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The Urban Lab of Europe !

The Super Circular Estate project Journal N° 1

*Project led by the **city of Kerkrade***

CIRCULAR ECONOMY

European Union
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Région Hauts-de-France

The Super Circular Estate project

The **Super Circular Estate (SCE)** project addresses the urgent social and environmental challenge of both material and social circularity.

Faced with emerging trend in shrinking of the population and possible appearance of underperforming/abandoned areas due to a demographic change in Region of Parkstad,the Super Circular Estate project aims to reverse the conventional approach of urban transformation (by demolition and relocation of residents) into a circular approach, aiming at closing material circles within own restructuring area while reusing physical and social values and using these as social and physical building blocks for the new construction. The project explores the potential of CIRCULAR MANAGEMENT for SOCIAL HOUSING ASSOCIATIONS including bought material and social circularity.

At the times that many European countries are investigating potential models for transition towards circular economy and its implementation in the built

environment, the Super Circular Estate project, focuses on the biggest urban transformation challenge in the Netherlands. Region of Parkstad together with Housing corporation HeemWonen, the city of Kerkrade and with support of construction industry and knowledge institutions, is working on delivering a circular neighborhood which will be transformed and rebuilt on principles of exploiting existing buildings as bank of materials for the new buildings and circular neighborhood where old residents become new residents. This unique project operates on front lines of the world's quest towards circular buildings and in search for the answers about the reuse potential of the existing buildings, materials and their socio-economic and environmental added value in new construction project. In search of the answers, the Super Circular Estate project aims at deconstructing the existing 10 story housing block built in 1968 and using 75% -100% of its material to construct four, and later potentially, sixteen houses in the same neighborhood.

Traditionally demolition of buildings result into (i) loss of social cohesion, (ii) loss of its residents (iii) low (or no) market value of recovered materials, (iv) as well as high environmental costs manifested through the demolition waste, lost embodied carbon in materials, and embodied carbon in new row materials.

If experiment in Kerkrade succeeds in achieving its ambitions it would set-up new blueprint and open new horizons for circular transformation, upgrading and exploitation of the existing built environment across Europe.

As such Super Circular Estate has at its core two key innovation pillars:

1. Technical innovation: exploring material circularity and their numerous reuse options in new construction. Besides closing of material loops, closing of water streams within the neighborhood is also addressed through this project

2. Social innovation: exploring new concepts of participative communities and shared economy (through shared products, facilities and services) that may strengthen connectivity, cultural identity of the neighborhood and its social cohesion

Partnership:

- Municipality of Kerkrade
- Brunssum municipality
- Landgraaf municipality
- Stadsregio Parkstad Limburg – regional authority
- VolkerWessels Construction – construction company
- Real Estate Development South and Dusseldorp Infra – construction company
- Water Board Company Limburg – water management infrastructure provider
- Limburg Drinking Water Company – water management infrastructure provider
- IBA Parkstad B.V – higher education and research institute
- Zuyd University of Applied Sciences - higher education and research institute
- HeemWonen – social housing corporation
- Association of Demolition Contractors (VERAS) – advocacy organisation

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1. Executive Summary

Figure1: Reuse options of materials Super Circular Estate

It is through buildings and cities that mankind is increasingly changing the environmental balance of the planet, through which various stocks and flows of environmental capital are shaped (Durmisevic 2011)–.The physical impact of the increasing building mass has become undeniable. In Europe, the building sector accounts for 38% of the total waste production, 40% of the carbon dioxide (CO_2) emissions and 50% of all natural resources are used within construction (EIB, 2015).

There is worldwide consensus that the way forward is through transformation of linear consumption model of natural resources into a circular one. The Dutch government went further in specifying its national goal to develop a circular economy in the Netherlands by 2050 and to realize an objective of a 50% reduction in the use of primary raw materials by 2030 by designing products and buildings in such a way that they can be reused with a minimum loss of value and without harmful emissions entering the environment.

Despite the fact that many European countries have adopted similar environmental goals and strategies not much progress has been done in implementing circular economy principles into construction sector, simply because there are many unknowns related to the reuse potential and performance of construction materials in different reuse scenarios.

In addition, 50% of investments in building construction in the Netherlands are spent on partial demolition and adaptation of the existing

buildings and 42% of new construction is due to the replacement of demolished buildings which do not have capacity to be modified to accommodate new needs (PBL, 2013).

In order to bridge the gaps between linear and circular construction, it has become crucial to understand the capacities of buildings to transform a negative environmental impact to a positive one, e.g. tons of degraded materials and CO_2 emissions.

Super Circular Estate project is addressing this challenge and is focusing on understanding multi-layered capacity of existing building structure and its potential to reverse process of material degradation during transformation project towards high value recovery and reuse of materials. The aim of the project is to investigate, test and potentially upscale tools and methods that could enable the construction industry to preserve a value of the building materials within the existing building stock and potentially create a new value for the society in the future. The objective is to build new buildings by reusing 100% local materials which have been recovered from the underperforming building block. Besides circular approach to use of materials, the project is focused on social aspects impacted by circular transformation projects. The aim here is to get back at least 20% of old inhabitants after transformation and urban restructuring, to preserve social cohesion of the neighborhood, but also to create a shared spaces as workshop space, washing and meeting spaces all created with local retrieved materials. Besides material and social circularity a third aspect of this circular project is implementation of a water recycling system which accommodates shared facilities with reused water.

