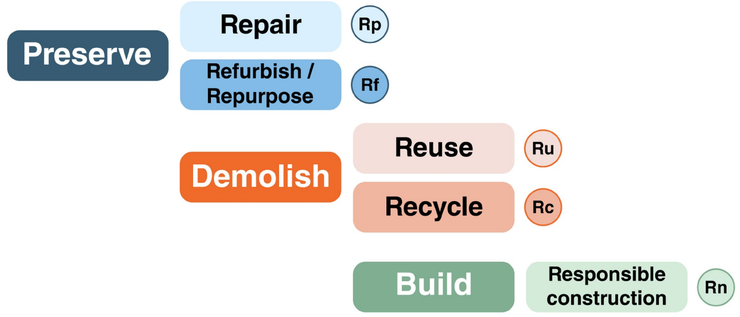


Figure 26. Circular construction activities

Repair
Preserve buildings by doing the necessary maintenance works without changing their current function or performance.

Refurbish/repurpose
Preserve most of the buildings and extend their lifespan through extensive interventions and/or modification of their current function and performance.

Reuse
Recover materials before or after demolition and re-introduce them into the chain of supply without changing their original purpose.

Recycle
Recover materials after demolition and re-introduce them into the chain of supply as raw materials for products with similar and/or equally valuable applications.

Build responsibly
Build taking into account the future possibilities for the repair, refurbish, reuse and recycle activities as well as using bio-based and renewable raw materials with a minimum or positive carbon footprint.

2.2.2/Negative externalities

Despite being instrumental for a sustainable future, circularity can still produce negative spatial, environmental and social impacts.

In terms of space, a circular C&D industry tends to occupy larger areas. This is a consequence of the transition towards construction processes based on modularity and prefabrication, which require large storage facilities. For example, prefabricated concrete plants sometimes need up to 20 times more space than their “wet” counterparts (Kort, 2017). A similar principle applies for the facilities that make bio-based construction parts, which do not only need the aforementioned areas, but also need spaces for storing the unprocessed raw materials. This means that, if not managed correctly, circular industries could increase the pressure on land and its value.

From the perspective of environmental impacts of circular processes related to CDW, two main negative externalities were identified: first, a higher demand of bio-based materials, mainly wood, could stimulate irresponsible harvesting practices in the countries of origin of these materials. Luckily, and unlike other construction materials, wood already has certification systems in place that could be tightened over time (Goodland, 2016). Second, the processing of stony materials in recycling plants are related to the emission of noise, transportation as well as energy and material losses (Cavalline, 2017; Icibaci, 2019). Other nuisances can derive from agglomeration of other industries close to the recycling and concrete plants. These plants are less predictable and can change over time, but should be considered as part of the impact.

2.2.3/Current thresholds in South Holland

Research on CDW management in the Netherlands (Deloitte, 2015) has shown that there is a lack of policies supporting sustainable management of materials. They describe the absence of quality gradations or labels for recycled materials. Next to this, the prices of material do not include recycling or waste processing. While taxes do exist in the construction sector, this is mostly on labour while there is a lack of taxes on materials (Gladek et. al., 2018). Finally, for the lack of policies they describe a need for the reduction of demolition permits as they could encourage reuse of existing buildings and avoid waste production.

In terms of bureaucracy, this research describes the need for knowledge in the different parties that is currently missing at local authorities. Next to this, many projects on sustainable use of CDW are not fully developed yet, therefore, they cannot be implemented. It seems like a general standard on how to deal with this problem is missing. This might function as a bottleneck for circular project execution in combination with the lack of knowledge by local governments. For example, regulations limit the use of refurbished elements such as old doors due to height regulations in building codes. The final remark that is described in the report is the traditional culture of the construction industry, which tends to hold back the transition into a circular model.

Another crucial factor that limits the possibilities of creating circular flows of CDW is the dependency on large-scale demolition companies for the recovery, processing, storage and commercialisation of reusable products. Some consequences of this are: 1) these companies only sell reused materials when there is available space in their facilities; 2) there is a “weak specialisation of skills required for each activity, especially when demolition companies operate reuse as a side or secondary service within the company” (Icibaci, 2019, p.123); 3). The harvesting and preparation of CDW is not “treated as a specific activity or sector, reflecting inadequate legal representation and lack of further support in the form of investments for Research and Innovation” (Icibaci, 2019, p.124).

The only exception to this dynamic are small-sized demolition and renovation works, where owners can choose to directly offer their reusable CDW via e-commerce platforms (figure 27), which reduces the need for recurring to large demolition companies, storage spaces and large logistic operations (Icibaci, 2019).

Other challenges for the effective integration of CDW into the supply chain have to do with innovation processes and education initiatives. On the former, it has been indicated how the construction industry has the tendency of assimilating innovations at a very slow pace, needing

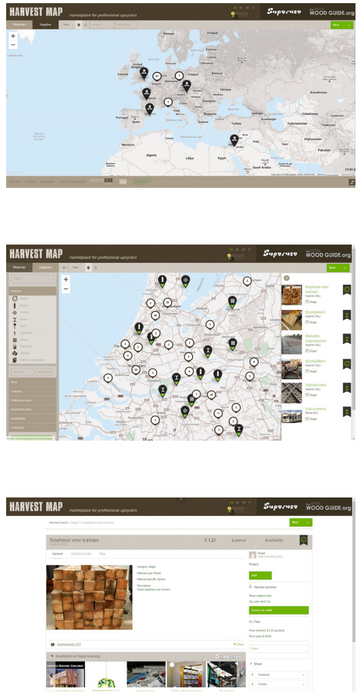


Figure 27. An example of an online platform for trading of reused C&D materials (https://www.oogstkaart.nl/)

periods “for changes to diffuse in construction” that “may range from several decades up to a century” (Hekkert, 2001, p.171). On the latter, a process of training in new circular technologies is needed in order to involve companies and labour force into the game.

2.2.4/Social Challenges

There are social issues related to the C&D sector that could be deepened, but also improved, by circularity.

First, there is the resistance of residents to technological changes. This is mainly relevant when repair and retrofitting works lead to the upgrade of heating and other systems. According to studies (Brown, Swan, & Chahal, 2014), there are different reasons for dwellers to reject these improvements: the lack of understanding the need for such changes, new interfaces that make these technologies harder to use, and the lack of interest in changing energy consumption behaviors. A careful strategy for the implementation of these actions, based on local needs and preferences, is necessary in order to guarantee the success of retrofitting in existing social housing projects.

Another social implication of the transition towards a circular C&D sector is related to job security and the welfare of workers. As mentioned earlier, a large portion of the workforce is employed in large construction projects that are composed of hyper-mobile migrants working under sub-standard conditions. This means they have little or no involvement with the local context and the opportunities offered by this context (Berntsen, 2016), which translates in being left out of the (re)education processes. This is especially relevant when considering that a circular construction and demolition industry needs a more specialized, and therefore educated, workforce. It can be understood that, in a transitioning market, the exclusion these workers are subject to now could render their skills obsolete in the future.

2.2.5/Drivers and potential for circularity

According to the report written by Deloitte (2015), the construction industry is willing to pay for materials if there are guarantees, such as quality labels that are ensuring a sustainable resource. Currently, because of the low prices of secondary materials, companies tend to be interested. Next to this there is an increasing demand for circular materials.

Another potential would be to add more flexibility in terms of regulation. For example, reused materials do not meet current building codes for new buildings, but are still safe to use. Governmental institutions could also facilitate circular building by their own tenders, to showcase possibilities to private investors as well. De Bes et al. (2018) also describe that specifically for construction hubs, governments can support the use of these by letting these hubs take part in regional and urban design processes in the future as well as helping them to find locations. For example, this could be in former industrial areas in order to get a permanent location.

Additionally, the hubs in the research done by De Bes et al. (2018) rely on delivery from a wide range of separate suppliers. The examples are mostly at the scale of a city or multiple cities, as a sufficient amount of material flow is needed, as well as the knowledge and planning of future projects nearby to make sure the hubs do not need to be relocated. This means continuity is needed in order for potential hubs to succeed. A possibility can be scaling up the existing agglomeration areas to ensure continuity in the future. For this continuity, a material passport can help, not only for characteristics of materials used, but mostly for future availability and current implementation to guarantee a continuous, closed loop, supply chain.

For the most abundant type of CDW, concrete, another potential specific for the province is mentioned. Nowadays, the current processes needed to obtain recycled concrete in the Netherlands are “energy intensive, expensive, and produces a sludge whose final disposal is landfilling” (Xicotencatl, 2017). Nonetheless, the reuse of materials for new concrete could be economically feasible due to the lack of nearby raw material sources (Kamrath, 2019) and the high demand for them. Therefore, the natural limitations of the region could translate into different stakeholders being eager to fund research and design (R&D) for recycled concrete.

2.2.6/The scales of circularity

Departing from the previously mentioned definitions and potentials, some examples of initiatives necessary for applying circularity in the C&D sector of South Holland were analysed in terms of reach and scale, as well as the stakeholders involved. From figure 28 can be concluded that the lower the impact of activities (i.e. repair, refurbish and reuse), the smaller the scale of initiatives, getting even to the resident and neighbourhood scales. In opposition, recycling and responsible construction require powerful stakeholders interacting on large scales. A clear directionality is defined, at least for the current state of things: the less we demolish, the higher are the chances of communities and neighbours being involved.

	Dimension \ Scale	Resident	Neighborhood	Municipality	Region	National
Preserve	Repair	DIY	Workshops and education	Consultancy Coordinate trading Small scale storage + trading		
	Refurbish / Repurpose	Tech. conversion	Participatory meetings	Assess before demolish Subsidies Pilot projects		
Demolish	Reuse	E-commerce DIY	Workshops and education	Coordinate trading Manage storage spaces Limit demolition permits Circular tendering Encourage circular demolition	Large scale storage + trading Coordinate constr./demolition Urban mining assessment Material database	Enforce circular demolition Mandatory material passport
	Recycle			Locate recycling hubs Reduce waste as backfilling (Re) education in circularity	Coordinate CDW Flows R&D in circular design (Re) education in circular jobs Construction hub	Enforce circular demolition Mandatory material passport Discourage downcycling
Build	Responsible construction			Resource-conscious management of land Circular tendering (Re) education in circular jobs Coordinate constr./demolition	Implement circular design Construction hub	Enforce design for reuse Mandatory material passport Encourage use of clean mat.

Individual / Business · Communal · Private corp. · NGO · Government · Education + research

Figure 28. Actions, stakeholders and scales

Conclusions

It can be concluded that circularity has been extensively researched and defined from theoretical perspectives, but application still remains a challenge. On the positive side, the future realization of a circular C&D sector for the Province of South Holland has a solid base of theoretical work to back it up; therefore, many of the future challenges circularity will have to face, have already been identified and discussed, and can be addressed in the proposal for a circular future for the C&D sector that is presented in this work. Some of these challenges: on the one hand, the national government needs to define clear standards and definitions on circularity and promote them through laws and regulations. On the other, R&D institutions and private stakeholders must work hand-by-hand to overcome current technical, financial and trust issues related to the implementation of circular processes. Furthermore, it was clearly shown that the realization of this transition is not possible without the active involvement of the less powerful stakeholders affected by it: migrant workers and regular citizens. Education is instrumental, as it creates understanding on the circular transition and helps empower workers and residents, allowing them to take part in the decision making from an informed perspective. Finally, it was shown how curricular activities have different scales of influence: while some of them require large scale operations, others easily adapt to smaller scales.

3 REALISING THE FUTURE OF ¡OPEN CONSTRUCTION!

3.1/Vision

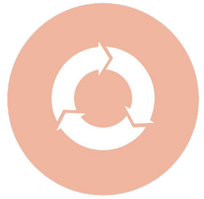
In this section will be explained how the analysis will be used to create a vision for a circular C&D industry in South Holland. This vision has been developed for 2050 and includes an intermediate vision in the transition phase of 2030. Three scales of openness are introduced: open network, open program and open edges. A method of guiding these developments supporting the realisation of our vision on circularity in de C&D industry will be introduced in this section as well.

Vision

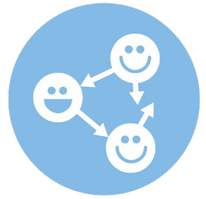
3.1.1/Vision statement

In 2050, more than 210.000 homes “have been built through the establishment of **a circular materials industry**. This urbanisation will be realised by refurbishing, redeveloping and expanding existing areas, creating **high quality and just living environments.**

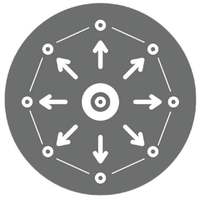
The material industry has undergone a transformation from a decentralised network of C&DW plants to the establishment of **mixed-use material hubs**. These hubs enable an increase in **transportation efficiency and availability of materials**, especially for bio-based materials. These mixed-use hubs will welcome a variety of activities ranging from education to trading. **Closely monitoring** the material cycle developed in collaboration with knowledge institutes, has become mainstream in construction education. **A materials database** will allow for the planning of construction and demolition works by all stakeholders. This will result in an inclusive industry that aims to incentivize the trading of reused materials for all societal **scales**.



circular materials industry



high quality and just living environments



mixed-use material hubs

transportation efficiency and availability of materials

bio-based materials

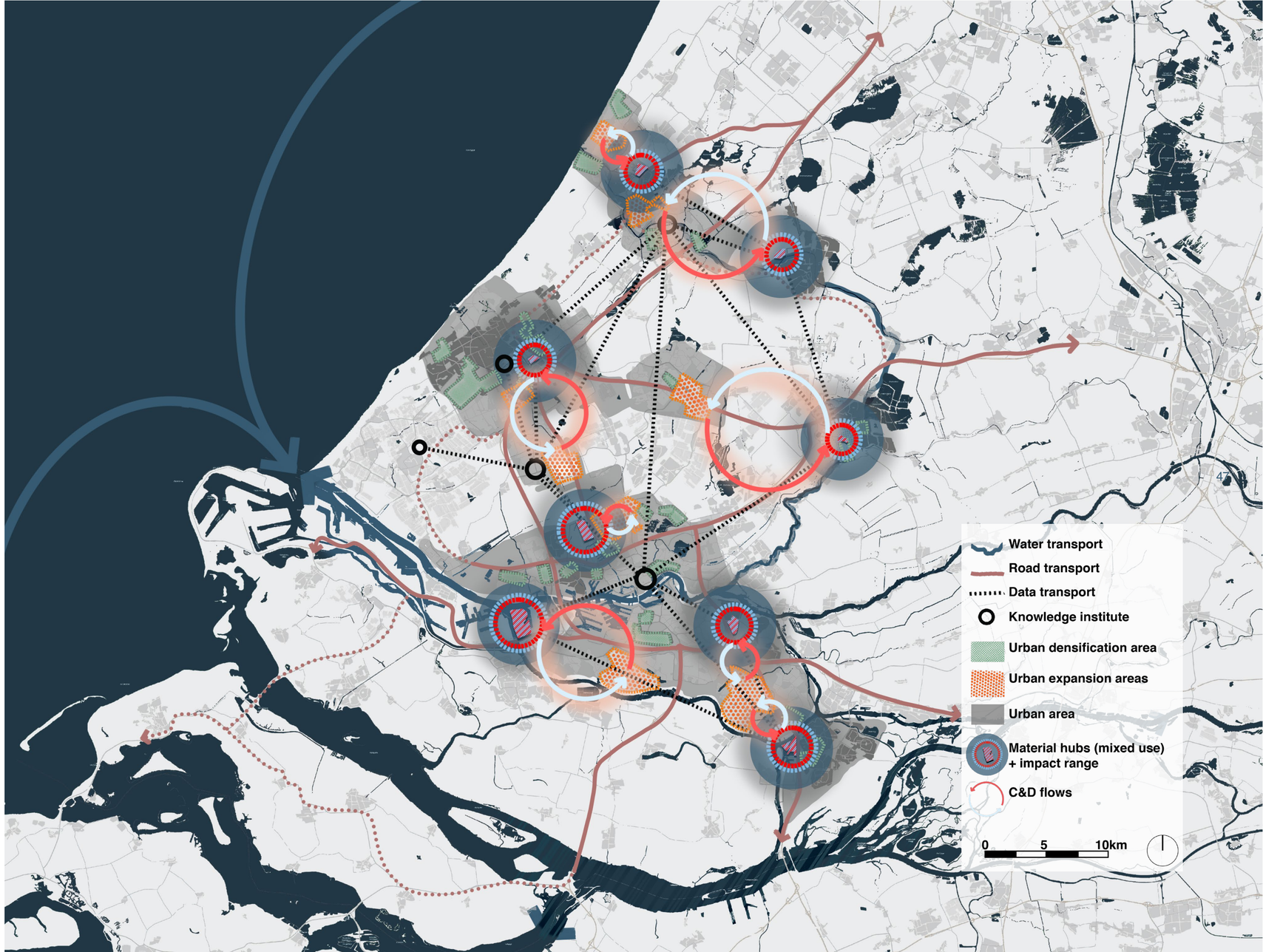
Closely monitoring

materials database

scales

3.1.2/Vision 2030

To reach the 2050 vision, a 2030 vision is needed that can be used to transition to the new system. For this vision, several logistics-material and mixed-use hubs are created. These hubs are located in industrial areas where different construction company agglomerations exist, and/or locations that are located within the potential area between highways and waterways for good accessibility. The hubs will be developed with the help of the knowledge of institutions based in the province, like universities, schools and sector-specific institutions like the Greenport Westland. The collaboration of the different universities and knowledge institutes will be used to further innovate in the construction sector and the possibilities for existing materials. In order to create a knowledge corridor, the participation of knowledge institutes in Leiden, The Hague, Delft and Rotterdam is needed as well as the established hubs. These industrial areas should be connected to waterways and/or highways for good accessibility. In these hubs new functions will be added, companies that do not have functions in the construction industry will be relocated to free up space for these new functions. Facilities for the recycling and reusing of materials will be added to the hubs. Next to this, locations are provided for facilities to refurbish and repair materials. New materials can still be produced by the construction companies present in these areas. At the same time materials coming from demolition and (de)construction of building sites for densification and urban expansion will be provided. These materials can then be reused, recycled, repaired or refurbished in these areas.



3.1.3/Transition phase

Material transition

Between 2030 and 2050 a transition phase is needed. There will be a shift in the production methods causing the production to diffuse. Less site specific products will be produced as there will be a shift towards prefabricated products. Also in 2050, buildings should be fully modular and automation is a big topic. Bio-based materials will be used more frequently, there will be clean transport and the new circular economy will be data driven. Because of this shift, functions of the material hubs will be focusing on recycling, reuse, refurbishing and repairing, resulting in production not being needed in these areas anymore. There is only one hub that will keep the function of producing, this is the production hub in the port of Rotterdam. This hub will mostly produce prefab materials. These materials will be distributed to the material hubs in other locations in the province. However, because of this shift to prefab materials, more space is needed for storage as shown in figure 29. Therefore, the material hubs will also have functions in storage.

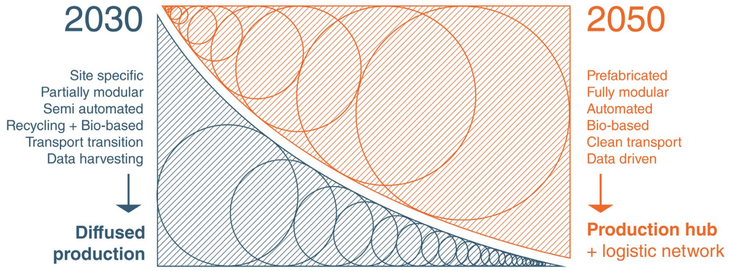


Figure 30. Shift in production (Based on: Kort, 2017 and Metabolic, 2018)

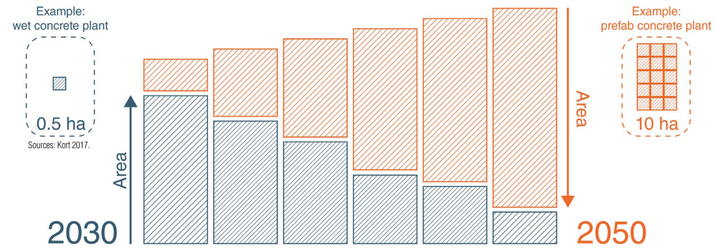


Figure 29. Shift in spatial needs (Based on: Kort, 2017 and Metabolic, 2018)

Job transition

Not only will there be a transition in materials and, therefore, a need for storage, but also a change in job functions will be needed for a circular system to work. Between 2030 and 2050 the jobs in production of sustainable resources will likely increase and stagnate. It is expected that more jobs are needed in this sector because more sustainable products will be needed for a circular system. However, at some point, a high level of circularity might be reached. Therefore, the amount of jobs in production of (raw) biobased materials is expected to stagnate at a certain moment because of lifetime extension seen in figure 31 (Gladek et al., 2018). At the same time, production from primary and unsustainable resources is expected to be decreasing and replaced by sustainable production, causing less employment in this sector, this can be seen in figure 31.

Finally, in figure 31 is shown that using materials in a circular way will most likely provide more jobs in terms of maintenance. Next to this, recycling, repairing, reusing, refurbishing and repurpose will also cause and increase in jobs as these are more labour-intensive than processing materials as waste (Drift & Metabolic, 2018).

Especially the sorting and logistics part and the investments in research and development for these materials will likely cause an increase in jobs (Gladek et al., 2018). Next to this, the establishment of a circular management authority alongside with the gathering and organisation of data will likely provide an additional amount of jobs (Drift & Metabolic, 2018). Current numbers are already showing a shift towards more higher-educated employees in the construction sector as construction systems are becoming more standardised, which might especially be the case for circular construction. (EIB, 2019) In total, the shift to a circular economy will impact approximately 13.000 jobs in the province of South Holland.

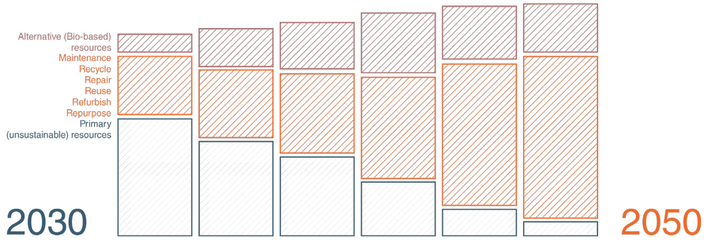


Figure 31. Shift in job needs (Based on: EIB, 2018;2019 & Metabolic, 2018)

Location transition

Part of the transition towards circularity is related to the reconfiguration of the current “productive landscape” of the C&D industry. The differences and reasons in favor of the proposed model are explained in the following paragraphs.

1. For these hubs, both transport from production facilities to these hubs, as well as transport from hubs to building sites can become more efficient, as both can take as much materials as possible. Production transport can be loaded with material for different building sites, and transport towards building sites can take materials from different production facilities in one transport.

2. A model where production is centralized takes advantage of the already unused perimeter of these industries. In general, C&D materials industries have one entrance by land and a quay on the waterways. If in an inhabited area of the city the edge, where public and private meet, is the most important place of interaction, both commercially and socially, the industry reverses this logic by treating it as the place to be blocked and protected from external factors. Therefore, apart from the above mentioned entrance points, the perimeter is not of fundamental importance for industries, which makes them susceptible to being agglomerated in a single hub as long as those points of procurement are respected.

3. A permanent flow of recycled materials. A large-scale operation of recycling requires a constant flow of CDW materials that allow the recycling plants to operate continuously and, therefore, be cost-efficient. In this system, a network of smaller hubs are dedicated, among others, to the constant gathering and shipping of CDW to the central hub. However, in a decentralized model as the one existing today, CDW is transported to the plant that is nearest to the demolition site, which makes the future availability of material a permanent uncertainty, therefore discouraging any investment in new infrastructure of R&D.

