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REPAiR

REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism

D5.2 Catalogue of solutions and strategies for Amsterdam

Version 1

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Acronyms and Abbreviations used in this Deliverable

AMA	Amsterdam Metropolitan Area
CM	Consortium Meeting
CDW	Construction and Demolition Waste
CE	Circular Economy
DoA	Description of Action
EC	European Commission
EIS	Eco-Innovative Solution
EU	European Union
FW	Food Waste
GA	Grant Agreement
GDSE	Geodesign Decision Support Environment
KT	Knowledge Transfer
PULL	Peri-Urban Living Labs
UM	Urban Metabolism
WP	Work Package
WMP	Waste Management Plan

Table of Content

Publishable Summary

This document presents the Eco-Innovative Solutions (EIS) that have been co-developed for the pilot case of the Amsterdam Metropolitan Area (AMA), and the methodology and approach to develop the solutions.

The methodology for developing the EIS was developed by REPAiR in the Peri-Urban Living Labs (PULLs) in the pilot cases of Amsterdam and Naples, and is described in the deliverable 5.4, Handbook: How to run a PULL. This handbook describes the development of a Co-creation process, methodology in five phases, namely Co-Exploring, Co-Design, Co-Production, Co-Decision, Co-Governance. Together with the stakeholders in the AMA, the choice was made to focus on developing EIS for the flows Food Waste (FW), Construction and Demolition Waste (CDW) and on Wastescape.

The EIS presented in this document are developed following two different paths, namely 1) transfer and adaptation of existing EIS from literature and reference projects towards the AMA for CDW, FW and Wastescape, and 2) an original co-design process of specific EIS for the AMA with local stakeholders and students. Both paths are influenced by the knowledge and expertise of the REPAiR research team, partners and advisory board. The activities are performed according to the identified objectives of the AMA understood from the process model analysis (Material Flow Analysis and Spatial Analysis, Deliverable 3.3, REPAiR 2018) and the issues emerging during the PULL. The methodology has been applied to select, adapt and elaborate the EIS as described in Deliverable 5.4 (REPAiR 2018).

The EIS developed play different roles in the transition towards circularity although none of the solutions are completely circular. The majority of the solutions tend towards circularity without completely achieving it, as eventually they still lead to generation of waste, even if limited. This result helps to demonstrate the difficulties and the complexity in the design process in pursuit of circularity. The result also demonstrates the limitations of the current technological, political and legal systems within the AMA context. Moreover, the complexity of redesigning urban, material and spatial processes that involve generation and treatment of FW, CDW and Wastescapes, obliged the REPAiR team to ask itself questions that go beyond our field of knowledge, and consequently to explore the systemic thinking method.

1. Introduction

The Deliverables D5.2 “Catalogue of solutions and strategies for Amsterdam” presents a catalogue of Eco-Innovative Solutions (EIS), which aims to transform material and territorial waste into resources for this pilot case of REPAiR. More specifically, EIS are aimed at preventing the generation of waste, within the context of the peri-urban.

The EIS have been developed based on the research explored within the Amsterdam pilot Peri-Urban Living Lab (PULL), following the five-step methodology that includes the phases: Co-Exploring, Co-Design, Co-Production, Co-Decision, Co-Governance. This methodology is further explained in the Deliverable 5.4 “Handbook: how to run a PULL”. The phases pay specific attention to site-specificity, general context, data, models, and availability of stakeholder input.

For an effective identification of challenges and objectives towards the definition of preferred, feasible and transferable EIS, a challenge-tree based methodology for defining the EIS was developed by the WP5 team in collaboration with WP6 and WP7.

In collaboration with WP3, the focus area was identified. Within WP3, wastescapes have been identified and mapped (see more details in Deliverable 3.3). The specific target locations for developing EIS were defined as enabling contexts or possibility context. These spaces are the areas for which it is more urgent to develop Eco-Innovative Solutions, or where it is easier to start the process of definition (and eventually implementation) of EIS (e.g. they are publicly owned areas). See more details in the Deliverable 3.3 p. 26). The enabling contexts were produced combining several layers of spatial, socio-economic and material flow information in an iterative and discursive process by the consortium members. Therefore, these contexts are sensitive to different actors and interests in the territory and their meaning depends greatly on the precision with which data was processed, maps were generated, and perspectives of stakeholders and experts were employed. .

As such, ‘enabling contexts’ were determined to develop the solutions, as follows:

The Amsterdam case considered a network of synergetic relationships between landscape, infrastructure and flows, leading to the identification of common patterns in enabling contexts. This complex interdependence of waste processes, material flows and spatial issues led to the development of the EIS.

2. REPAiR definition of Eco-Innovative Strategies and Solutions

The awareness of moving towards circularity has raised the necessity to change and renew existing technological production and socio-political, environmental and economic behavioural patterns. At best, such awareness may produce different types of responses, the so-called solutions and strategies, to make the shift towards circularity. Moreover, this consciousness for change has led to increasing application of the term 'eco-innovation' in environmental, technological, economic management, urban planning and policy making. Many kinds of innovation can be defined as eco-innovations. This raises the importance of a common understanding across the different disciplines and roles involved in REPAiR on what eco-innovation and eco-innovative solutions exactly mean.

In literature, several attempts have been made to define eco-innovation, however a common understanding is still missing (Kiefer et al. 2017; Carillo-Hermosilla & Könnölä 2010). As stated in the REPAiR Deliverable 5.4 (REPAiR 2018), the definition included in the Eco-innovation Action Plan of 2011 is shared between the different partners of REPAiR.

"*Eco-innovation refers to all forms of innovation – technological and non-technological – that create business opportunities and benefit the environment by preventing or reducing their impact, or by optimising the use of resources. Eco-innovation is closely linked to the way we use our natural resources, to how we produce and consume and also to the concepts of eco-efficiency and eco-industries. It encourages a shift among manufacturing firms from "end-of-pipe" solutions to "closed-loop" approaches that minimise material and energy flows by changing products and production methods – bringing a competitive advantage across many businesses and sectors*" [EC 2011].

The Horizon 2020 REPAiR call "WASTE-6a-2015" stated that eco-innovative solutions are "*demonstration, at an appropriate pilot scale, and market replication, of integrated eco-innovative cost and energy-efficient TECHNOLOGIES, PROCESSES and/or SERVICES for waste prevention, treatment, enhanced collection, recycling and recovery of high- grade valuable materials from waste.*" The REPAiR team, with the support of the user board, aims at developing **Eco-Innovative Solutions** (EIS) and integrate them into systemic and territorial Eco-Innovative Strategies. Eco-Innovative Strategies and Solutions can be defined as follows:

1. Eco-innovation refers to all forms of innovation – technological and non-technological – that create business opportunities and benefit the environment by preventing or reducing their impact, or by optimising the use of resources. Eco-innovation is closely linked to the way we use our natural resources, to how we produce and consume. It encourages a shift among manufacturing forms from "end-of-pipe" solutions to "closed-loop" approaches that minimize material and energy flows by changing products and production methods – bringing a competitive advantage across many businesses and sectors.

Eco-Innovative Strategy *is an alternative course of action aimed at addressing both the objectives and challenges identified within a PULL and develop a more Circular Economy in peri-urban areas* (REPAiR 2018, p.10).

The Strategy can be composed of a systemic integration of two or more elementary actions. According to the REPAiR Grant Agreement 688920, the "*Eco-innovative solutions developed will improve the capacity of urban environments to deal with future resource management challenges, while triggering positive transformations in spatial qualities, sustainability and urban metabolism. These shifts will together enhance quality of life*" (EC 2016: 157).

EIS will encompass decisions on the following aspects:

- The development and implementation of new materials, technologies or processes in connection with the development of sustainable economic activities, or adding new activities in value chains with the modification of the status of the current waste management systems, and the resource flows, also capable of modifying the spatial configuration of peri-urban areas (also from an environmental perspective);

- The modification of existing policies and governance, or new policy/governance developments;

- The definition of spatial and environmental design proposals.

These solutions will potentially lead to the modification of existing flows of materials, development of new flows and processes and/or change the spatial design of areas, and will generate change in the behaviour of stakeholders and inhabitants in the case study areas.
REPAiR's attempt to conceptualise solutions towards eco-innovation arises through a systemic process that refers to the interconnectedness and dynamic interaction between different actors, waste flows, policy and governance factors influencing the innovation process in the built environment. These premises invite us to explore-design the wide array of eco-innovations and to examine the occurred changes in several dimensions of eco-innovations. Hence, EIS are creative and smart ideas aimed to innovate and improve a specific and fixed process in relation of the management of waste as a resource and wastescapes (Figure 2)

More specifically, EIS:

- **Are elementary** responses to **case-specific** problems, in a contextual approach towards innovation, where the real innovation is the process to achieve the result. EIS derives from case-specific problems, but their final configuration is such that they can be used in all cases. Their transferability is obtained by abstracting how they function, trimming their structure from site-specific features.

- **Depend on local/regional/national policies/resources** (managerial, economic/financial, administrative capacity, etc.);

- **Are the result of a co-creation process implemented in the PULL environments**, which means that their content depends on the needs of the multiple stakeholders involved in the PULL;

- **Cross the multiple scales, the different dimensions and characteristics and densities** of the peri-urban territories investigated;

- **Assure the reciprocities between the natural and the built environment** (EC 2016: 153). EIS are not just changes in current technologies, but also process innovations (Dente, Coletti 2011) "contributing to the EU's ambition of a paradigm shift towards Circular Economy and a near-zero waste society" (EC 2016: 153);

- **And are based on the key environmental principle "Reduce-Reuse-Recycle-Recover"**.

Furthermore, through EIS, a new level of creativity is reached. Such creativity is needed to face the crisis of waste management and resource scarcity in a context of transition to circular economy as well as the problems related to regeneration processes of wastescapes.
To facilitate entry and testing of the EIS in the GDSE, EIS are classified according to the PESTEL framework following the dimensions that they can take, as:

- Political/organisational (P),
- Economic (E),
- Social (S),
- Technical (T),
- Environmental (E),
- Legal (L).

Developing and refining the EIS for Amsterdam was made possible through the inputs from:

- PULLs (including PULL workshops with stakeholders' inputs, Consortium Meetings, desktop research, internal meetings, etc.);
- Student's work;
- and literature review.

Strategies and solutions towards eco-innovation are normally used in the context of complex problems. According to Van de Ven et al. (2009)[1], non-structured or complex problems are defined as those which do not necessarily have a well-defined objective and/or set of strategies and solutions used to address the problem. In this context, different disciplines have traditionally worked under different approaches, related to different parts of the problem-solving process. Engineering disciplines are used to optimise processes, strategies and solutions when both solutions and objectives are well defined, while architects and urban designers usually work in contexts in which neither of those are well defined, using design to reveal new possibilities. In this light, the position of REPAiR is in the Innovation phase where the problems and objectives are well defined (they are the outcome of the work of the PULLs) but the solution are not defined yet (Fig. 1).

DIFFERENT APPROACHES TO ADDRESS COMPLEX PROBLEMS[2]		Are the problems and objectives defined?	
		YES	NO
Are the solutions defined?	YES	Optimisation	Negotiation
	NO	Innovation	Design

Position of REPAiR

FIG 1 The position of REPAiR in the matrix of solutions and objective when dealing with complex problems, Source: elaboration of the TUD Team based on "Solution Strategies to address various complex problems", source: Land & Water Management in the Urban Environment (2009) Van de Ven, F.H.M., H. Gehrels, H. van Meerten, B. van de Pas, E. Ruijgh, D. Vatvani, N. van Oostrom and Th van der Linden, Deltares, Utrecht/ Delft (p. 37).

1. Based on Table "Solution Strategies to address various complex problems". Source: Land & Water Management in the Urban Environment (2009) Van de Ven, F.H.M., H. Gehrels, H. van Meerten, B. van de Pas, E. Ruijgh, D. Vatvani, N. van Oostrom and Th van der Linden, Deltares, Utrecht/Delft (p. 37)

3. Design towards circularity: positioning the EIS

In the process of evaluating and developing EIS, design played a crucial role, addressing how to improve existing systems and create or transform to an entirely new system. Within a circular economy perspective, two different design rationales of eco-innovations can be distinguished: one considers the design of completely circular actions while the other focuses on designing strategies that optimise existing processes towards circularity, minimising the production of waste and maximising the re-use/transformation of waste into valuable products. Based on the study of Hermosilla et al. (2009), when these two perspectives are combined with the incremental and/or radical nature of Political, Economic, Social, Technological, Legal and Environmental changes and the degree of impacts to the systems, three different types of actions can be proposed to help the transition towards circularity (Fig.2).

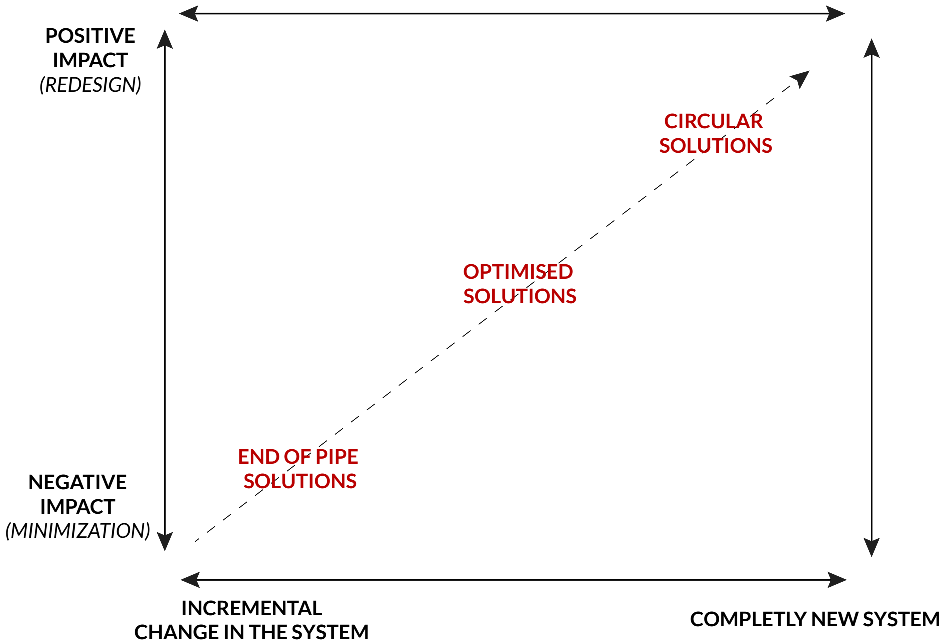


FIG 2 Typology of EIS Source: TUD Team (based on the study of Hermosilla et al. 2009 : p.1076)

End of pipe solutions are actions tending to minimise the negative impacts without necessarily changing the process and system that generate those impacts in the first place. These actions do not change the main process, they will only solve part of the problem, at the end of the pipe (e.g. treatment of hazardous emissions).

Optimised solutions toward circularity are actions tending to change one or more systems, i.e. by addressing its components and subsystems. These actions are designed with a view to shift from linear systems, in which resources move through the system to become waste, to circular systems in which wastes become inputs for new processes.

Circular solutions. Following the interpretation of McDonough and Braungart (2002), circular solutions are actions in which products, processes and systems are designed taking into account the entire life cycle of the product, process and system optimizing material health, “recyclability”, renewable energy use, water efficiency and quality, and social responsibility. Ideally circular solutions are designed to safely cycle within either a biological or technical metabolism and to be reused or recovered at their highest possible value.

In conclusion, the development of EIS leads to two alternative design perspectives: closed and open cycles. Closed cycles imply that recycling can be done indefinitely without degradation of properties, eliminating the creation of waste, whereas open cycles allow for downgrading (or ‘downcycling’) steps, postponing but not eliminating the creation of waste. In relation to the well-known waste hierarchy, also followed by the EC in its *Waste Framework Directive*[2], closed cycles focus on the preferred steps: 1) prevention, 2) reduction, 3) reuse, and 4) recycling/upcycling, while open cycles essentially lead to the less preferred steps: 5) recycling/downcycling, 6) energy recovery, and 7) disposal/landfill[3]. Within REPAiR, both closed and open cycle perspectives are considered. However, taking into account REPAiR’s ambition to move from linear to circular systems, the open cycle perspective is approached as a ‘transition perspective’, ie. not an ultimate solution, but the best temporary solution in the given - social, cultural, economic, and spatial - context. In the end, designing EIS goes beyond mere improvements in existing activities and waste management processes. Most of all, it imposes to public and private stakeholders, and society at large, to redefine production processes and behavioural patterns.

2. https://en.wikipedia.org/wiki/Waste_framework_directive

3 There are multiple versions and interpretations of the waste hierarchy. Here, we follow 7 steps, with particular attention for the distinction between step 4 (recycling as ‘upcycling’: restoring value) and step 5 (recycling as ‘downcycling’: destroying value).

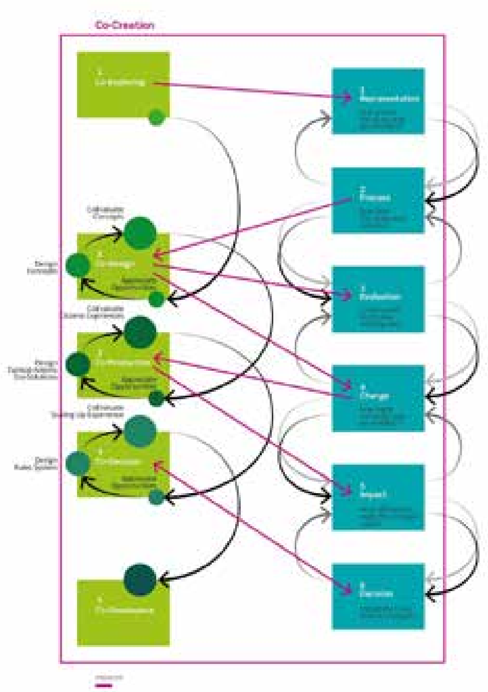
4. Methodology and steps to design the EIS

The development of Eco-Innovative Solution is structured around two principal simultaneous activities:

- transfer and adaptation of existing EIS from literature and reference projects towards the AMA for CDW, FW and wastescape. This process re-constructs and adapts the state of the art of existing and tested EIS, namely design strategies, good practices, innovative policies, innovative materials (...) released during the last 6 years across Europe;
- an original co-design process of specific EIS for the AMA with local stakeholders and students.

Both activities are influenced by the different knowledge and expertise of the interdisciplinary REPAiR research team, partners and advisory board. These are performed according to the identified needs of the AMA understood from the process model analysis (Material Flow Analysis and Spatial Analysis) explained in the Deliverable 3.3 (REPAiR 2018) and the issue emerged during the PULL. The encounter of different fields of knowledge poses a significant challenge that can be tackled appropriately only by implementing a specific methodology able to lead to the selection, adaptation and elaboration of high-quality EIS as described in Deliverable 5.4 (REPAiR 2018).