During the first year of the project important circular building features have been tested in order to set up a framework for the implementation stage. The primarily focus was on: Testing deconstruction technics, testing material composition of building, testing reusability of building components and materials, developing the framework for registration of materials and track and trace system and developing and testing the framework for resident's participation. These activities have created the basis for the next phase of experiment which will deal with the implementation of techniques and tools that have been shaped in previous months.

This journal will highlight the context of the SCE project and key elements of the framework that will enable material and social circularity during the next project stages.

2. The Context

2.1 Circular economy - Global level

The need to preserve the living conditions on the planet for future generations is one of the greatest challenges that humankind addresses today and represents a key challenge in meeting the United Nations Sustainable Development Goals (SDG's). According to the UN, the increasing consumption brought on by rapid growth of population and economic prosperity, means that in the last four decades, the amount of extracted raw materials has been tripled and earth's resources to support human living and prosperity will be compromised if more effective and circular patterns in use of resources are not implemented. (figure 2)

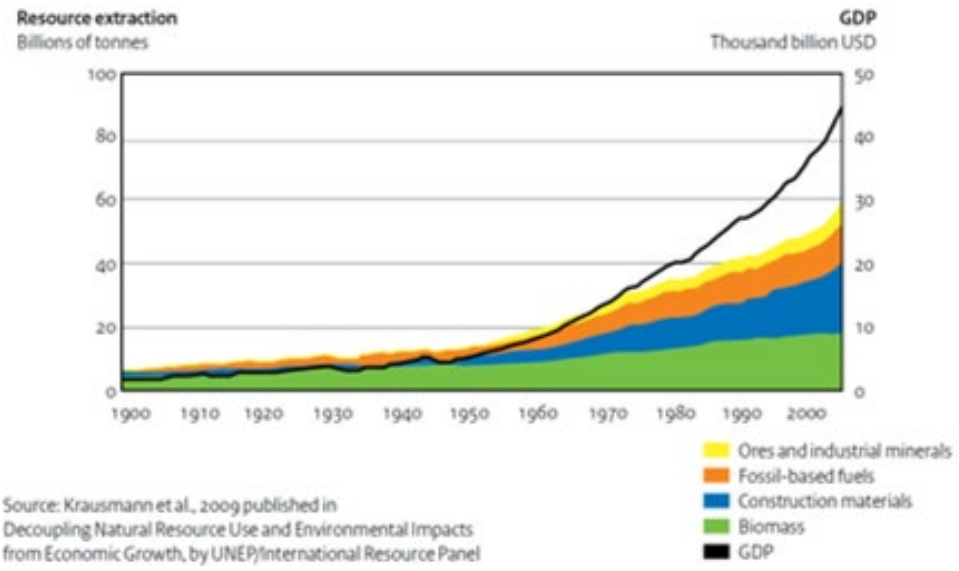

Figure2: Worldwide resource extraction in billions of tons, 1900-2005, (UNEP IRP, 2017)

The exponential increase in population and contemporaneous increase in standard of living will mean that the demand for essential goods and services will increase at least by factor two in the next few decades (Natalis Dias, TU Delft 2007). Numerous raw consumption models predict that this trend in an linear system of raw material exploitation will require multiple planets to provide the necessary resources to sustain growing population and its prosperity.

The way forward is through transformation of linear consumption model of natural resources into a circular one and through transition from linear to circular economy. A circular economy is an economic system where products and

services are traded in closed loops or 'cycles'. A circular economy is characterized as an economy which is regenerative by design, with the aim to retain as much value as possible of products, parts and materials. This means that the aim should be to create a system that allows for the long life, optimal reuse, refurbishment, remanufacturing and recycling of products and materials (Kraaijenhagen, Van Oppen & Bocken. 2016, Ellen MacArthur Foundation, 2016).

This challenge will require introduction of change in a broad sense and full implementation of technological, social and system innovations.

In order to make towards this systemic change, UN reached agreement in 2015 defining seven Sustainable Development Goals *(*SDG's) in which circular economy is addressed in different ways.

UN Sustainable Development Goals (SDGs) (UN 2015):

- Promote continuing, inclusive and sustainable economic growth, full and productive employment and decent work for everyone (e.g., by decoupling economic growth from environmental degradation);
- Promote sustainable industrialization and innovation (e.g., by adapting industries in order to make them sustainable, with a focus on greater efficiency in the use of resources and cleaner and environment-friendly technologies and industrial processes);
- Make cities and human settlements inclusive, safe, resilient, and sustainable (e.g., through inclusive and sustainable urban development and building capacity for participative, integrated and sustainable planning);
- Ensure sustainable production and consumption (e.g., reducing global food waste by half, through sustainable government assignments and sustainability education);
- Conserve and make sustainable use of the oceans, the seas, and maritime resources (e.g., by preventing marine litter);
- Protect biodiversity and ecosystems (e.g. by integrating ecosystem and biodiversity values into national and local planning and into development processes).

2.2 EU level

At the European level, the European Commission sets out an action plan and a package of legislative proposals in 2015 in "EU action plan for the Circular Economy", to move from "waste" to "reuse" and to push the circular economy forward towards closing the loop (European Commission, Closing the loop – An EU action plan for the Circular Economy, 2015). The Circular Economy package of the Commission and the Council's conclusions, which were specified in the Environmental Council meeting of 20 June 2016, form an ambitious European policy agenda towards circular economy that many EU countries decided to follow.