4. An industry that relies on prefabricated, standardized and modular pieces does not need to be as close to the construction site as its “wet” counterparts. According to a document by Kort (2017), a plant where prefab pieces are produced can be placed as distant as 90 km from the construction site and still be cost effective. On the other hand, a “wet” concrete plant has to be at a maximum distance of 25 km or even closer when demand or traffic are higher than usual (i.e. cities). This means that production can be moved away and centralized, as there is no need to keep the current urban industrial areas as zones of production, but rather as places where storage, logistics and initial sorting of materials takes place.

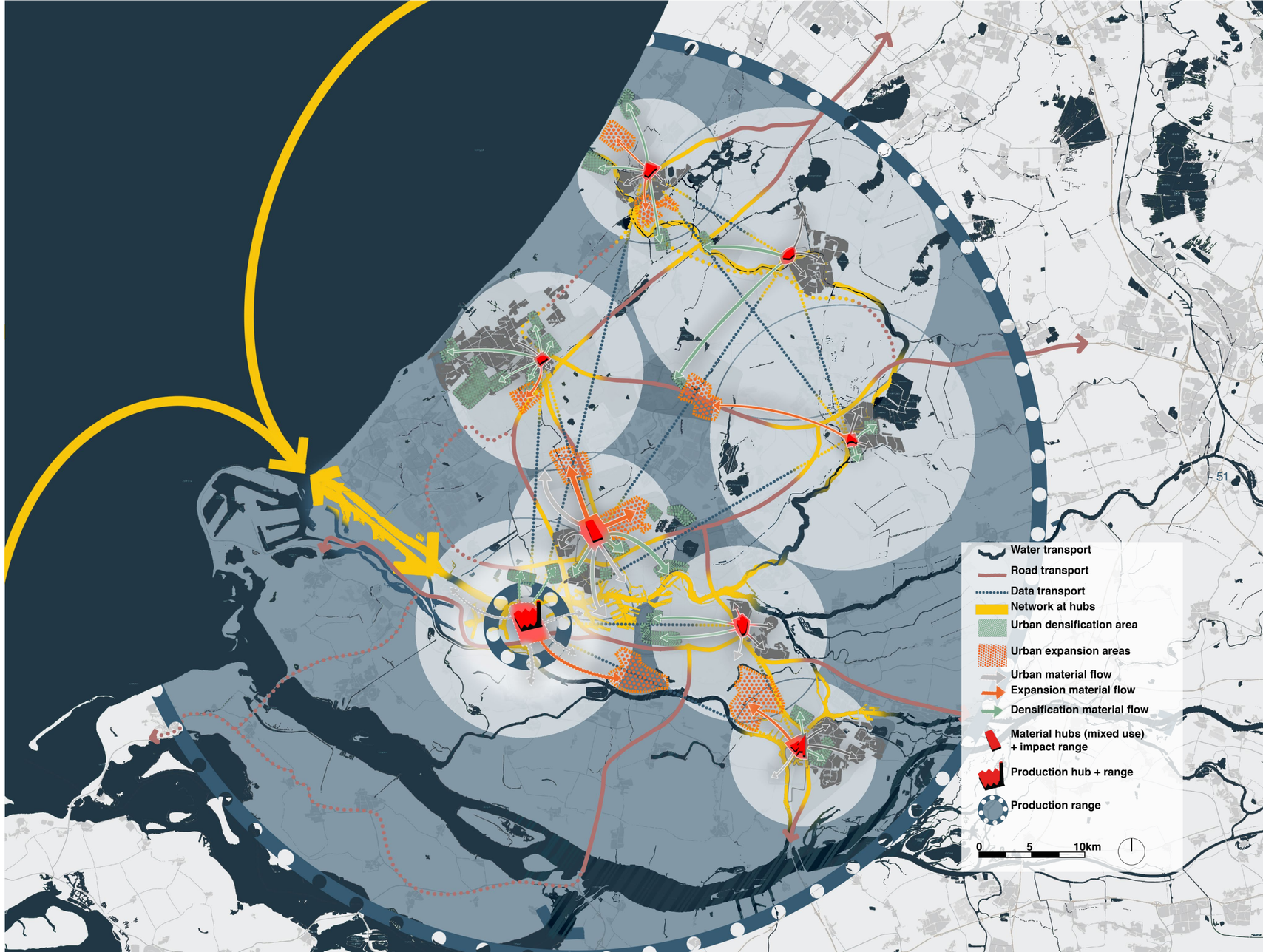
5. Also in terms of efficiency, hubs can be beneficial, for example in the case of sheltered workspace for construction preparations that are more specialised, compared to on-site preparation work.

3.1.4/Vision 2050

In 2050 there will be a central production hub in the port of Rotterdam that facilitates the several material hubs in different parts in the province of South Holland. These material hubs are located in places that are easily accessible by waterways and highways. Materials of the production hub will be brought here for storage, but also materials coming from demolition of buildings in urban densification areas and private projects will be brought back to these material hubs for reuse, recycling, refurbishing or repairing. They will not only facilitate urbanisation & densification, but also affect the surrounding neighbourhoods with small scale actions.

The hubs will make use of a material database to know what materials and amounts are available in which hub. Efficient use of transport will be established to provide the hubs of the materials. Empty freight trucks and ships are not desirable anymore, every possibility for transport should be used. New and existing buildings will be provided with material passports that will be useful in the future when demolition, refurbishment or repairing is needed in these buildings. A network of data is needed to provide for these material passports and databases. This network is established through the knowledge corridor between the cities of Leiden, The Hague, Delft and Rotterdam. Added to this network are the materials hubs and the production hub. In 2050 a circular management authority will be established with the function of managing the development of circularity in the C&D industry of the province.

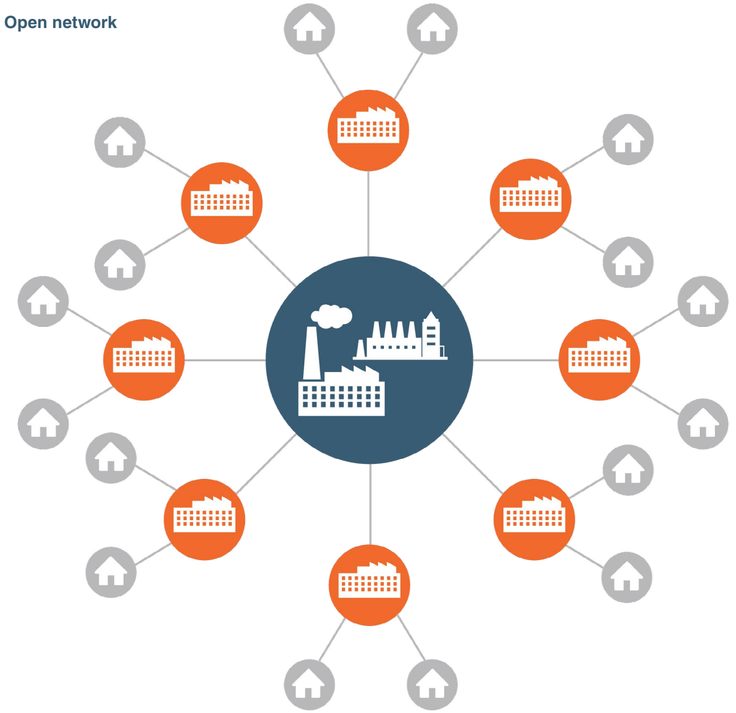
For this vision three open scales are introduced to realise the production hub in combination with the material hubs and create a healthy and enjoyable living environment.



3.1.5/**Three open scales**

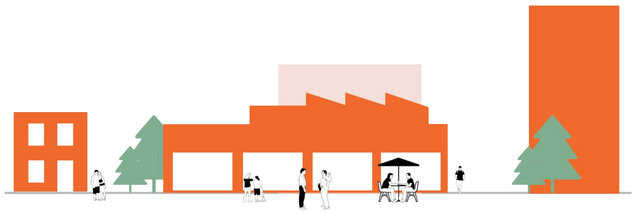
To achieve this circularity in the province of South Holland, changes have to be made on different scales. On the regional scale, an open network will be aimed for, on a city scale will be aimed for an open program and in the neighbourhoods will be aimed for open edges.

Open network



Open program

Open edges



Open network

An open network on a regional scale is reached by creating a connection between different functions in this circular system. This connection must establish communication between these functions. Material hubs and the production hub communicate through the data network as mentioned in the vision. Knowledge and innovation opportunities are shared and spread throughout the province. A Circular Management Authority monitors and provides aid in all hubs and their respective construction projects. The collaboration between several material hubs is not the only aspect to the open network. Hubs communicate and collaborate with the built area, the expansion areas and the producers of bio-based materials. This open network is a physical network in waterways and highways, but also a data connection through material databases and material passports.

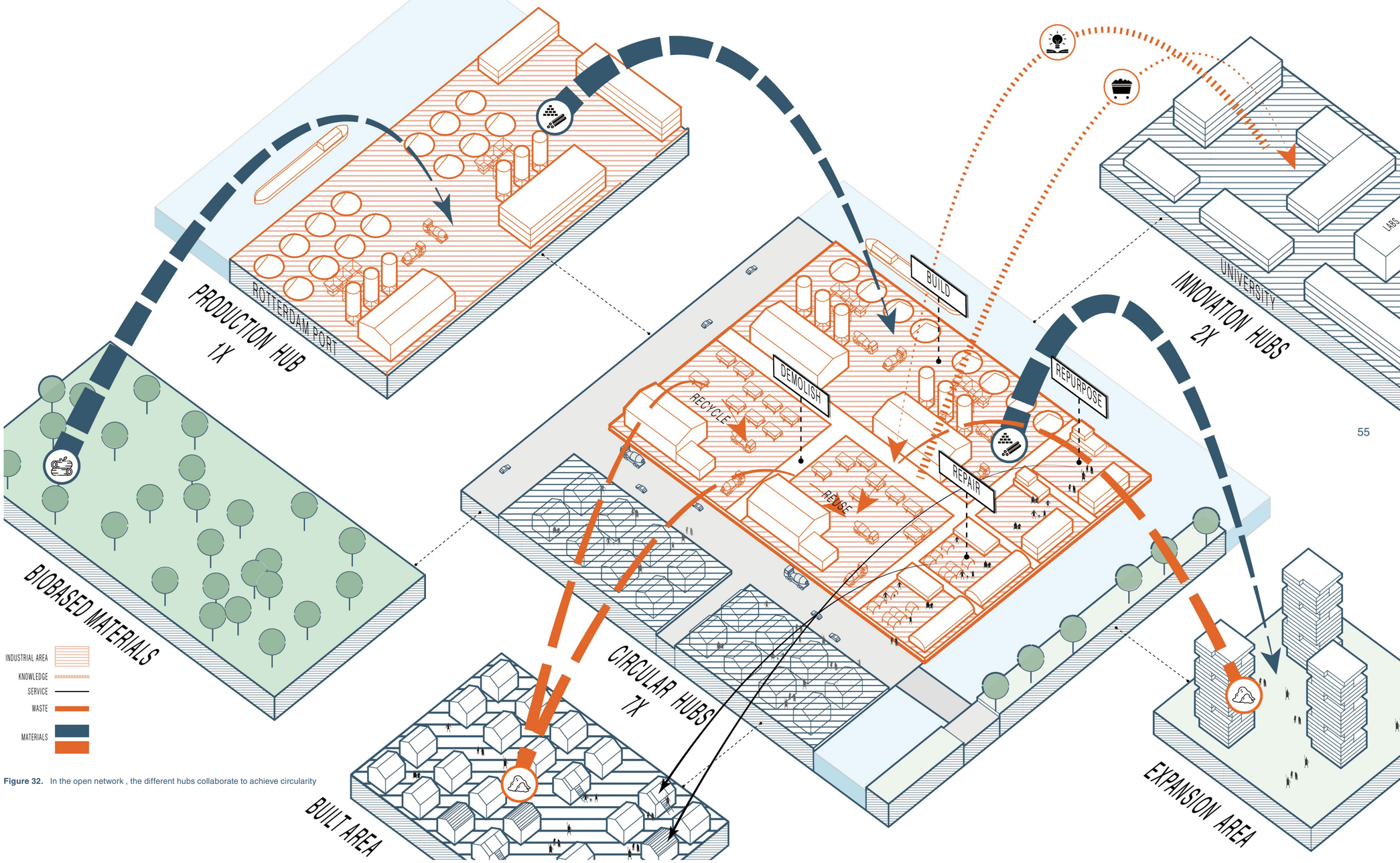


Figure 32. In the open network , the different hubs collaborate to achieve circularity

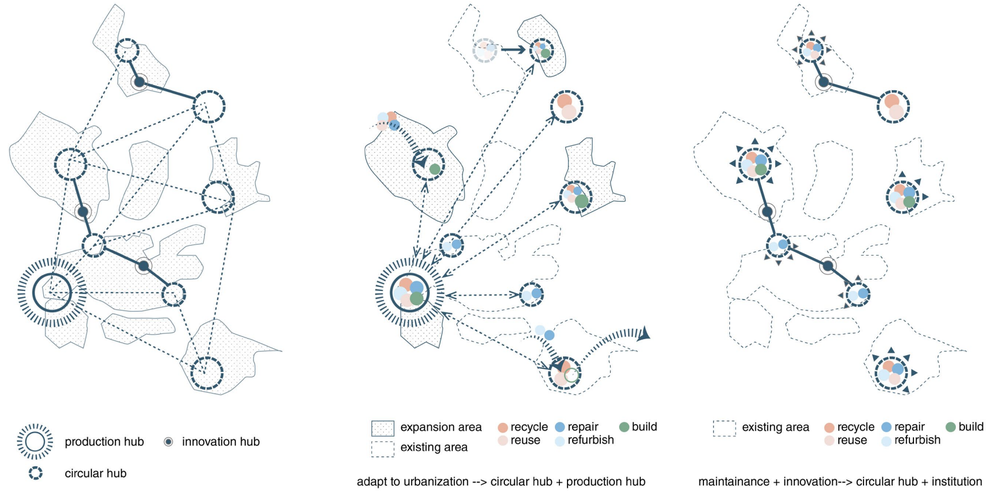


Figure 34. Open network spatial representation

National and beyond

This open network in the transition to a circular system will not only reach the province of South Holland but can also be achieved in other parts of Europe using the connections of the port of Rotterdam. In the Netherlands, other production hubs, managed by institutions similar to the CMA, can be located in cities with good accessibility and availability, a few examples are shown in the map.

A well connected network improves the resiliency of the system, as other hubs could take over the production when necessary, and the sharing of knowledge. A solid international network could also benefit international trading of raw materials that cannot be locally produced.

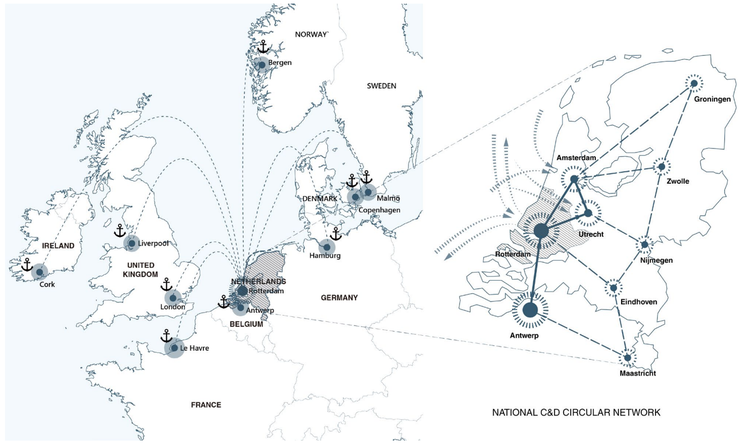


Figure 33. National and international network

Open program

The open program allows hubs to adapt to local conditions and still perform a role in the broader network they are part of. In this sense, each one of the circular actions mentioned before would have a place in the hubs (figure 36). Furthermore, the openness of the program should also allow for the different circular actions to react to local market and social needs: in this way, the initiatives with more potential for social interaction could be located on the edges, and the productive activities could specialise depending on the technologies available and the construction and demolition activities taking place in the area of influence of each hub (figure 35).

The direct consequence of having a diverse and dynamic program in each hub is the capacity of acting upon and being affected by actions on all scales: from the house, going though the neighbourhood and the city, up to the regional scale (figure 37).

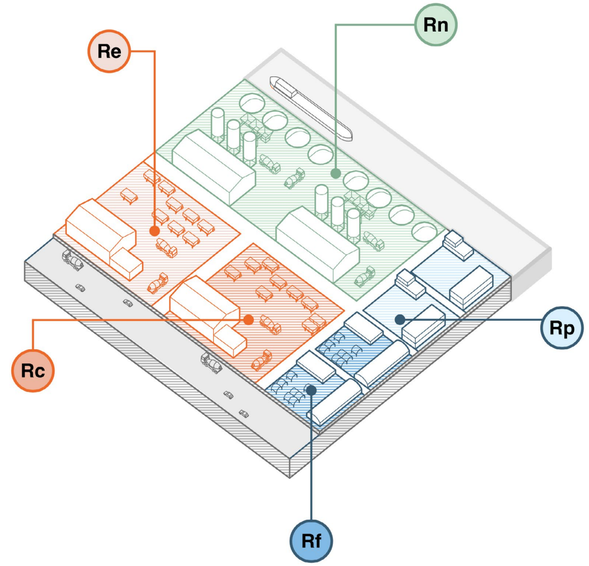


Figure 36. Open program spatial representation

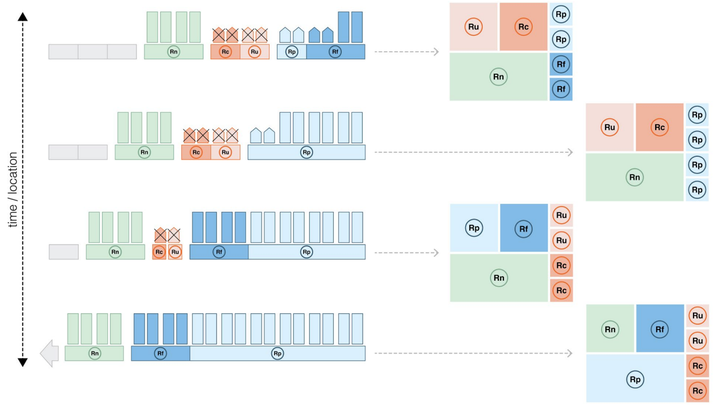


Figure 35. Shift in construction activities

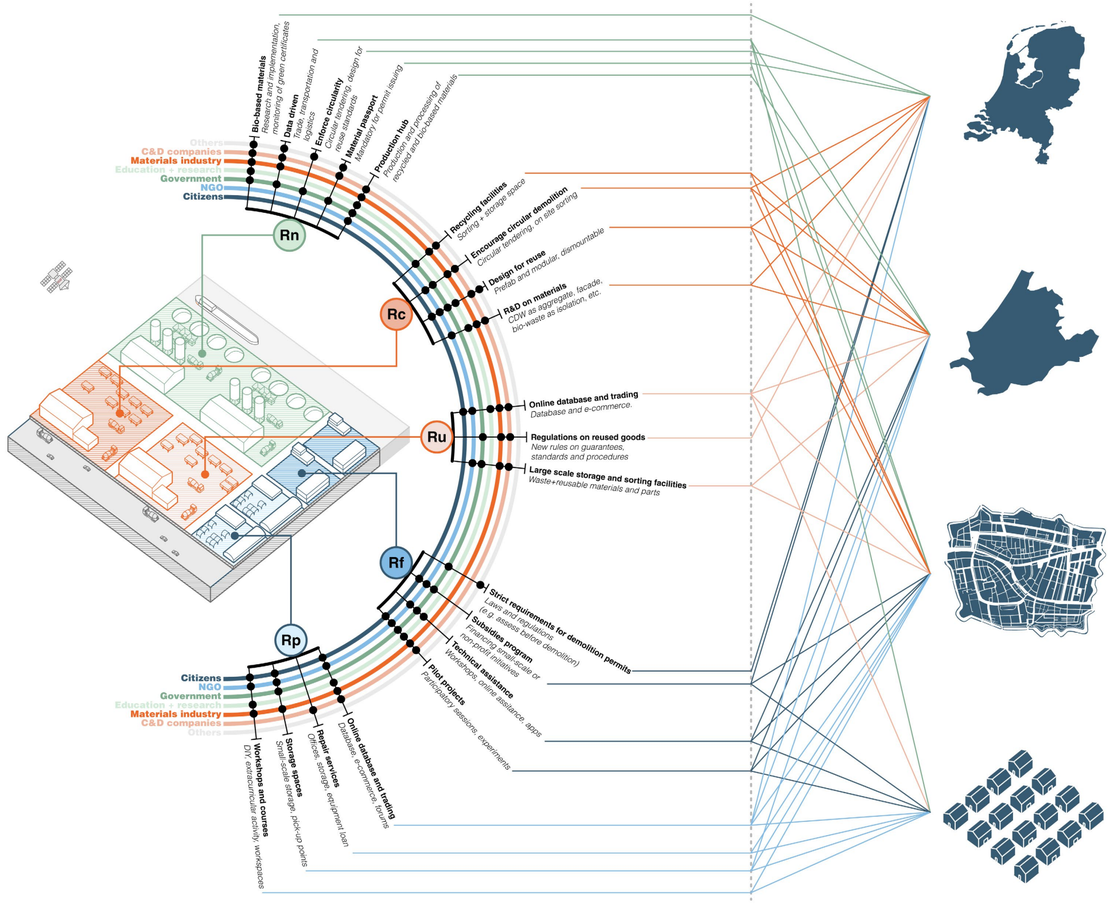
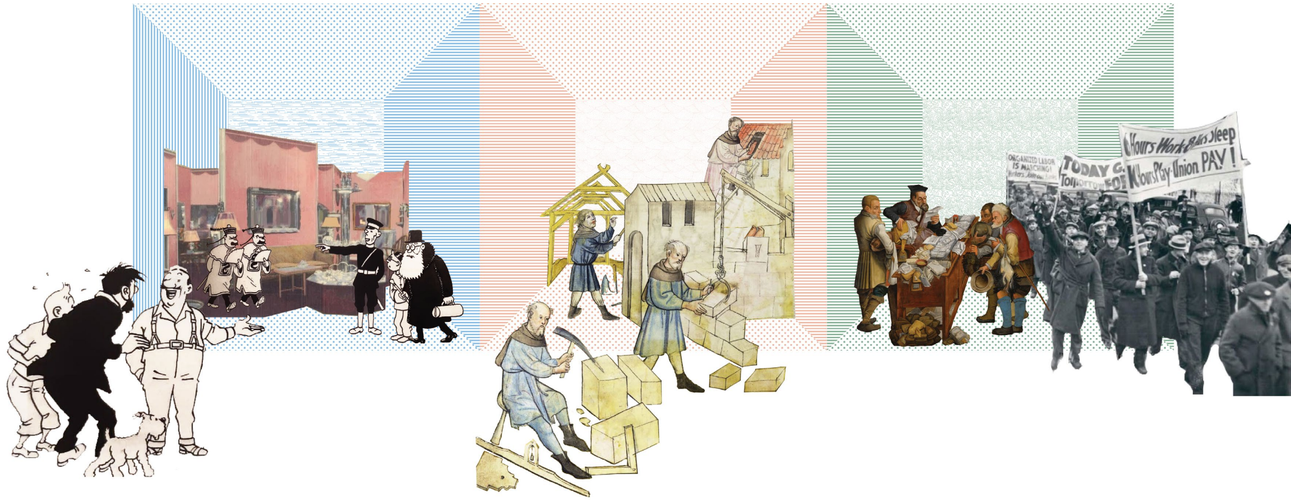


Figure 37. Actions, stakeholders and scales involved in circular hubs

Open edges

The enclave condition of urban industrial areas produces the stronger impacts on the local scale: edges that avoid any interaction with their surroundings, fenced streets and streets dedicated to freight transport are the common denominator. That is why the proposed hubs' edges open to their direct surroundings by offering spaces, services and opportunities for nearby communities, small contractors and workers. This allows for the activation of the perimeter of industrial areas that would otherwise be defined by walls and fences. Furthermore, their transformation into areas mainly dedicated to sorting and storage of materials, instead of production, aims to reduce the direct impacts (mainly noise) of production processes.