Whitin REPAiR this methodology is defined as a Co-creation process. The Co-creation process of REPAiR comprises the following five iterative phases (Figure 3), which were already described in the Deliverable 5.1 (REPAiR 2017b, page 29) and deepened in Deliverable 5.4 (REPAiR 2018, page 14):



1. Co-Exploring;

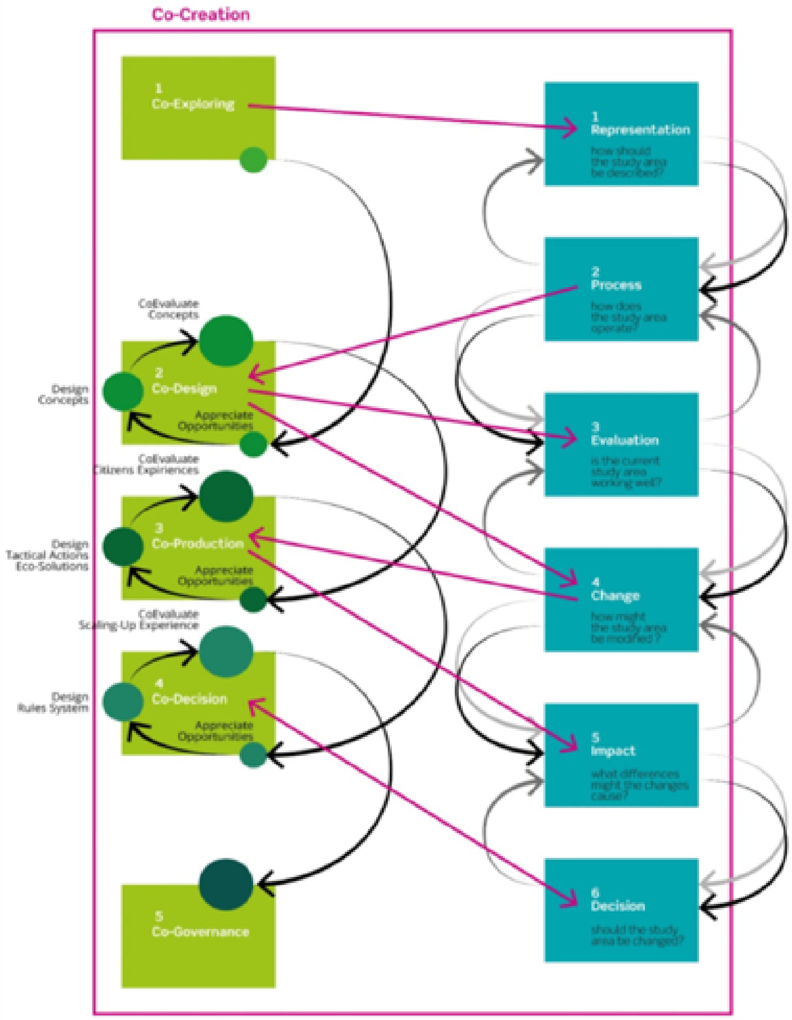
2. Co-Design;

3. Co-Production;

4. Co-Decision;

5. Co-Governance.

FIG 3 Scheme PULLs methodology . Source: (Deliverable 5.1; REPAiR 2017, page 33)



Co-Exploring: September 2016 – February 2018, define location, challenges, objectives

Co-Design: February 2018 – September 2018, design initial Eco-Innovative Solutions (EIS)

Co-Production: September 2018 – February 2019, evaluate and refine EIS, develop Eco-Innovative Strategies

Co-Decision: February 2019 – April 2019

Co-Governance: April 2019 – September 2019

FIG 4 Scheme PULLs methodology applied to the AMA

Figure 4 shows the PULLs methodology applied to the AMA, including the time-line for the activities that were conducted so far, and a rough planning for the next months.

1. Co-Exploring

The Co-Exploring phase is based on cooperation between (mainly) the WP5 and WP6, using interviews and workshops to define the location. Interviews, workshops and surveys were used to define challenges and objectives.

2. Co-Design

The Co-design phase is based on workshops with the AMA stakeholders and experts, and cooperation with education (when possible), developing preliminary EIS as part of a research and design studio.

3. Co-Production

We are now in the phases of co-production and co-evaluation and scaling-up the solutions . Like the Co-design phase, this phase is based on workshops with the AMA stakeholders and experts, and cooperation with education. The co-production and co-evaluation phases will be concluded in February 2019. Then, the solutions will be implemented in the GDSE and the phases Co-decision and Co-governance can start.

4.1. Identification and selection of existing EIS

The identification of appropriate EIS requires partners to have background knowledge of circular economy, systemic design, expertise on construction and demolition waste flows, food waste flows and wastescape dynamics and knowledge about the AMA regional context. This knowledge was provided by the TU Delft Repair researchers, partners and advisory board members during the PULL meetings and along the project especially within the WP5 meeting.

The identification phase started with the initial collection of EIS from the literature and practice and solutions simultaneously developed within the second pilot case of Naples. The identified EIS are systematically described through a similar format. This format consists of 13 questions, specifically designed to understand aim and structure of the EIS and its transferability to the AMA context (Fig. 5 below). This phase led to the identification of 12 solutions derived from the literature and practice and 3 transferable solutions from the second pilot case study. Each of the selected EIS are available in the annex x1.

FIG 5 Example of the solution used for the identification and selection process

GENERAL INFORMATION		
TITLE OF THE ECO-INNOVATIVE SOLUTION (EIS)	Name	Logo
KEYWORDS		
SPECIFIC OBJECTIVE	Aims 1) 2).....	
CATEGORY OF OUTCOME RELATED TO "PESTLE"[2]		
OWNER OF THE EIS		
LOCATION OF THE GOOD PRACTICE	*Country / Region*	
DETAILED DESCRIPTION		
SHORT SUMMARY OF THE PRACTICE	What is it? What does it do?	
DETAILED INFORMATION ON THE PRACTICE	Which kind of flows are involved? Is it a single or systemic solution? How does it work? What are the spatial implications? Which actors are involved?	
RESOURCES NEEDED		
TIMEFRAME (key dates)	*Start*	
	End	
RESULTS		
POTENTIAL FOR LEARNING OR TRANSFER		
FURTHER INFORMATION	www.....	

4. "PESTLE is a mnemonic which in its expanded form denotes P for Political, E for Economic, S for Social, T for Technological, L for Legal and E for Environmental. It gives a bird's eye view of the whole environment from many different angles that one wants to check and keep a track of while contemplating on a certain idea/plan". Source: http://pestleanalysis.com/what-is-pestle-analysis/ [accessed 22 May 2018]

4.2. Analysis, selection and transfer of existing EIS to the AMA context

Once completed, the formats were shared and discussed within the TU Delft research team during the preparation for the PULL meeting held on September 18, 2018. In this occasion 6 of the most interesting existing EIS and 3 of the EIS developed in the Naples pilot case were selected to be transferred and included in the Amsterdam catalogue of solution and strategies.

The selection followed three main criteria:

1. Degree of innovation related to Construction and Demolition Waste, Food Waste and Wastescape flows;

2. Degree of innovation towards circularity. The content of the selected EIS should go beyond the mere activities of reuse and recycle and establish new relations with the Amsterdam social, environmental, and economical context;

3. Transferability to the AMA. The EIS should expressly be related to the AMA Challenges and Objectives defined within the PULL meetings together with local stakeholders.

Selected EIS were further improved and adapted to the AMA following the same process and scheme of the newly developed EIS (see paragraph below).

4.3. Co-design and Co-production of EIS

Parallel to the identification in the literature of the existing EIS, a new set of 23 EIS was designed. As described in the Deliverable 5.4, the conceptual ideas for EIS are developed in the Co-design phase, and the further development (providing more details) of EIS is taking place in the Co-Production phase. The aim of this phase was to move from conceptual idea of solutions to specific, operationalised, assessable solutions, looking in particular to the objective and challenges identified by AMA stakeholders' and within the AMA territory[5] (Fig. 6).

The Co-design phase consisted of several different investigations developed throughout the first 24 months of the REPAiR project, in which 1 PULL workshop and several smaller meetings with experts, stakeholders, Repair partners and advisory board were organised as well as four urbanism master courses. The Co-production phase again consisted of refining the EIS throughout the months 25-30, in which 2 PULL workshops and several smaller meetings with experts, stakeholders, REPAiR partners and advisory board were held and will be held to conclude the phase.

The design investigations combined spatial analysis, material flow analysis and an actor analysis based on the data collected and interpreted in the deliverables D3.2 and D3.3. and D6.1 and 6.3.

5. For further detail on this process see WP6 Milestone 26.

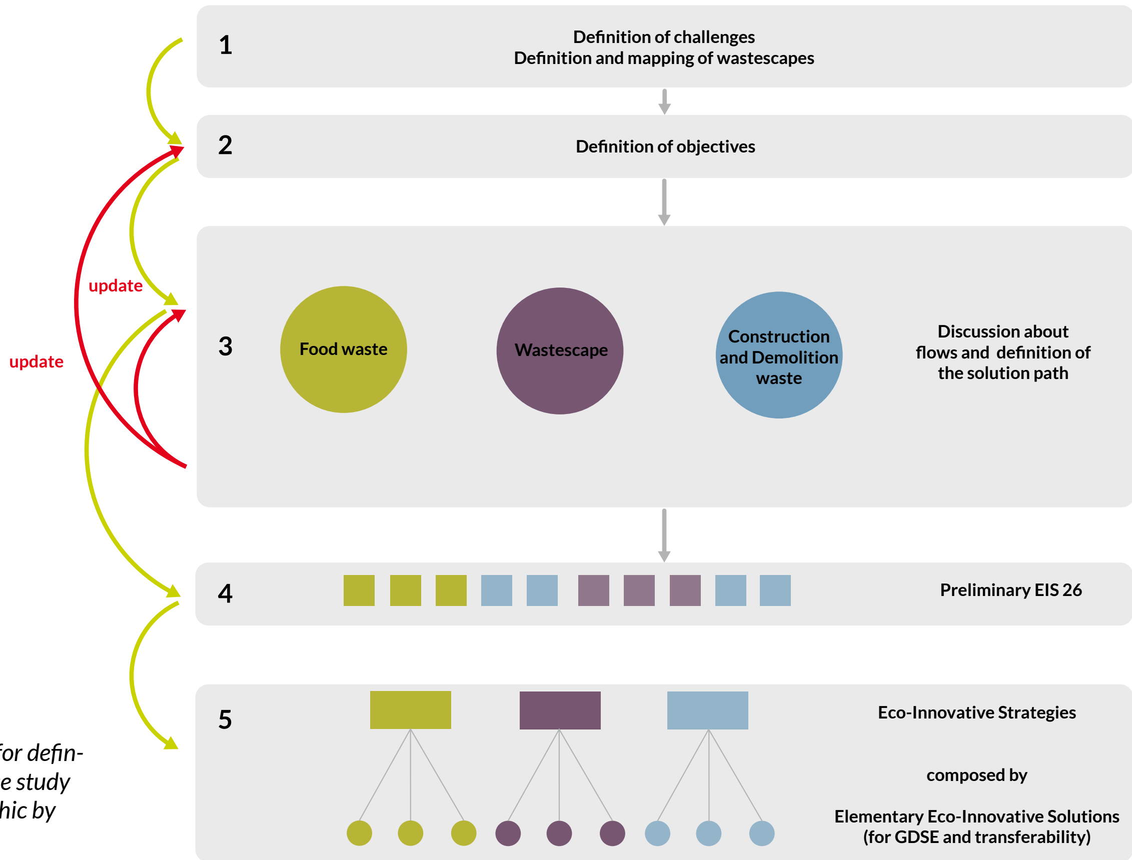


FIG 6 Methodology for defining the EIS in the case study of Amsterdam. Graphic by Libera Amenta.

Thereafter, the collected data were interrelated through a systemic design approach. For systemic design approach we consider a method, in which large-scale territorial dynamics and different material flows chains are interrelated in order to find synergies. This approach enables an understanding of how environmental, technological, political, economical, and social systems dynamically operate on a regional, local and product level, and how their interrelation through scale is the basis for an innovative design. By analysing existing territorial-flow dynamics and the waste they produce with multi-layer strategies and historical transformations, as well as plans and trends concerning the future development, this method allows to understand how elements of socio-technical and socio-ecological systems can be reintegrated (Berger 2009 in Furlan 2017). Hence, waste could become a key element for an innovative design going beyond the traditional planning schemes (Furlan 2017).

The overall iterative process consists of the Co-design and Co-production phases together:

- academic presentations;
- PULL workshops;
- expert meetings;
- interdisciplinary geodesign courses at TU Delft (a.y.2016-2017; a.y.2017-2018) with master students from the disciplines of architecture, urbanism and industrial ecology

The latter helped to validate and refine the objectives and led to the definition of a series of design strategies anchored on the challenges defined of the stakeholders of the AMA territory [Fig.7].

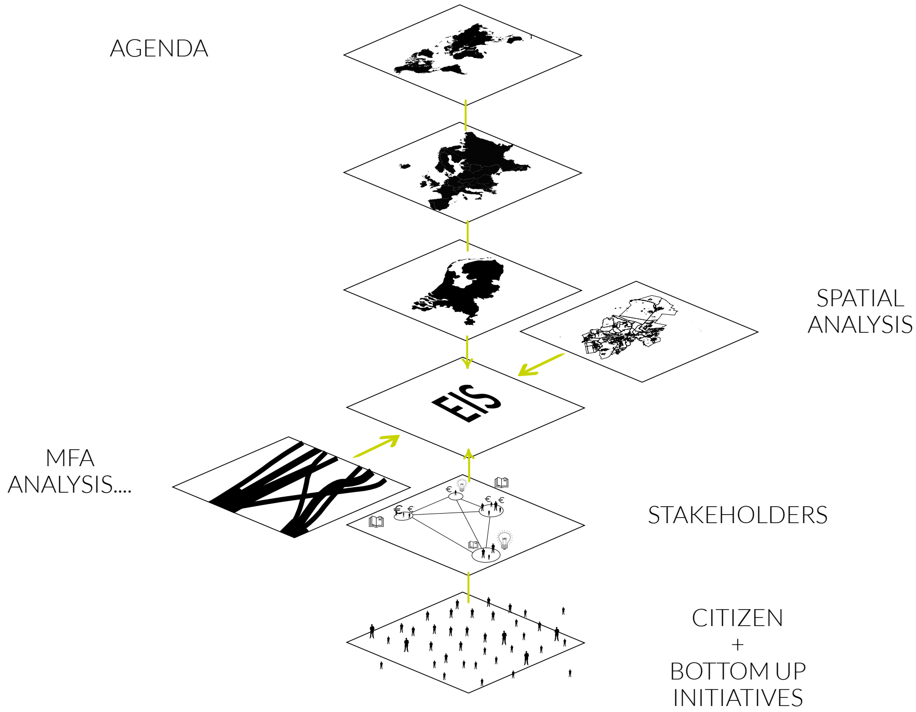


FIG 7 Scheme of the co-design process and systemic design operations towards the development of EIS

The resulting understanding of the current situation was mainly generated by the aforementioned cartographic research, process models and design strategies and complemented the results form the stakeholder interviews (WP6) and PULL workshops (WP5). The ambition of the design strategies is not to deliver definitive solutions, but, rather, to clarify the complex interdependence of waste processes, material flows and spatial issues and demonstrate possible synergies between systems that could be acquired through the development of integrated solutions and strategies and thereby inform local and regional decision makers.

The 26 solutions presented in this catalogue are divided according to the two key flows (CDW and FW) and wastescapes, see Fig. 7.
Each solution is described and structured across four main parts, namely idea, process model, evaluation model and representational model, following the digital workflow of the Geodesign framework (Steinitz, 2012), which has been applied and further developed during the first two years of REPAiR, and describes how an EIS addresses four main research questions:

- **what is the content of the EIS?**
- **how does the EIS change the process of the area?**
- **why is the EIS valuable?**
- **where could the EIS be applied observing in particular the spatial role and component of the EIS**

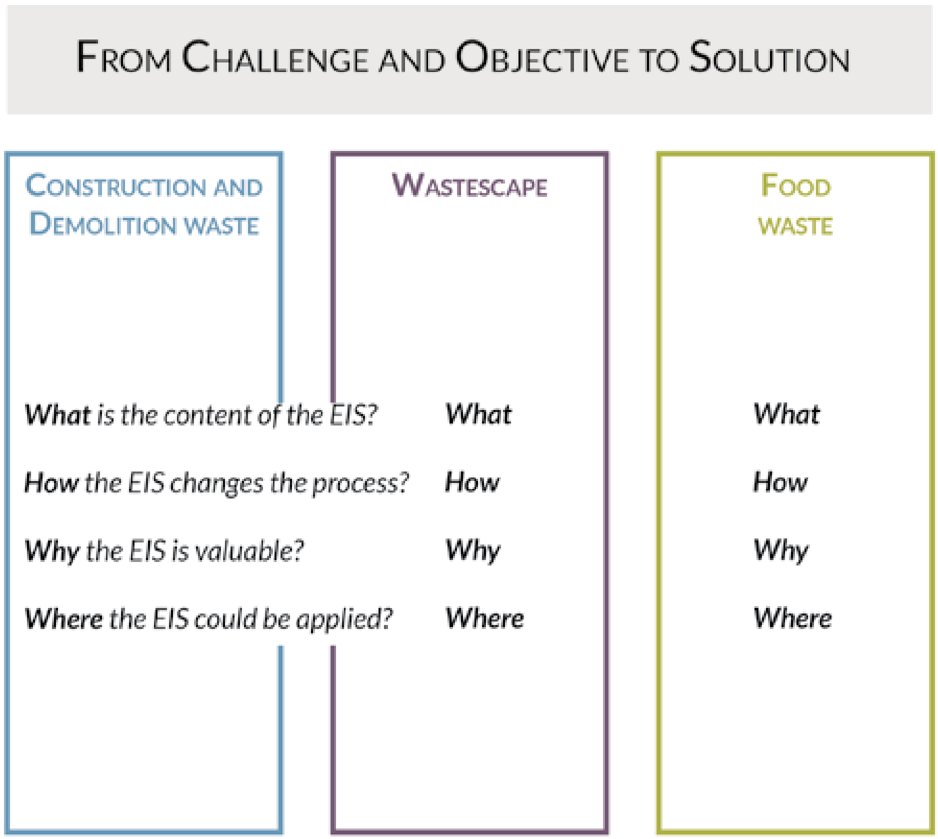


FIG 8 Scheme of the catalogue structure

The 23+3 solutions are presented in different levels of detail as the development of the solutions is part of a co-design process that involves stakeholders and experts from different disciplines, which is still ongoing and will soon enter its next phase, namely to specify the solutions towards a level that allows them to be assessed by the REPAiR sustainability framework (WP4).

4.4. Knowledge Transfer

As mentioned above, three of the EIS covered in the Amsterdam PULL process originated from the PULL in Naples. The inclusion of these three solutions was part of the knowledge transfer activities of WP7. The aim of the latter is to facilitate a strategic transfer of EIS between the case study regions, avoiding copy-pasting of 'best practice' and instead promoting a knowledge transfer within the 'relational space' of the network of REPAiR's PULLs (see deliverable 7.1). Given that the Amsterdam and Naples regions are pilot cases in REPAiR and their respective PULLs initiated the process of co-production of EIS earlier than the PULLs in follow-up regions, only solutions from Naples were available for transferring at this stage.

Solutions from Naples to be considered in the co-production of EIS for the Amsterdam case were selected carefully in co-operation between the partners from both regions. First, a short list of potentially transferable EIS was established. The selection was based on (1) the fit between the flows covered in Amsterdam and Naples cases, in occurrence, construction and demolition waste and wastescapes, (2) presence of major barriers in terms of contextual differences in relation to governance, regulations, territorial characteristics, etc. The agreed upon short list contained three EIS which were then discussed with stakeholders of the Amsterdam PULL in the context of a workshop. A set of questions on transferability, choice of elements of the EIS, adaptations needed, barriers to transfer, location where the solution would best be implemented and the actors to involve was then discussed with several groups of stakeholders during the workshop. The three solutions from Naples PULL used for knowledge transfer are integrated into this catalogue, including considerations for their transferability and adaptations to the characteristics of the AMA, elaborated on the basis of the inputs from stakeholders participating in the knowledge transfer event on 12 September 2018, moderated by Marcin Dąbrowski (TUD), Viktor Varju (RKI) and Libera Amenta (TUD/UNINA). These three solutions are outlined in more detail in the REPAiR's Deliverable 5.3 containing the catalogue of EIS for the Naples pilot case study, elaborated by the UNINA REPAiR team[6].