2.3 Dutch context

The Netherlands is contributing to the previously mentioned UN and EU goals and, to this end, has put forward activities in the Government-wide program entitled "Wide Program for a Circular Economy in the Netherlands by 2050". This program has been developed and published by the Ministry of Infrastructure and Water Management and the Ministry of

Economic Affairs and Climate Policy, also on behalf of the Ministry of Foreign Affairs and the Ministry of the Interior and Kingdom Relations (Government 2016) https://www.government.nl/documents/letters/2016/09/14/government-wide-programme-for-a-circular-economy.

The figure 3 bellow represents the strategy for transition towards circular economy defined in Government-wide Program 2015. The scheme draws relation between the way resources are exploited and environmental impacts and proposes a shift from relative decoupling of economic growth from the use of natural resources to a positive coupling between economic growth and growth of natural resources.

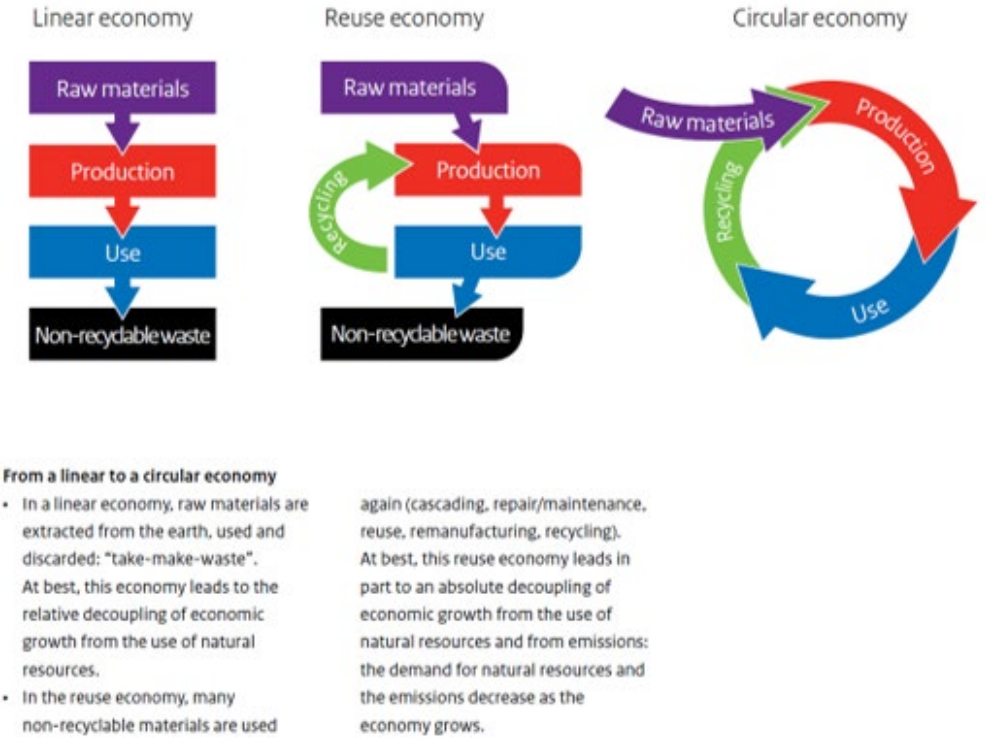

Figure 3: Dutch strategy: From Linear to circular economy (Government-wide Program 2015)

The Dutch government specified its national goal to develop a circular economy in the Netherlands by 2050 and to realize an objective of a 50% reduction in the use of primary raw materials by 2030. This should be achieved by designing products and buildings in such a way that they can be reused with a minimum loss of value and without harmful emissions entering the environment (Government-wide Program 2015). To keep with the European agreements, Dutch government set up the following ambition: By 2050, the construction industry will be organized in such a way, with respect to the design, development, operation,

management, and disassembly of buildings, as to ensure the sustainable construction, use, reuse, maintenance, and dismantling of these objects. Sustainable materials will be used in the construction process, and designs will be geared to the dynamic wishes of the users. (Government-wide Program 2015)

2.4 Construction waste streams in the Netherlands

Dutch Ministry of Infrastructure is collecting the data which address individual waste streams in construction on yearly basis. According to their data 89% of materials coming from the construction sector has mineral substances (brick, concrete, ceramic tiles) and 11% is metal, wood etc. 98% of the mineral waste in the Netherlands is traditionally being down-cycled and reused as a road base aggregate. The data in Figure 3 is being collected by the Dutch Ministry of Infrastructure in which individual operators and waste streams in construction are addressed.

Type	Sub-type		2012
Total CDW waste		Kton	25597
Recyclable waste	Iron	Kton	732
Recyclable waste	Metal	Kton	164
Recyclable waste	Mixed metal	Kton	75
Recyclable waste	Glass	Kton	49
Recyclable waste	Wood	Kton	1322
Recyclable waste	Paper	Kton	6
Recyclable waste	Plastic	Kton	34
Recyclable waste	rubber	Kton	0
Recyclable waste	Textile waste	Kton	0
Recyclable waste	Other	Kton	0
Mineral waste		Kton	22550
Electronic waste		Kton	4
Animal- and biodegradable waste		Kton	427
Mixed waste		Kton	200
Sludge		Kton	18
Chemical waste		Kton	17

Figure 4: CDW in The Netherlands (CBS, 2015d)

The existing patterns in Construction and Demolition waste management in the Netherlands indicates that the industry has made great steps towards recycling /down cycling of the construction material. (PBL)

According to the Rijkswaterstaat and National Institute for Public Health and the Environment (RIVM 2015), the reuse of (commercial and nonresidential buildings) C&NRB construction and demolition waste in the Netherlands is already widespread (>95%), even though in many cases materials are not reused at the same or higher level. The reuse rather involves, for example, construction rubble being processed to granulate to be used as a foundation material in Soil and Civil engineering (S&CE) sector. The need for such foundation material in the S&CE sector is expected to decrease, as this sector increasingly tends to use residual material from other sources. This "saturation" in S&CE generates an incentive for developing more circular uses for construction materials in the C&NRB sector.