In terms of programme, apart from traditional commercial and services activities these open edges will also house spaces for the negotiation and resolution of social conflicts related to circular transition and the C&D industry. In this sense, there are three social issues which are tackled through the open edges: the resistance of residents to technological changes, the risk of existing labour to become obsolete when facing circularity and the sub-standard work-



Showroom and training for use of new technologies

Re-training of workforce and DIY workshops

Counseling and advise on working conditions and opportunities

Figure 38. Social interactions at the neighbourhood scale

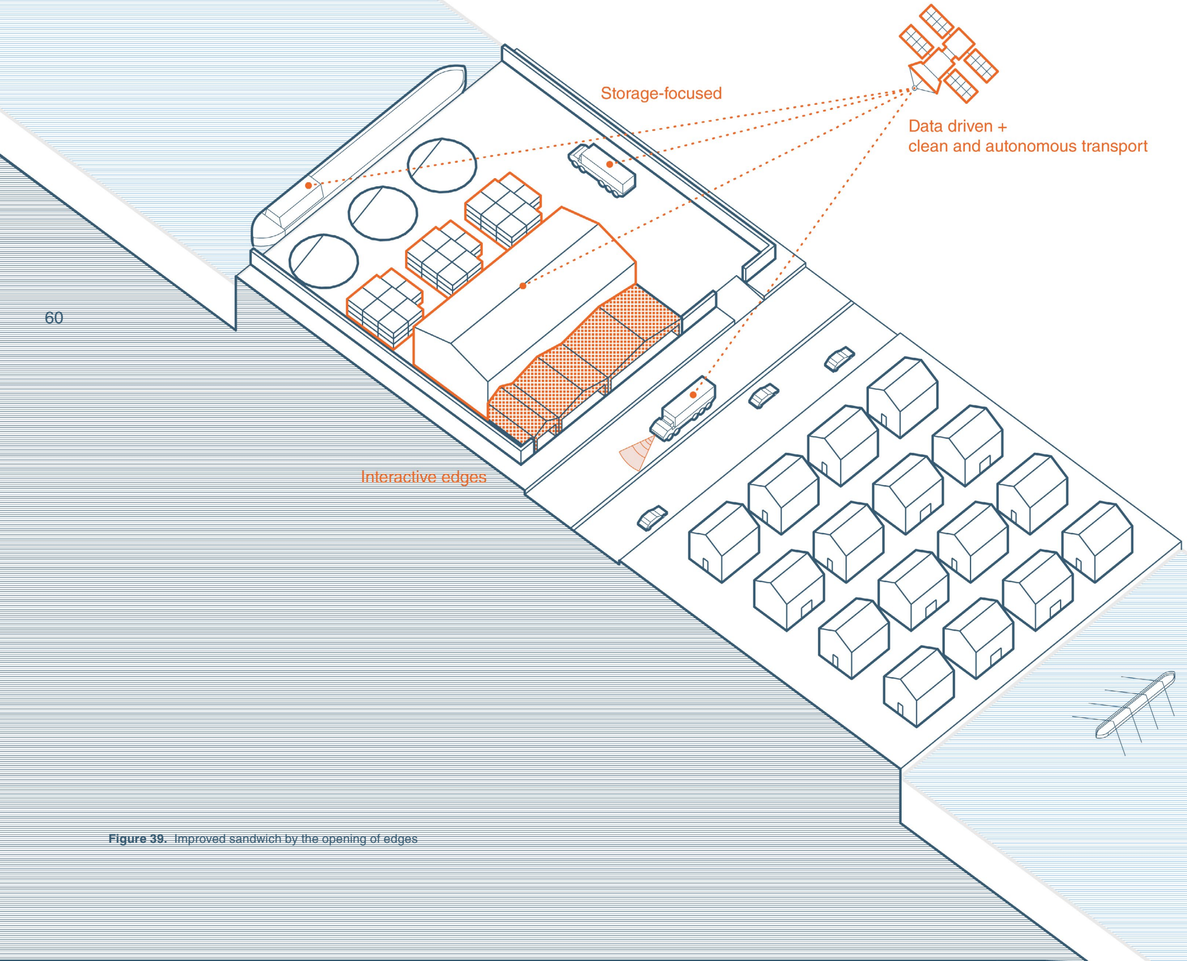


Figure 39. Improved sandwich by the opening of edges

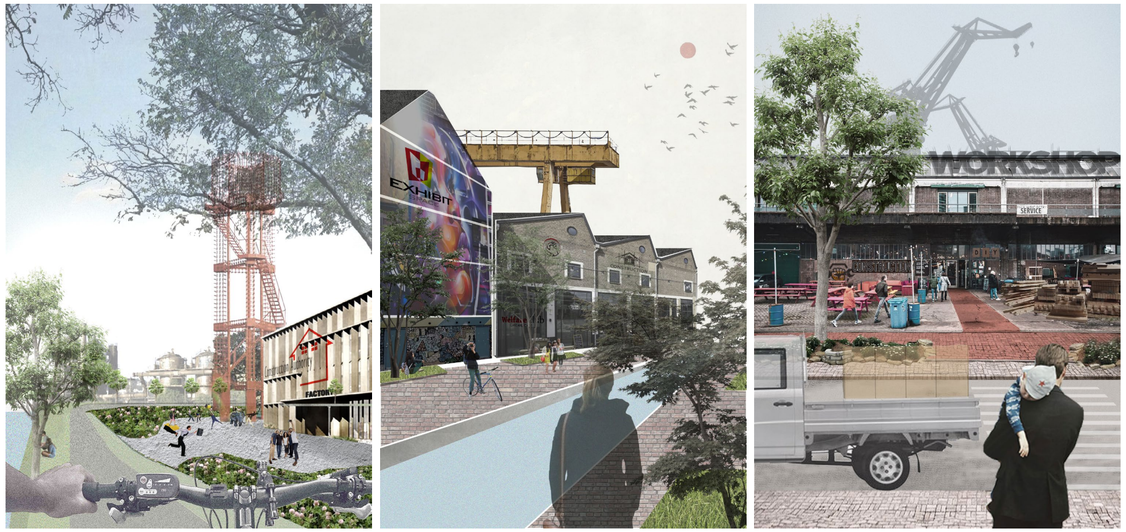


Figure 40. Visual representations of our open edges proposal

ing conditions of hyper mobile migrant workers. In order to do so, the following functions are proposed: 1) Showrooms where residents can select and learn how to use new circular technologies; 2) Education facilities where the workforce can be trained or retrained in new circular jobs. DIY enthusiasts will also have access to these areas; 3) Facilities where advice is given to hyper-mobile migrant workers, the weakest chain in the current C&D production system, on the new working conditions and job opportunities: the presence of representatives of trade unions, NGOs, local authorities and even translators will be required.

Conclusions

From this section can be concluded that the 2050 vision cannot be achieved without a vision for 2030. A transition between these two stages is essential for this vision of Open construction. The use of materials and ways of producing will change, which will lead to a transition in jobs and education. Also, a change in need for locations will occur because of these changing systems. To realise these transitions, several open scales are introduced: the open network, the open program and the open edges. The open network is established on a regional scale and will be reached by creating a connection between different functions in the created circular system. The open program is based on a city scale and allows hubs to adapt to local conditions and still perform a role in the broader network. And finally, on the neighbourhood scale, the open edges open to their direct surroundings by offering spaces, services and opportunities for nearby communities, small contractors and workers.

3.2/Strategy: Realising Open Construction

To reach this vision in 2050, a strategy has been developed. This strategy consists of the establishment of a network for circular construction in the province of South Holland. A physical network is needed, but also a data network will be established. In this strategy, a new stakeholder will be introduced, the Circular Management Authority (CMA). One of its functions is managing and coordinating the flow of construction materials between producers and consumers. Another part of the strategy is introducing strategic projects. Projects in Rotterdam, The Hague and Gouda will be defined later in this chapter.

3.2.1/Definition of phases and goals

For our strategy to work, different transition phases are created according to the needs of the C&D industry. The phases represent a gradual change from small to large scale transitional components.

In figure 41 we can see how the replacement of raw materials, the change in construction and demolition methods and the processing and production methods happen in a cascading order. This is done to avoid excessive stress on the building industry, giving more time for transition to those activities which are less adaptable to change.

In general terms, the phases are meant to represent the different stages needed for the C&D sector to make the transition from the current situation to a fully circular network at regional scale. In order to define a strategy, different goals were defined inside each phase: some

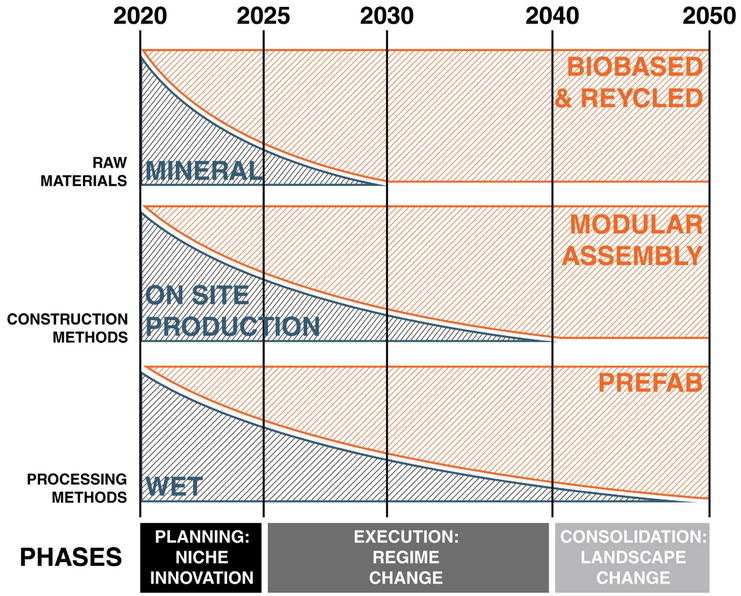


Figure 41. System and phases for the proposed C&D industry

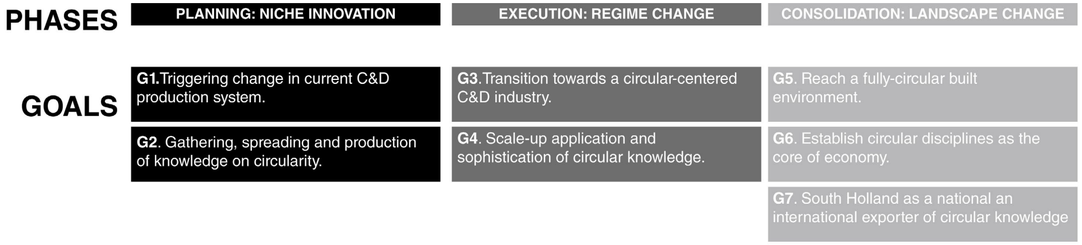


Figure 42. System and phases for the proposed C&D industry

3.2.2/Stakeholder definition

are strictly related with the production industry (G1, G3 and G5), while others have to do with the flow of knowledge and information (G2, G4, G6 and G7).

In addition to the temporal dimension, the strategy is also defined through spatial projects: a production hub, several expansion and densification material hubs. A network, existing both in the physical (infrastructure) and digital (data and knowledge) realms is also needed. Together with these projects, there are also social instruments and policies that guarantee the successful implementation of the strategy in different phases (figure 43).

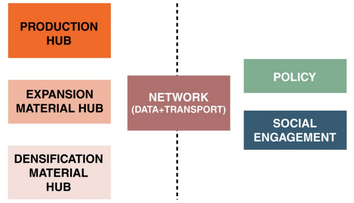


Figure 43. Spatial implementation of proposed strategies

The following pages delve into the spatial and temporal complexities of what has been presented so far. Perhaps, some clarification about the way in which the stakeholders were defined needs to be made: as the proposed vision is centered in a productive system that is unavoidably linked to the market, the analysis of the main actors was carried out following their main involvement in the dynamics of supply and demand of C&D materials and waste. This was useful for understanding who was performing an irreplaceable role in the game, and who was less important.

The result is shown in figure 44: while the materials industry, construction and demolition workers and Research and Education institutions define the available supply of materials, the construction companies, government and civil society determine the patterns of consumption of those commodities. In the meantime, Infrastructure and transportation networks act as facilitators of such flow, as well as the Circular Management Authority, a stakeholder we introduce as part of the strategy.

As it can be seen, these are general categories of stakeholders. They will be specified upon in the next pages, according to the specific challenges of each project and location.

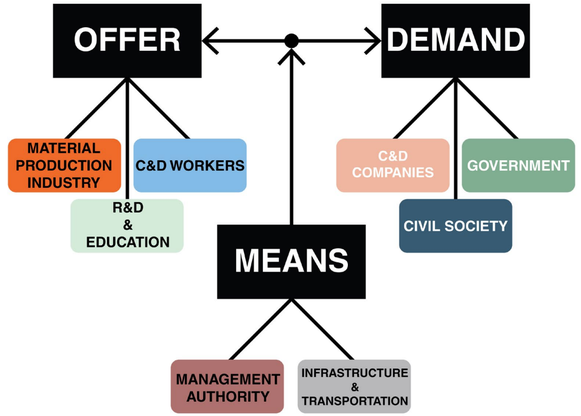


Figure 44. Supply and demand dynamics for the proposed strategies

3.2.3/**General timeline**

This timeline (figure 45) is a general overview of the interaction between the phases, goals and actions previously defined. As it can be seen, every project is sectioned into different specific actions corresponding with the goals and phases they are part of. It is also evident that certain events from one phase overlap or continue into other phases; this is an indicator of the flexible nature of the categories we propose, which, by extension, guarantees the adaptability of the strategy they conform.

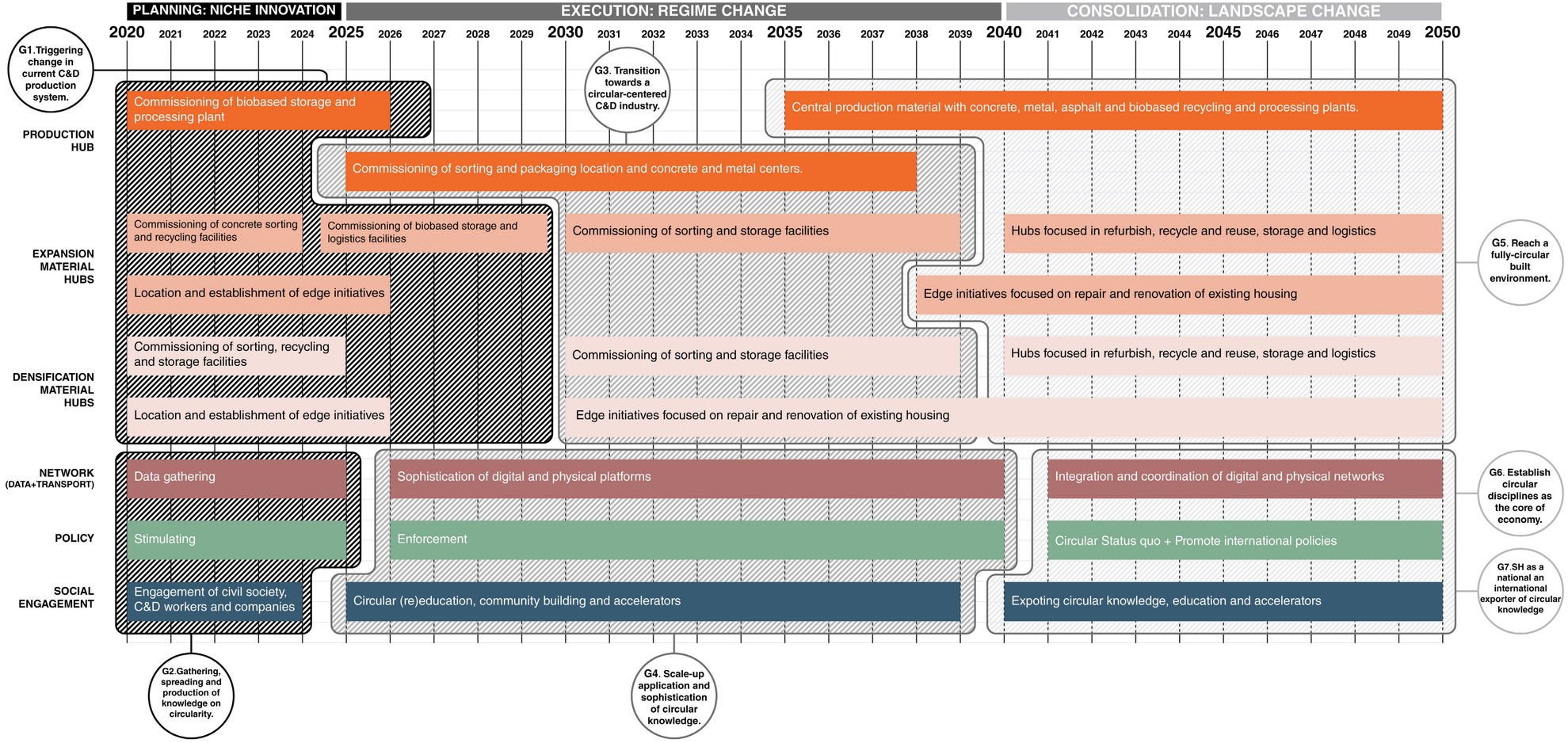
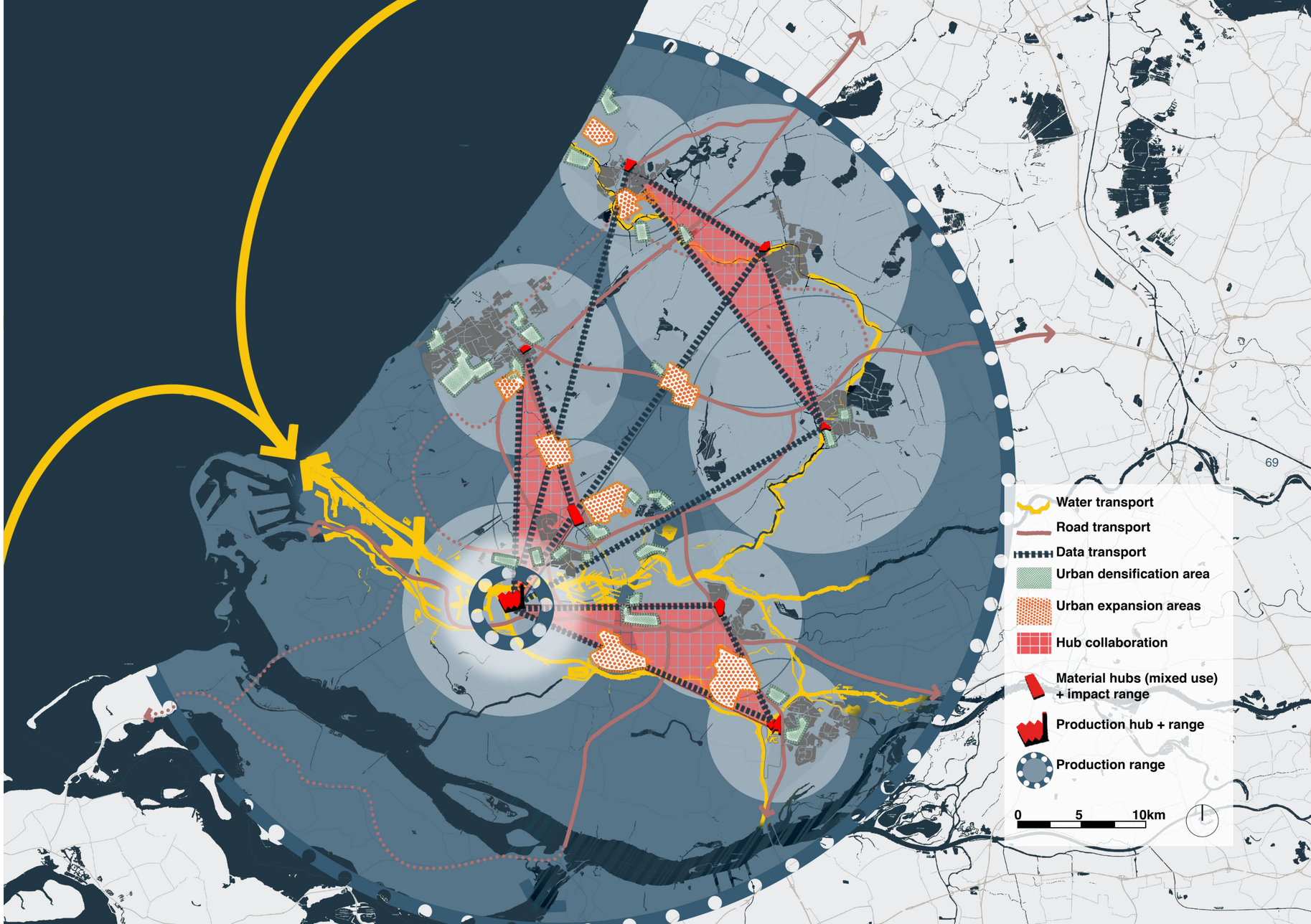


Figure 45. Timeline of necessary actions and phases for the proposed strategies

3.2.4/**Network**

On this map, the physical and digital network that is used for the logistics hubs in the proposed vision is shown. Some hubs do collaborate on supplying several projects nearby. The data network of the CMA is used which has been established in an earlier stage with the help of knowledge institutes and governments. The existing network of water & highways can be used as the logistic efficiency has improved to put less pressure on these existing networks when transporting material between hubs. Also, the data network is needed to exchange knowledge about the available materials per hub, but also the material passport of new and existing buildings.



Stakeholders

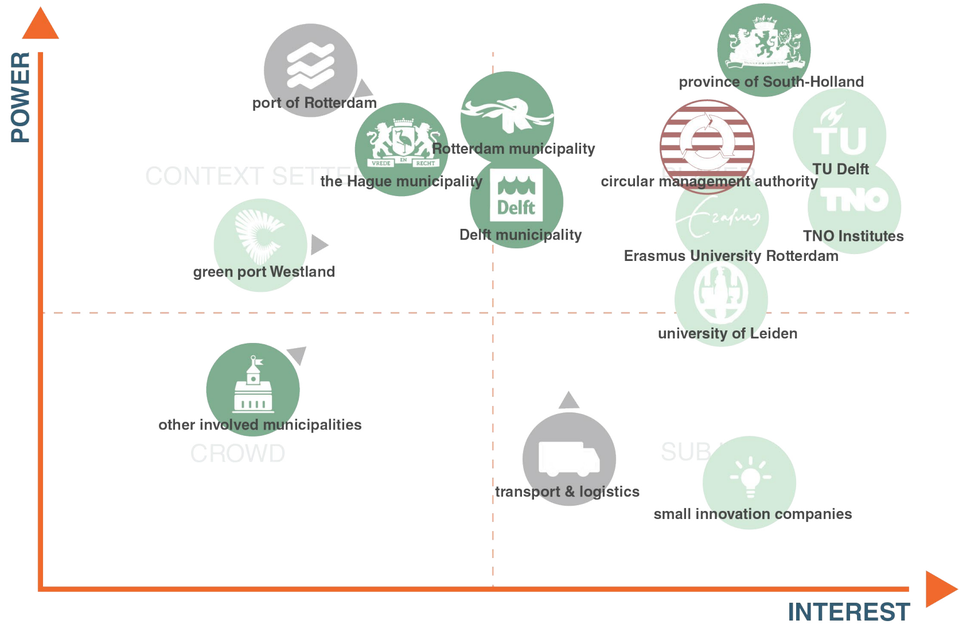


Figure 46. Power-interest matrix of proposed network

In the province, stakeholders interested in the network are defined. These consist of the several municipalities of the bigger cities. The Hague, Delft and Rotterdam are defined as they are the center of innovation and education and are therefore likely to be interested in the network. In figure 47 is shown that Delft especially consists of several TNO research institutes. Also included in this map is the Port of Rotterdam as they can influence this project.