6 At the time when the knowledge transfer event in the Amsterdam took place, the EIS in Naples were still being developed and refined. What was used for the discussion with stakeholders for the transfer to Amsterdam region, were draft EIS for Naples. Thus, the EIS from Naples presented in this catalogue have been further elaborated since the said knowledge transfer event. While their core ideas and substance did not change, they were renamed and considered as strategies and broken down into elementary eco-innovative solutions.

5. From challenges and objectives to solutions

In the Co-Exploring phase from September 2016 to February 2018, the study location was defined, in a collaboration between the TU Delft researchers and the Dutch REPAiR partners and user-board parties. Also, interviews that were held by WP6 formed input for defining the location.

The initial aim of this phase was to define the challenges that the AMA is facing in order to move towards circularity.

1) Defining the challenges: The first public PULL workshop was held in September 2017, and here the challenges for implementing the Circular Economy in the AMA were co-explored and defined. Ten challenges were found:

1. Lack of data and knowledge on material flows for different organisations;
2. Mistrust between municipalities in AMA hindering collaboration;
3. Taxation – lack of incentives for embracing CE by companies;
4. Bouwbesluit (Dutch Building Regulation Decree) – building regulations are too rigid and do not consider circularity, which hinders experimentation with circular products and processes, and makes it difficult for municipalities to impose circularity as criteria for building permits;
5. Omgevingswet (Dutch Environment and Planning Act) – at present circularity is not promoted by spatial planning regulations;
6. Circular tendering – no criteria and experience in tendering for circular products and services, no shared practices and guidelines;
7. Plastic Bottles;
8. CDW - reduce the amount of waste and the negative impacts generated in the building refurbishment process, towards an energy efficient built environment;
9. Organic and food waste – how to properly collect heterogenous waste from various actors.
10. Wastescapes - re-use, re-evaluate, re-generate the : Buffer zones of Schiphol; 2) Harbour of Amsterdam; 3) Underused offices; 4) Derelict greenhouse areas.

2) Defining the objectives: After the first PULL workshop, the TU Delft researchers worked on proposals for objectives for implementing the Circular Economy in the AMA. The objectives were also discussed in interviews with AMA stakeholders that were held by WP6. The draft objectives were presented to experts and stakeholders in the second public PULL workshop that was held in February 2018. The workshop participants worked on developing co-explored and defined. The most important objectives that were found were:

For Wastescapes:

1. Introduce tax incentives to change waste behaviour among households and companies;
2. Re-use/re-program polluted wastescapes in the Amsterdam Harbour;
3. Re-develop wastescapes around Schiphol within construction restrictions;
4. Develop guidelines for information sharing about material flows among stakeholders;
5. Create trust and collaboration among all stakeholders in the AMA;

For Food Waste:

1. Introduce tax incentives to change waste behaviour among households and companies;
2. Create trust and collaboration among all stakeholders in the AMA;
3. Develop guidelines for information sharing about material flows among stakeholders;
4. Collect and reuse organic and food waste flows from households and companies;

For Construction and Demolition Waste:

1. Introduce tax incentives to change waste behaviour among households and companies;
2. Create trust and collaboration among all stakeholders in the AMA;
3. Reduce amount of waste and negative impacts generated in the Building Refurbishment Process;
4. Introduce circularity criteria into building decree allowing room for experimentation;
5. Develop guidelines for information sharing about material flows among stakeholders;
6. Introduce circularity criteria into Building Tendering Procedures;
7. Incorporate circularity into Spatial Planning Law (Omgevingswet) and its implementation.

3) Draft Eco-Innovative Solutions In the public PULL workshop of February 2018, also the first draft Eco-Innovative Solutions were developed by the workshop participants. Developing these first ideas, the participants were asked to react to the challenges that were defined earlier in the Co-Exploring phase. The solutions that were proposed comprised:

For Wastescapes:

1. Natural reserve: Develop a natural reserve within the airport noise contour area;

2. Reuse of underused green buffer zones or zones within the airport noise contour area:

    - Leisure facilities: Bike paths, and ecological green blue infrastructures;

    - Productive space: Production of biomass for energy production, or eco-materials for building construction;

    - Islands for biodiversity: Planting different types of local vegetation, excluding specific plants that attract birds that can create safety problems in the airport area.

    - Smart grid: Temporarily host a smart grid for energy production and storage;

3. Reuse/transform empty greenhouses;

4. Reusing empty or abandoned space as storage space;

5. Office transformation: transformation of outdated offices into housing for young people;

6. Reorganising water management system within the region;

7. Coping with soil pollution: covering/containing pollutants on the ground and using the soil in a different way;

8. CCU: Carbon Capture and Utilisation, aiming to convert large un-buildable green areas and polluted sites to areas for the energy production.

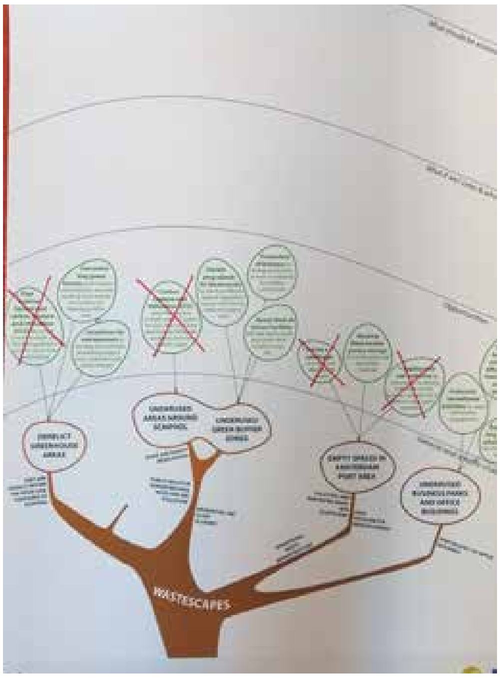


FIG 9 Challenge tree on Wastescape. Last update July 2018.

For Construction and Demolition Waste:

1. The circular building decree: allowing room for experimentation, developing an adaptive flexible building decree;
2. Environmental act: Incorporating circularity into the new spatial planning law "environment act" (omgevingswet), developing a set of state of the art, or minimal standards for circularity;
3. Circular tendering: Introducing circularity criteria into building tendering procedures;
4. Adaptive: Develop adaptive products and processes;
5. Broodfonds: Develop a platform for open-source innovation and sharing;
6. Madaster: Sharing information about available building materials;
7. BIM: Develop Building Information Modelling to include existing buildings;
8. Information guidelines: For information sharing about material flows among stakeholders, specifically necessary to create trust in larger developments.

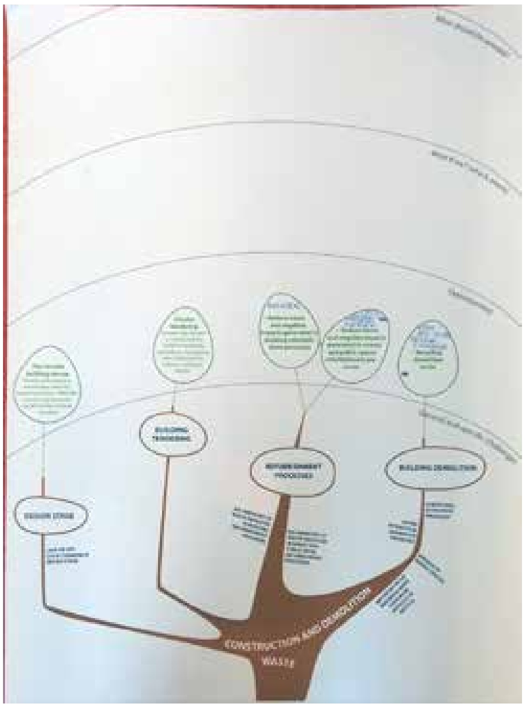


FIG 10 Challenge tree on Construction and Demolition flow. Last update July 2018.

For Food Waste:

1. Kitchen sink grinder;
2. Reverse matchmaking: Starts from requirements of the final use of an end-product, like high-quality compost for rooftop/urban agriculture;
3. CE label on products: Make data available/insightful for the total costs (purchasing and disposal costs) involved in packaging in the food service industry;
4. Develop further packaging options including individual sizes for to reduce throwing away food waste generation;
5. Transition the harbour or chemical industries from fossil-based to bio-based;
6. Coconut pallets instead of using other pallet material;
7. Waste maps: The city can be mapped on the typical kinds of waste produced and, therefore, the expected pH-value;
8. Festivals as pilots: Festivals are perfect for creating one waste stream;
9. Connecting platform: Set up an online platform that connects the food distribution sector and social organisations.

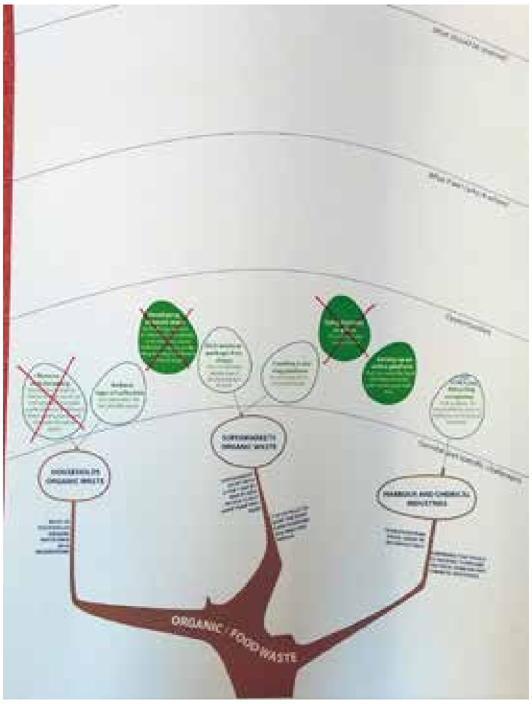


FIG 11 Challenge tree on Food waste flow. Last update July 2018.

During the same occasion on February 2018, the workshop participants were asked to sketch preliminary solutions, based on the predefined objectives, or to define new objectives if they had the idea that something was missing. The participants worked in 3 subworkshops, each focusing on a different aspect of the EIS that REPAiR aims to deliver.

The initial solutions showed a wide scope, ranging from detailed technical solutions to systemic approaches and social and political initiatives. Therefore, these solution were developed further by the TU Delft team and TU Delft (MSc) students of Urbanism, Industrial Ecology and Architecture. 26 Solution were developed and discussed with AMA stakeholders and REPAiR partners on September 2018 during the third PULL workshop

Moreover, during this occasion EIS that were developed for the Naples PULL were brought in the discussion , in order to test the transferability of solutions from one location to another.

CHALLENGE TYPE	OBJECTIVES	SOLUTION PATH	ECO-INNOVATIVE SOLUTIONS
Wastescapes	Re-developing Wastescapes around Schiphol within Construction Restrictions	• Reuse areas within noise and safety contour from airport, port, railways and roads, increase the quality and quantity of natural green areas (biodiversity) • Concentrating green houses, reuse other green houses • New use for polluted soil	• Bio-seasonal parking • Land rotation • Transform empty greenhouses • Transformation of outdated offices into housing • Transforming vacant office buildings into areas for inclusive recreational activities • Transforming green buffer zones into leisure facilities • Transforming wastescapes into stepping stones for biodiversity • MYC Blocks • REC.OVER: (*Transferred from MAN)* • *Soil reclamation through local vegetation (Transferred from MAN)*
	Re-using/re-programming Polluted Wastescapes in Amsterdam Harbour		
Overarching WS	Developing Guidelines for Information sharing about Material Flows among Stakeholders		
	Creating Trust and Collaboration among all Stakeholders in AMA		

FIG 12 Summary table on challenges objectives and solutions developed whit in the PULL.

Overarching WS	Developing Guidelines for Information sharing about Material Flows among Stakeholders		
	Creating Trust and Collaboration among all Stakeholders in AMA		
	Introducing Tax Incentives to Change Food Waste Behaviour among Households & Companies		
Construction & Demolition waste	Introducing Circularity Criteria into Building Decree		
	allowing Room for Experimentation		
	Incorporating Circularity into Environment and Planning Act (Omgevingswet)		
	Introducing Circularity Criteria into Building Tendering Procedures	Circular tendering: Public-private (urban area) development	• Circular tendering. • Introducing Circularity Measures into the BREEAM standard.
	Reducing amount of Waste and Negative Impacts generated in the Building Refurbishment Process	CE Business models • Open and secure material exchange • Cross sectoral material and process platform	• Eco-SEE wall panels. • MYC Blocks. • Microalgae bio-asphalt. • Open secure material exchange platform. • Cross-sectoral platform for open-source innovation and sharing.. • Establishing a circular construction market for refurbishing projects • Land rotation for storing CDW

Overarching CDW	Developing Guidelines for Information sharing about Material Flows among Stakeholders		
	Creating Trust and Collaboration among all Stakeholders in AMA		
	Introducing Tax Incentives to Change Food Waste Behaviour among Households & Companies		
Organic and food waste	Collecting & Re-using Organic & Food Waste Flows from Households & Companies	• Alternatives to the predetermined (big) portions at supermarkets • Smart biorefinery • Separation of plant-based and animal-based OW • Rethinking the chain - start with the requirements for the end-product	• Insect Protein Tanks. • Decentralised food waste collection and compost. • From bread to beer. • Peel-pioneer. • Fruit-leather. • Bio-bean. • Smart biorefinery • Food rescue platform. • Compost district *(Transferred from MAN)*
Overarching O&F	Developing Guidelines for Information sharing about Material Flows among Stakeholders		
	Creating Trust and Collaboration among all Stakeholders in AMA		
	Introducing Tax Incentives to Change Food Waste Behaviour among Households & Companies		

5.1 Repair Eco-Innovative Solutions

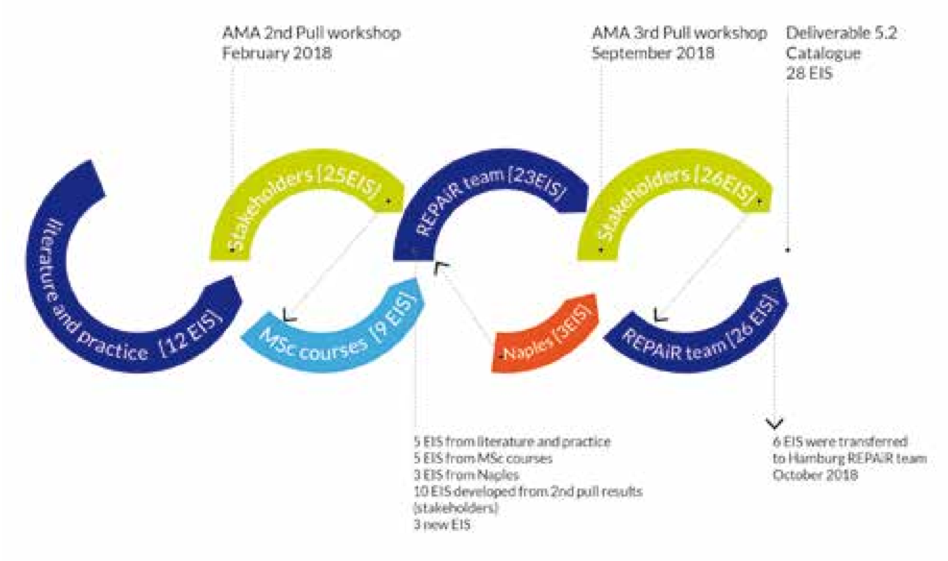


FIG 13 Eco-innovative solutions iterative process

List of solutions

Wastescape

1. **MYC blocks.** A new bio-isolation materials made out of plant fibers and fungi *(solution shared by CDW and wastescape sections)*
2. **Bio-seasonal parking.** A temporary parking solution using a biode gradable structure
3. **Land rotation.** An alternative way for temporary storage of CDW *(solution shared by CDW and Wastescape sections)*
4. **Reuse empty glass houses** (through policies, incentive and design for new entrepreneurs)
5. **Transforming wastescape into stepping stones for biodiversity**
6. **Transforming green buffer zones into leisure facilities**
7. **Re-purposing vacant offices into housing** *(solution shared by CDW and Wastescape sections)*
8. **Re-purposing vacant offices into areas for inclusive recreation al activities to engage the local community** *(solution shared by CDW and Wastescape sections)*
9. **RECALL:** REmediation by Cultivating Areas in Living Landscapes; *(Transferred from UNINA catalogue of solutions, , see REPAiR 2018 Deliverble 5.3 Eco-Innovative solution Naples)*
10. **Beyond INERTia.** Circular supply chain for CDW *(Transferred from UNINA catalogue of solutions, , see REPAiR 2018 Deliverble 5.3 Eco-Innovative solution Naples)*

Construction and Demolition Waste

1. **Circular tendering**. Providing tools to assess the extent to which the proposed construction processes, materials and building types comply with the principles of circular building.
2. **Open secure material exchange platform.** Developing an interface for material exchange for the construction sector.
3. **Microalgae bio-asphalt.** An alternative solution for conventional asphalt based on microalgae
4. **Eco-SEE wall panels.** A new type of insulation panel based on ecological materials
5. **Cross-sectoral platform for open-source innovation and sharing.** An alternative platform to share specifics in regards to innovative materials and process among all the sectors involved with the construction and demolition process.
6. **Introducing Circularity Measures into the BREEAM standard.** Integrating strategies and indicators for circular building into (global) standards for sustainable building .
7. **Re-purposing vacant offices into housing** *(solution shared by CDW and Wastescape sections)*
8. **Re-purposing vacant offices into areas for inclusive recreational activities to engage the local community** (solution shared by CDW and Wastescape sections)
9. **Establishing a circular construction market for refurbishing projects**
10. **Greening up the city:** new solution for reproducible green facade
11. **Land rotation:** an alternative way for temporary storage of CDW *(solution shared by CDW and Wastescape sections)*
12. **MYC Blocks.** A new bio-isolation materials made out of plant fibers and fungi *(solution shared by CDW and Wastescape sections)*

Food Waste

1. **From bread to beer.** Converting discarded- unsold bread into beer
2. **Bio-bean.** From waste coffee ground to biofuel.
3. **Food Waste Insect Protein Tanks**
4. **Peel-pioneer.** Converting citrus wastes into value-added products.
5. **Fruit-leather**: from fruit peels to leather
6. **Food rescue platform.** Creating a food sharing platform between the great distribution of supermarkets and social organisations (NGO)

7. Smart biorefinery

8. Decentralised food waste collection and compost

9. **Re-Compost Land.** Short supply chain of organic waste *(Transferred from UNINA catalogue of solutions, see REPAiR 2018 Deliverble 5.3 Eco-Innovative solution Naples)*

Literature and practice
12 EIS

CDW
Closed loop wallboard collaborative
BAMB
Eco-SEE wall panels
Ecopharmabuilding
High value cascading
Green cast solution

FW
Bread to beer
Peel pioneers
Fruit leather
Bio-bean energy powered by coffee

WS
EcoBox
Agrocité

Stakeholders (2nd AMA Pull)
25 EIS

CDW
Circular building decree
Circularity in Environmental Act
Circular tendering
Development of adaptive processes and products
Broodfonds: Platform for innovation and sharing
Madaster: sharing information about available building materials
Development of BIM to include existing buildings
Deveopment of information guidelines for material flows

FW
Kitchen sink grinder
Reverse matchmaking
CE label on products
One-person packaging size
Transition to bio-based industries in harbour
Coconut pallets
Waste maps
Festival as pilots
Food sharing platform

WS
Natural reserve in airport noise contour area
Reuse of green buffer zones in airport noise contour area
Reuse of empty glasshouses
Reuse empty space as storage space
Unused office buildings transformation
Reorganizing water management system
Coping with soil pollution
Carbon capture and utilisation

TU Delft MSc courses
9 EIS

CDW
Greening up the city
MYC blocks
Microalgae bio-asphalt
Towards circular construction

FW
Food Waste Insect Protein Tanks
Enzymatic fuel cell
Hospital bioplastic

WS
Bio-seasonal parking
Phytoremediation energy crops

Naples team knowledge transfer
3 EIS

FW
Re-Compost Land. Short supply chain of organic waste

WS
Beyond INERTia. Circular supply chain for CDW
RECALL: REmediation by Cultivating Areas in Living Landscapes

REPAiR team compilation for 3rd AMA Pull
23 EIS (not including 3 Naples EIS)

FW
Decentralised food waste collection and compost
From bread to beer
Bio-bean energy powered by coffee
Fruit Leather
Peel pioneers
Smart biorefinery
Food rescue platform
Food Waste Insect Protein Tanks

CDW
Eco-SEE wall panels
Circular building decree
Circular tendering
Cross-sectoral platform for open source innovation and sharing*
Open secure material exchange platform
Greening up the city
MYC blocks
Microalgae bio-asphalt
Circular construction market for refurbishing projects*

WS
Transformation of wastecapes into stepping stones for biodiversity
Transformation of bufferzones into leisure facilities
Reuse of empty glasshouses
Transformation of outdated offices into housing
Bio-seasonal parking
Land rotation

*They are not included in AMA 3rd Pull wokshop report

The EIS coming from the 2nd Pull workshop were developed further by the REPAiR team. Names might not be exactly the same, and might not have the same title.