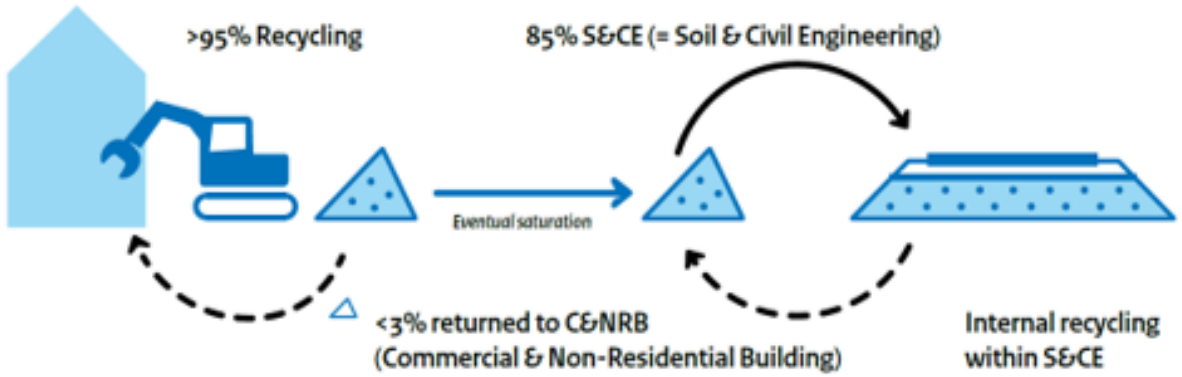

Figure 5: Typical reuse option of building materials, (Rijkswaterstaat and National Institute for Public Health and the Environment, RIVM 2015)

The building blocks of Super Circular Estate project in Kerkrade represent the average material composition of buildings and their waste streams now. Without the UIA project, Super Circular state buildings would end up in conventional waste streams in The Netherlands. As presented in previous figures these waste streams are organized around down-cycling of building materials at the moment.

2.5 Composition of the housing stock in The Netherlands

In the period from 1900 to 2011 about 92% (CBS, 2016) of the present building stock has been built in the Netherlands.

By the end of Second World War 12% of residential buildings were social housing units. Form 1945-1975 the proportion of social housing grew to 41% and by early 1990 the share had reached 44% (Pieter Boelhower, 2003, Social Housing Finance in the Netherlands). Difference between social and private housing is even bigger, on the social housing side, in big Dutch cities. For example, in Amsterdam ca. 30% of housing is privately owned and ca. 70% is rental housing manly developed by housing corporations The post war reconstruction that took place from 1945 until 1975 was dominated by industrialized

housing systems developed after the second world war to answer urgent need for housing, focusing on mass standardization. Throughout this period dominant portion of ca. 36% of nowadays housing stock in the Netherlands has been produced. The peak in construction was reached between 1965 and 1975 (see diagram, figure 6) *CBS Bouwhulpgroep, 2015*. This makes **Super Circular Estate representative for the typology and methods of construction for the period when major percentage of the exiting housing stock in the Netherlands has been formed. Only in the region of the Parkstad 1250 of the same social housing apartments have been registered.**

Figure 6: Housing stock growth in the Netherlands (1900-2015) CBS 2015)

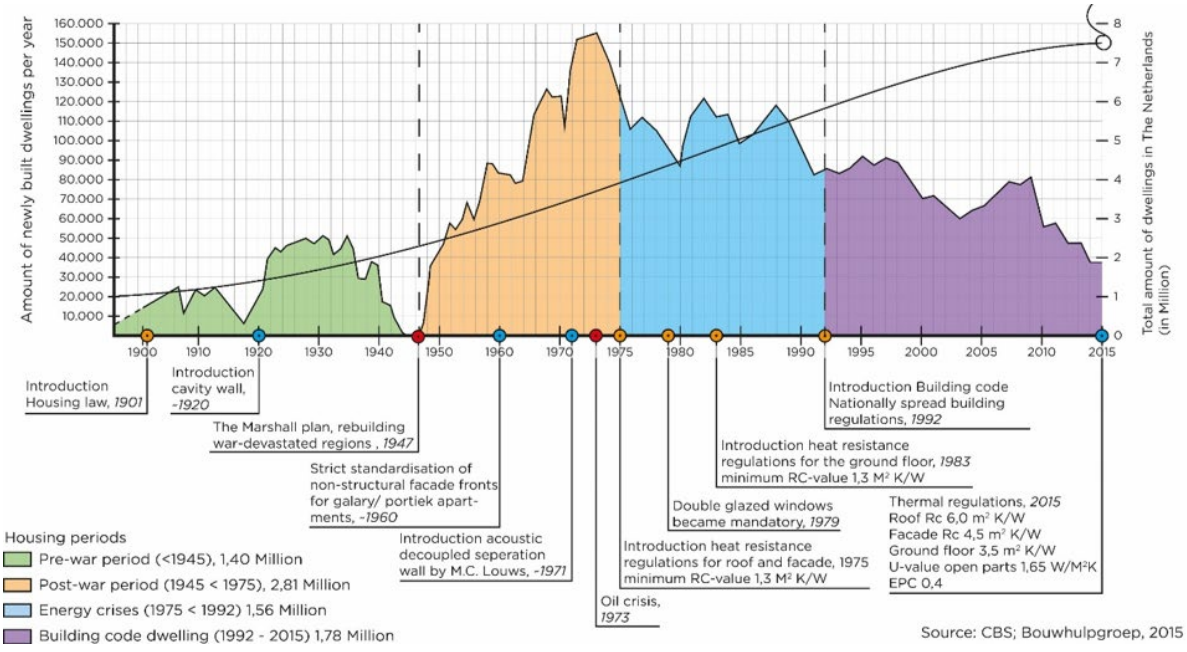

Figure 6: Housing stock growth in the Netherlands (1900-2015) CBS 2015)