In figure 46, the power-interest matrix of the network is shown. Also, the shift of the stakeholders in the future is visible in this graph. The Port of Rotterdam has a lot of power but little interest. When applying the vision, in 2050 the Port of Rotterdam should have less power compared to others, however their interest should increase as circularity will affect the port of Rotterdam and its economy. The province of South Holland has high power in combination with high interest. Through research, innovation and policies the province can create a circular economy, however they do need help from innovation and education facilities, but also different municipalities. These municipalities might not be as interested in a circular province, as they are used to working on smaller scales. Collaboration between these municipalities is needed. Also, a new stakeholder is introduced, the circular management authority, which will bring together all the different stakeholders and their functions.

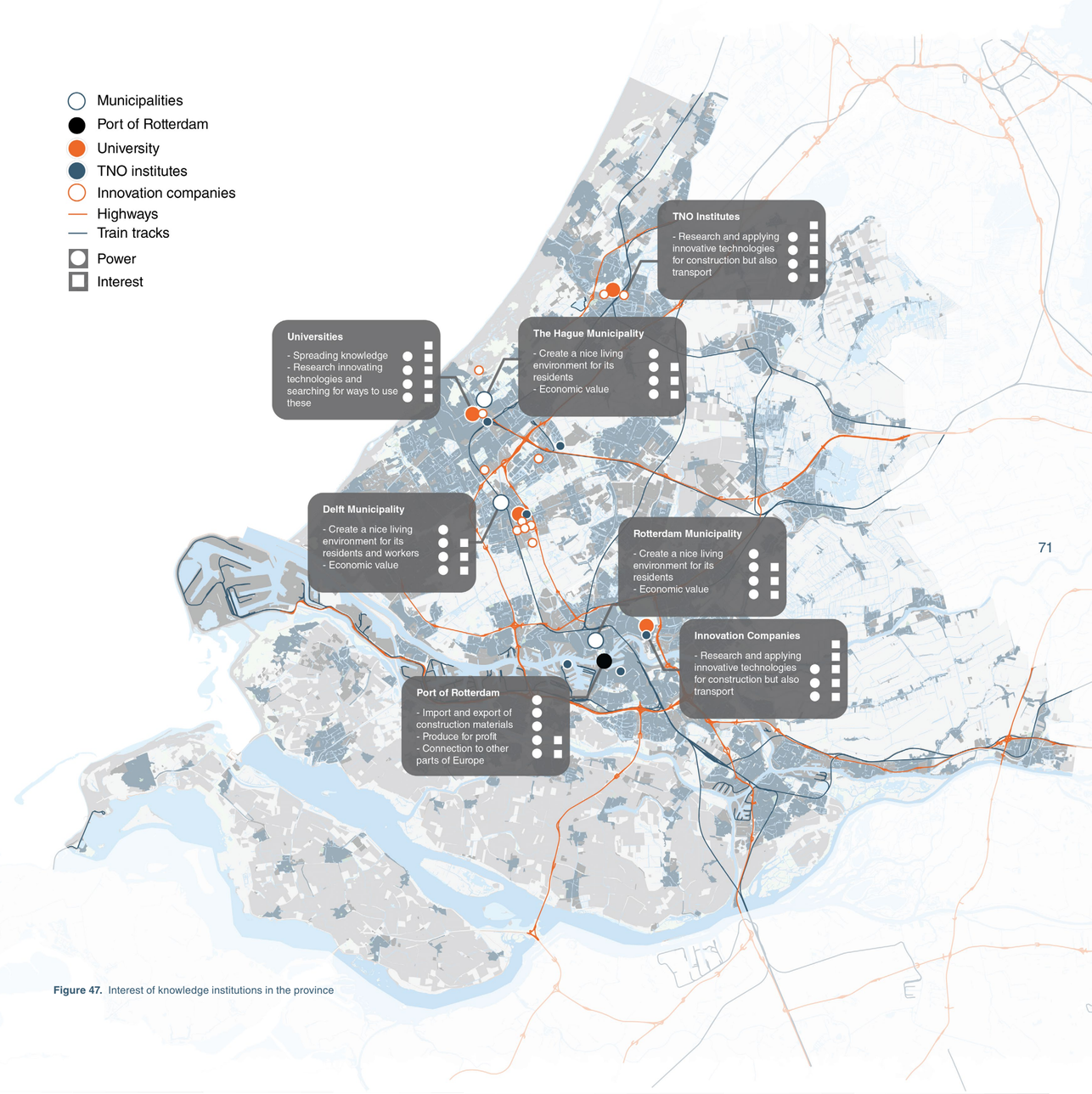


Figure 47. Interest of knowledge institutions in the province

3.2.5/The Circular Management Authority (CMA)

Functions

The Circular Management Authority is the institution in charge of managing and coordinating the flow between producers and consumers of new, recycled and ready-to-use construction and demolition materials. It provides information to the several hubs that have been established and is also the means to scale up the circular system to other provinces and even to other countries in a later stage. In this way the system on a smaller scale, for example in a province, can rely on other areas in the case of (temporary) changes in material flows and supply. In this way, the CMA also provides resilience for this system on different scales.

In order to do so, the CMA should have total access to the database of materials in these hubs, as well as the material passports, with information of (future) availability of materials from the existing building stock as well. It should also be involved in the system of material storage and logistics. Next to this the CMA is responsible for managing the land and infrastructure of the hubs where all the processing, production and storage facilities are.

Next to facilitating the shift towards circularity for the construction industry, it can also negotiate with- and inform- governments on how to stimulate this transition. The authority can become a representative for the circular construction industry and help overcome procedural thresholds and advocate for changes in policies to allow for circularity in practice.

Organisation

The CMA is the product of a public-private partnership for the circular transition of the C&D industry in South Holland. Its board is composed of representatives from the Province of South Holland, the C&D materials industry, development and construction sector, TNO, TU Delft and civil society. Depending on the situation, decision making should include municipal governments, representatives of civil society, the Port of Rotterdam and trade unions.

Area of influence

Its area of influence exceeds the borders of the Province of South Holland, as it is meant to establish alliances with similar national and international institutions in order for the circular system to become resilient.

Establishment

The authority should be established as soon as possible. However, this will be done in steps, starting with initial support and coordination of existing hubs and gathering of data. It should be in charge of coordinating research institutes, C&D industry and land owners in order to find the necessary spaces for the hubs to be built.

Location

The headquarters of the CMA are located in the central production hub, in the Port of Rotterdam. Smaller offices and logistic centres are located at each material hub.

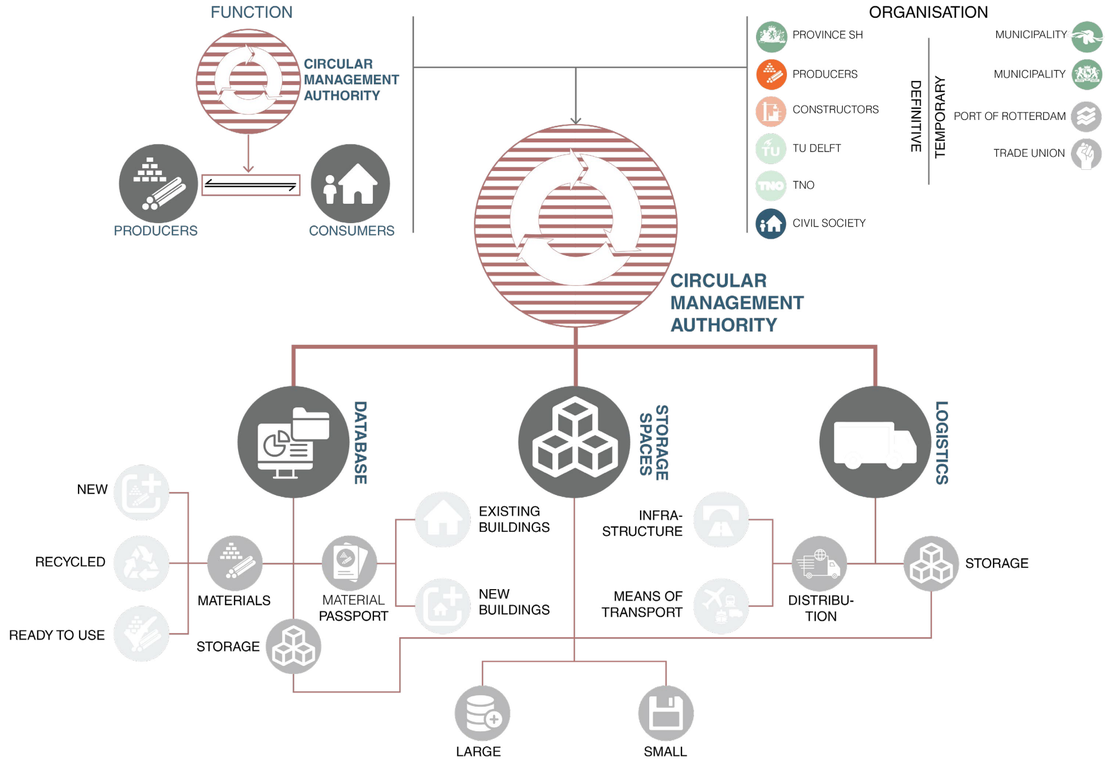


Figure 48. Functions of the Circular Management Authority

3.2.6/**Strategic projects**

In order to realise ¡Open construction!, several areas have been selected for the establishment of material hubs. From these, a production hub in the port of Rotterdam has been selected, as well as a material hub in the urban area of Binckhorst in The Hague and a material hub in the industrial area Kromme Gouwe in Gouda.

3.2.7/Rotterdam production hub: Vondelingenplaat, Port of Rotterdam

The production hub in Rotterdam is selected because of the presence of a recycling and construction material production agglomeration, and its strategic location within the sandwich between waterways and highways. Next to this, it is located in a central location for the province and in the Port of Rotterdam where most raw materials are transported to in the future such wood as a bio-based resource.

Stakeholders

Figure 49. Power-interest matrix for involved stakeholders

Currently, on the Vondelingenplaat, a few companies can be found. An asphalt production company and Recycling Kombinatie can be found on the northern part of the Vondelingenplaat. These companies have high interest in the circular economy as it concerns their sector of work. Next to these companies in the construction industry, also other companies out of this industry are located here. Shell is a big stakeholder in this location as they use most of the area for their refinery. Therefore, Shell is a stakeholder with high power. However, by 2050 a significant decline in the oil industry is expected in which Shell is aware of and will transition their role in the energy sector (Vaughn, 2018). This means that Shell and other oil companies will no longer use all of their refineries, this frees up some space that can be negotiated for.

In the power-interest graph in figure 49 is shown that Shell is likely to lose power in the future as the demand for fossil fuels is likely to decrease, however, their interest stays the same. Waste companies will also lose some power, as recycling and reuse will be the standard. Therefore, recycling companies will gain power and interest from medium to high. In this stakeholder analysis, ports in other parts of Europe are also included as they are well connected to the port of Rotterdam.

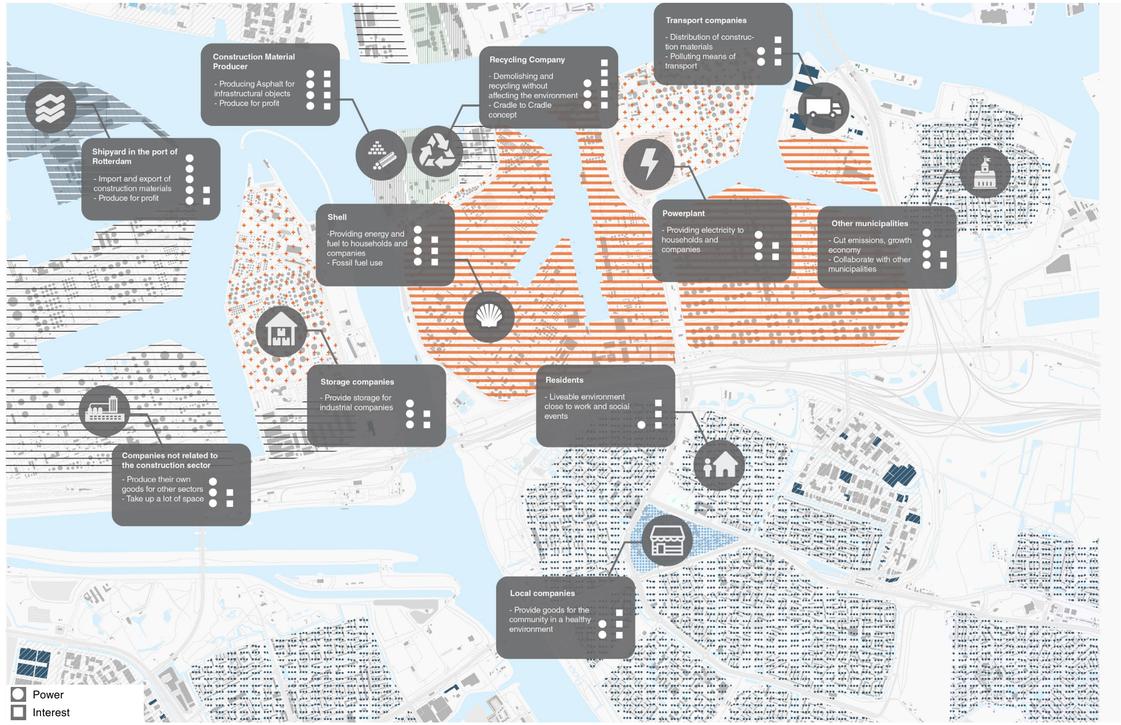
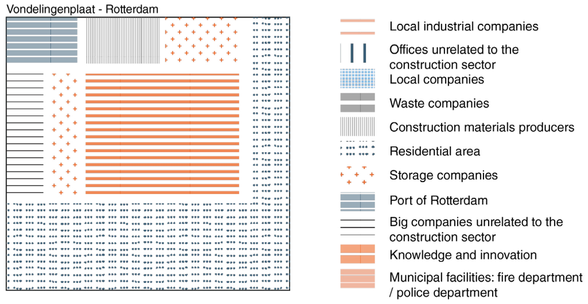


Figure 50. Stakeholder interest for the proposed location



Functions

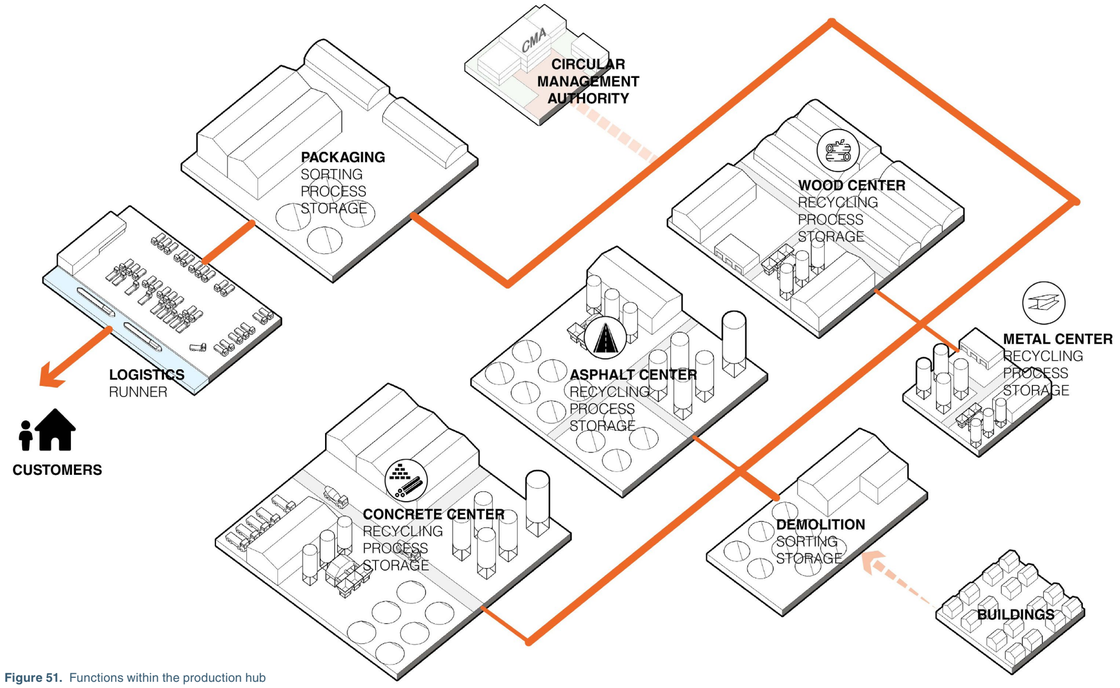


Figure 51. Functions within the production hub

The production hub has multiple functions such recycling and producing materials for construction from primary (bio-based) resources. Materials for this hub are coming from both construction and demolition waste of buildings as well as an input of bio-based resources such as wood and waste products from the food industry. These materials will be sorted first and recycled if needed and will then be processed to make new materials. From this, materials will be sorted again and grouped into packages for their respective hubs in order to create an efficient transportation logistics system. Monitoring and logistics of such materials is where the CMA is involved through data management. With their information on availability and demand, the material packages for each hub can be assembled. From this, the packages are ready for distribution to the several hubs in the province, as well as building sites nearby that are served directly by the production hub.

Phasing

During the first phase there will be niche innovation. The commissioning of a facility for bio-based material storage and processing will be located along the waterways, as can be seen in figure 54. The first edge initiatives can be started with the help of the companies, neighbouring residents and the first organisation of the CMA. This is also part of the engagement of residents, companies and other interested parties like other provinces. At the same time the CMA can be established with the help of logistic companies, knowledge institutes and municipalities.

In the next phase (figure 53), The logistic centres are established as by this time the CMA is expanding its organisation and activities. Next to this, production of other resources for construction can be established in the area. The former areas for storage of fossil fuels will be relocated as there will be less demand in the future. Education and community building will have become part of the hub, and especially, the edge initiatives. From here the renovation of existing housing can get started in the edge by giving workshops, providing showrooms and DIY materials and tools. As the CMA is establishing its platforms of data and knowledge in this phase, the local coordination of material flows for production, distribution and recycling will be starting and continuing in phase III (figure 52).

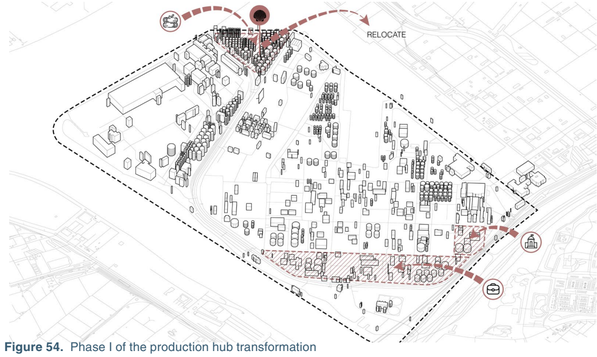


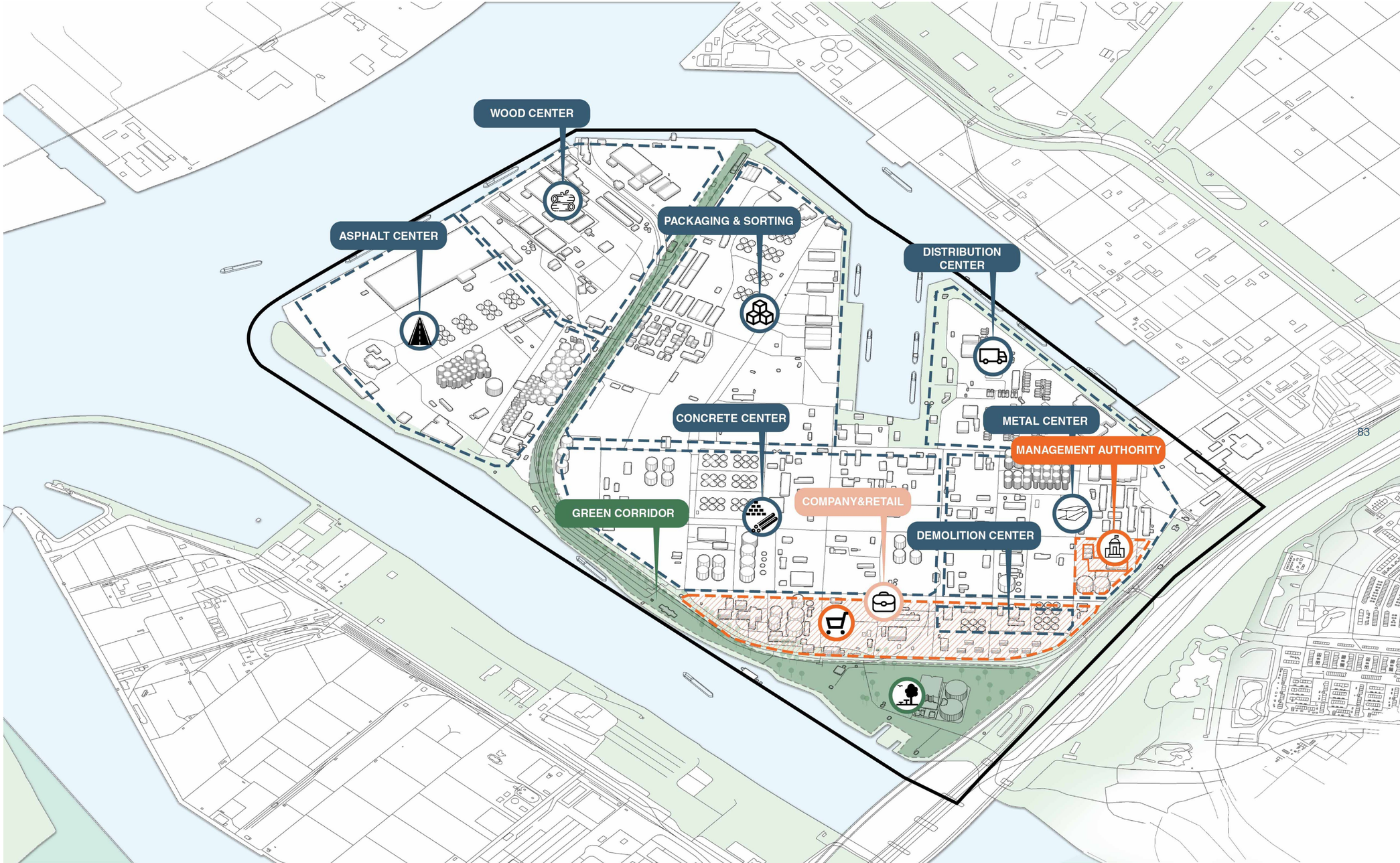
Figure 54. Phase I of the production hub transformation

Figure 53. Phase II of the production hub transformation

Figure 52. Phase III of the production hub transformation

Bird’s eye view

In phase III, existing renovations supported by the edge will continue to go on. At this time the CMA will integrate its networks with other hubs and coordinate material flows from there. The CMA can start expanding to other provinces from the start of this phase to become resilient in the future. From here, the network is expected to become fully functional in the province of South Holland. The first results can be applied in other provinces that have not been involved yet, in order to become fully resistant in the future by scaling up the network of production and material hubs. The knowledge and data from the CMA can then become another product of export for the Netherlands in order to establish a circular construction network on an international level as well.