Deliverable 5.2 Catalogue
26 EIS

FW
Decentralised food waste collection and compost
From bread to beer
Bio-bean energy powered by coffee
Fruit Leather
Peel pioneers
Smart biorefinery
Food rescue platform
Food Waste Insect Protein Tanks
Re-Compost Land. Short supply chain of organic waste

CDW
Eco-SEE wall panels
Circular building decree
Circular tendering
Cross-sectoral platform for open source innovation and sharing
Open secure material exchange platform
Greening up the city
MYC blocks
Microalgae bio-asphalt
Circular construction market for refurbishing projects

WS
Transformation of wastecapes into stepping stones for biodiversity
Transformation of buffer zones into leisure facilities
Reuse of empty glasshouses
Transformation of outdated offices into housing
Bio-seasonal parking
Land rotation
REC.OVER Free eco-lab
Soil reclamation through local vegetation
Beyond INERTia. Circular supply chain for CDW
RECALL: REmediation by Cultivating Areas in Living Landscapes

FIG 14 Eco-innovative solutions

6. Stakeholder Survey on the EIS

The third AMA PULL workshop was held on September 18, 2018 and focused on the further co-development of GDSE-friendly EIS that address the CE challenges identified for the AMA. Participants worked on draft solutions developed previously within the AMA PULL. At the end of the workshop, participants completed a survey questionnaire[7]. They were asked to rate the likelihood of the EIS, which they helped co-develop in the workshop, to help address the specific objectives for each CE topic in the AMA. The EIS were co-developed on individual 'sub-workshop' tables, each focusing on one of the three CE topics. For each CE objective in the AMA, participants rated the impact of each co-developed EIS from 1-5, with 1 being 'very likely to address the objective and 5 being 'very unlikely to address the objective'.

According to the responses, Wastescapes objective 'Redevelop Wastescapes around Schiphol within construction restrictions' had the highest ranking (classified as 'likely to address the objective'), whereas 'Tax incentives' ranked last (yet with an average score classified as 'neither likely nor unlikely' to address the objective). Food Waste objective 'Collect & reuse organic & food waste flows from households & companies' had the highest ranking (classified as 'very likely'), whereas 'Create Trust and Collaboration' ranked last (yet classified as 'likely'). Construction and Demolition Waste objective 'Create trust and collaboration among all stakeholders in AMA' ranked the highest (classified as 'very likely'). 'Tax incentives' ranked last (classifieds as 'unlikely'), which was also a bit surprising, because it was found to be a very important objective in the second workshop. Objectives concerning tax incentives are difficult to operationalise and will not be covered in the PULL's further development of the EIS.

Participants were also asked to identify the specific EIS they co-worked on and rate their effects on the CE objectives. Some EIS were selected more often than others. The following three tables (1,2,3) provide rankings of EIS selection by participants, and also indicate ratings of the potential effects of each EIS on the CE objectives for Wastescapes, Food Waste, Construction and Demolition Waste, respectively .

7. Some of the EIS names have changed throughout the process of the PULL, due to the iterations of the solutions in the different meetings. Therefore, the names of the EIS might be slightly different in the reports of the surveys, and in the first parts of the catalogue.

		Wastecape (WS) Objectives				
Eco-Innovative Solution	**#times picked**	**WS1**	**WS2**	**WS3**	**WS4**	**WS5**
		Redevelop Wastescapes around Schiphol	Reuse polluted wastescapes in Amsterdam Harbour	Develop guidelines for stakeholder flow information sharing	Create trust + collaboration among stakeholders	Tax Incentives to change food waste behavior of households & COs
Reuse / Transform empty greenhouses (through policies, incentive and design for new entrepreneurs)	8	**1.60**	3.75	2.60	2.33	3.00
Transformation of outdated offices into housing for young people	8	3.00	3.00	2.33	**2.00**	2.50
Transforming wastescapes into stepping stones for Biodiversity	4	**2.00**	3.00	4.50	**2.00**	4.00
Land rotation: an alternative way for temporary storage of CDW	4	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**
Bio-seasonal parking	3	**3.00**	**3.0**0	3.50	3.00	3.50
Transforming green buffer zones into leisure facilities	3	**1.67**	2.00		2.00	
Transforming vacant office buildings into areas for inclusive recreational activities to engage the local community	3	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**
MYC Blocks, development of new bio-isolation materials	3	**1.00**		2.00	2.00	

Table1. Ranking of EIS usage and perceived effect on CE objectives for Wastecapes (a rate score in bold denotes the CE objective with the maximum effect

		Construction and Demolition Waste (CDW) Objectives						
Eco-Innovative Solution	**#times picked**	**CDW1**	**CDW2**	**CDW3**	**CDW4**	**CDW5**	**CDW6**	**CDW7**
		Intro-duce circu-larity criteria into building decree	Incorp. Circu-larity into spatial planning law	Intro-duce circu-larity criteria into building tendes	Reduce waste + negative impacts from building refurb	Develop guide-lines for SH flow info sharing	Create trust + colla-boration among SHs	Tax Incentives to change FW be-havior household & COs
Circular tendering	5	3.00	3.00	**1.00**	4.00	2.00	**1.00**	4.00
Cross-sectoral platform for open-source innovation and sharing	3	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**
Open secure material exchange platform	3	2.50	3.50	3.00	3.00	**2.00**	**2.00**	5.00
Greening up the city: new solution for reproducible green facades	3	2.67	2.00	**1.50**	2.00	3.00	3.00	4.00
Transform outdated offices into housing for young people	3	2.33	**2.00**	**2.00**	**2.00**		**2.00**	
Circular building decrees	2	**1.00**	3.00	2.00	2.00	2.00	2.00	4.00
Transform vacant office buildings into areas for inclusive recreational activities to engage the community	2	**2.00**					**2.00**	
Eco-SEE wall panels	2	**2.00**						
Establishing a circular construction market for refurbishing projects	1	**2.00**						

Table2. Ranking of EIS usage and perceived effect on CE objectives for Construction and Demolition Waste (a rate score in bold denotes the CE objective with the maximum effect . (Part a)

		Construction and Demolition Waste (CDW) Objectives						
Eco-Innovative Solution	**#times picked**	**CDW1**	**CDW2**	**CDW3**	**CDW4**	**CDW5**	**CDW6**	**CDW7**
		Intro-duce circu-larity criteria into building decree	Incorp. Circu-larity into spatial planning law	Intro-duce circu-larity criteria into building tendes	Reduce waste + negative impacts from building refurb	Develop guide-lines for SH flow info sharing	Create trust + colla-boration among SHs	Tax Incentives to change FW be-havior household & COs
Experimenting new types of housing unit with less strict regulations	1	**1.00**						
MYC Blocks, development of new bio-isolation materials	1	**1.00**						
Land rotation: an alternative way for temporary storage of CDW	1	**3.00**						
Decentralised food waste collection and compost	1	**4.00**						

Table2. Ranking of EIS usage and perceived effect on CE objectives for Construction and Demolition Waste (a rate score in bold denotes the CE objective with the maximum effect . (Part b)

		Food Waste (FW) Objectives			
Eco-Innovative Solution	**#times picked**	**FW1**	**FW2**	**FW3**	**FW4**
		Collect & reuse organic & food waste flows from households & COs	Develop guidelines for stakeholder flow information sharing	Create trust + collaboration among stakeholders	Tax Incentives to change food waste behavior of households & COs
From bread to beer	4	1.75	**1.00**	2.00	2.00
Decentralised food waste collection and compost	4	**1.33**	1.75	2.33	2.00
Bio-bean - Energy from Coffee Beans	2	**2.00**	2.50	**2.00**	3.00
Smart biorefinery	2	2.00	**1.50**	2.00	**1.50**
Fruit-leather: from fruit peels to leather	2	**2.00**	**2.00**	**2.00**	
Peel-pioneer: from fruit peels to products	1	**1.00**	2.00	2.0	**1.0**
Zero waste or package free shop	1	5.00	5.00	3.00	**1.00**
Creating a food sharing platform between the great distribution of supermarkets and social organisations (NGO)	1	3.00	**2.00**	4.00	5.00
Insect food-waste composter	1	**2.00**			

Table3. Ranking of EIS usage and perceived effect on CE objectives for Food Waste (a rate score in bold denotes the CE objective with the maximum effect .

7. Transferability of the Eco-Innovative Solution

In this section, first, transferability of solutions from the Naples case study to the AMA will be discussed, on the basis of the knowledge transfer event organised as part of the PULL workshop in Amsterdam on the 12th of September 2018. Second, the attention will be turned to the transferability of solutions developed in the AMA PULL to other cases, in particular that of Hamburg, on the basis of observations from the knowledge transfer event held on the 10th of October 2018.

Transferability of Naples EIS to the AMA

Discussion with stakeholders on the transferability of the EIS from Naples to that of Amsterdam was weaved into the workshop proceedings. The discussion focused on three pre-selected EIS:

1. Beyond INERTia. Circular supply chain for CDW;
2. Re-Compost Land. Short supply chain of organic waste;
3. RECALL: REmediation by Cultivating Areas in Living Landscapes.

The discussion revolved around the following question related to knowledge transfer in order facilitate a purposeful and strategic transfer of the solutions or their elements and point to the expected barriers and adaptations needed to make a solution suitable to the Amsterdam context.

The three solutions turned out to be very different in terms of transferability:

- Beyond INERTia was deemed the least transferable by the participants, mainly due to cultural differences when it comes to illegal dumping and the different organisation of disposal, collection and recycling of CDW. Thus, only some of the ideas behind this EIS were deemed transferable (e.g. providing support for handling CDW by individuals and support for informal waste collection from individuals engaged in small-scale construction work).
- Re-Compost Land was deemed to be of medium transferability, with some of its elements transferrable, due to local regulations on the use of food waste and patchy food waste collection across the municipalities..
- The soil reclamation EIS was deemed the most transferable and suitable to deal with polluted soil in the wastescapes in the AMA. For this EIS, the stakeholders were able to identify the most suitable areas on the map (e.g. port urban expansion areas, areas in the noise contour of Schiphol airport).

In terms of adaptations needed, in the case of Beyond INERTia , assuming that only some elements of this EIS could be implemented in the AMA context, collection would need to happen through a network of neighbourhood collection points. Another adaptation suggested were digital support tools to provide accurate and real-time information on the material to reuse at different collection points. Example of adaptation for the compost district included adjustment to the local food waste framework. What was deemed worth to adapt was to educate people how to compost (and properly segregate organic waste beforehand). Here, the key aspect is that composting facility is close to the community, hence education would have to be on site. The closeness has a spin-off impact in terms of neighbourhood "quality control". Based on the stakeholders statements this aspect is important for the AMA communities as well. For soil the reclamation with hemp adjustments needed entailed mainly accommodating the competing land uses. One option was to combine hemp production with other functions such as recreation landscapes or energy production. A related adaptation proposed entailed a periodic rotation of hemp production on a plot with solar panels and combination of species. Another adaptation proposed was to link to the existing businesses that could use hemp products (e.g. paper industry in Haarlem, creative industries) and consider development of hemp-based body care products.

As mentioned above, the exercise also aimed at identifying potential barriers for transfer, which should be borne in mind when considering 'importing' EIS or merely drawing lessons or inspiration from them. In the case of Beyond INERTia EIS, many barriers for transfer to the Dutch context were identified. First barrier related to the different organisation of the flow of CDW, with hardly any illegal dumping problem and predominance of companies (as opposed to individuals) in the construction sector, having well organised processes to dispose of their waste. The second barrier related to the limited availability of space for storing CDW, making accessibility of collection points a challenge. Finally, a possible legal barrier was identified, with lack of quality assurance and liability for the recovered materials making the operation of the EIS unlikely in the Dutch context, unless it would entail robust certification and quality control.

Relating to the Re-Compost Land EIS the main barrier would be the legislation on organic waste in the AMA. One can process one's own waste but processing someone else's waste is considered as commercial activity and it is against the law. ¬¬Therefore, the community/neighbourhood based composting and - especially - the use of compost on site cannot work without a central legislative modification. Another key barrier is that organic waste is not collected in some of the municipalities in the AMA. Finally, a cultural barrier was identified. Local food tradition is highly valued in Campania, as everywhere in Italy, while in the AMA local food culture is not prominent and most of the available food on the market is from highly industrialised production and not necessarily "local." It has an effect on the composition of compost and the attitude towards locality, local community actions.

The barriers for transfer in the case of the soil reclamation EIS were mainly the competition for land in the region (and predominance of other uses for the wastescapes, like airport expansion or housing development) and possible cultural associations with cannabis (resulting in confusion and possible vandalism on hemp fields).

Transferability of the AMA EIS. The case of Hamburg

Due to the timing of the PULL process in the other case study regions of REPAiR, an opportunity arose to organise a KT event in Hamburg, feeding into the process of development of solutions for that region. Using a similar procedure as for the selection of EIS to transfer from Naples to the AMA, the Hamburg partners pre-selected six EIS developed in the Amsterdam's PULL from a shortlist proposed by the Amsterdam team. On the basis of the fit with material flows covered (organic household waste and tree nurseries waste) in Hamburg PULL and the contextual features, the following EIS were selected for the knowledge transfer event in Hamburg:

1. EcoLab;
2. Bread to Beer;
3. Decentralised Food Waste Collection and Compost;
4. Bio-Bean;
5. Peel-Pioneer;
6. Insect Food.

The same method to organise the discussion on the 'imported' Amsterdam EIS was organised, with small groups of stakeholders rotating to discuss the transferability of the six different solutions questions. The same set of questions was used to guide the discussion as in the case of the Amsterdam knowledge transfer event. As in the case of transfer of EIS from Naples to Amsterdam, the transferability of solutions, as agreed upon by the participating stakeholders, varied from solution to solution, albeit the food waste solutions were deemed largely transferable.

For instance, in the case of Bread to Beer, there was a consensus that the solution was almost fully transferable to Hamburg, where there is also a growing trend of local craft beer production. The entire solution was deemed transferable and several suitable locations were identified in Altona district (focus area), albeit some reservations were made on the cultural differences with respect to the German beer culture and its strict requirements on quality and the use of only basic ingredients for making the beverage, which could imply reluctance of consumers towards such a circular beer. Moreover, the solution would compete with other uses of (waste) bread, for instance for charity organisations. The implication of the latter is that the quality of the bread used must be high. Proposals were made to adapt the practice to suit to the local regulations on beer quality and combine collection of bread at different scales (from households on community level and from businesses, like bakeries and supermarkets, on the district or city scale).

However, the solution of 'Insect food waste' seemed to be hardly transferable. The solution itself is relatively simple (in a special equipment insects transform the food waste to bio-compost and as an accompanying process protein from insects are made that is used for animal feeding), although there was major opposition from stakeholders.

The reasons were that: 1) this solution would be a competition on 'food waste market' that is relatively treated well; 2) no potential usability of the protein product (e.g. no fish pods nearby; 3) people take insects with grain of salt in their neighbourhood. Since the (un)transferability of this EIS in this case was depending very much on socio-cultural and economic local context.

Finally, it is worth noting, that the knowledge transfer process in REPAiR at the time of development of this catalogue remained at an early stage. Thus, the selected solutions co-produced in the Amsterdam PULL will be considered in the upcoming knowledge transfer events in the remaining PULLs, namely in Łódź, Naples, Ghent and Pécs, using a similar methodology.

8. Reflections and conclusion

Four lessons to be learned from a co-production process of developing Eco-Innovative Strategies (EIS) and solutions: a transition towards circularity

1)Contribution of the EIS towards circularity

This deliverable started with defining a common understanding of the concept of Eco-innovative strategies (EIS), solutions and their circular character within REPAiR.26 EIS have been developed through design exercises and an open process. The developed EIS are different in their affected material-flows, actors and processes involved. Consequently, each solution plays a different role in the transition towards circularity although none of the solutions is completely circular.

The majority of the solutions tend in different ways towards circularity without completely achieving it, as eventually they still lead to generation of waste, even if limited. This result does not indicate a failure to develop fully circular solutions. However it helps to demonstrate the difficulties and the complexity in the design process in pursuit of circularity. The result also demonstrates the limitations of the current technological, political and legal systems within the AMA context. Moreover, the complexity of redesigning urban, material and spatial processes that involve generation and treatment of both food waste, construction and demolition waste and wastescapes, obliged the REPAiR team to ask itself questions that go beyond our field of knowledge, and consequently to explore systemic thinking methods.

2) In search for a Systemic Design method

The design exercise of the articulation of EIS involves the roles of both the designer and the industrial ecologist. Moreover, it stretches them from a spatial and material design specialist to a designer of integrated and complex flows and mechanisms that have various impacts on specific place dynamics.

The changes in multi-scalar waste processes that the EIS propose, require input and feedback from stakeholders (e.g. the municipality, business developers,..), as well as various experts (e.g. landscape ecologists) in an open co-production design process. In REPAiR this led to the development of strategies and solutions that aim to simultaneously tackle several waste systems: food waste, construction and demolition waste and wastescapes. Therefore, systems thinking is the core of the design of the EIS. Systemic design is about flows, processes and operations and is rooted in the ecological idea that products of one process are interlinked with another. In the catalogue this approach suggests alternative and creative ways to redirect waste and eliminate it from the stream. The EIS design approach essentially treated material flows as spatial phenomena as the starting point for a more resource-efficient spatial planning, rather than approaching the transition to a circular economy from a numbers-driven perspective (Marin & De Meulder 2018).

The design of the systemic solutions is conceived as a visual and analytical tool for envisioning complex transition processes: involving stakeholders as well as shifting flows and processes towards less resource-dependent forms of urbanization. Finally, the design of specific EIS will be further developed in collaboration with stakeholders and decision-makers throughout a second phase of a co-production open processes in the upcoming PULL workshops.

3) Limitation of the co-production process

The co-production process integrates across sectoral knowledge, shaping coalitions and their ability to generate collaboration and action across the AMA (Marin & De Meulder 2018). Interactions between researchers, designers, students and stakeholders help to deepen the level of understanding and increase awareness of the AMA context and its specific needs and limitations in the transition towards circular economy. On the stakeholder side, this understanding includes both what EIS can and cannot offer. This generates a vibrant context of learning and experimenting.