2.6 Social context in the Region of Parkstad

Figure 7: Super Circular Estate project area, Kerkrade

Once wealthy Region, the Region of Parkstad (flourishing on the exploitation of coal mines) has faced its transformation by closing of mines (between 1968-1974)which has set up a trend of economic decline and shrinking of population. Super Circular Estate project is placed in Kerkrade with prediction of 10% shrinkage of the population in coming 10 years. (PC kwadraat 2017). In the next 30 years, the Parkstad Limburg region's population will shrink by 27% due to population ageing and young generation moving to bigger cities. This implies that less housing accommodation will be demanded in the following decades. High-rise apartment buildings, which were mainly built in the 1960's and 1970's, when housing shortage was a primary issue, no longer satisfies the requirements and inhabitants'needs and are listed for demolition. Demolition of buildings traditionally has negative impact on both social and material level, which is doubling down the shrinking population and degradation of materials (Both being addressed by the UIA project).

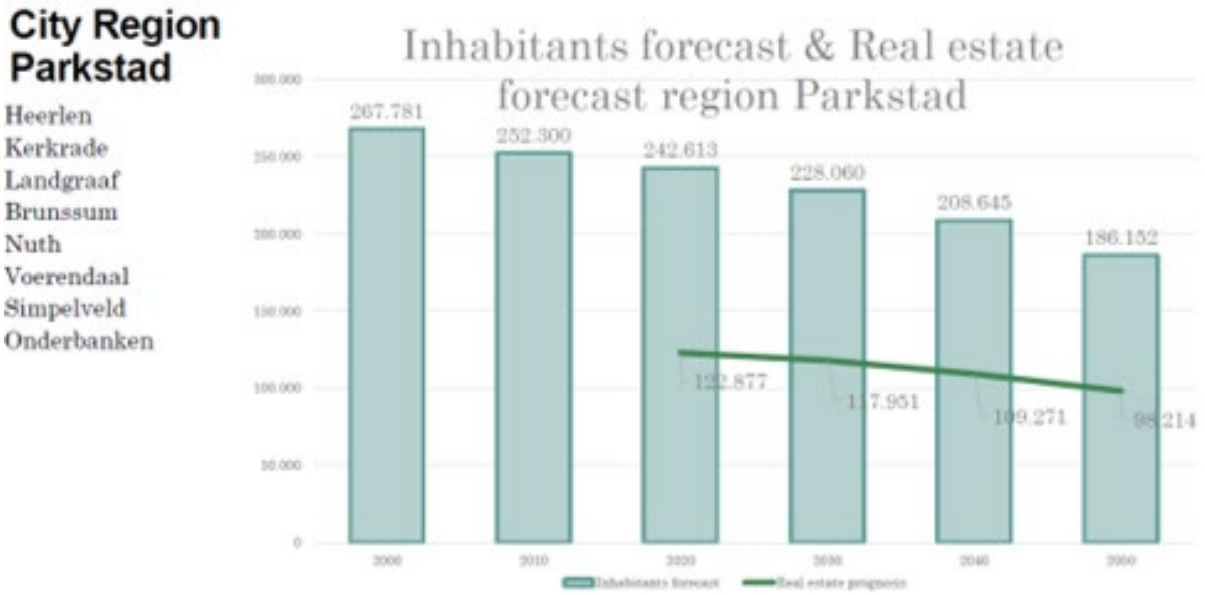

Figure 8: Demographic forecast for the region of Parkstad

3. Super Circular Estate | Goals

Transforming weakness into strength

Three vacant high-rise apartment buildings in the project-area in the City of Kerkrade contain valuable materials, qualities and former social structures. Demolition of these buildings will irreversibly impair these values. The objective of the Super Circular Estate is to circularly reuse these values within the project area whilst boosting the local economy and creating a high-quality and desirable urban environment. The former social structures will be recovered by actively stimulating former inhabitants to take residence in the area again. The proposed Innovative Urban Action is to experiment with new circular economy processes aimed at 100% reusing and recycling of materials acquired from the project-area in Kerkrade.

Altogether, considering this unique situation and potential knowledge coming from the circular transformation, Super Circular Estate proposes to turn weakness into strengths. It proposes a concept of Shrinking regions as Region of Parkstad to become “Material bank for the Netherlands”. It builds on front-runner developments to collect & map information on availability of reclaimed building products and contributes with quality confirmation data on digital circular building platform.

The project serves as a best example for approximately 1250 similar housing accommodations in the Parkstad Limburg region. However, results can be implemented in a much broader area since the housing block of Super Circular Estate is representative for the methods of the construction of the housing in the booming construction period in the Netherlands. The building blocks of Super Circular Estate in Kerkrade are representative of the housing stock in the Netherlands built in the postwar period form 1945-1975. 36% of nowadays housing building stock has been constructed during this period.

At the same time targeted building blocks of Super Circular Estate project (reinforced concrete high-rise buildings (tunnel formwork technology)) represent typical material composition which forms todays waste streams in the Netherlands.