Timeline

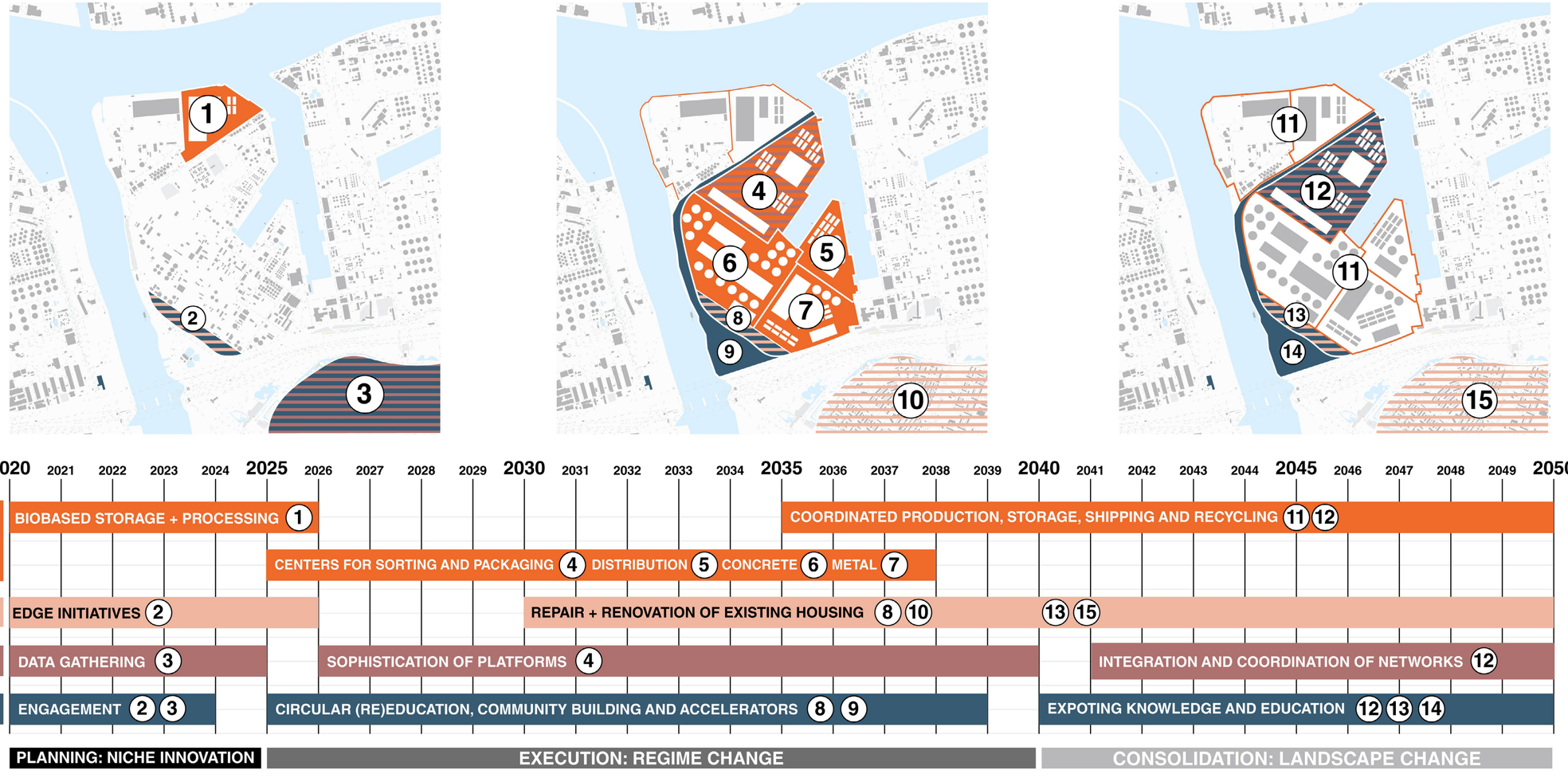


Figure 56. Timeline for production hub strategic project

Before / After

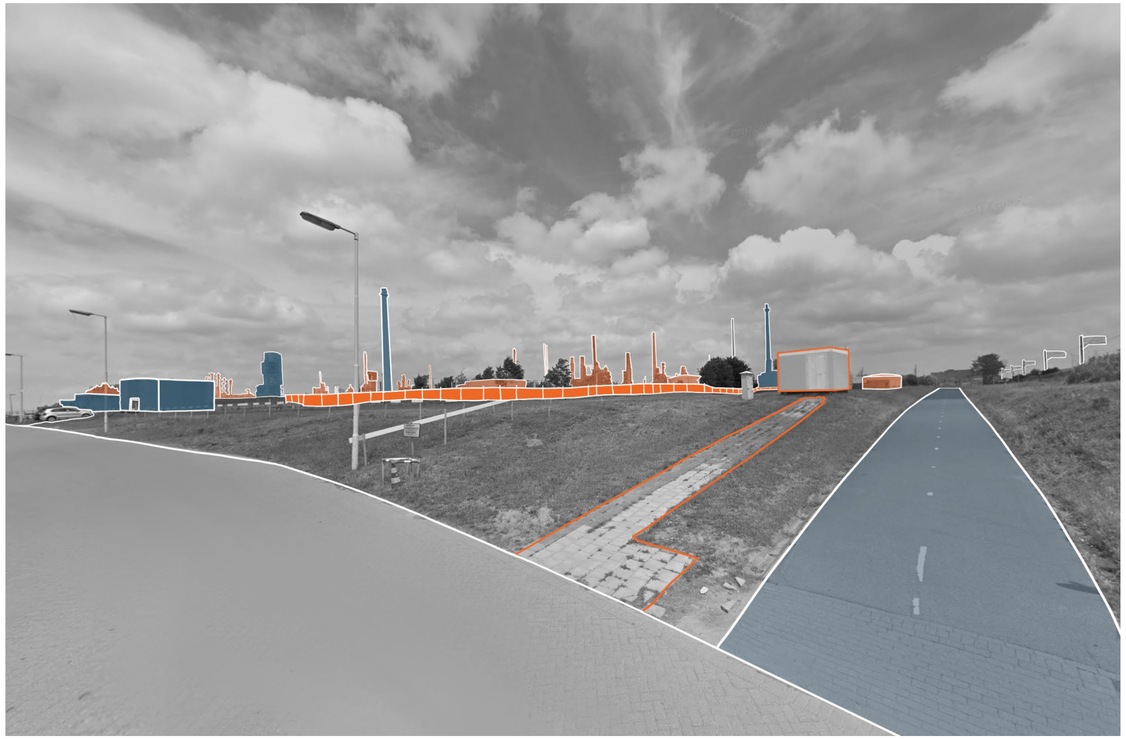


Figure 57. Rotterdam Vondelingenplaat. Based on: (Google, 2017). In the current situation, the production hub area is monofunctional. The area is fenced off and the space is uninviting, and for a reason: visitors are not allowed to be there as valuable materials are stored there and it would be unsafe to walk around.

Figure 58. Rotterdam Production Hub. In the new situation, the edge of the production facility is opened up. While the area itself has changed as well. Storage of fossil fuels has been transformed into production and processing of materials for, and coming from, construction. The edges are areas with small scale initiatives like shops, DIY workshop areas and showrooms to educate and involve residents of neighbouring areas in the circular construction industry. These areas are safe as they are small scale and designed for being used by visitors. The production facility would however be more closed. At the same time, it is possible to visit the area guided, as the purpose is to show and inform people on the circular construction industry and the way these hubs work.

3.2.8/The Hague circular material hub: Binckhorst

The material hub in the Binckhorst area of The Hague has been chosen due to an established presence of companies regarding construction and recycling and because of the area's close proximity to waterways and highways. Binckhorst is currently undergoing urban transformation to a mixed-use neighbourhood. On the map showing potential areas (figure 25) and the densification potential (figure 23) , The Hague is shown to have many areas with potential for densification. This material hub is therefore more focused on densification. However, other functions concerning social integration for both workers and neighbours are important for this area as will be explained later in this paragraph.

Stakeholders

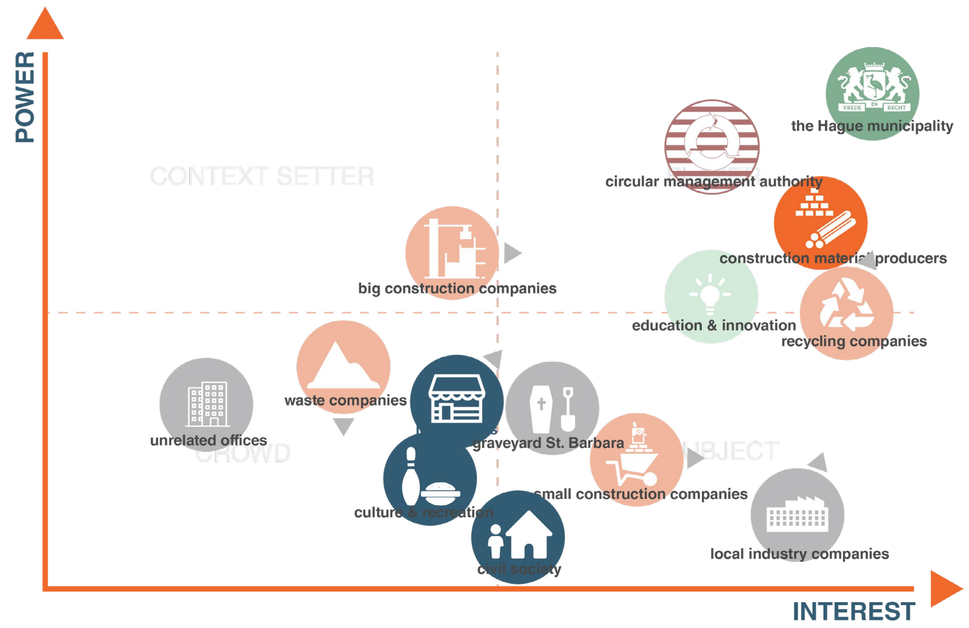


Figure 59. Power-interest matrix for involved stakeholders in the Binckhorst

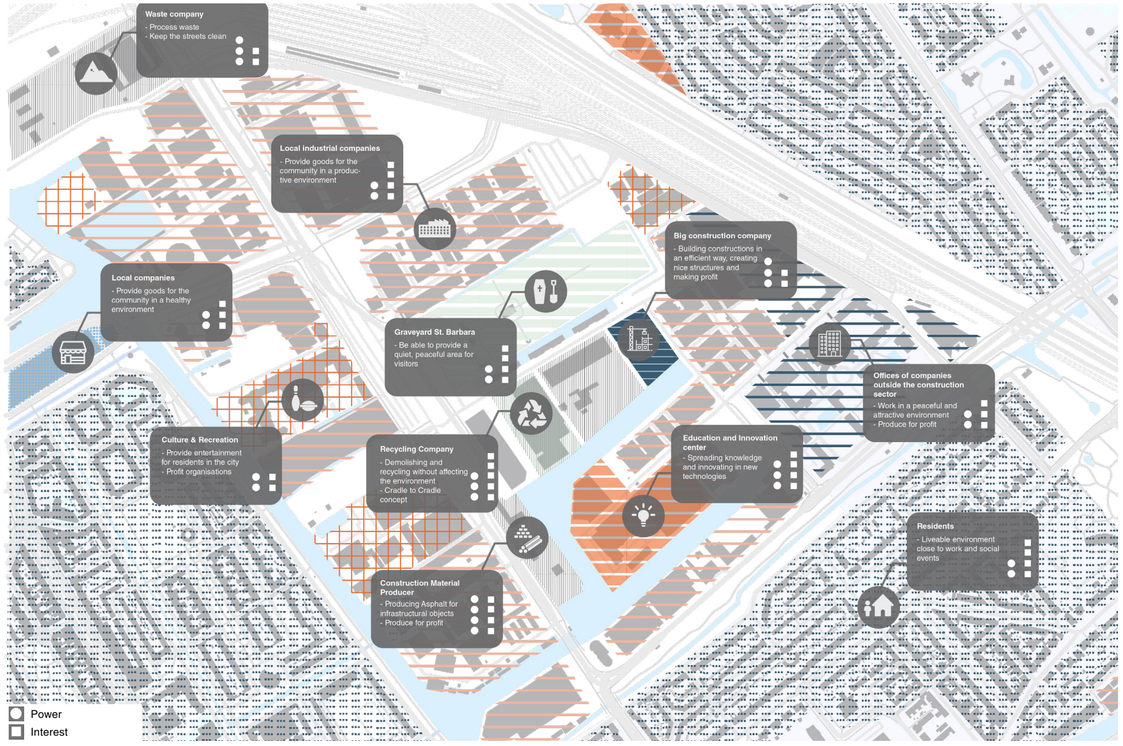
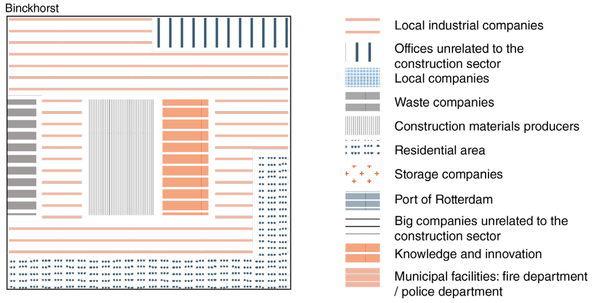


Figure 60. Stakeholder interest for the Binckhorst



The Binckhorst is, as shown in figure 60, mostly occupied by companies that have industrial functions other than construction. However, in the middle of the area, a few construction companies are located. Renewi, a recycling company, is located here as well as several construction material producers and BAM, a big construction company. Currently, in the southern part of the Binckhorst, an innovation and knowledge center can be found. This is also a place where small startups can be found.

In the power-interest (figure 59), these companies can also be found. Large construction companies might not have a lot of interest initially because of the large investments and changes that come with shifting towards circularity. At the same time smaller companies are likely to be more flexible and will therefore gain more interest. It is then expected for the larger companies to follow afterwards. Also small construction companies will also gain interest. A special stakeholder in the Binckhorst is graveyard St. Barbara, a graveyard that is located in the middle of an industrial area, near polluting industries. This graveyard owns a big part of land, therefore, it is important to include their interests in the power-interest graph.

Functions

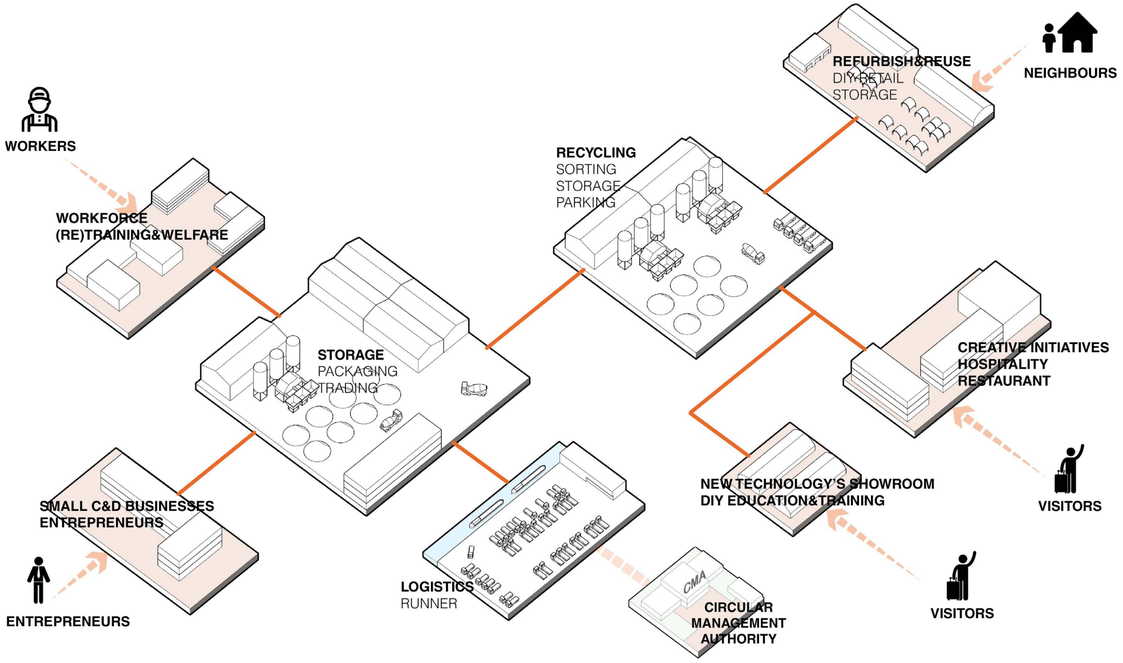


Figure 61. Functions within the Binckhorst material hub

In the material hubs, materials coming from construction and demolition waste and the production hub are sorted first. Secondly, materials in need of transformation should be processed. Thereafter all materials are sorted again in order to be distributed to the building sites in packages. Next to this, smaller types of materials are being distributed to the DIY, retail and workshop areas within the hubs themselves. At the material hubs, there is room for C&D entrepreneurs, as well as small scale initiatives to facilitate the workers of the hubs. For the workers, an educational & welfare centre is located at the hubs as well. Here education on implementing circularity in practice can be taught in collaboration with the existing educational institutes. Furthermore, it provides a place for the workers to get help with difficulties such as bad working or living conditions. It is therefore not only for workers from within these hubs, but also for those who work outside the hubs that can find help on these social and personal issues.

Phasing

In phase I, the recycling and storage of material is established. This is one of the critical functions for the Binckhorst hub, as it will get materials coming from the many densification and renovation projects in and around The Hague. This can be seen in the potential map (figure 25). Because of this, it is important to start developing the edges as both a buffer and a connection, in terms of functions, between the surrounding neighbourhood. The neighbourhoods (3) can also be developed in this phase as a start in transforming them has already been made. At this time, the CMA will start gathering data on the projects involved in the Binckhorst material hubs as well, as the Binckhorst is one of the first hubs to be developed.

In the second phase, storage facilities will be expanded as the hub will service more areas, including small scale urbanisation and projects for private customers for example. These private projects are facilitated by the social initiatives and information provided on the edge. This is being done in all the hubs.

Finally, the CMA will have established a fully circular network to coordinate. Logistics and storage in the Binckhorst hub will be further developed to include all material flows for distribution. From here, the Binckhorst will continue to function as a material hub, while it remains to be supported by the CMA for logistics and further developments of the area.

Figure 64. Phase I of the Binckhorst material hub transformation

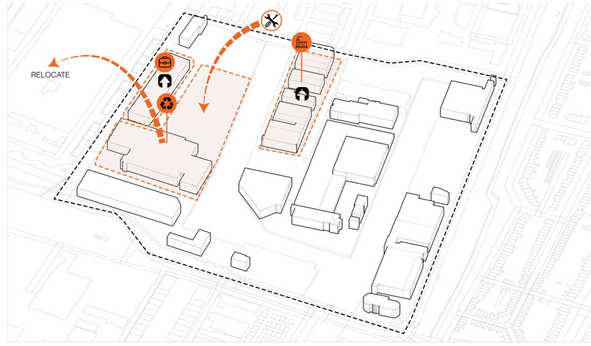


Figure 63. Phase II of the Binckhorst material hub transformation

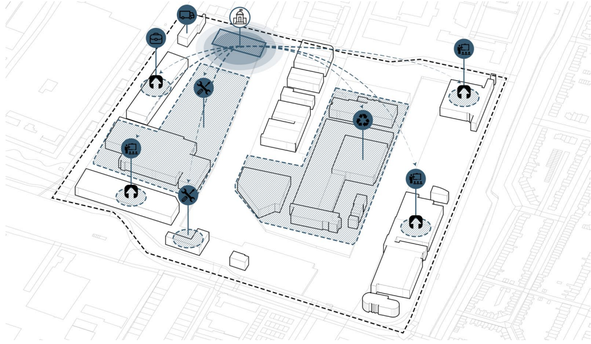
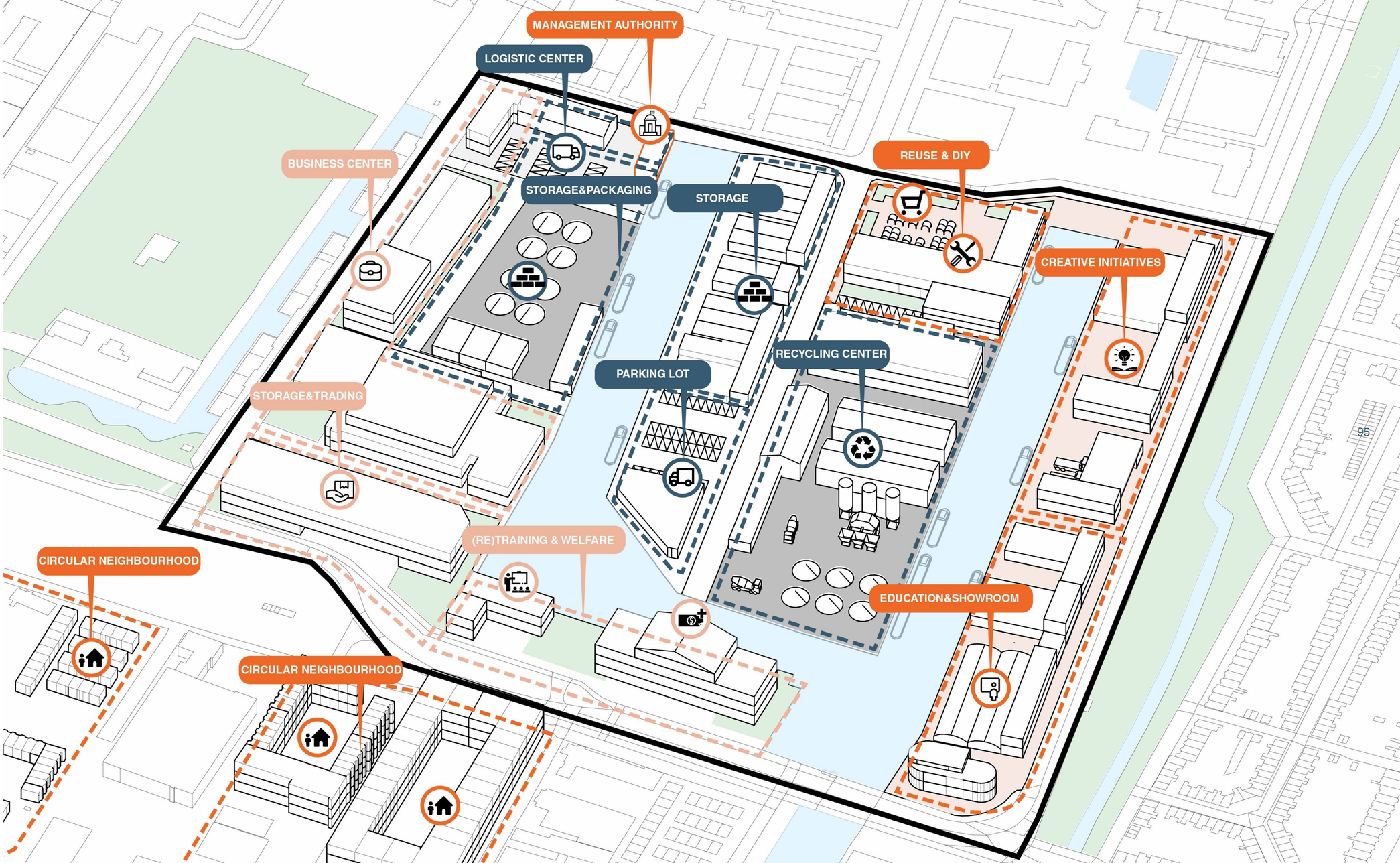
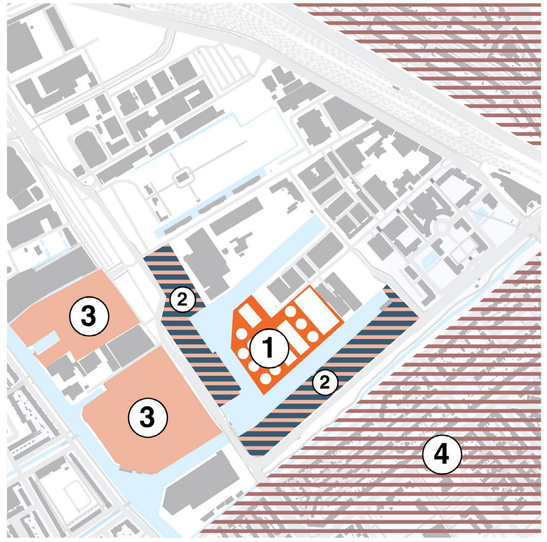