However with this process we encounter some challenges and limitations:

- meeting the demand and expectation to achieve full circularity of the involved stakeholders, researchers and students
- confronting the competitive interests of the stakeholders
- keeping the interest in the co-production process of the stakeholder high and constant
- involving with continuity local actors as well as students in the different steps of the EIS design
- generating a better and faster communication among the different actors of this process

4) Role of the space in the EIS

The last lesson learned from the co-production process of designing the EIS concerns the role of the space and the built environment in the transition towards circularity. Although the spatial reflection was fundamental in each of the developed EIS, often the physical spaces and infrastructures in which these food waste and construction and demolition waste flows, exist only as abstractions. As Kennedy et al. (2011) affirm, working with flows, still tends to be added on rather than inherently embedded in urban territory. Indeed, several solutions still focus on optimizing material flows in smart cities through digital infrastructure or the processes of sharing by-products and resources without consimakes abstractions of resources' places of origin. However in each EIS, there is an attempt to generate spatial representations or potential sites in which solutions may be developed and eventually implemented as well as potential actors to be involved. As such, the design of EIS can, even with many limitations, ground top-down quantitative material flow analysis.

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on Wastescape

MYC blocks

Category of outcome: Technological
Owner of the EIS*: Ankita Singhvi and Lou Krabshuis (TUD)

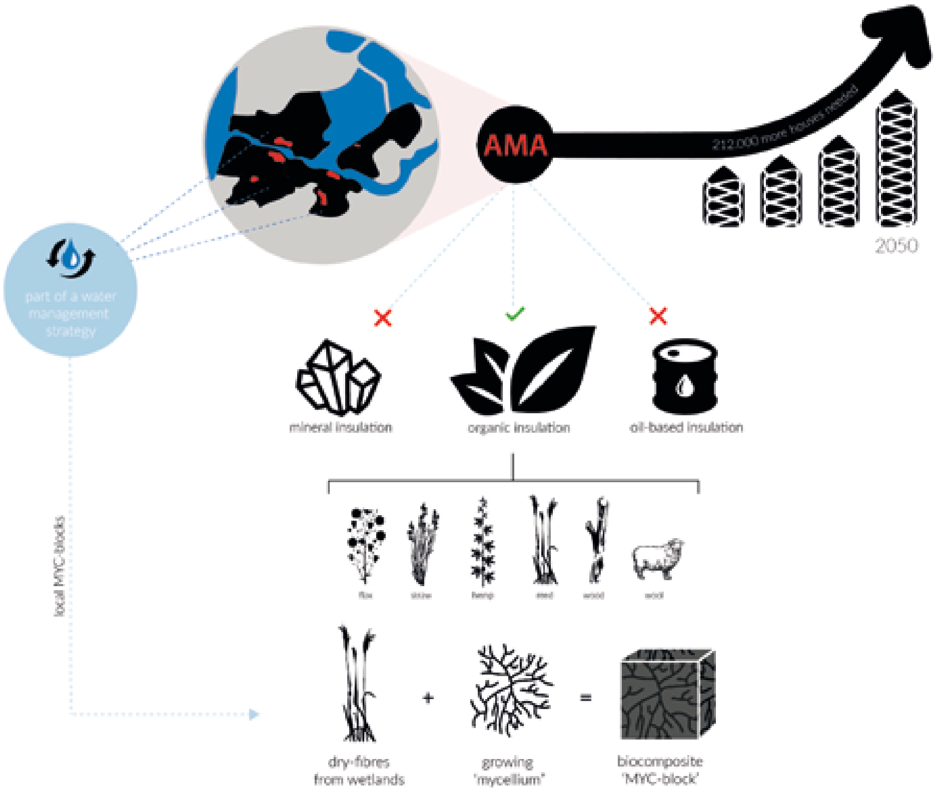


FIG 1 Idea diagram. Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Idea

MYC block solution propose a building insulation material made out of plant fibres and fungi as an alternative. This material is a biocomposite that is self-growing, renewable and can be locally produced (Ecovative, 2018; Klarenbeek, 2018; The Living, 2018). The biocomposite is produced as follows: plant fibers are harvested, they are processed (cut and sterilized, no chemical treatment), then they are collected in molds and fungi is grown around them as the 'glue'. This is then baked to strengthen the bonds between materials and kill the organism, creating a strong biocomposite. For the plant fiber we propose the plant fiber phragmites australis (reed) because it is suitable to the local climate, has a high yield, does not need fertilizers or chemicals to grow in wetlands and has low labor and machine costs (Smit et al, 2012). For the fungi, only the vegetative part of a fungi (mycelium) is needed to act as the binding for the biocomposite. Dried mycelium forms a strong, organic material that is water-resistant to a certain point, fire-resistant and mold-resistant (Ecovative, 2018). It can be transformed into various applications as a construction material, like: insulation material. The solution propose the local growth of the biocomposite (within the AMA region)in agricultural underused land or "wastescapes" alongwaterways, rivers and lakes.

Current process

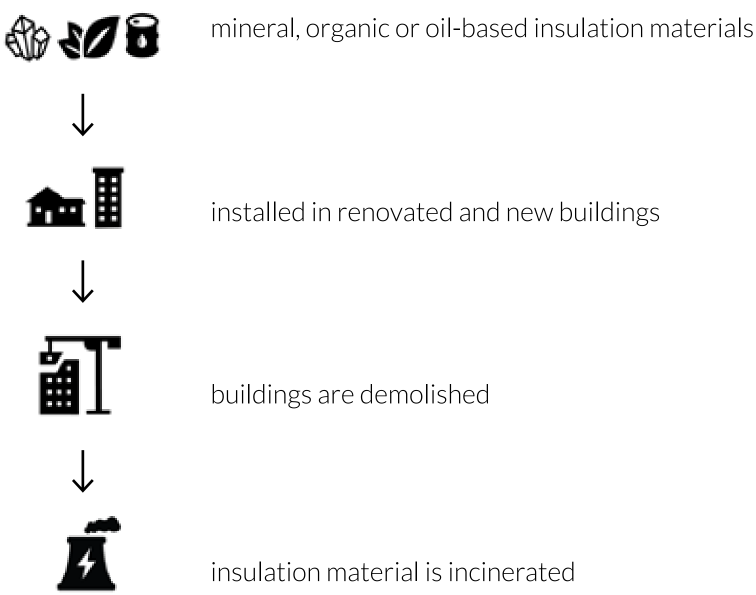


FIG 2 Current process diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Usually, conventional existing insulation material already available in the markets conclude their life cycle with incineration or landfill processes, whereas the implementation of MYC-blocks would change this value chain because it can be disassembled, composted and used as a fertilizer. The proposed EIS is a complete circular solution. The key components in the processes model for the MYC-blocks are the agricultural ditches and fields, wetlands to grow the reeds, the factory to pasteurize the reeds and grow the mycelium, and - where possible - waterways for transporting the materials to construction sites. The key material flow is the reed. Moreover, unlike other insulation materials such as EPS, the MYC -blocks solution, is renewable, has a low embodied energy, is locally produced (decreasing transportation emissions) and at the end of life cycle as insulation material is completely bio-degradable (Ecovative, 2018).

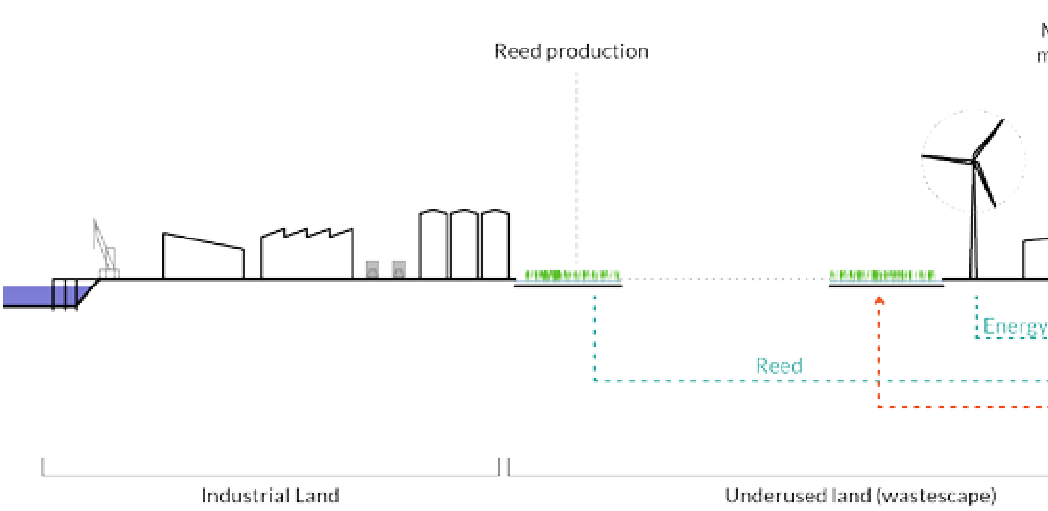


FIG 3 Systemic Section. Source: REPAiR EU H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Proposed process

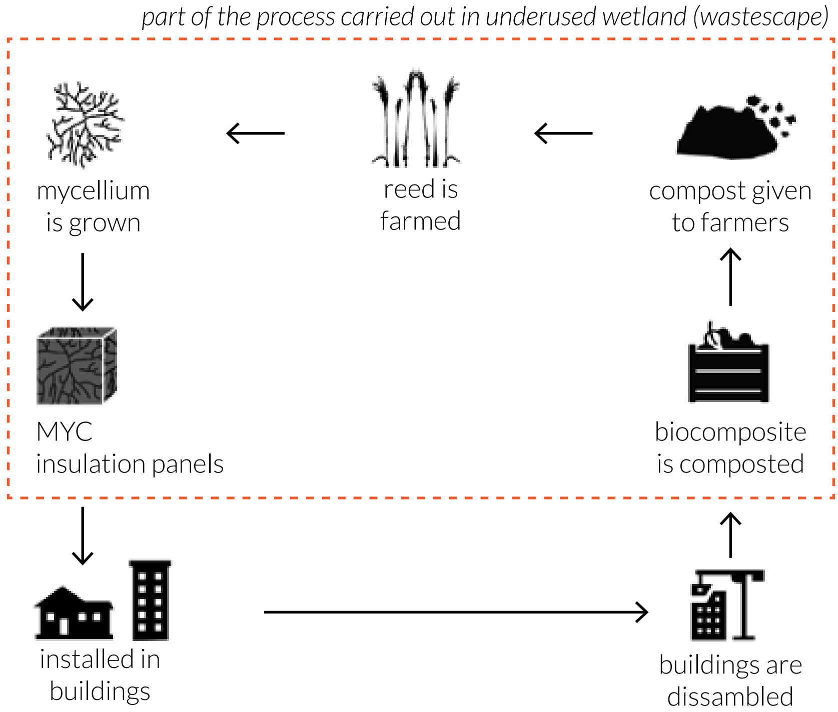
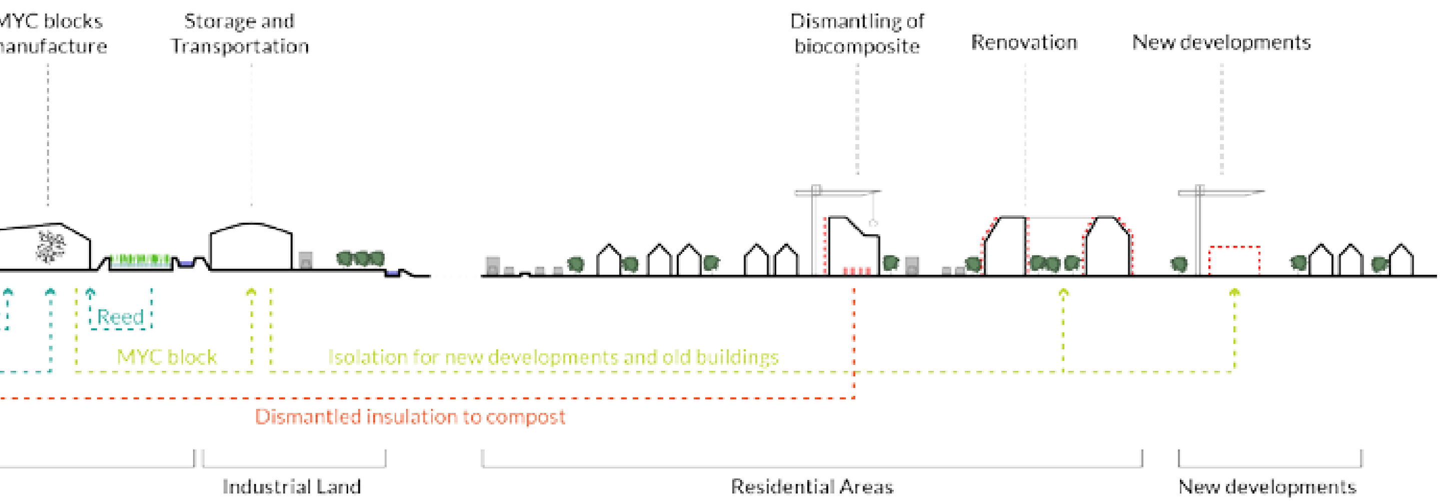


FIG 4 Proposed process diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

The section below shows how MYC blocks solution works within AMA context on a systemic level. Reed is grown on agricultural fields where there is the salinization risk of the ground water, or ditch-side where agricultural run-off is causing eutrophication. From here, it is harvested and cut into short pieces to be transported to a factory where it can be pasteurized at high temperatures. This pasteurization process gives mycelium an advantage to grow by killing competing fungal spores. Mycelium is then introduced to the reed plant fibre in order to grow the biocomposite, which is then shaped and baked to create the building material needed. This is then transported to construction sites, where it can be used as a renewable alternative to traditional construction materials in renovation, re-purposing and new projects. At the end of its life cycle as construction material, MYC Block are collected and transported in specific location to be composted.



Evaluation model

FIG 5 Evaluation indicators. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

In order to simulate the overall value of the MYC- block, this evaluation is done with the aim of insulating 1000 medium-sized dwellings per year. Therefore, assuming to have 1000 houses, there would need to be 60,000 (wet agriculture peatlands). This is equivalent to 133 ha of reed culture.

The expected ecosystem services provided by this amount of paludiculture is: desalination, a filter against eutrophication, nature conservation (attractive for residents and tourists) and stabilization of the ground water table according to different seasons. In order to understand the extent to which each of expectations can be achieved, we specify indicators to evaluate the wetlands and MYC-blocks.

Environmental impact indicators:

Nutrient levels -> removal of ± 1594 kg of N per hectare per year, which also leads to the de-acidification of water. (Turpie et al., 2010). Conductivity ->reeds growing in wetlands desalinate water (Gao et al., 2015). Biodiversity (added habitats for animals) ->Wetland birds are a valuable addition to biodiversity in an area that arises from constructed wetlands (Fritz et al., 2014). By implementing this EIS in 133 ha of wetlands, 200 ha of habitats for wetland species would be created.

Economic impact indicators:

At the moment, growing reed costs 17,50 Euros/ton to take it to the composter (Hildebrand, 2014). A profitable return investment should be comparable to at least 25 Euros/ton.

Growing reed saves the water manager 10 Euros/ton. The harvesting costs of reed are relatively high (500-1500 Euros/hectare) but the transport costs are very low: approximately 10 Euros/ton of dry reed. Therefore, in order to breakeven, the reed must be sold at a minimum of 25 Euros/ton.

The running costs and R&D necessary come out to about 1,2 million Euros. In order to make this back, the MYC-blocks must be sold at 20 Euros per m2 in order to break even.

Social impact indicators:

How much reed can be grown, and how many houses would be insulated based on this? Tons of reed/hectare/year = 15 tons/hectare/year. Weight of 1m3 MYC-block = 0.1 ton. m3 of insulation needed for typical app. dwelling = 10m3 = 1 ton. Therefore, 1 ha of reed wetland could insulate 7,5 dwelling. The aim is to insulate 1000 dwellings: 20% of the yearly projected building demand until 2050.

In order for the mycelium facility to work, it would need to employ about 6-8 full-time people, therefore also contributing to the local economy.

FIG 6 Comparison of mycelium-reed biocomposite with other insulation materials Source: Hildebrand, 2014

Possible locations within AMA

FIG 7 Depth of the border between sweet and saline ground water (the map shows the risk of salinization of ground water). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Data retrieved from: http://data.overheid.nl/data/dataset/beschikbaarheid-zoet-grondwater-verzilting/resource/3a863112-e9bc-4b4c-be28-7b88ea741d38 "DANK:DANK-008a_verzilting_grondwater"

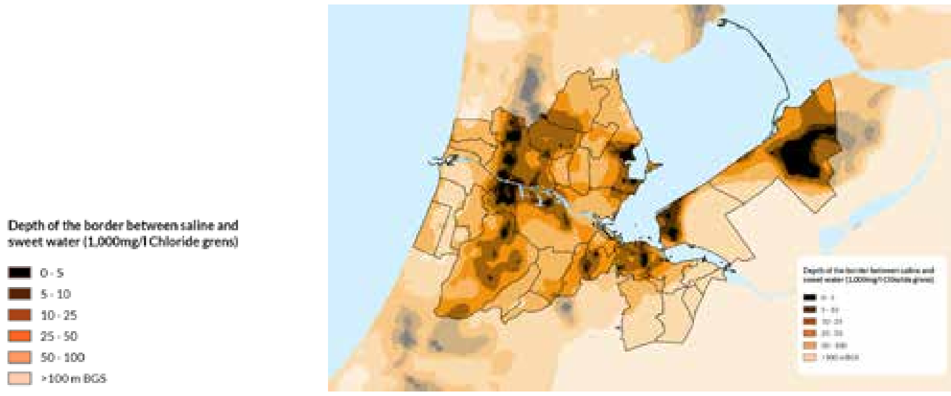


FIG 8 (left) Planned building and renovation in the AMA. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Data retrieved from: http:// gisservices.noord-holland.nl/ags/services/pnh_dataservice_alg/MapServer/WFSServer?&request=GetCapabilities&service=WFS

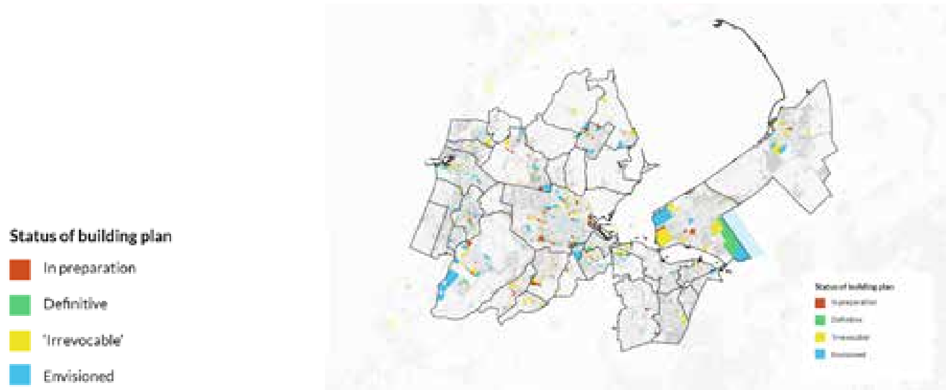


FIG 9 (left) Use of land in the AMA. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Data retrieved from: http://pdokviewer.pdok.nl "Bestand Bodemgebruik (BBG) 2012"

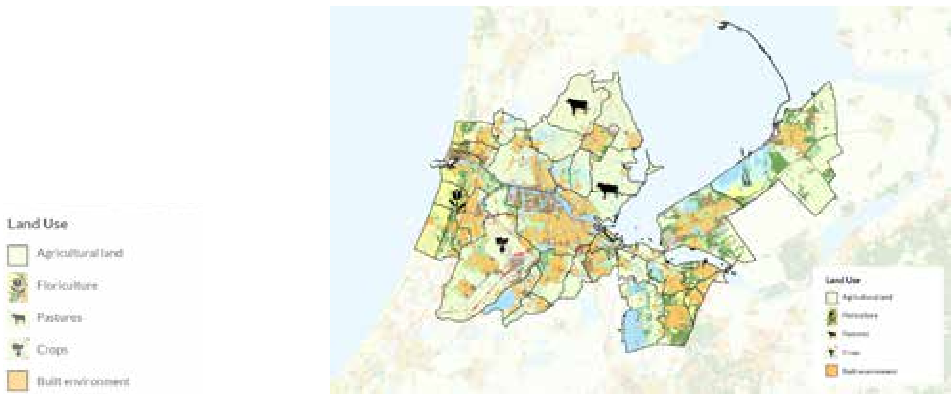
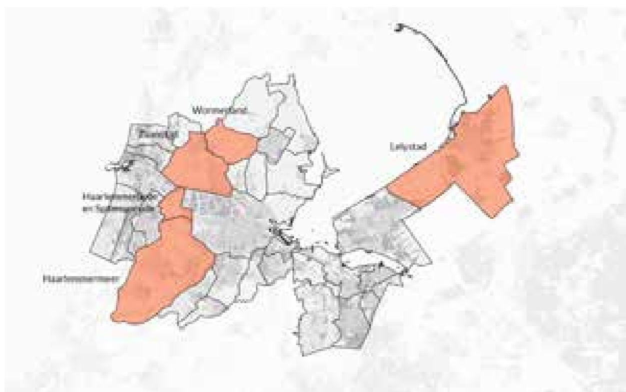


FIG 10 (left) Municipalities that have the highest potential for growing reed. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018).