From the social circularity point of view the aim is to reinforce social cohesion by transforming partly empty building block into a new ground based homes and bring old residence in.

The strategic objective of the Super Circular Estate is to contribute to a sustainable, circular economy through management of smart urban transformation (as an answer to shrinking) in Parkstad Limburg NL, by creating high quality, urban environment and affordable housing opportunities based on breakthrough innovative circular material and social solutions in the housing sector.

Project ambition is to achieve these objectives through:

- keeping the value of the buildings, systems, products and social ties by introducing circular economy principles and methodologies into the everyday decision making and management of social housing association

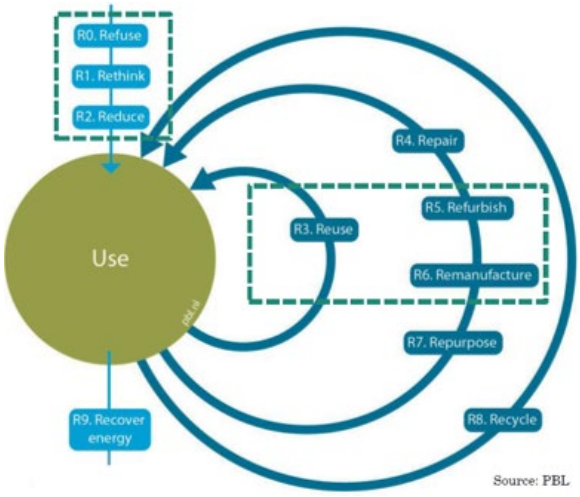

Figure 9: Circular building material flow (PBL, 2016)

- supporting industry and policy makers with hard-core evidence on circular reconstruction and material harvesting and
- design, experiment and evaluate 100% reuse and recycle practices in demolition projects for reinforced concrete high-rise buildings (tunnel formwork technology).

The Hierarchy of the material flow in SCE is following the principals defined in figure 9. The aim is to favor Reuse first than Refurbishment/ Remanufacture and only as the last option Recycling.

Super Circular Estate's innovation aim is to revolutionize management of social housing associations towards sustainable, resource efficient decision making, delivery models and processes.

3.1 Steps to take

In order to achieve project objectives, the following milestones have been defined:

- Finalize Expo building built of 100% reused materials and components, as a first test case prior to UIA project with support from IBA Parkstad.
- Implement Knowledge from the expo building into developing and construction of four test houses as part of the UIA Super Circular Estate project.
- Collect feedback from the residents of 4 experimental homes. Allow inhabitants from the neighborhood to sleep in a few nights and provide feedback. Rent the 4 experimental homes out to old residents.
- Upscale two out of four test homes and construct twenty properties (with their own material passports) in the same area.
- Form a strong bond with the inhabitants (alumni group). Involve inhabitants in the decision making process and invite former inhabitants to come inhabit circular homes. At least 20 homes will be inhabited with former residents, so that some of the district's DNA will come back again.
- Realise a social plinth within a second flat building which will be renovated and transformed into 110 houses beyond UIA project. Social plinth, which is a part of UIA Super Circular Estate, will be realized using harvested materials from the area. The plinth will host shared facilities and leave space to future residents to develop desired functions. The social plinth will offer the space to introduce circular social functions: cooking together or a washing machine room, urban farming, repair café.

4. Project progress and learning point

In the last 10 months a progress has been achieved on:

1. Testing the quality of harvested material from the 10-story housing block. The key questions investigated were related to the quality of the materials technology needed for the reparation /refurbishment and potential reuse options of harvested materials (e.g. floor elements which were taken from the galleries of the building reuse as a road pavement). Testing of materials has been done by the following methods: (i) visual examination, (ii) material testing of concrete and steel samples, (iii) asbestos report, (iv) physical inspection as to how easy it is to recover material without damages based on time and equipment needed.

2. Investigating policy and regulation gaps related to the reuse of materials and finding the ways to bridge the gaps. With respect to regulations, compromising solutions had to be found with the municipality of Kerkrade, since the recovered materials did not fit the requirements for the new construction. After consultations between the Municipality of Kerkrade and Dutch Ministry in Den Haag, it has been agreed to apply, in this case, the regulations that address the existing building and not the design of new building. This meant that the structural calculations had to comply with NEN 8700:2011 (existing buildings), the floor to ceiling height is also compatible only with the regulations for the existing buildings. More discussions will take place with respect to the regulations as project goes through the building permit procedure. Especially issues related to the health and safety impacts of deconstruction and construction process with reusable materials will be part of future discussions.

3. Preliminary and definitive design of four individual houses by using harvested material from the 10-story housing block has been completed and application for the building permit submitted. In coming months, building permit application will be processed by the municipality and potential new questions about meeting the desired safety, environmental and other requirements with SCE methodology may come forward. As soon as the building permit is issued the project partners will continue to work on technical design including the preparation for construction.

   Design process itself was innovative. Besides architect, structural engineer and installation advisor forming the core of design team, in the case of SCE, deconstruction contractor and general contractor were important members of design team from the initial design phase. During design of four independent houses (figure 11) the team walked through the existing 10 story building and inspected the materials and key dimensions in order to create an initial material database that will be used for design of houses. These decisions have been made jointly.

   For example, in the first-place architect was in favor of deconstructing the area around the staircase because of the wide space attached to the staircase, but deconstruction contractor and the rest of the engineering

team came to the conclusion (after expecting the building and old construction reports) that deconstruction of that part of the building is not feasible from technical point of view.