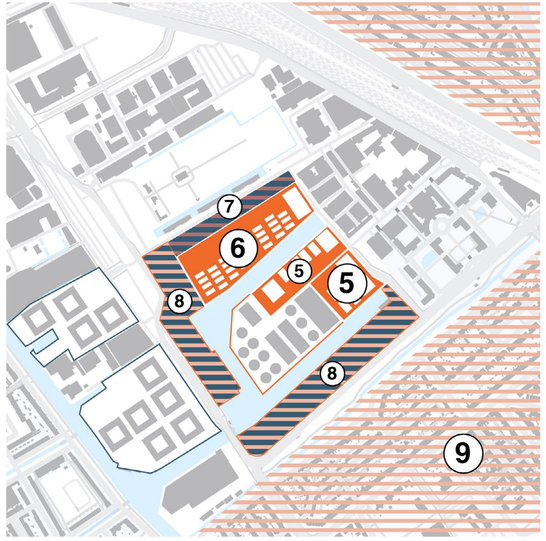
Figure 62. Phase III of the Binckhorst material hub transformation

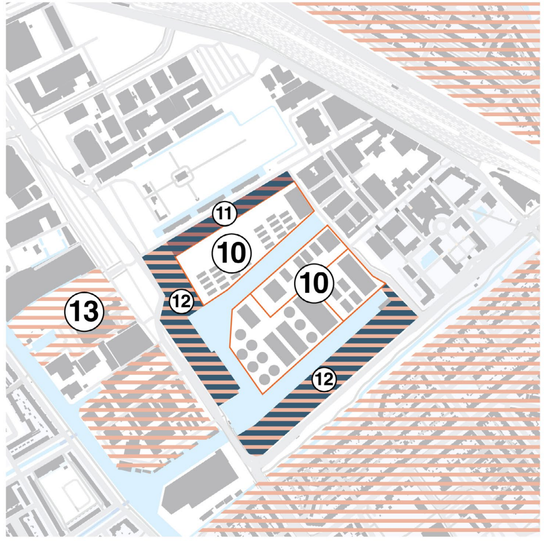
Bird’s eye view



Timeline







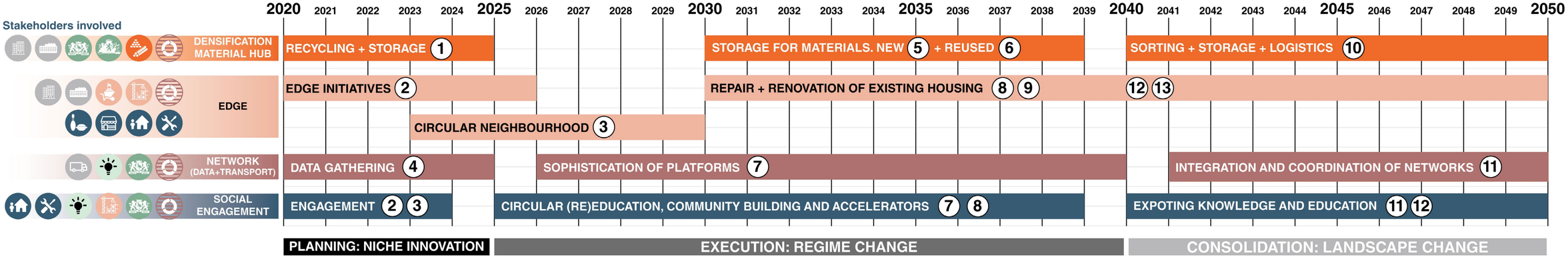


Figure 66. Timeline for the Binckhorst material hub strategic project

Before / After

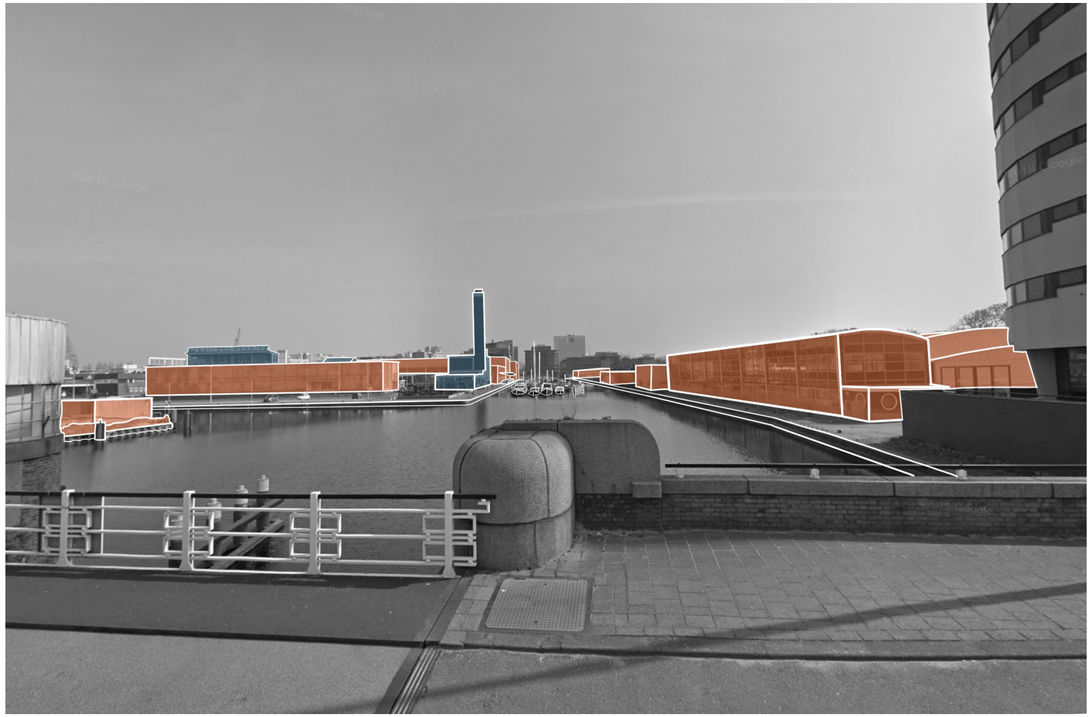


Figure 67. Binckhorst. Based on: (Google, 2019). The southern part of the Binckhorst already has room for small initiatives, however, it is still dominated by large industrial buildings with closed facades, while the concrete production company is on the edge. However, some buildings are of importance for the area in terms of heritage and are therefore preserved.

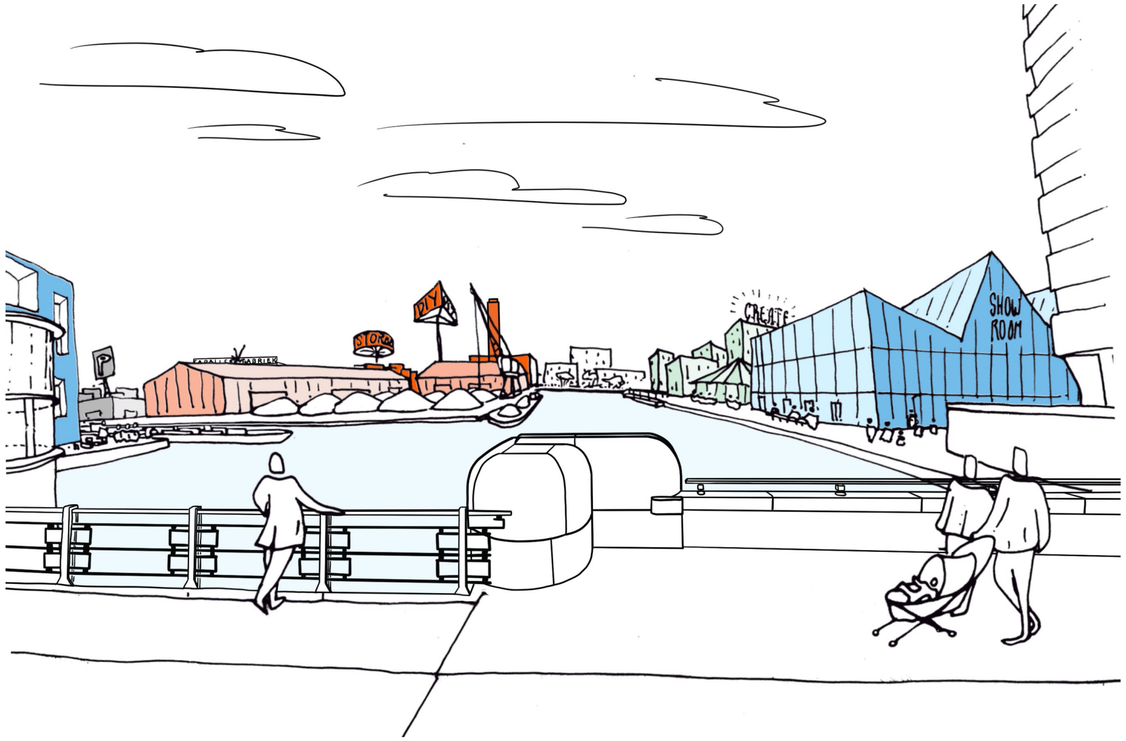


Figure 68. Binckhorst Material Hub. The processing of materials, like the recycling of concrete, now takes place in the area that is surrounded by the edge. In this way, the edges provide a buffer. The functions in the edge make use of the material coming from the processing facilities in the hub. They facilitate activation of the edges facing the surrounding neighbourhoods with functions like workshop areas, small scale companies on creative use of the material, and facilities like small restaurants and cafes to serve both the workers as well as the residents.

3.2.9/Gouda circular material hub: Kromme Gouwe

The Gouda material hub has been chosen to differentiate from the more urban one in Binckhorst as Gouda is located in the less densely populated area of our study area. Another factor for choosing this location is that the functionality conflict can be directly seen here between industrial and residential functions. Gouda could function as the main material hub in the urban expansion area in between Gouda and The Hague, while the Binckhorst hub then focused more on the urban densification in the city itself. Next to this, Gouda's hub can service the surrounding villages and cities in terms of expansion projects.

Stakeholders

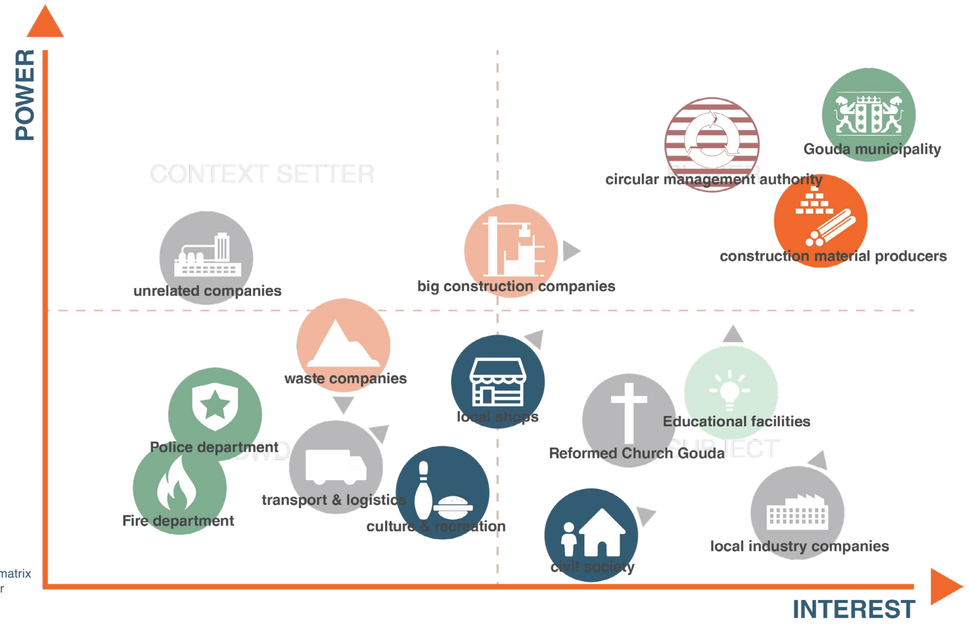


Figure 69. Power-interest matrix for involved stakeholders for Gouda

In Gouda, several construction material producers can be found. Next to these companies, also a lot of local companies outside of the construction industry can be found. Around the industrial area, schools, churches and even police and fire departments are present. Also a lot of housing is located near this industrial area, with a buffer of waterways between the two functions. Next to this, a waste company can be found in the area.

In the power-interest graph in figure 69, it can be seen that the area in Gouda is similar to the Binckhorst. The local industrial companies will be interested in the change to a circular economy, however, they do not have a lot of power as they are only local companies. Waste companies will lose power if they do not shift towards reuse of waste materials for circularity. Educational facilities will gain power, as there will be more education needed for circular technologies. Also the civil society will gain interest, as they are in close connection to this area and will be even more after the vision of 2050 is applied.

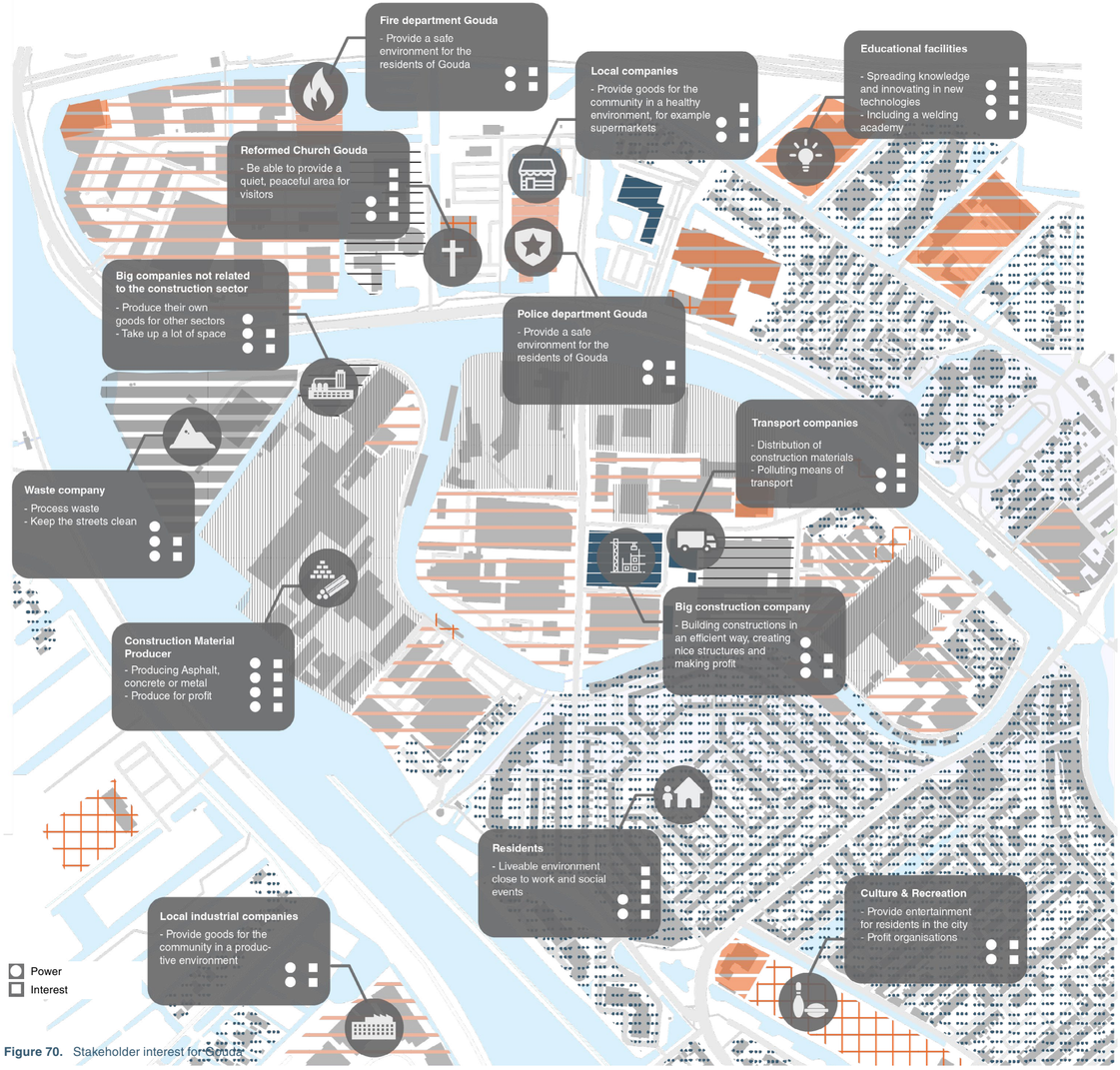


Figure 70. Stakeholder interest for Gouda

Functions

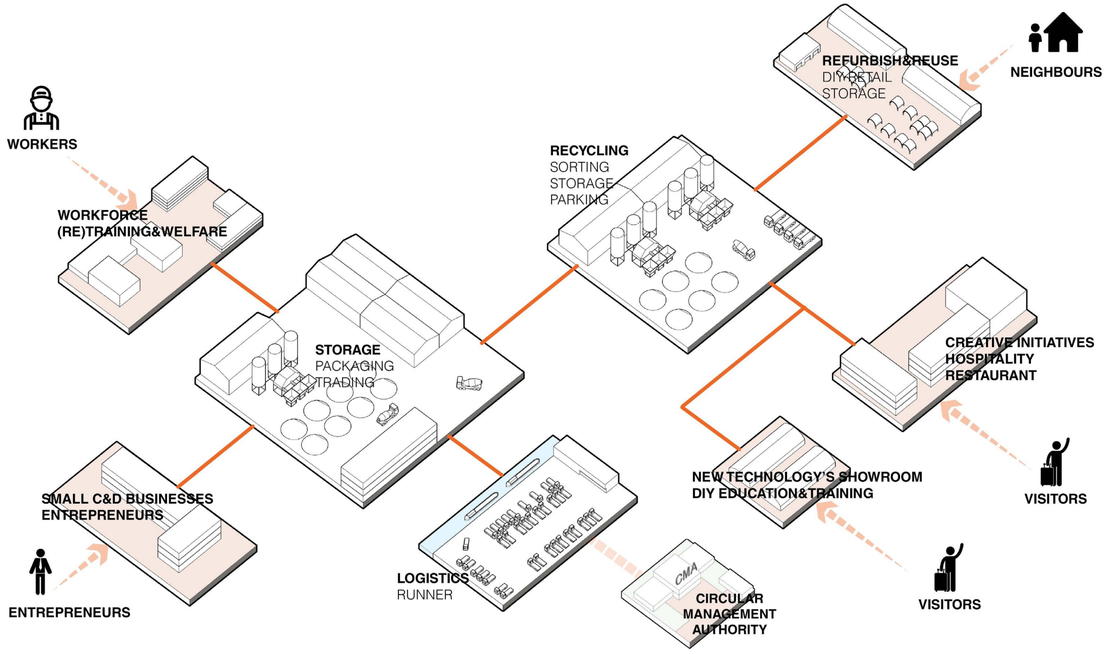


Figure 71. Functions within the Gouda material hub

The functions of the Gouda Material hub are mostly the same as the one in The Hague, as explained before on p.92. However, the Gouda one does need more input of material from other sources as it is not focused on densification and does therefore have less waste material coming from demolition that can be reused. Gouda is at the same time more focused on smaller private projects in its surrounding area, which will be explained further in this chapter.

Phasing

In the Gouda Material hub, the hub will be supporting an urbanisation area, as well as smaller scale projects in the surrounding neighbourhoods and villages. Therefore the storage for materials for construction and the logistics for distributing this is developed initially. At the same time, edges with multiple functions regarding the small scale construction industry and facilities for workers are developed. These also facilitate the circular neighbourhoods for which a start will be made in the first phase as well. Like in all the hubs, the CMA will start gathering data on materials and start the engagement of current and future stakeholders in collaboration with the present industries.

In the second phase sorting and storage facilities will be expanded and aligned with the logistics system as the platforms for this are realised by the CMA. Repairing and renovation will start later in this phase as in Gouda the focus is initially on the urban expansion projects and the smallest scale of private projects. For education, Gouda is one of the locations where workers can be educated on the transition to circularity in construction.

Finally, the storage and logistics will be expanded. The hub will become fully integrated in the network of hubs established by the CMA and knowledge on practice and education can be exported to other areas.