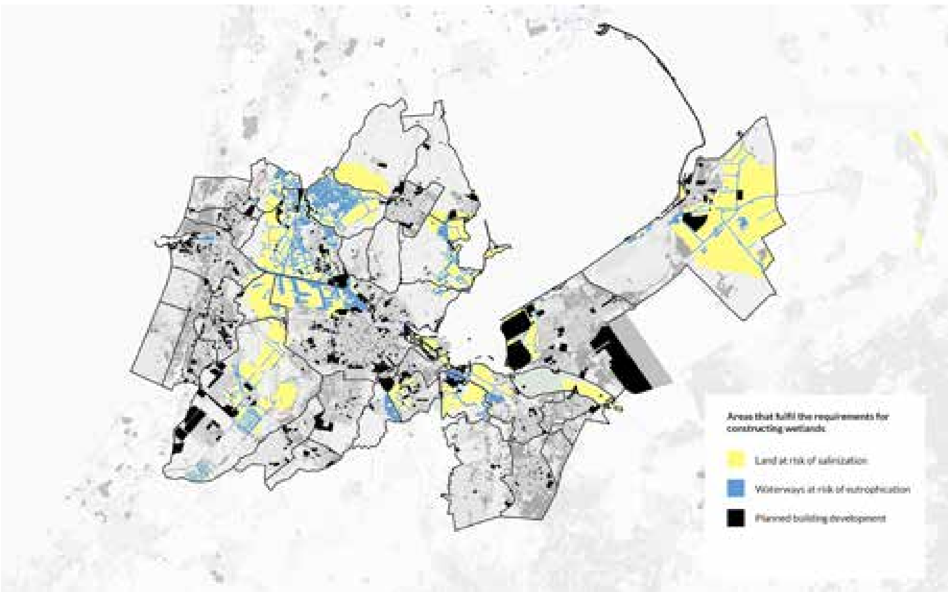


FIG 11 Areas that fulfil requirements for constructing wetlands. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018).

AMA territory is predominantly under sea-level, with the lowest areas around Schipol, Almere and Beemster lying on average around 4m below sea level. The soil type here is predominantly peat and reclaimed land. Furthermore, there is a uniquely high proportion of agricultural land in comparison to most metropolitan areas in the world, out of which most is used as pasture for cattle. Additionally, there is a large area between Haarlemmermeer and Alkmaar where the ground water is at high risk of salinization as the depth of the border between sweet and saline water decreases. Salinization is the increasing concentration of salt in the soil or water. Salinization of the ground water occurs due to ground water levels rising, which brings salt accumulated in the soil to the surface, and therefore creates the risk of salinization of surface water.

AMA region has projected a growth of 0.8 million people, for which they will need to provide 212,000 houses (MRA, 2017) over the next 30 years. This means that the region will either have to build new dwellings or renovate old ones to current building standards: the planned projects are illustrated in FIG 7. For all the planed building capacity, there will be a demand for housing that adheres to new stricter requirements of the Bouwbesluit, including insulation values.

MYC-blocks are the link that bring each of these demands together. Reed is already grown in the AMA, predominantly in wetland areas along some canals, especially in Almere/Lelystad region. Reed thrives in wet soil, low-lying soil, and by constructing wetlands along the ditch sides and along salinization wells, the risk of agricultural wastelands decreases.

In this perspective area areas at risk of salinization and eutrophication, unused agricultural land at the edge of canals and waterways, and in proximity to planned building developing area, represents the potential location for the cultivation of reeds necessary for the production of MYC-blocks. These are summarized in figure 9 -10 to show municipalities where the majority of these areas fall, and therefore the municipalities that the eco-entrepreneurs should approach in order to align their interests with MYC-blocks'.

Examples of possible implementation of the EIS

FIG 12 Collage of a possible application. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Based on http://snoekenindepolder.nl/polder/de-haarlemmermeer/

Out of the five potential municipalities that were suitable for implementing the proposed system for MYCblocks, Haarlemmermeer was chosen to test the process model because producing MYC-blocks aligns perfectly with the municipality's vision of having a bio-based economy (Gemeente Haarlemmermeer, 2015). Implementing the system would change the area as follows:

From a morphological perspective, the contours of ditches in proximity to agricultural land would change (Section 5.3). At least 40% of them would have reeds growing for a metre on each side as a buffer between the agri-

FIG 13 (left) Saltwater wells in Harlemermeer. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Data retrieved from Witjes et al., 2008
FIG 14 (right) Growing reed along the ditches in Hrlemermeer. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018). Data retrieved from Witjes et al., 2008

cultural land and the water way. This would filter the excess fertilizer components before they could reach the waterways and cause eutrophication. Moreover, the growth of reeds would create a golden edge along the ditches (Impression 6.1) which will break the traditional flat green polder image.

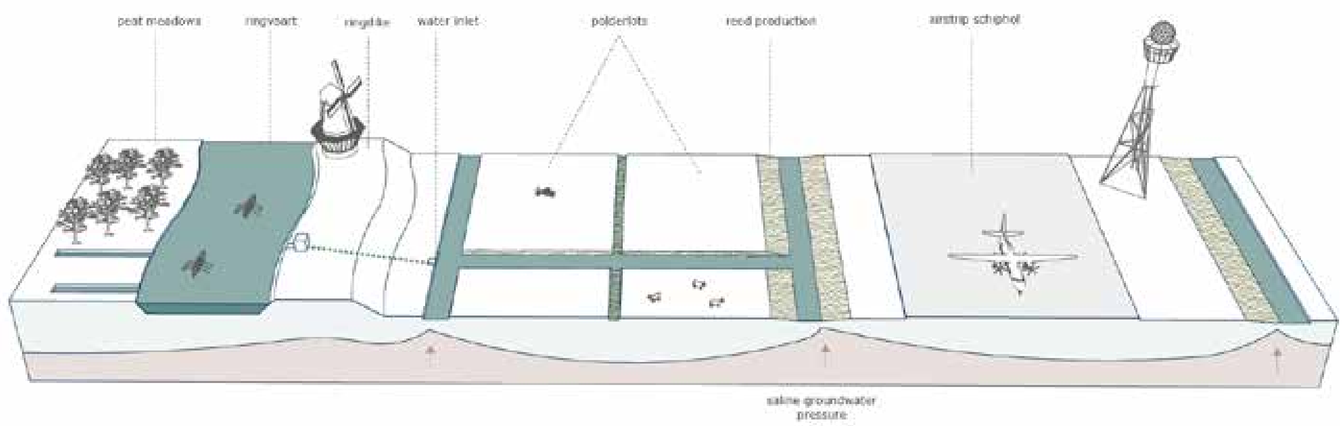
From a physiological perspective, raising the surface water level around the saltwater wells will increase the pressure on the rising salinity, which will counteract salinization (Map 5.1). This is beneficial to the area, and is an ecosystem service that plays into the water management vision that Haarlemmermeer has (Gemeente Haarlemmermeer, 2012). The factory in Haarlemmermeer is placed in an area that is unsuitable for residential building due to the noise pollution. A full-scale factory is able to produce insulation materials for up to 1000 dwellings each year. Six to eight people are need-

FIG 15 (left) MYC biocomposite panel. Source: Archdaily, 2014)
FIG 16 (right) Example of MYC biocomposite application. Source: The Living, 2018

ed to operate the factory, its research department and sales/management, depending on the season. After harvest in late autumn, winter there will be more work than in the spring and summer periods. Therefore, from an economic perspective, this factory contributes to bio-based innovative jobs that Haarlemmermeer wants.

FIG 17 (below) Section of the proposed system next to airport area. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018).

From a social perspective, the use of an insulation material that originates from mushrooms may cause hesitation in homeowners and developers. The main change here can only be brought about slowly, through examples and references of the use of mushroom based materials in other every day prod-



ucts. Here, the eco-entrepreneurs will have to work with architects and designers to increasingly use biocomposites such as MYC-blocks in their designs, normalizing the material and making it a part of evert day life.

MYC-blocks would not change the external esthetical appearance of buildings. The structural element of the façade will be modified to accommodate the MYC-block panels. Each panel can be moulded according to different shapes and therefore accommodate different uses.

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Bio-seasonal parkings

Category of outcome: Technological

Owner of the EIS: Twan Goossens and Elena Rossoni (TUD)

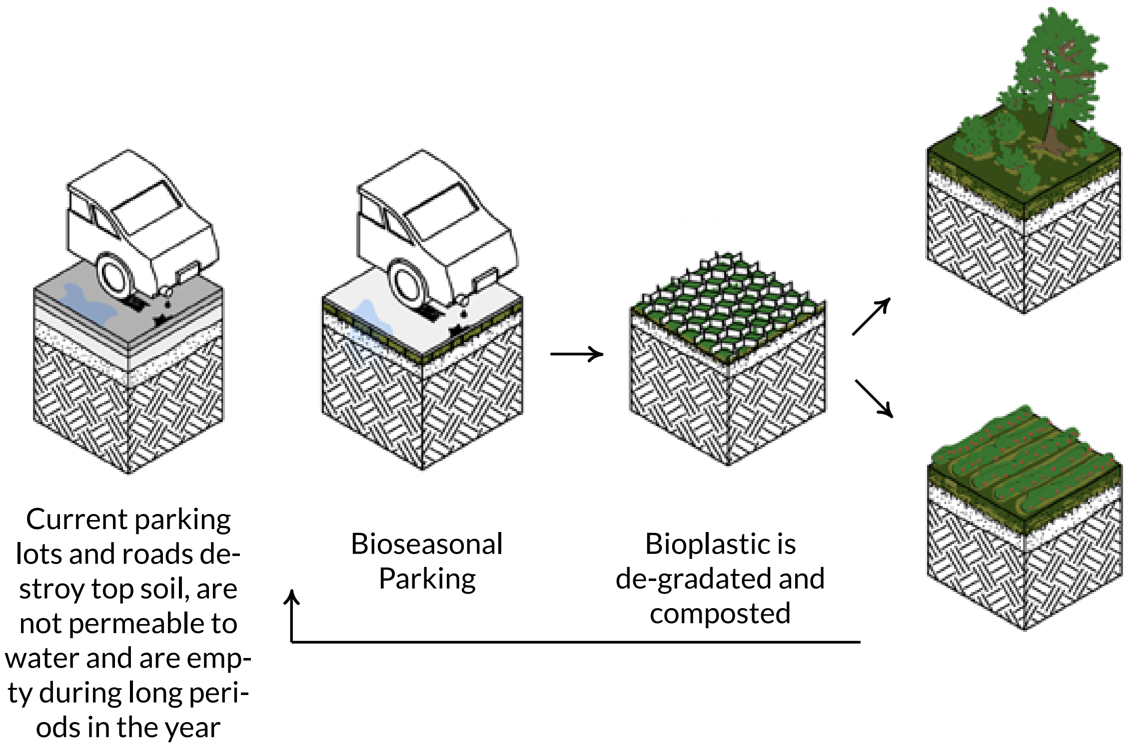

FIG 1 Idea diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Open and fertile land is deeply affected by paved surfaces. Water absorption is slowed down, salinization of the soil is increased and removing the top layer of the soil speeds up erosion. In the Netherlands, coastal areas and low polders, as Harlemmermeer, are very vulnerable to these processes.

One of the most dramatic examples are the seasonal parking lots around Schiphol airport, in which big portions of agricultural land are covered by parking lots. Even though we will focus on this area, bioseasonal parking could be applied in many other areas and situations, such as festivals, sport events or the parking areas that result of the summer exodus to the beach. There are over 37,000 official parking lots around Schiphol and many more in private hands. Except for the season with highest demand (July and August), about 40% of these parking lots remain empty. Moreover, societal changes and technological developments will change the amount of parking lots needed. Co-riding, car sharing and autonomous driving will all contribute to the reduction of the parking spots and a redundancy of numerous car parks. This EIS aims at making this underused land available for other functions by allowing water drainage and regenerating the top soil. Bioseasonal parking will already prepare this soil for a quicker transition to cultivable lands.

This EIS proposes providing temporary parking grounds using a bioplastic structure that will degradate and compost the land when parking is not needed. This will at the same time regenerate the top soil and prepare it for other uses when parking is not needed, be it seasonally or permanently.

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Current process

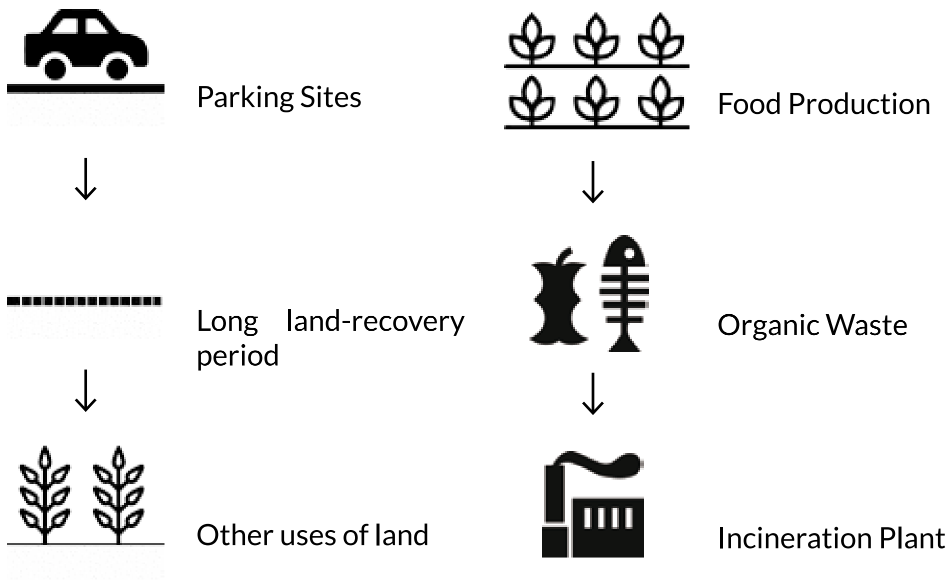
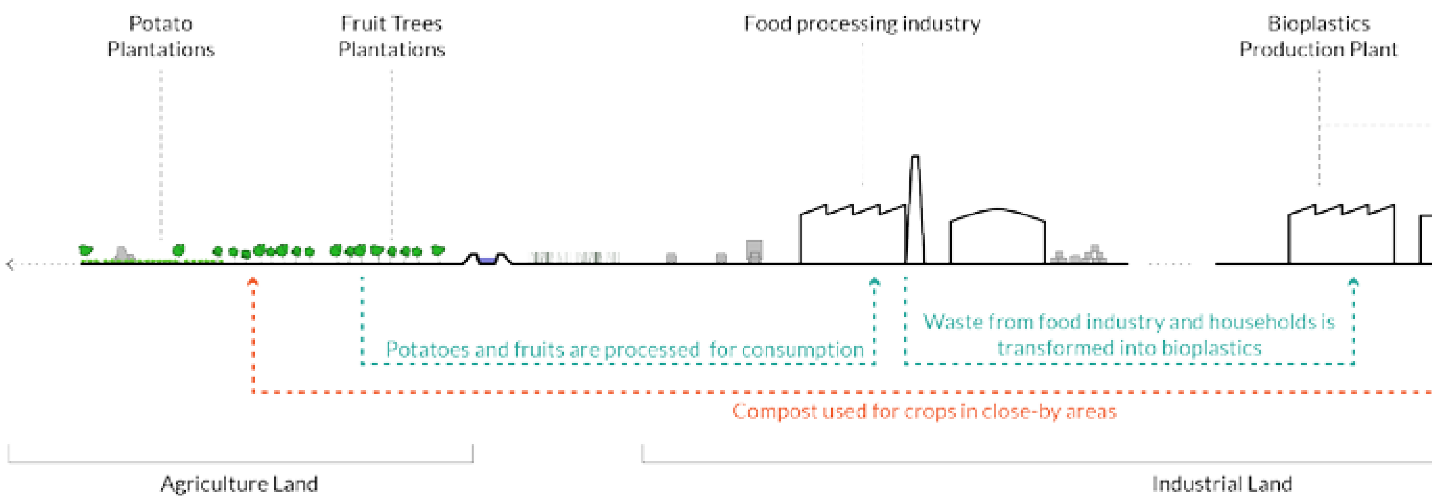


FIG 2 Current process diagram. Source: REPAiR EU H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Bioseasonal parking acts on two different waste flows within the AMA. The fist one was already mentioned. Land captured for parking purposes is underused and needs long recovery periods for the soil to allow productive uses. Parking pavement usually blocks water infiltration and fosters erosion of the soil, making the transition difficult and slow.

The second flow is related to food waste. The bioplastic paving material can be processed out of starch and vinegar. These can be acquired from farms which grow fruit, vegetables or potatoes, or companies processing potatoes, starch or vinegar. If the demand for bioseasonal parking grows, supermarkets or households generate also significant ammounts of foodwaste. In 2012, 236,970 tonnes of food waste were produced from processing and preserving fruit and vegetables in supermarkets in the Netherlands. Most of this waste is usually incinerated, producing energy in the process.