The interaction between deconstruction contractor and design team was essential during the preliminary and definitive design phase. Each design proposal was dependent from the judgment of deconstruction contractor on its ability to recover materials with minimum damages and by understanding the material properties of existing materials.

Preliminary and definitive design phase resulted in design of four types of ground floor houses with a garden and garage. Those are:
Houses Type A (74m^2) and Type B(64m^2) two bedroom and one-bedroom houses. These two types will be built with 3D modules which are directly deconstructed from the 10-story building.
Houses Type (C) 40 m^2 and Type (D) 20m^2 studio houses will be constructed using concrete elements as roof and façade. 10-story building has galleries and balconies, whose concrete plates will be reused in the foundation (as foundation plates). The ambition is to build the four houses with 100% of materials being reused from the 10-story building.

More detailed information about the design process will be highlighted in next journals.

4. Soundingboard group (Neighborhood Steering Platform) of residents has been formed. These residents are at the same time the ambassadors of the project.
5. Development of a coding system of materials that will enable registration of individual materials coming out of the building. The registration system in the form of material passport contains standardized material property sets including embodied CO_2 per material.
6. Dissemination of knowledge through national and international symposiums and events as well as through organized visits to the site for professionals and dwellers.

Major learning points are addressed in the following chapters.

5. Material passports

In order to enable closed material stream loop through the built environment, it is necessary to develop a registration system for traceability of and information about materials composition of buildings. This was one of the aspects that was embraced by the project team and demolisher at the beginning of the project. The registration system including track and trace QR-code has been developed by demolisher Dusseldorp and implemented in the 10-story building that is planned for deconstruction. All materials are given a barcode and *materials passport of a flat building has been created*. Dusseldorp [deconstruction company] has created a materials database in which they can code materials and add QR-codes. Other track and trace options using chip technologies have been investigated but have turned out to be more complex and expensive to develop within required timeframe.

After all, as project leader at Dusseldorp stated during the interview "you can fabricate a QR-code yourself with an app, which can then be scanned. We now have a very large database containing the whole flat that is fully stickered. You can almost see it as a store." Each material is logged into the database. When material leaves the building/site it is being logged off from the database and afterwards logged on/nested in the new building as a part of the material passport of the new building.

Based on the experience so far, the project team envisions that in the future every building will have its own database with standardized dataset and materials will be logged in or logged out as they are coming and leaving the building. Datasets developed so far contain information about material properties, position in the building, function and size. The aim is to equip the code with information about the embedded CO_2 within each material. This will enable to calculate related societal costs for the materials which will be reused. The ambition of the housing cooperation is to provide all four houses with such material passports and to upscale this registration system to the rest of its building stock. Developed coding system helps to *create a virtual material gate of the building. Accordingly, building passport of every building can be created by registering every material that passes through the virtual building gate. This will enable to know exactly what is in the building after its completion, during its use, at the end of its use life cycle as well as to register saving of materials and embodied carbon at the beginning of their second life cycle.*

Housing corporation HeemWonen would like to implement such registration system and building passports within three years.

Figure 10: Closing the material loop by material registration system

6. Harvesting materials for construction of four houses

Figure 11: Four UIA SCE buildings to be made of 75-100% reusable materials

Although the ambition of the project is to aim for direct reuse of materials and products that are deconstructed from the 10-story building, first testing of material and component reuse indicates that refurbishment is more feasible than direct reuse. The reason for this has to do with health issue (as removal of asbestos from the window frames), change of regulations and performance requirements as for example energy performance of the building, etc. The project team has identified 16 different material streams which can be classified into the four reuse category types: direct reuse, reuse by remanufacturing, reuse by recycling and reuse by downcycling. The coding system mentioned above enables the project partners to identify 10-story building as material bank whose capital will be distributed along the specified material streams. For example, Loadbearing elements, windows, doors, façade will be ending within construction process of four houses and others will end up on the internal databases and web shop for the second-hand materials. Pre-demolition audit produced by deconstruction contractor indicated that 10-story building contains 13.300 tons of material out of which 330 tons can be marked as C&DW. The ambition is to find a second use options for the other

12.700 tons of material. During preliminary and definitive design phase, samples of materials on the 10th floor have been tested and their reuse potential has been investigated by following techniques: (i) visual examination, (ii) material testing of concrete and steel samples, (iii) asbestos report, (iv) physical inspection as to how easy it is to recover material without damages based on time and equipment needed. According to above investigation a material passport has been created containing materials from the 10th floor. All materials in material passports are classified into three categories: 1 (easy to recover) to 3 (difficult to recover) without damaging materials (as for example the case with insulation material which is fixed to the roofing, or windows which contain asbestos). Further applications of the material will be investigated during the technical design phase and preparation for construction.

7. Multidisciplinary Team work as main driver of innovation

Successful innovation team cannot be formed by procurement process and partner selection based on the price, but by the right mindset.

Super Circular Estate development process is innovative.

The design process is reversed from daily process because architect needs materials at the front that are only released at the end of the demolition. The quality of the material is defined by the recovery process. The demolition contractor defines how elements can be extracted without much damage. The contractor needs to specify work needed to make harvested material fit for new purposes. The structural engineer needs to proof whether structure made of reusable materials is stable. In the design process, the architect is not leading the design process but the synergy in the team is leading the process. The municipality needs to accept reused materials and structural calculations to issue building permit. The process faces many unknowns in search for smart solutions to overcome the gaps between the linear and circular legislation, design, construction and liability contracts. This can be achieved only by teamwork and having the team players around the table ready to step out of the comfort zone of daily profession and listen and reach to others. This is why all partners in the project indicate that choice of partnership for innovative project cannot be made by conventional procurement but by mindset needed to carry out the innovation project.