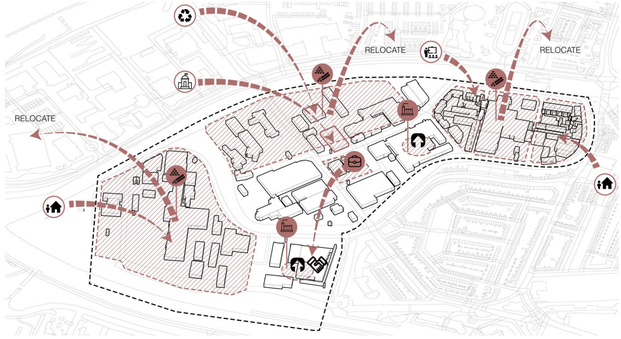


Figure 74. Phase I of the Gouda material hub transformation

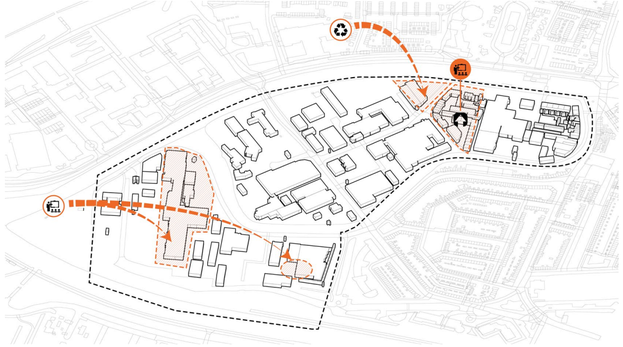


Figure 73. Phase II of the Gouda material hub transformation

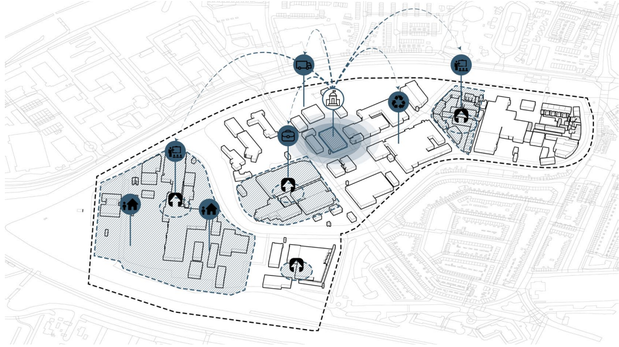
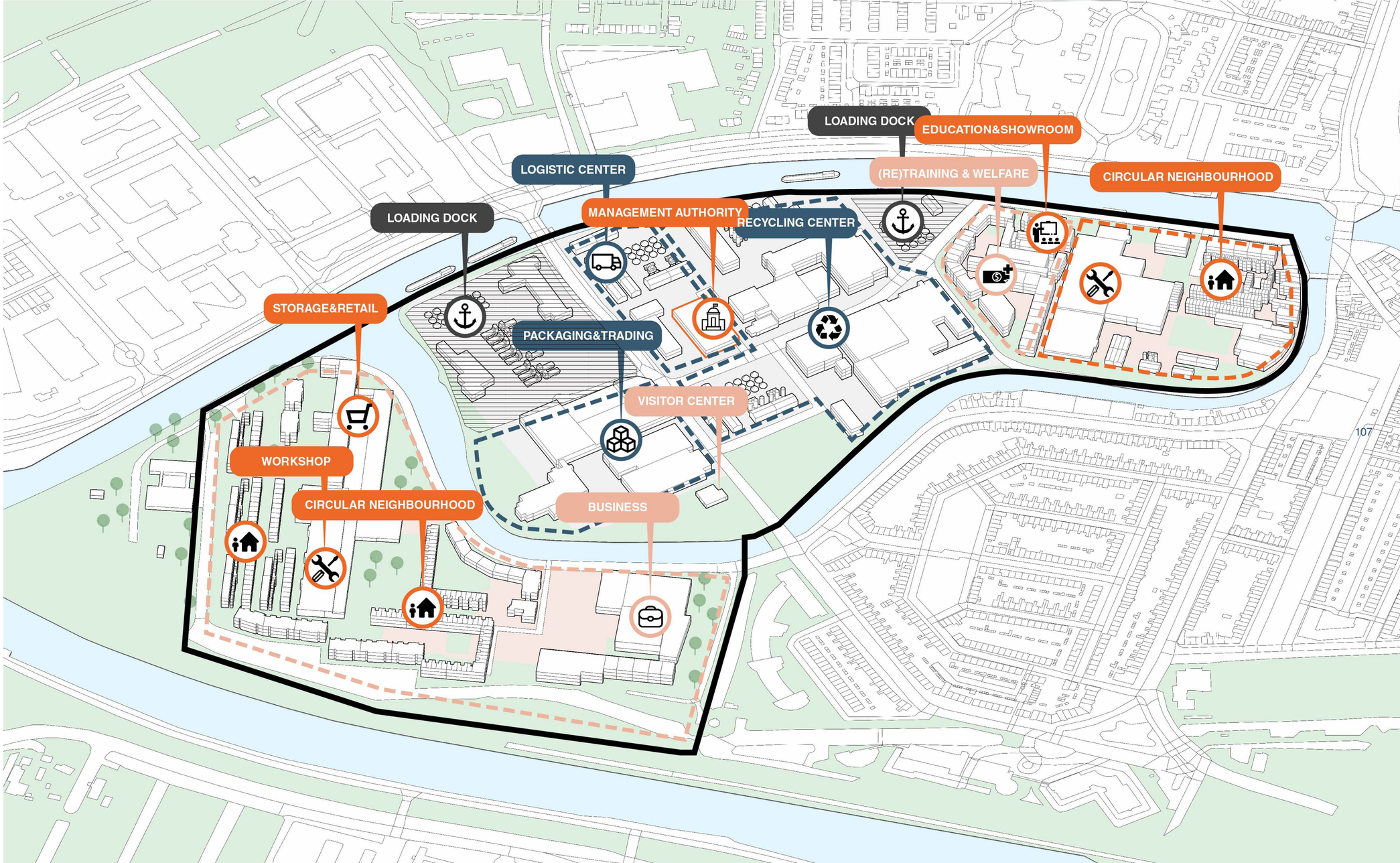
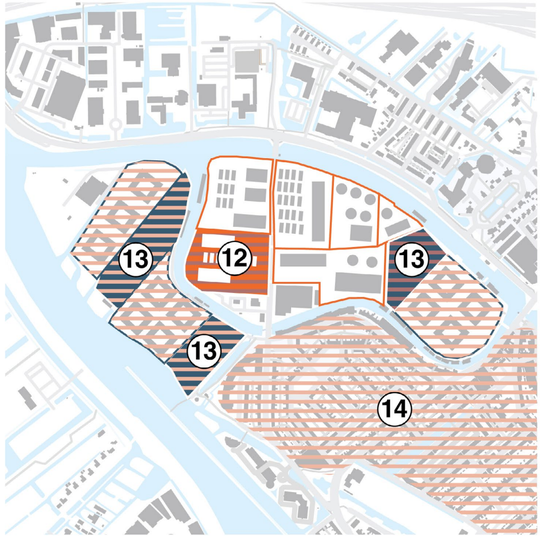


Figure 72. Phase III of the Gouda material hub transformation

Bird’s eye view



Timeline



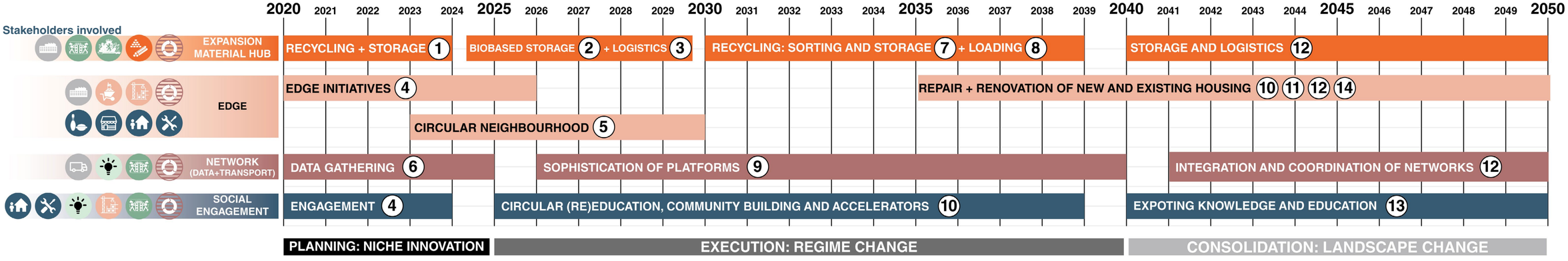


Figure 76. Timeline for the Gouda material hub strategic project

Before / After

Figure 77. Kromme Gouwe in Gouda. Based on: (Google, 2019). The current situation shows large scale industrial areas in the back and buildings for storage facilities and abandoned commercial uses, next to a neighbourhood of heritage facing the city center of Gouda.

Figure 78. In Gouda the edge has been transformed to house education and initiatives for residents to use circular construction material. In this specific area, circular housing is developed as well as part of the circular neighbourhood. The mixed-use provides an activated edge to connect to the city center of Gouda.

3.2.10/**Roadmaps**

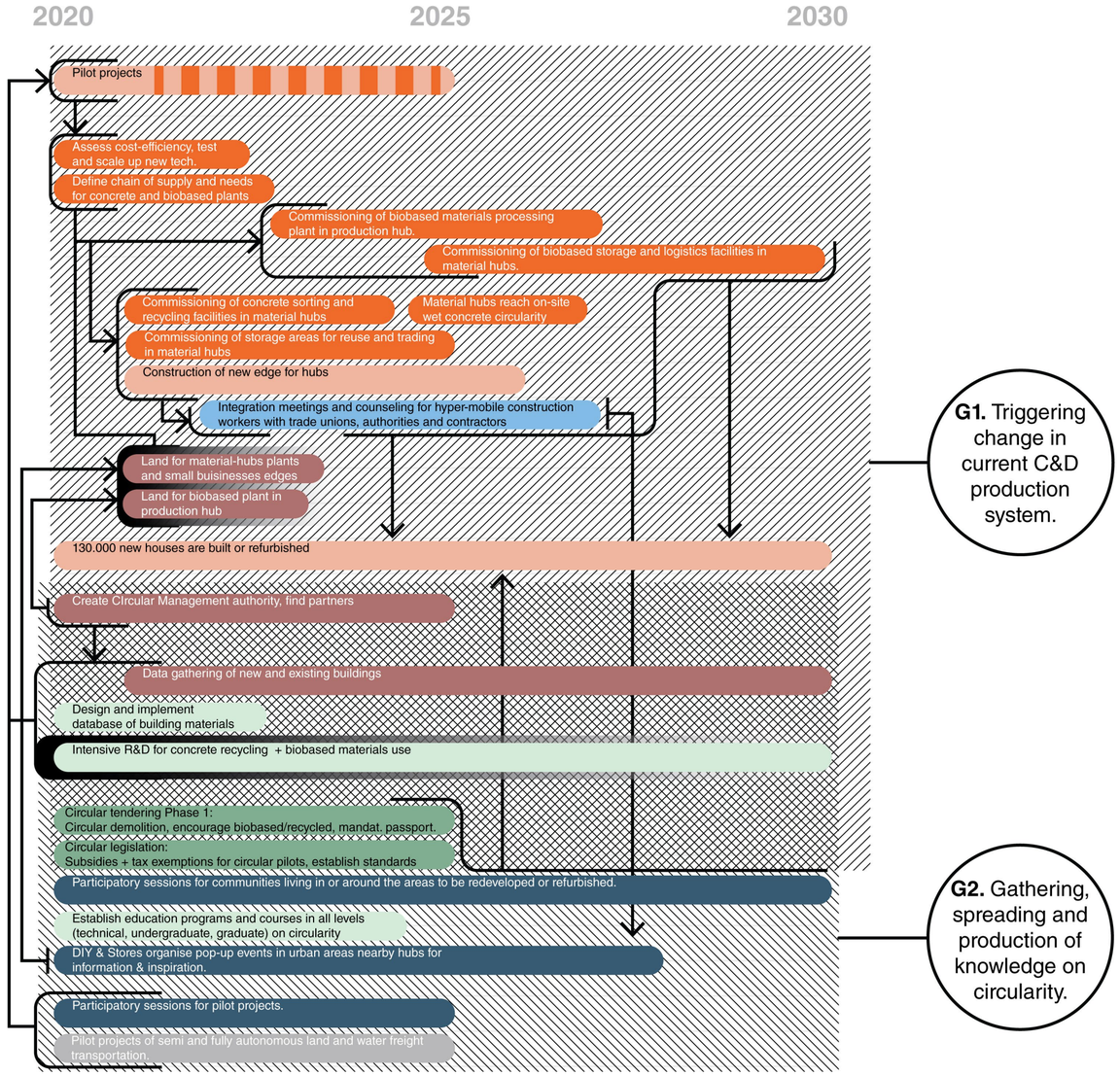
A careful understanding of the sequential actions and the stakeholders involved in each phase allows to foresee future bottlenecks and conflicts to be resolved before they become an impediment for the execution of the vision. On this page, the roadmaps based on the timeline are shown that can be followed in order to execute the strategy.

Planning: niche innovation

Conclusions

G1. Given the punctual nature of spatial interventions, land management is fundamental for the success of the plans.

G1 & G2. R&D in use of recycled and biobased materials is determining for most key actions. A slower pace in innovation will affect the speed of implementation of the whole strategy.

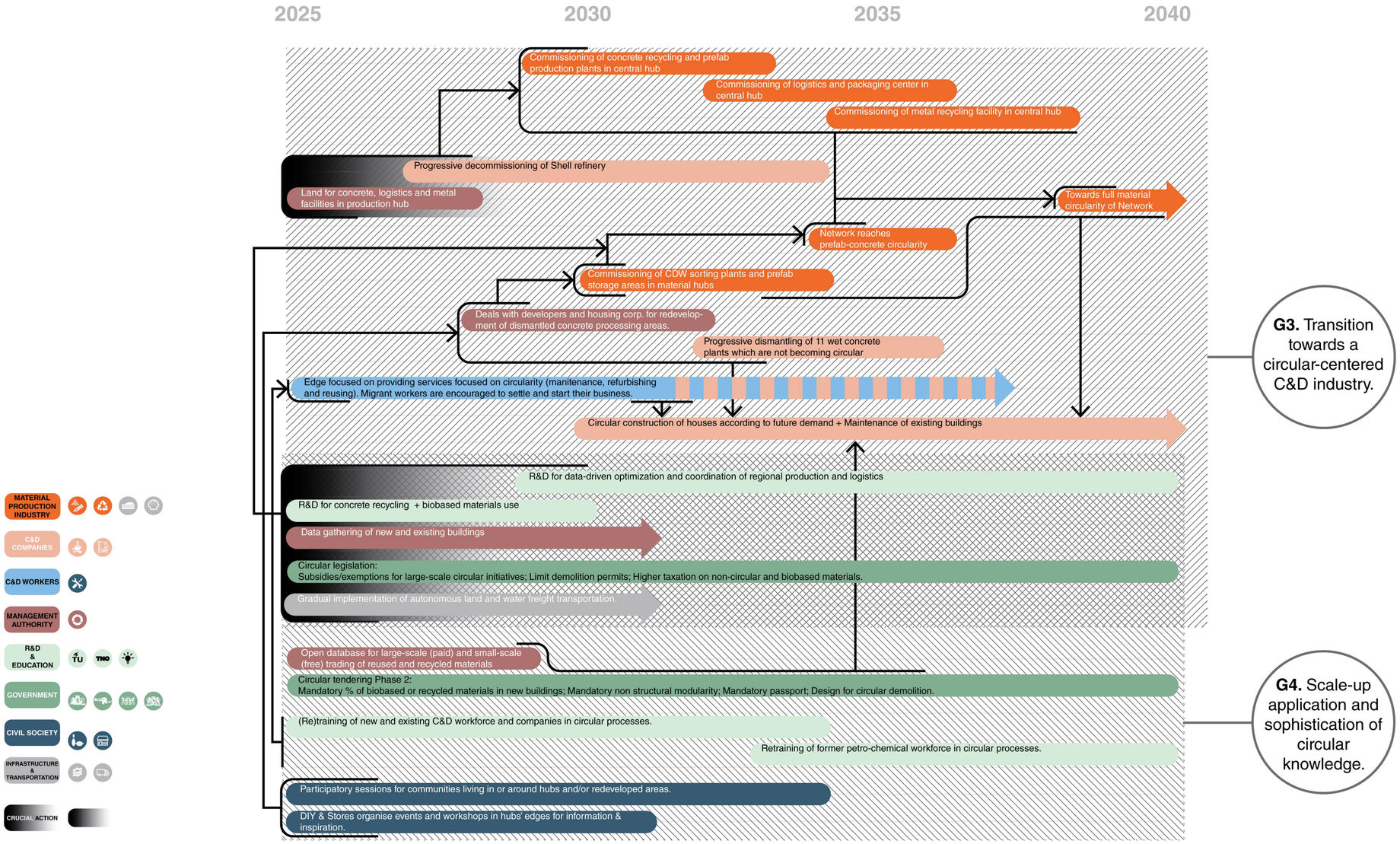


Execution: regime change

Conclusions

G3. The enlargement of the production hubs relies on the gradual decommissioning of the Shell refinery. Future energy transition initiatives make this scenario feasible, but also determine the rhythm of the decommissioning process. The CMA should have a plan B for locating the production hub.

G3 & G4. Coordination between policy, data management, research and new transportation technologies is key for successful implementation of a unified regional system. Miscommunications or unsolved conflicts of interest between stakeholders could delay the process.



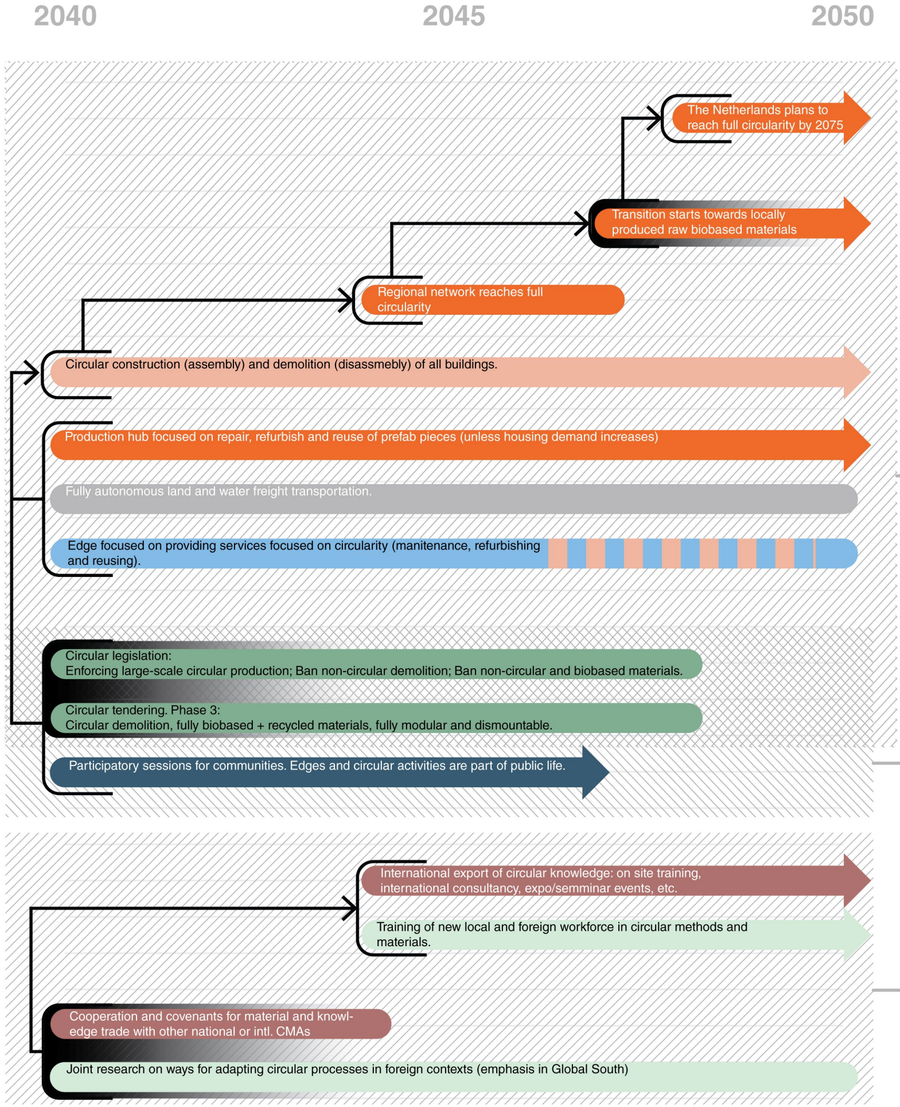
Consolidation: landscape change

Conclusions

G5. Transition to full circularity in the sector will never be complete unless a local solution for the production of raw biobased materials is found. Land management and research in forestry will be needed.

G5 & G6. Even if by this point the use of non-circular materials should be near to zero, any processes still relying on them could prevent the general ban on these materials to be enforced.

G7. Only the creation of other CMAs in the Netherlands, or similar institutions in other countries, will guarantee a systemic and substantial impact from national and international cooperation.



Conclusions

To conclude, the circular industry can be achieved through the implementation of material hubs and a production hub for raw materials. These work together through a network of logistics and data management on materials that is established by the CMA. This CMA will collaborate with the existing knowledge and governmental institutions and stakeholders related to the construction industry, in order to have access to data on materials and material flows in the province. These hubs will have edges between industry and residential areas, providing room for small scale initiatives for both residents and workers. This is established in order to distribute the materials and knowledge on the smaller scales as well. In this, local stakeholders like residents will be actively involved and become part of the circular system. Finally, the CMA will support the transition towards a circular C&D industry within the province of South Holland, while sharing the lessons learnt on a national and international level. By doing this, a resilient circular C&D industry will be established that exceeds the borders of the province.

4 CONCLUSION AND DISCUSSION OF ¡OPEN CONSTRUCTION!

4.1/CONCLUSION & DISCUSSION

4.1.1/Assessment

Looking back at the vision statement that was created for this project, the improvement of the different topics used in this vision statement can be assessed. For most topics, the vision and strategy create possibilities to grow as shown in figure x. The focus of this project is based on the circular materials industry. Therefore, this industry will get a lot of attention in the next 30 years. In 2050 the industry of circular materials should reach near the maximum of their productivity. Another topic that will improve a lot over the next years are the mixed-use material hubs that are introduced in the vision. Another focus in this project are the different scales. Regional scale, city scale and neighbourhood scale are very well presented in the vision and the connection between these scales will improve very much when applying the vision. Less attention is given to the transition of technologies. However, this vision expects the efficiency of transport to improve without needing much attention, as it is currently already happening and most of our ideas are making use of the existing network of transport. Also the material database should be established in this vision. However, this topic could be elaborated and improved upon with upcoming technologies. Another part that does not score very high in this assessment is the closely monitoring aspect as it is mentioned but also not elaborated on. From this can be concluded that the most important and elaborated topics in this vision are the circular materials industry, the mixed use material hubs and the scales. The part on monitoring and the database could therefore be researched further, also including possible difficulties on privacy and owners of the data for example. The topic of biobased materials could be part of another strategy on using bio-based resources.

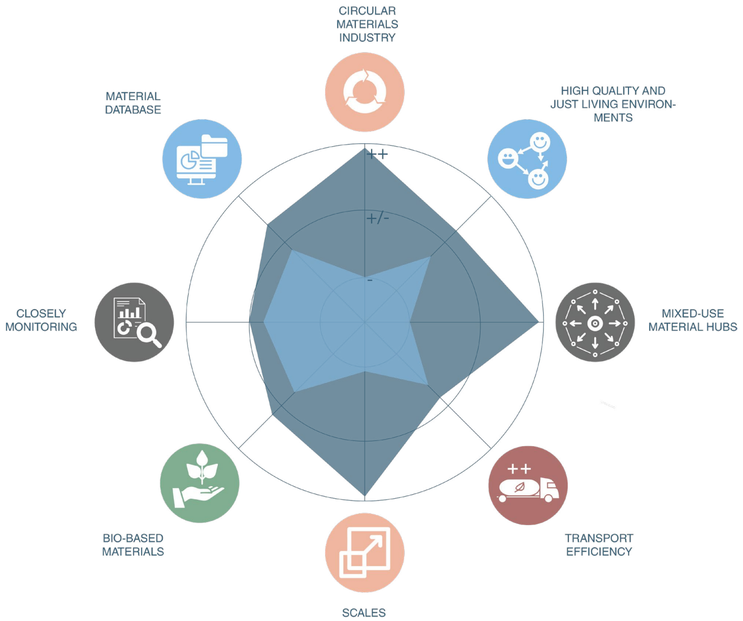


Figure 79. Assessment of proposed vision

4.1.2/Conclusion

The main question of this report **"How can regional planning facilitate a circular model for the construction and demolition material industry in the case of urbanisation in South Holland?"** was answered by the several sub questions in combination with the conclusions on different topics in the report. The answers to the sub questions are formed through analysis of the construction and demolition industry in the province of South Holland. The transition from the current system to a circular model is an important topic in this report.

The first sub question: **"What are the spatial implications of a circular industry?"** is a question that is also found in the report in the section on transitioning from the current system. In a circular industry, new ways of production will be established. Less site specific products will be produced and bio-based materials will be used more frequently. In the Open Construction concept, one production hub will facilitate the whole region. In this hub mostly prefabricated materials will be produced. These prefab materials need more storage than current site specific materials. This means more space is needed for storage in a circular industry. Currently, there is a conflict between residential and industrial areas, as they compete for the same areas. Both of these areas favour locations near highways and waterways. Another spatial implication of the circular industry can be found in the nuisances like noise pollution that are decreased by decreasing the amount of locations, and therefore the perimeter of areas where materials are produced. As circular production requires more area in terms of land, the edges can ensure both a connection and buffer area between industrial and residential areas. Neighbourhoods and industrial areas can be placed near one another without creating complications. The circular industry will, therefore, create more productive space.

For this transition different scales of circularity can be defined. The next question can be answered: **"What are the scales of circularity with respect to the construction and demolition industry?"** The circular activities that are mentioned in the analysis, belong to preserving, demolishing and building in the construction and demolition industry. For preserving activities, such as Repairing and Refurbishing/Repurposing are mentioned. Reuse and Recycling are placed in the category of demolishing and for building, it is important to build responsible constructions. These circular activities are based on different scales. The residential scale, neighbourhood scale, city scale, regional scale and national scale are defined. On smaller scales, preserving activities are most common to take place, for the larger scales demolishing and responsible construction is what is applied most often.