FIG 3 (bottom) Systemic Section. Source: REPAiR EU H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)



Proposed process

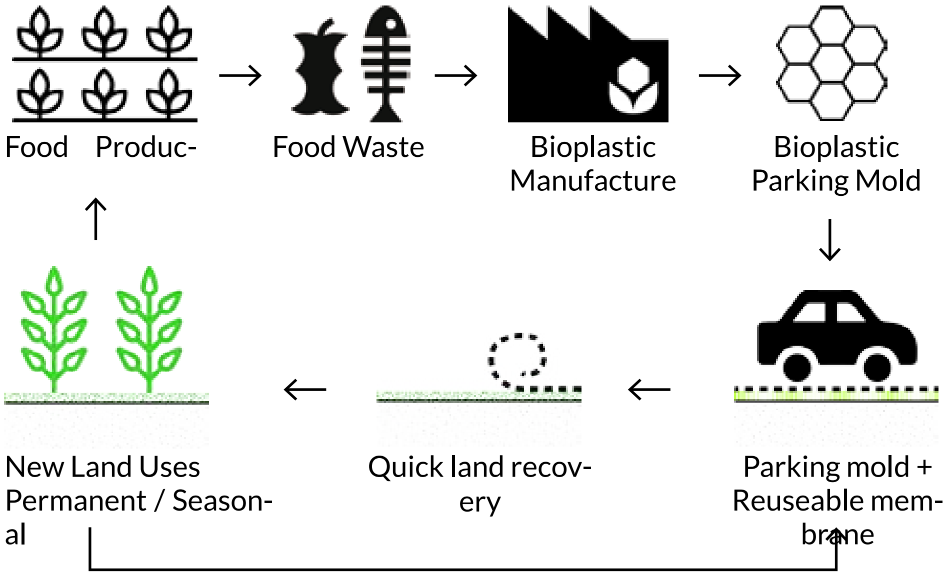
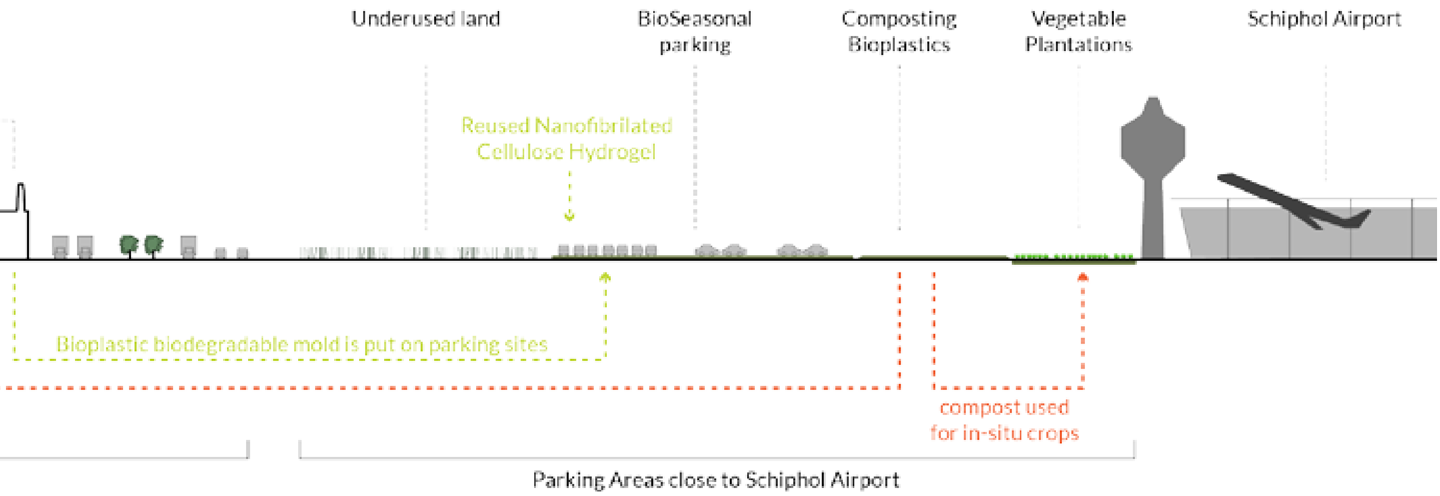


FIG 4 Proposed process diagram. Source: REPAiR EU H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Bioseasonal parking aims at closing the loop by connecting these two flows. A new bioplastic industry would use food waste (starch and vinegar) to create the parking molds. The installation of the parking pavement would occur during times of high parking demand such as June, July and August. Pieces are placed on plain soil and are water permeable. A layer of biodigradible membrane (possibly nanofibrilated cellulose hydrogel) is placed on top of the paving mold in order to prevent harmful substances from contaminating the soil, like dripping oil from the cars. This layer is hydrophillic, therefore allowing water infiltration. When the parking grounds are no longer needed, the top layer is removed and the pavement gets composted on site, acting as fertiliser for the soil beneath. Aerated static compost does not require any mechanical assistance. Within a short time, the soil is ready to be cultivated until the next high parking demand period. Since food could only be grown during winter and spring, vegetables which are more suitable for this season would be preferred: carrots, cabbage, rocket or brussel sprouts.



Evaluation model

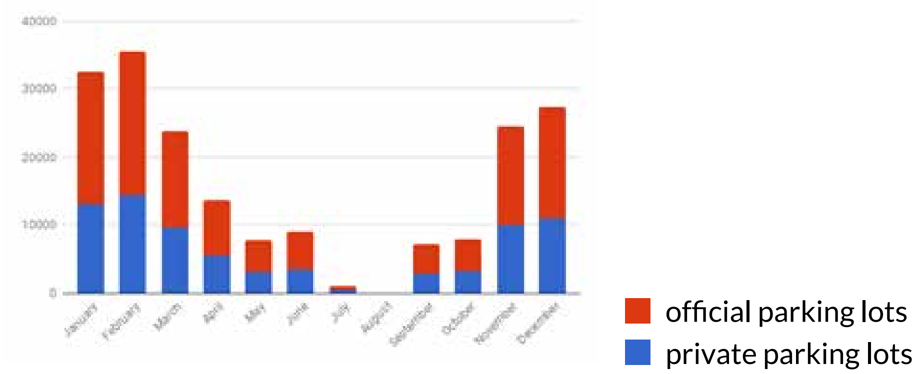


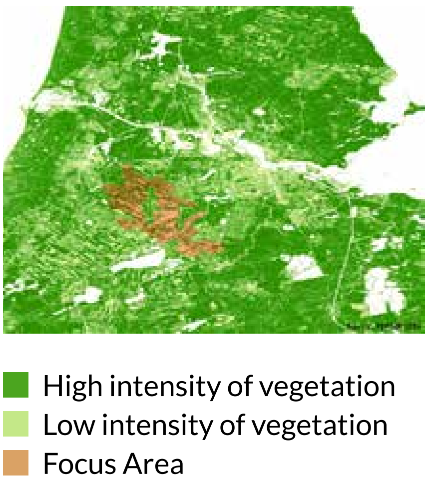
FIG 5 Empty parking spots at official parking lots for every month (based on amount of passengers during peak days) Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Indicators allow us to assess the positive changes the bio parking implementation will cause, but also to present the immense implications, losses and dangers the ecosystem and the economy face currently.

The main problem seasonal parking creates nowadays is related to the lack of flexibility of the land. Parking spaces hold the land "hostage" and don't allow for other activities to take place. This is particularly negative during low season, in which many of those parking lots are not used for parking either (fig 5). From an economic perspective, it prevents the land to create potential jobs and income.

Food production is an important matter in the Netherlands, where a surface 15 times its own land is needed in order to provide resources for its population. Having more surface for agriculture production would bring a positive change in the AMA. Moreover, food transportation costs and the environmental foodprint would also be reduced. In order to allow for agriculture production, soil needs to be prepared. Levels of soil pollution will have to decrease and the top layer restored, so water infiltration is allowed. Bioseasonal parking would be applied in seasonal cycles also with this purpose: preparing the land for productive uses. Ultimately, this process would increase the chances for more biodiversity in these areas.

Parking wastescapes and urbanisation in the AMA generate big gaps between protected and intensely vegetated areas (fig 6), preventing green dense areas in the country to connect environmentally with the coast.



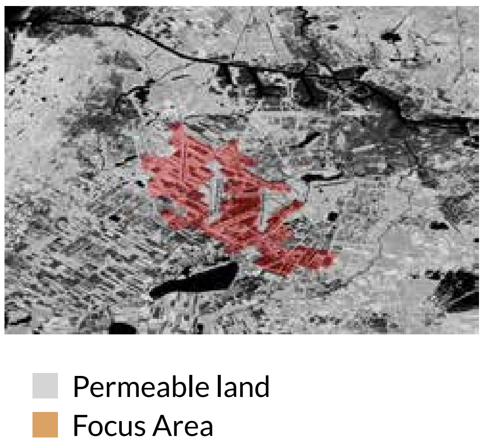


FIG 6 Presence of vegetation in AMA. Source: REPAiR, D3.3, 2018.
FIG 7 Water permeability in AMA. Source: REPAiR, D3.3, 2016.

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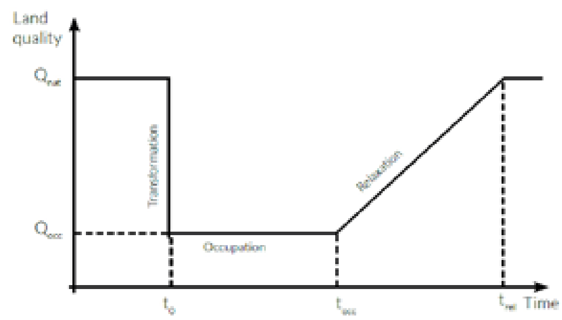
Reuse parking space to increase land quality and allow new productive activities	Economic	Food waste incineration costs reduced
		Income generation from soil fertilization
		Increased land surface for agricultural production (or other uses)
	Environmental	Water infiltration capacity increased
		Biodiversity increased
		Reduction of soil toxicity
		Surface of top soil layer preserved

Water permeability is critical for soil's future erosion and potential to be cultivated. As seen in fig 7, many land in the periurban area of Amsterdam does not allow for water to infiltrate. Asphalt should therefore be avoided if possible, allowing for the top soil restoration and permeability. Indicators are organized into two categories (impacts): economic and environmental. All of them could be measured and tested before and after the implementation of the bioseasonal parking, according to the specific site of the project. From an economic perspective, bioplastics production would probably rise, promoting a more eco-friendly industry than concrete. The use of food waste would also create new flows on producing and managing waste, promoting a new industry and stimulating job opportunities. The same would happen if land is used throughout the year, creating new jobs during harvest and growing seasons.

Bioseasonal parking will allow for a shorter cycle of land restoration. This will mantain a higher land quality value through time and will decrease the costs of keeping paved surfaces too long in time. By providing quality to the soil, this EIS will also give flexibility to the land, being able to switch to other uses easily (Fig 8 & 9).



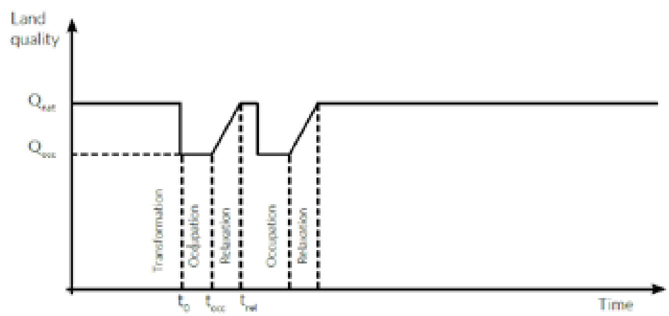


FIG 8 Relation between land top soil quality and parking use (current). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 9 Relation between land top soil quality and parking use (proposed). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Possible locations within AMA

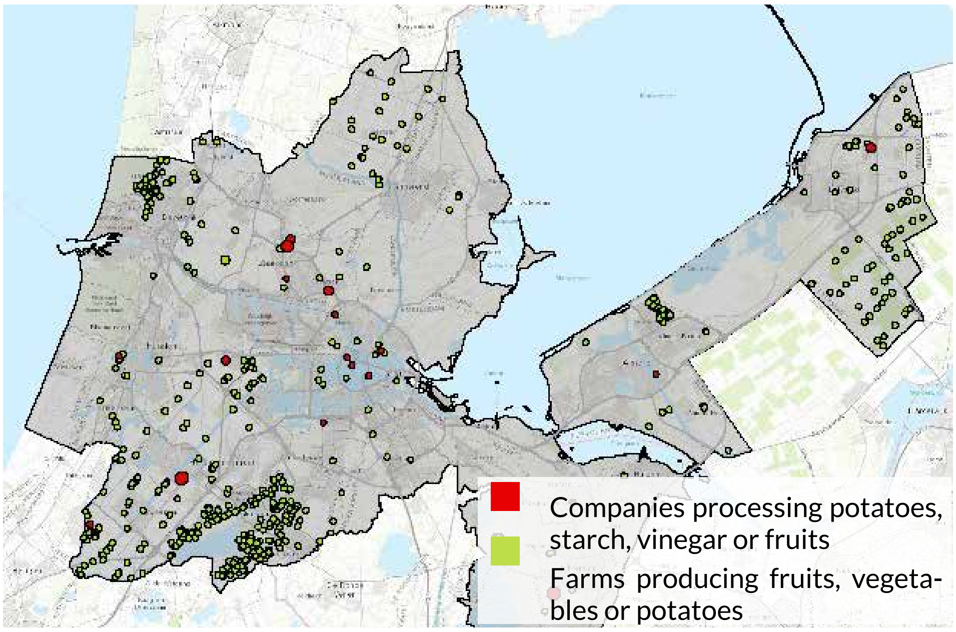


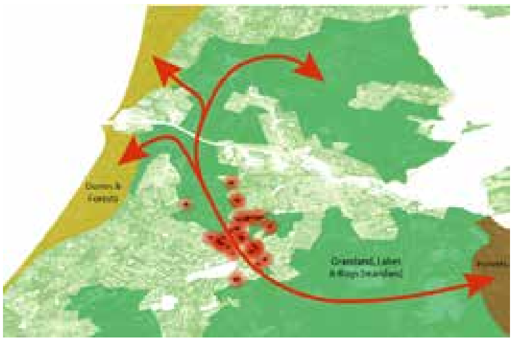
FIG 10 Companies related to organic food waste and processing. Source: REPAiR, D3.3, 2016.
FIG 11 (bottom left) Polluted land within AMA. Source: Landsat 8, 2018; REPAiR, D3.3, 2018.
FIG 12 (bottom right) Ecological bridge between areas with high vegetation and biodiversity. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Companies that grow fruit, vegetables or potatoes, as well as those which process starch or vinegar, are key to the proposal (fig 10). Its close location to industrial land where bioplastics can be produced will ease the production of the parking molds.

Polluted land in the AMA is located mainly where industrial activity takes or took place (e.g. port of Amsterdam) and in some areas of the periurban area (fig 11), including land around Schiphol airport that is currently used as parking space. This area of the AMA is also a potential bridge to create an environmental corridor (fig 12)between the forests, marsh lands and the coast, allowing for biodiversity to run through the area.

The abundance of seasonal parking lots in Schiphol area (fig 13) makes this an excellent location to test this EIS. Its proximity to farms and companies that could provide resources to produce bioplastics also helps for this purpose. Using Schiphol parking lots as a pilot projetc, bioseasonal parking could then be implemented in other areas of the region.

Polluted Areas



Official Parking Lots

Private Parking Lots

FIG 13 Parking Areas around Schiphol. Source: Google Earth, 2018 (image), Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

FIG 14 (top right) Types of crops according to time of the year in which they are produced and the yearly yield. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 15 (bottom left) Possible impact of the proposal in land quality and value. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 16 (bottom right) Possible impact of the proposal in use of land and income generated. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 17 Situation of parking area during August (parking high season). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Examples of implementation

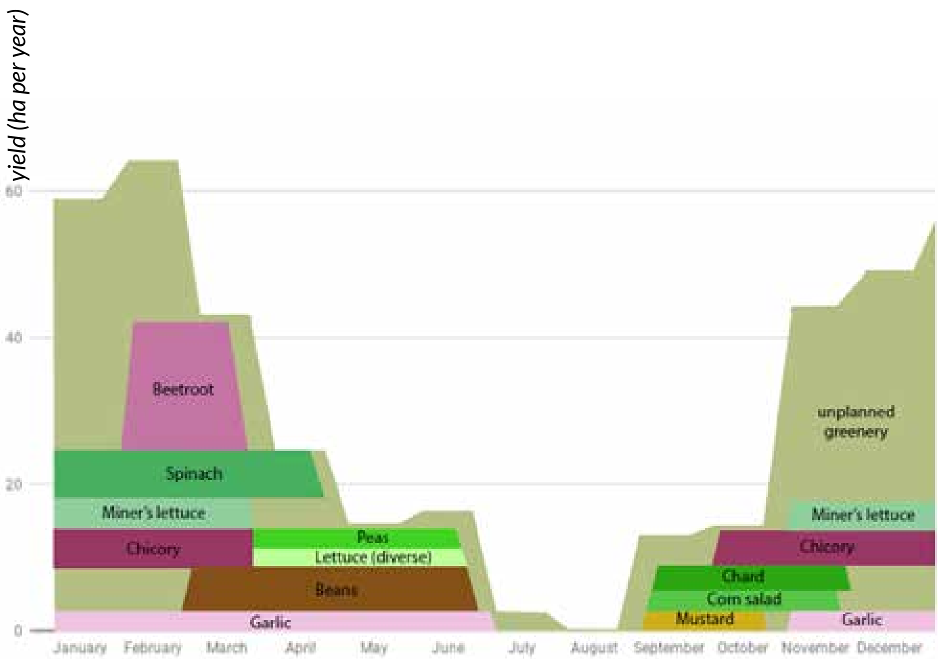
If bioseasonal parking is implemented in Schiphol, parking grounds will spatially change, especially during low parking demand season, where the grounds will be covered by fruit and vegetables crops. Its aesthetic value will therefore also rise.

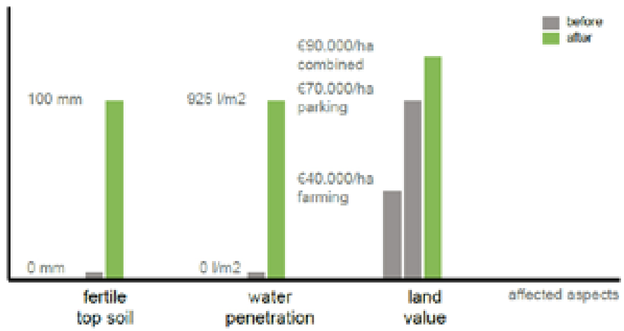
The bioplastics are molded into a hexagonal modular shape which is able to bind with the other hexagons without the need of extra material, so when multiplied, each piece interlocks with the surrounding ones, easily forming a large even surface. This also makes the transportation and installation easier and quicker.

The surface of land covered by bioplastic pavements and used for parking lots, and the land used for agriculture or productive uses will vary during the year, creating different landscapes in the areas close to the airport (fig 16, 17 &18). Many different crops are suitable for winter and spring periods (fig 15), creating a wide range of possibilities for the regenerated land.

There are 35,500 empty parking spots at Schiphol airport parking areas during times of low demand. This means at least 45 ha of available land for food production and tonnes of vegetable production.