8. Social Impact

The housing corporation and the municipality of Kerkrade were active in involving inhabitants into the process of urban transformation that will be carried out within SCE aiming at creating a strong bond with the neighborhood throughout the project and let them experience circular resource use. This has been done through regular events and discussion sessions and talks about the project progress. The ambition of the city and housing corporation is to attract inhabitants back to the community after the transformation has been completed. During the interviews with both project partners it became evident that residents are very proud of the project and that Super Circular Estate has created a new identity for the community and the city that everyone can build on. They have managed to build strong bond with representatives of the residents that have started acting as ambassadors of the project.

Municipality of Kerkrade and housing corporation HeemWonen organised meetings with representatives of residence groups (*Neighborhood Steering Platform of residents*) 5 times last year. During these meetings residents were informed about the developments in the area and the objectives, planning and progress of SCE project. At the beginning of SCE areal development, residents living in direct proximity to the SCE housing blocks were involved in a decision-making process regarding demolition steps. Further on, representatives of the residents were involved in the process of architects' selection who will design the social shared facility on the ground floor of the 10-story building that will be refurbished. They will also be involved in design process itself together with potential new residents in coming months.

9. Challenges ahead

The Super Circular Estate contributes to a sustainable, low carbon, resource efficient economy by creating high-quality, desirable urban environment and affordable housing opportunities based on breakthrough innovative material and social circular solutions. Such high ambitions are faced with many challenges.

In order to reach the goal, the project has a number of challenges ahead.

Further development of the Super Circular Estate will address many of these challenges. Key once are specified bellow:

- Testing of the technology for high value recovery and solving issues of liability and certification when it comes to the reuse of the existing material.
- Collaboration between the demolisher and contractor as the point where the work of demolisher ends and the work of the contractor starts is not strictly defined in such circular project.
- Regulations as to how to go about with approving construction which relies on reuse of the materials which were initially designed for other purposes and other regulations.
- Procurement is seen as a big challenge in an innovation project as Super Circular Estate. For many actions it is difficult to find even one party that can do the job. Merely putting the question to the market is not helping the project since the market does not yet have answers to many project questions.
- Upscaling the technology and methodology to a level of wide application is a big challenge since it will depend on financial feasibility of the technology and methodology, and both are in the experimental phase.
- Social circularity by keeping residents informed and active and mobilizing the former residence who will be willing to come back and live in circular homes.

Below you could find the cross-cutting challenges with their level and related observations:

Table 1: UIA SCE challenges

Challenge	Level	Observations
1.Leadership for implementation	Low	Leadership is strong, however leadership in an innovative project, which deals with systemic change, remains a challenge. In comparison to regular project where leadership focusses on management of time, costs and content, leadership of SCE process is about continually stimulating partners to be innovative and to investigate options which are beyond the work as usual. This will need special attention through the whole process.
2.Public procurement	Medium	Important procurement issues have been addressed already and few issues and lessons are emerging in particular the once related to the construction phase. Considering that approach and objectives of SCE have never been addressed or tested before, there is no established market and knowledge that can provide tailored solutions for SCE project. In order to find a construction/deconstruction partner for SCE, housing corporation invited four companies and asked them to develop and propose own ideas and strategies to best meet the requirements of SCE. The company has been chosen based on its strategy and commitment.
3.Integrated cross-departmental working	Low	This is a challenge, although the urban authority managed to mobilise different departments throughout the first experimental phase, as preparation for the UIA project which has created a strong commitment and understanding within organisation. However it will remain challenging as a project moves further towards more practical levels of construction and its safety and security.
4.Adopting a participative approach	Low	High levels of participation evident across stakeholder groups.
5. Monitoring and evaluation	High	The progress has been made to identify KPI of material and social circularity, but monitoring and evaluation remains a significant challenge in particular around social circularity. In the early stage of the project the focus was on developing methodology for measuring the technical innovation and material circularity. Setting up a measurement system for evaluation of social circularity and social impacts of the SCE project is a challenge as there are no standard blueprints that can be followed yet. Partners will focus on defining strategy for measuring the social impacts during the next project phase.

Challenge	Level	Observations
6. Financial Sustainability	High	The project has significant challenge in relation to the Financial sustainability. The potential is evident, but needs to be monitored and evaluated along the progress line.
7. Communicating with target beneficiaries	Low	Impressive communications campaign and activities are now in place. The project communication team developed a consistent communication strategy and communication plan around three important milestones that were clearly illustrating the objectives and significant potentials behind the project. The three campaigns were covering (i) acceptance of the project proposal by UIA; (ii) the deconstruction process of the first 3D module out of the 10-story building, (iii) opening of the first expo pavilion made of 100% reused modules and materials recovered from the 10-story building. These milestones have been promoted extensively on the social media, on regional TV stations, websites and newspaper. This has brought the recognition of the project on national level and created a positive image of the project. As a result, the project managers are organising frequent tour and presentation to the groups of professionals coming to the SCE site from all over the Netherlands and EU region. This has also raised the awareness among the residence. At the same time, residents become proud of their neighbourhood. The estimation is that these campaigns have reached more than 1000 people so far.
8. Upscaling	High	The challenge here relates to financial sustainability related to the broad applicability and high adoption level of the technology and tools being developed. The project partners are focused on development of four types of houses first, prior to investigating potential of the broader implementation of the technology and upscaling.

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