The third and last question before answering the main question is:**"What are the social and technical implications of a circular industry in terms of job creation, public acceptance and cohesion?"** As mentioned before, 20% of the construction industry jobs are located in the province of South Holland. This means that applying circularity to this industry will bring lots of changes in these jobs, as jobs will also need a transition to the circular industry. Low educated workers might resist this technological transition because of their lack of knowledge. Most workers will need to change jobs or be reeducated. However, this transition to circularity will increase the amount of jobs in the construction industry as new jobs will be introduced. Jobs in maintenance, both software and hardware, will increase. But also jobs in more technological sectors will increase as a database of materials needs to be established. Knowledge should be spread along governmental institutions as well in order to avoid limitations for circularity because of existing policies and regulation. The transition to a circular model, in the vision of Open Construction, will also involve smaller stakeholders such as residents in civil society by locations for DIY and workshops in the edges and initiatives in the surroundings of the hubs. These are mostly in use by the smaller scales.

With this knowledge the main question: “How can regional planning facilitate a circular model for the construction and demolition material industry in the case of urbanisation in South Holland?” can be answered.

In the Netherlands, there is a need for an addition of **one million dwellings**. South Holland needs to facilitate approximately a quarter of these houses, therefore, **a regional plan** is needed. Existing dwellings will be demolished to make room for densification. In other parts of the province, cities will be expanded. The C&D industry produces the third largest material flow in the province mainly because of demolition and renovation projects. Currently, materials released from demolition represent an end point in the **current linear system** as these materials are either downcycled or sent to waste facilities. These existing waste facilities lead us to another problem: **land use conflicts**. Industrial and residential areas compete for access to highways and waterways creating conflicts. Applying a **network** of hubs would allow for a positive interaction between both land uses.

For this circular model to work, many **institutions and stakeholders** must intensively collaborate to overcome current technical, financial and trust issues related to the implementation of circular processes. **Education** is used as an instrument to create understanding on the circular transition and should empower **workers and residents**, allowing them to take part in the decision making. Also activities in the hubs can influence several **scales** with diverse impacts.

This knowledge can be used to create an **Open Construction vision** for **2050** for the province of South Holland that facilitates a circular model for the construction and demolition material industry. One **production hub** in the port of Rotterdam in combination with several, also in the province located, **material hubs** are established. These hubs work together through **a network of logistics and data management** on materials that is established by the **CMA**. This CMA will collaborate with the existing knowledge and governmental institutions, and stakeholders related to the construction industry, in order to have access to data on materials and material flows in the province.

This network of hubs will be established in **2030**, these hubs will still have functions in production, but are also partly circular. However, in the years after 2030, the function of production will disappear and be slowly adapted to only circular activities. Realising an open system by creating an **open network**, an **open program** and **open edges** will facilitate this, a **resilient** circular C&D industry that exceeds the borders of the province.

4.1.3/**Recommendations**

Raw biobased materials are a solution in terms of local environmental impact, but their chain of supply will still depend on international trade, which means they can produce negative externalities in their countries of origin that go unnoticed in the Dutch context. This raises the following questions: What are the negative externalities of biobased raw materials? Who is affected by them? And where? Can those materials be produced in The Netherlands?

Perhaps only a strategy that transcends national policies will avoid these kinds of impacts.

Another subject for which further research could be done is on the relocation of companies, as only the relocation of the larger stakeholders has been investigated. Research could show how to provide alternatives and different locations and make sure most stakeholders agree on this. An economic feasibility strategy for this relocation could then also be researched further.

Further research is also needed on how to ensure the CMA will remain independent and how it will generate funds to finance their work. It is also important to understand the extent that the material hubs can be autonomous in their decisions in order to make sure the proposed strategy is really ‘open’.

Another field of research would be on jobs, as the estimated number for the province is based on the national increase by circularity. However, it might depend on the type of network that is established to what extent jobs will increase because of circularity.

Finally, innovations and/or initiatives to reduce noise and air pollution must be researched and funded. Employing such innovations will allow for industries to better integrate into the urban fabric. This will also allow for faster implementation of mentioned strategies to open up industrial edges.

5 REFERENCES

5.1/REFERENCES

Balz, V. E., & Zonneveld, W. A. M. (2015). Regional design in the context of fragmented territorial governance: South Wing Studio. *European Planning Studies,* 23(5), 871-891. DOI: 10.1080/09654313.2014.889662

Beelen. (2020). Circulair. *Beelen.* Retrieved from: https://beelen.nl/circulair-1

Bastein, T., Roelofs, E., Rietveld, E. & Hoogendoorn, A. (2013). *Kansen voor de circulaire economie in Nederland.* Delft: TNO.

Berntsen, L. (2016). Reworking labour practices: on the agency of unorganized mobile migrant construction workers. *Work, Employment and Society,* 30(3), 472–488. https://doi.org/10.1177/0950017015617687

Broitman, D., & Koomen, E. (2015). Residential density change: Densification and urban expansion. *Computers, Environment and Urban Systems,* 54(November), 32-46. https://doi.org/10.1016/j.compenvurbsys.2015.05.006

Brown, P., Swan, W., & Chahal, S. (2014). Retrofitting social housing: Reflections by tenants on adopting and living with retrofit technology. *Energy Efficiency,* 7(4), 641–653. https://doi.org/10.1007/s12053-013-9245-3

Boelhouwer, P.J. (2017, June 22). Bouwgrond raakt op, woningbouw in de knel. Cobouw. Retrieved from: https://www.cobouw.nl/woningbouw/nieuws/2017/06/fd-bouwgrond-raakt-op-woningbouw-de-knel-101249923

Cavalline, T. (2017, March). *Environmental Considerations in Concrete Recycling* [Presentation slides]. Retrieved from: https://intrans.iastate.edu/app/uploads/sites/7/2018/08/RCA-Environmental-Considerations-03-29-2017.pdfCBS Statline (2019). Dwellings and Non-Residential Stock; Changes, Utility Function, Regions. Retrieved from: opendata.cbs.nl/statline/#/CBS/en/dataset/81955ENG/table?ts=1582374962410.

Climate-KIC, & C40 cities. (2018). *Municipality-led Circular Economy Case Studies.* 135. Retrieved from: https://c40-production-images.s3.amazonaws.com/researches/images/75_Circular_Cities_brochure.original.pdf?1547819784

Dąbrowski, M. (2020, March). *Stakeholder Analysis* [Presentation slides]. Retrieved from: https://brightspace.tudelft.nl/d2l/le/content/192733/viewContent/1632791/View

De Bes, J., Eckartz, S., Van Kempen, E., Van Merrienboer, S., Ploos van Amstel, W., Van Rijn, J., & Vrijhoef, R. (2018). *Duurzame bouwlogistiek voor binnenstedelijke woning-en utiliteitsbouw: Ervaringen en aanbevelingen.* TNO. Retrieved from: https://publications.tno.nl/publication/34627168/B2WTlu/TNO-2018-bouwlogistiek.pdf

Deloitte. (2015). *Screening template for Construction and Demolition Waste management in The Netherlands (Vol. 2).* Retrieved from: http://ec.europa.eu/environment/waste/studies/deliverables/CDW_The Netherlands_Factsheet_Final.pdf

Drift, & Metabolic. (2018). *Zuid-Holland Circulair.* Retrieved from: https://www.zuid-holland.nl/onderwerpen/economie/circulaire-economie/

van Duin, C., te Riele, S., & Stoeldraijer, L. (2018). *Huishoudensprognose 2018-2060: opmars eenpersoonshuishoudens zet door.* Retrieved from: https://www.cbs.nl/nl-nl/achtergrond/2018/51/huishoudensprognose-2018-2060

Ellen MacArthur Foundation. (2016). *Circularity in the Built Environment: Case Studies.* Retrieved from: https://www.ellenmacarthurfoundation.org/assets/downloads/Built-Env-Co.Project.pdf

Ellen MacArthur Foundation. (2017). *Cities in the circular economy: An initial exploration.* Retrieved from: https://www.ellenmacarthurfoundation.org/publications/cities-in-the-circular-economy-an-initial-exploration

European Parliament and Council. (2008). *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.* Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

Economisch Instituut voor de Bouw. (2019). *Trends op de bouwarbeidsmarkt 2019-2023.* Retrieved from: https://www.eib.nl/publicaties/arbeidsmarkt/trends-op-de-bouwarbeidsmarkt-2019-2023/

Goodland, H. (2016). *Promoting sustainable building materials and the implications on the use of wood in buildings: a review of leading public policies in Europe and North America.* Geneva, Switzerland: UNECE/FAO.

Geels, Frank (2005). The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860 –1930). *Technology Analysis & Strategic Management,* 17(4), 445-476 http://www.tandfonline.com/doi/abs/10.1080/09537320500357319

Gharfalkar, M., Ali, Z., & Hillier, G. (2016). Clarifying the disagreements on various reuse options: Repair, recondition, refurbish and remanufacture. *Waste Management and Research,* 34(10), 995–1005. https://doi.org/10.1177/0734242X16628981

Gladek, E., Exter, P. van, Roemers, G., Schlueter, L., Winter, J. de, Galle, N., & Dufourmont, J. (2018). *Circular Rotterdam.* Rotterdam: Municipality of Rotterdam.

Google. (2019). *Streetview.* Retrieved from: https://maps.google.com

Google. (2020). *Map of the Netherlands.* Retrieved from: https://maps.google.com

Hekkert, M. (2001). Wood in the residential construction sector; Opportunities and constraints. *Resources, Conservation and Recycling,* (34), 53–74. https://doi.org/10.1515/9783110289039.734

Icibaci, L. I. (2019). Re-use of Building Products in the Netherlands - The development of a metabolism based assessment approach. *A+BE | Architecture and the Built Environment*, 424. https://doi.org/978-94-6366-119-5

Kamrath, P. (2013). Demolition techniques and production of construction and demolition waste (CDW) for recycling. *Handbook of Recycled Concrete and Demolition Waste,* 186–209. https://doi.org/10.1533/9780857096906.2.186

Keilbach, M. C. (2000). *Spatial Knowledge Spillovers and the Dynamics of Agglomeration and Regional Growth,* p44. Weinheim, Germany: Beltz Verlag. https://doi.org/10.1007/978-3-642-57698-0

Kenai, S. (2018). Recycled aggregates. In R. Siddique, & P. Cachim (Ed.). In *Waste and Supplementary Cementitious Materials in Concrete.* (pp. 79-120). Duxford, United Kingdom: Woodhead by Elsevier Ltd. https://doi.org/10.1016/b978-0-08-102156-9.00003-1

Kort, E. De. (2017). *Sector Sketch: concrete industry.* Retrieved from: https://www.zuid-holland.nl/publish/pages/17961/16-284sectorschetsbetoncentraleszhred.pdf

Larsen, G. L. (2012). An Inquiry into the Theoretical Basis of Sustainability. In J. Dillard, V. Dujon & M.C. King (Ed.). *Understanding the Social Dimension of Sustainability (pp. 45-82).* London, United Kingdom: Routledge.

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2018). *Leefbarometer* [Map] Retrieved from: https://www.leefbaarometer.nl/home.php

Ministerie van Infrastructuur en Milieu; Ministerie van Economische Zaken. (2016). *Nederland circulair in 2050. Rijksbreed programma Circulaire Economie*. The Hague, Netherlands: Ministerie van Infrastructuur en Milieu.

Ministerie van Infrastructuur en Waterstaat. (n.d.). *Geluid in Nederland (Lden) Atlas Leefomgeving* [Map]. Retrieved from: www.atlasleefomgeving.nl

OpenStreetMap (2018). *Map of the Netherlands*. Retrieved from: download.geofabrik.de/europe/netherlands.html

Ng, S., & Engelsen, C. J. (2018). Construction and demolition wastes. In R. Siddique, & P. Cachim (Ed.). *Waste and Supplementary Cementitious Materials in Concrete*. (pp. 229-255). Duxford, United Kingdom: Woodhead by Elsevier Ltd. https://doi.org/10.1016/b978-0-08-102156-9.00003-1

Royal HaskoningDHV. (2017). *Verkenning circulaire economie, analyse startpunt beleidskader.* Retrieved from: https://www.royalhaskoningdhv.com/nl-nl/blog/urban/hoe-komen- we-tot-een-beleidskader-circulaire-economie-q-case- zuid-holland/7795

van Schaick, J. (2020, February). *Shaping Holland: Lessons from 25 years of Regional Design in the Southern Randstad* [Presentation slides]. Retrieved from: https://brightspace.tudelft.nl/d2l/le/content/192733/viewContent/1620501/View

Sennett, R. (2006). *The Open City. Towards an Urban Age*. Retrieved from: http://richardsennett.com/site/senn/UploadedResources/The%20Open%20City.pdf

United Kingdom DEFRA Department for Environment, Food and Rural Affairs. (2011). *Guidance on Applying the Waste Hierarchy.* Retrieved from: https://www.gov.uk/government/publications/guidance-on-applying-the-waste-hierarchy

Vaughan, A. (2018, September 11). Global Demand for Fossil Fuels Will Peak in 2023, Says Thinktank. *The Guardian.* Retrieved from: www.theguardian.com/business/2018/sep/11/global-energy-demand-fossil-fuels-oil-gas-wind-solar-carbon-tracker.

Xicotencatl, B. M. (2017). *Scenarios for concrete-rubble recycling in the Netherlands Scenarios for concrete-rubble recycling in the Netherlands* [Master's Thesis]. Delft University of Technology, Delft; Leiden University, Leiden. Retrieved from: https://repository.tudelft.nl/islandora/object/uuid%3A1eb96393-0d86-476b-b563-5a4035104b66

6 APPENDIX

6.1/Individual Reflections

Federico Ruiz

The following text intends to discuss the role of governance in the project and strategy presented in this work. Perhaps, the best way to start is by emphasizing the fact that at the core of the proposal lies the concept of a network that operates at different scales. In contradiction, our vision might seem as a collection of disconnected points with specific roles assigned. Therefore, an inevitable question arises: what is keeping them together? And, as a corollary, how can they have an influence on the whole province?

It is precisely that question that led us to include a governance dimension into our strategy. After the research part of the process, we had realized that a lot of coordination and dialogue between stakeholders was needed in order to radically reconfigure the productive regional landscape of the C&D sector. This is because the scale of the proposed operations exceeded the capacity of any single actor: from the gathering of enormous quantities of data, through the altering of the material supply chain, to the decommissioning of a Shell refinery. How to facilitate these processes while maintaining an equilibrium between the interests of all parties involved, from the most powerful to the weakest?

A first option could have been to enforce the transition through a governmental institution with a technocratic character in charge of the enforcement of regulations through time on a national scale. Instead, we decided to create a public-private partnership, the Circular Management Authority (CMA), with the role of coordinating and managing the network of hubs on behalf of all the stakeholders involved, all of which have direct representatives in the directory board independently of how powerful they are. In this way, the CMA is both a regional platform for an inclusive discussion of goals, sharing of knowledge and resolution of conflicts, and an entity with executive and managerial tasks, such as land negotiation, research funding and logistical coordination. In this way we expect the circular transition of the C&D sector to rely mainly on collaborative processes, only supported by enforcement policies when strictly needed.

Nonetheless, the existence of the CMA did not impede us from defining the roles of existing institutions and authorities in our vision and strategy. For instance, we still expect municipal governments to make use of planning tools in order to, for example, allow the proposed hubs to keep functioning as industrial areas despite the urbanization going on around them, or limiting the amount of demolition permits issued in order to reduce waste. At the same time, housing corporations are instrumental for promoting circular construction practices through tendering. Finally, the national government also has a central role in the transition we propose, as it is the only one with the power for enforcing circular construction standards and procedures, as no extra requirements on construction can be set by local governments (Climate-KIC & C40 cities, 2018).

As a conclusion, what defines our project as a network is the new configuration of governance mechanisms through an integrated platform for dialogue and consensus, the CMA. Its existence, together with a careful use of policy tools by existing authorities, also ensures the influence that our project will have in the province.

Nicolás Carvajal Ordoñez

The following reflection sets out to answer the question of what is the role of a vision in the planning and design proposal of your group project and how has it influenced your development strategy?

The role of a vision for **¡Open construction!** means understanding current challenges related to the construction and demolition industry in order to be able to apply theories through planning and design for more conscious development in the future. Envisioning the construction and demolition industry in 2050 is a process that takes into account such present challenges in a way that presents a desirable future for the province of South Holland. Although a vision represents a need for a desirable future and not a concrete set of actions, it describes social, economic and environmental goals that are supported by a set of arguments in the form of strategies.

Proposing a future vision enables a forward-thinking approach for coming up with solutions that can be integrated if future circumstances align with the mentioned goals in the vision. The realization of our proposed vision for a circular future for the construction and demolition industry with regards to conscious development is explained through a set of strategies. Because we have made a vision for 2050, coming up with strategies is more applicable than plans since we are dealing with the uncertainties of the future. From Dr. Balz's SDS presentation based on a lecture by Dr. Nadin, strategies are not about making decisions based on detailed tactics but are an abstract guide for actions based on policies. Because strategies act upon a set of policies, developing a vision based on strategies influenced us to come up with an agenda that helps the province reach their goals of becoming fully circular and developing 210.000 homes by 2050.

Because of the uncertainty of designing with a distant future in mind, approaching such a task with a vision is most appropriate. Applying this vision-strategies method to planning and designing our project facilitated discussions that led to purposeful suggestions and considerations when dealing with transitioning to a circular construction and demolition industry.

Laura Conjin

In the proposal of ¡Open construction! the relationship between research and design creates a new, regional approach to the idea of the open system that is mentioned in The Open City (Sennet, 2006), in which productivity should not come at the cost of liveability. Several parts of this open system are researched and applied in a vision for a circular model in the construction and demolition (C&D) industry in the province of South Holland. It is said that for every 100 houses, 24 are demolished, creating a big amount of waste that needs to be replaced by new and raw materials as many construction materials are currently only downcycled (Gladek et al, 2018). These waste streams and uses of raw materials cause many negative environmental effects. This calls for a circular model. To achieve a circular model in combination with applying an open system, a transition is needed. This transition will not only create possibilities to change the C&D industry into an open system and a circular model, but should also include the social aspects of this change. Transitional and sustainability theories are researched to create an understanding of these three different themes. Also research in policies is needed, as they could shape the regulations and show the possibilities for a new and circular system.

A way to apply this open system and circular model to South Holland is by creating several 'construction hubs' in the region, these hubs could facilitate circular building, the examples in the research done by De Bes et al. (2018) are mostly, just like the open system concept, in the scale of a city or multiple cities. For ¡Open construction! this concept is applied to the whole region. Not only the regional scale is represented in this project, the city scale and neighbourhood scale are also included as the vision will also affect these smaller scales. 'Dancing through scales' is needed to get a continuous re-interpretation of the territory (van Schaick, 2020).

On the regional, city and neighbourhood scale, involved parties can be found. These stakeholders are affected by the vision, and are, therefore, able to (sometimes) influence several decisions. For example, in this project, in the production hub area on the Vondelingenplaat in Rotterdam, the Shell is a big stakeholder. Shell owns and uses much of the space that is needed for this production hub in the vision. Is Shell interested in a circular model and what are the consequences if they do not want to move? These questions can be answered when researching into the different stakeholders and finding out what their importance is, what their power and interests are and what their goals are and also identifying the conflicts and synergies between the different stakeholders (Dąbrowski, 2020).

From this can be concluded that the research is needed to create a feasible design for a circular construction and demolition industry in a vision of the province of South Holland.

Christiaan Hanse

In this reflection the following question will be answered: 'In which way is the governance aspect embedded in the planning and design proposal of your group project?'. This will be explained starting with governance in the strategy '¡Open Construction!', followed by alternative forms of governance and future possibilities which have not been included in the strategy.

The CMA

In our project, an important part is the establishment of the Circular Management Authority. This is a public-private initiative consisting of stakeholders from related companies, governments and civil society. Such initiatives have been described to be useful in creating the conditions in decision-making for a design to be realised (Balz & Zonneveld, 2015). CMA makes sure current thresholds like the lack of knowledge in governmental institutions (Deloitte, 2015), and practical needs like continuity in flows (De Bes et al., 2018), are overcome. It does so by establishing a network of data on materials and flows, and distributing this along the several material hubs within the province. Next to this they can inform and negotiate with governmental institutions, large companies and civil society in order to engage all stakeholders.

Governance on the smallest scale is also applied through the initiatives on the edges, where material hubs are facing residential areas. Small initiatives allow for involving the surrounding community by informing residents and stimulating the use of circular materials.

Next to this, during the establishment of the several hubs, the CMA can negotiate with, and export their knowledge and data to, other provinces on a national and international level. This is in order to ensure resilience in case of a disruption in material flows in a part of the system on a smaller scale. As the CMA can scale up by establishing other local headquarters, it can connect to different scales of involved stakeholders to ensure multi-level governance.

Other forms of governance & future possibilities

Another way in which we attempt to apply circularity is by changing the educational system, not only the small initiatives that explain circular use through workshops, but also on the larger scale in current (practical) education for construction. At the hubs, we reserve space for these in order to make use of the local industry and knowledge in the educational programme. In this way knowledge on circularity in construction and demolition is spread which can empower workers and residents to be able to take part in collaborative decision-making processes and affect implementation of circularity positively.

As for our strategy the main way of influencing governance is through the CMA, there might be a risk when problems are emerging in execution, or parties don't want to be involved. In our strategy, we assumed the benefit of being part of the network of material hubs would encourage companies to collaborate in transition. However, if companies start to compete instead of collaborate by not sharing information this could become an issue. Governance could help by financial stimuli or regulation on the amount of circular material used for example. To conclude, governance is embedded by the CMA and its platform and network, and in order to improve, alternative paths for governance could be implemented to increase feasibility of the strategy.

Yixiang Huang

In this reflection, the answer would be given to the question: “what is the relationship between research and design in your group project?”

I think the information collected by the research gives the base for developing our idea on design. Research allows us to find points of concern. Then we could design for specific problems or demands. For instance, the article mentioned that there is an agglomeration of construction industry along highways and waterways because of its need for logistics. Also, plants should be located within a certain distance of the construction sites. After that, we combined the layer of residential area and the industrial area in GIS, and found an industrial agglomerated area at the edge of cities. This conclusion gives us the potential area for building up the network of construction industry, and it also points to the problem of low quality of living environment in the neighborhoods, which are adjacent to the factories. The strategies we proposed afterwards, such as reducing the pollution of the living edges, using these edges to develop retails and creative initiatives, were developed based on these research and analyses.

In addition, research is particularly important for large scale projects. These planning projects usually involve different disciplines. It is common to come across something we don’t know much about, for example, the construction and demolition industry. It would be helpful to conduct research in order to get a systematic understanding of it. At the beginning of this quarter, we tried to start our research by asking questions. We raised the main question, “how can regional planning facilitate a circular model for the construction and demolition material industry” and several sub-questions which focus on the technical and social implications of the circularity in the construction industry. And by the time we were able to answer those sub-questions, we had already known a lot about the material flow and industrial functions, as well as the current employment situation of construction workers and the conflicts between C & D industry and urbanizing areas. The Main question even requires us to research more on specific policies and actions, and also find out the stakeholders which are relevant to our project, which enable us to bring in more design for the social dimension.

What’s more, the strategies proposed based on the research are more feasible and practical. For example, from the research, we know that it is necessary to improve the transportation network and strengthen cross-regional cooperation of different organizations in order to improve logistics efficiency. And the government could play an active role in managing this. Therefore, we proposed to establish a circularity management authority, which is located in production and each material hub, forming a management network in the C&D industry.

In conclusion, research helps us to discover problems and principles behind the project, which sets a good base for developing strategies and designing.