Crop	Yield (ton/ha)
Beetroot	27.5
Spinach	12.5
Miner's lettuce	0.68
Chicory	10.5
Peas	7.5
Lettuce	35
Beans	15
Garlic	12.5
Chard	9
Corn salad	21.5
Mustard	1.3





Impact on land use

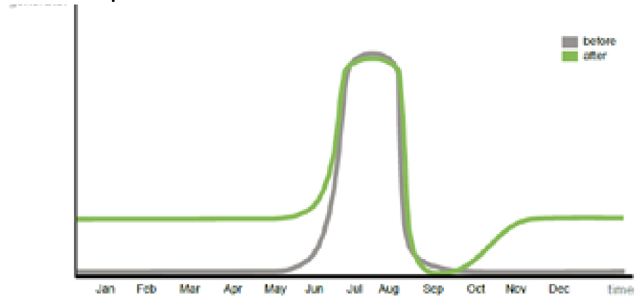


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FIG 18 Situation of parking area during October (parking + agriculture). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

FIG 19 Situation of parking area during February (agriculture). Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

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Land Rotation

Category of outcome: Political; Legal

Owner of the EIS: REPAiR

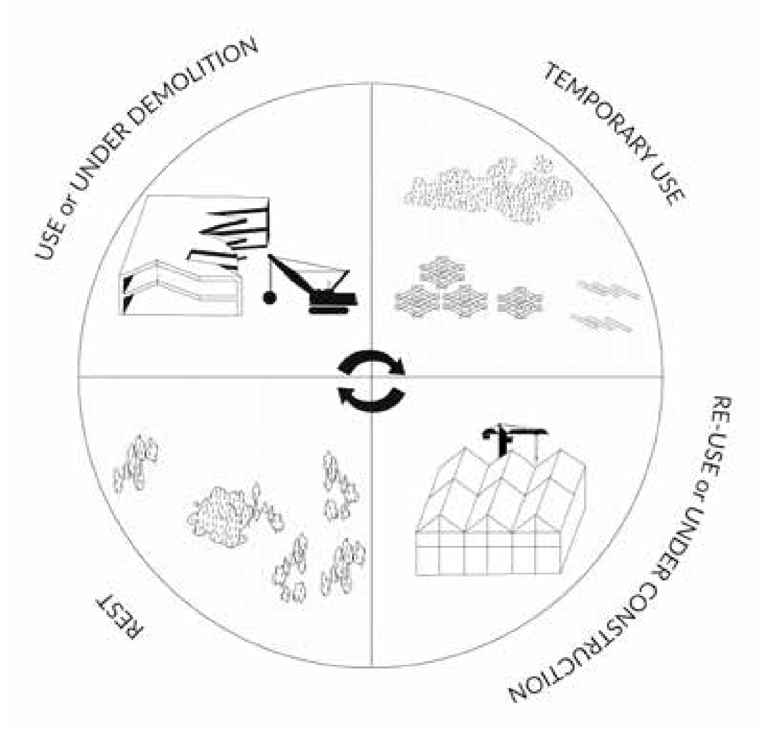


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

This EIS uses land rotation to free up space that could be used a as temporary storage for building materials. Every day, The logistics of building materials are heavily responsible for a large portion of the total road use leading to both congestion, fossil fuel based and pressure on the air quality.

Implementing a hub for construction materials close to a construction- or demolition project will limit the amount of trips to the sites, as these materials could be brought at the same time. It could also help match supply and demand of secondary building materials since these don't almost match on a temporal scale. Building hubs require space which is not always available in cities. Land rotation could provide the solution. Instead of having a central location, building hubs could also be temporary, using land that is available at a certain location at a certain time. This solution follows the scheme of rest-and-use rotation system that is similarly employed in agriculture land for crop rotation (see Fig 1).

According to Ludema & Merriënboer (2016), implementing measures for smart building logistics such as a hub for building materials could lead to a decrease of CO_2 emission of 35% and limit construction related trips by 45% for the entire construction and demolition sector.

Current process

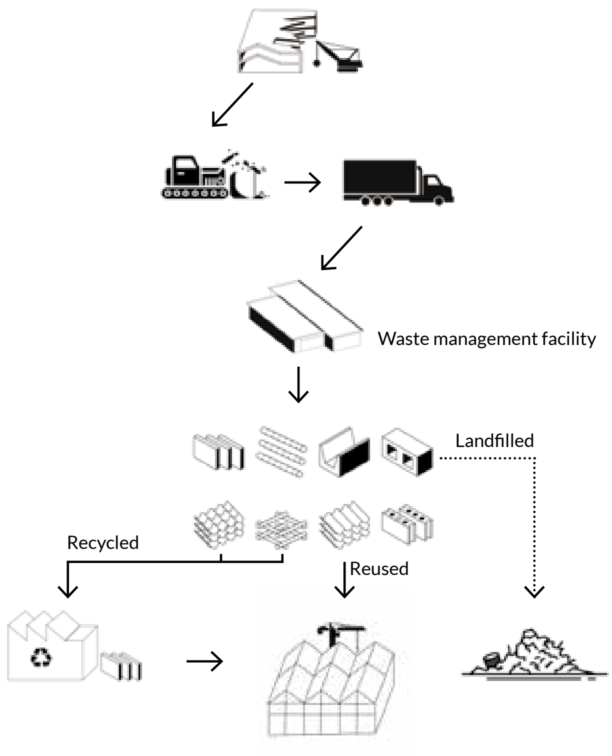
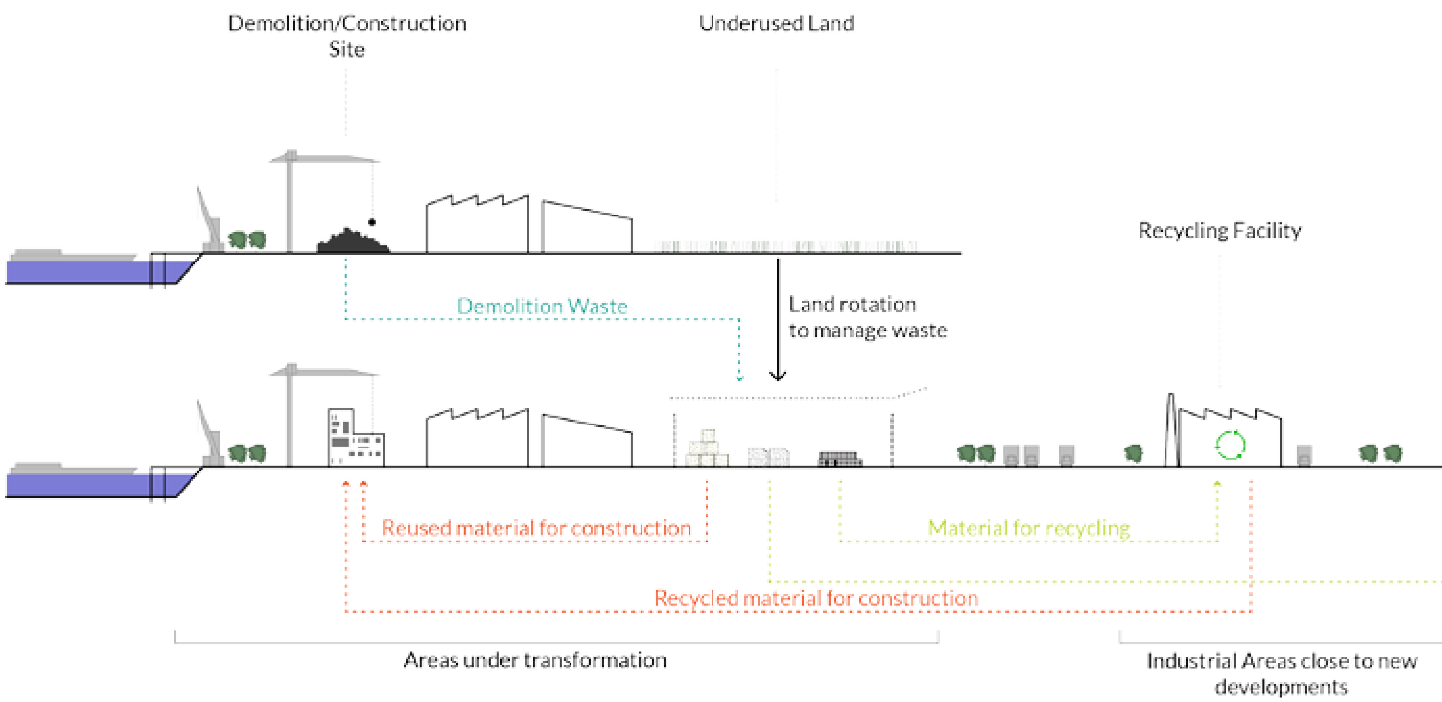


FIG 2 Process diagram of current situation. Source: REPAiR EU H2020 project.
FIG 3 Systemic Section of Land Rotation. Source: REPAiR EU H2020 project.

According to a Dutch logistics and building platform, approximately 30% of all material transport is related to the construction sector in the Netherlands. This leads to congestions, nuisance and emissions of all sorts both greenhouse gasses and (Duurzaam GWW, 2014). These emissions could be reduced by selecting a more sustainable alternative to fossil fuel based transportation or by limiting the trips bringing the building materials to the building site. The transportation of building and construction materials into cities cause heavy pressures on the existing infrastructure and congestion. It furthermore, has implications for road safety and air quality due to both greenhouse gas emissions and particulate matter (TNO, 2015).



Proposed process

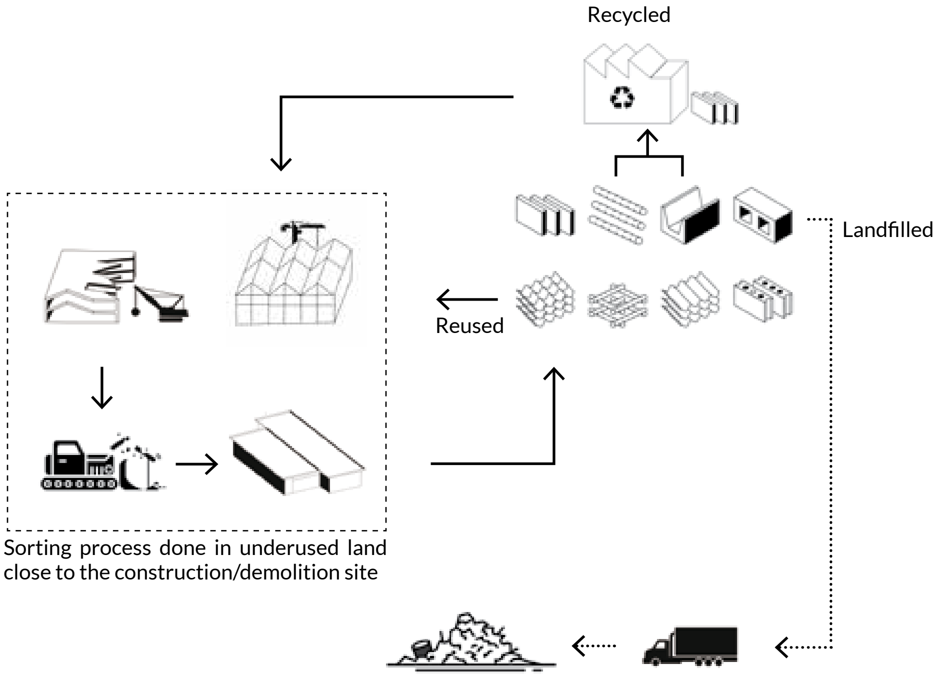
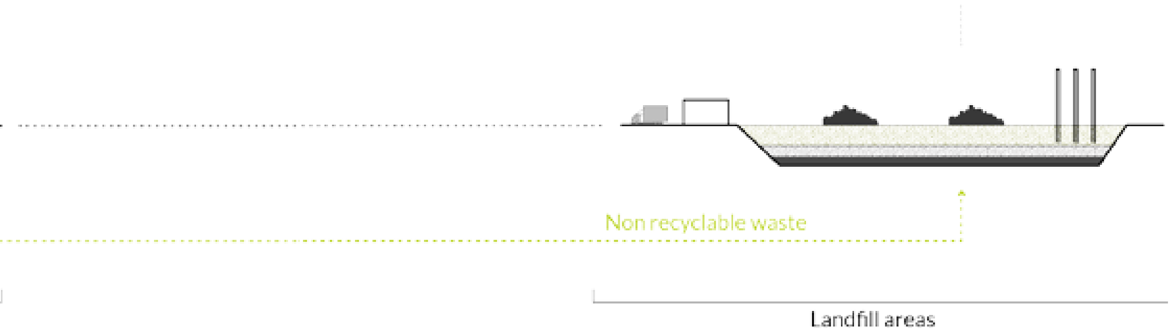


FIG 4 Process diagram of proposed situation. Source: REPAiR EU H2020 project.

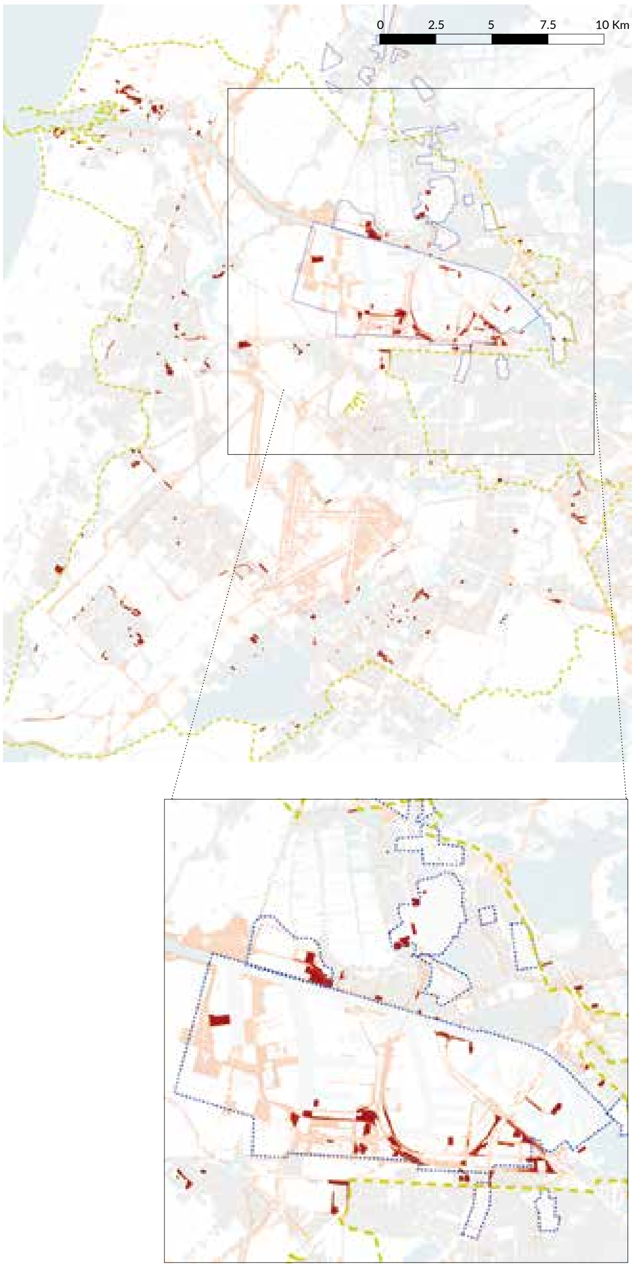
In areas under great pressure for development, land is under constant transformation. Demolition will give space for new constructions and underused land will coexist with redeveloped industrial areas. Often, the waste that is generated in demolition sites is piled up and transported to waste management facilities or dump sites, where it is sorted out in order to be reused, recycled or sent away to landfills or other final disposal waste facilities (Fig 2).

Transportation of building materials in and out of the city has many unwanted implications. We can limit the amount of transportation related to construction and demolition through a physical space used for storing building materials. Land rotation can help provide the space needed to facilitate this since space is often expensive and scarce in urban areas. It can furthermore help match supply and demand between construction and demolition projects and through that promote the use of secondary materials. A collaborative pilot of TNO, TU Delft, Hogeschool Utrecht and private parties in 2014 showed that introducing a building hub to store materials for the construction sector could result in 68% reduction of trips to the construction site, 69% less kilometers from construction sector related traffic and 68% reduction in greenhouse gas emissions (Merriënboer & Ludema, 2016).(Fig 3 and 4).



Possible locations within AMA

Unused and underused areas



Future expansion areas

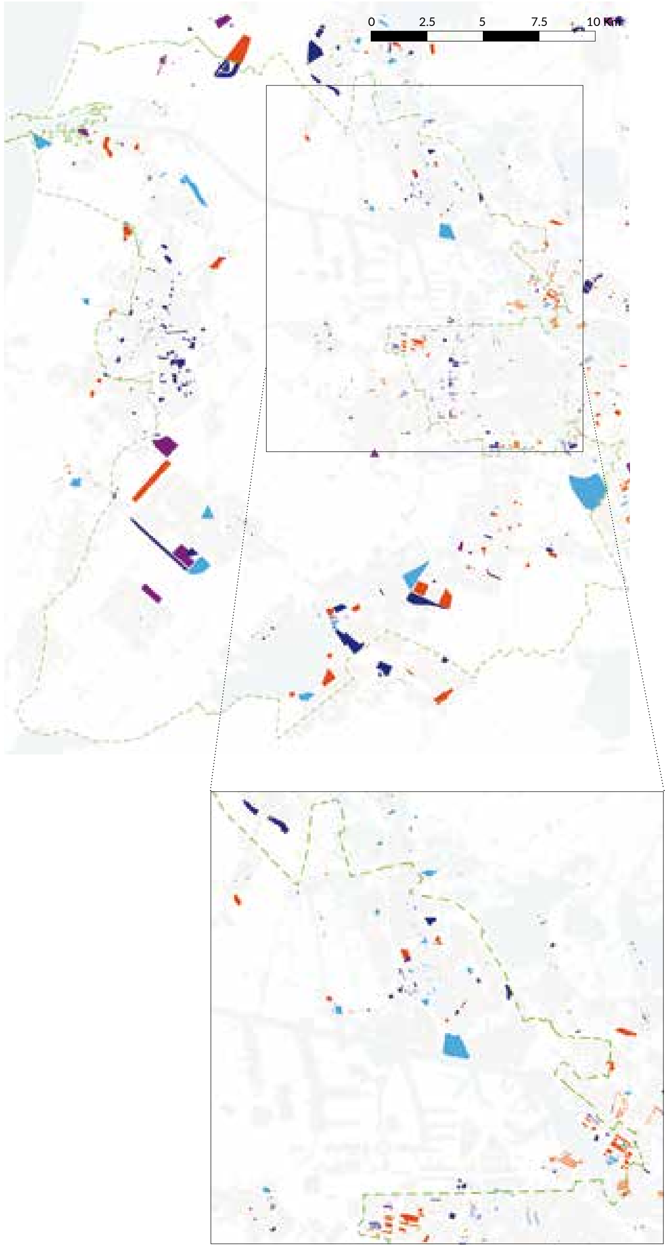


FIG 5 Unused and underused areas within Amsterdam Metropolitan Area. Source: REPAiR EU H2020 Project. Data processed from Urban Atlas (European Environmental Agency)

FIG 6 Future expansion Areas within Amsterdam Metropolitan Area. Source: REPAiR EU H2020 Project. Data processed from Ministry of Infrastructure and Water Management and Amsterdam Municipality.

In order to do implement this solution , firstly it would be necessary to create a catalogue of empty and abandoned spaces.

Maps show several possible location with a focus area of the AMA region (REPAiR 2018). (See Annex Deliverable 3.3)

The port of Amsterdam is a suitable area to implement Land Rotation EIS. Places such as Wespoort or Ruigoord are pointed out as redevelopment areas under circular economy directives (Amsterdam Circular, 2016). They are also close by potential expansion areas, defined by Amsterdam administration in the North banks of the IJ. Industrial uses coexist nowadays with underused land and a waterfront that is seen as an opportunity for new redevelopments, both industrial and residential. While waiting to be redeveloped and recycled, the underused spaces in afore mention areas can be systematically and temporarily used as storage land for construction and demolition materials.

Many of the underused areas are under private management, therefore information on ownership and leaseholds would be needed. A catalogue of underused plots would help make redevelopment processes much more efficient, saving costs and emissions in transportation, but also in time and availability of materials for new constructions.

The proposed solution can be particularly useful for regions under big pressure for redevelopment, like the Amsterdam port area. Nevertheless, a good management and design of these areas would be necessary in order to avoid perception problems and nuisances (e.g. they could seem not organised areas).

Possible adaption to the AMA context: the Harbour area

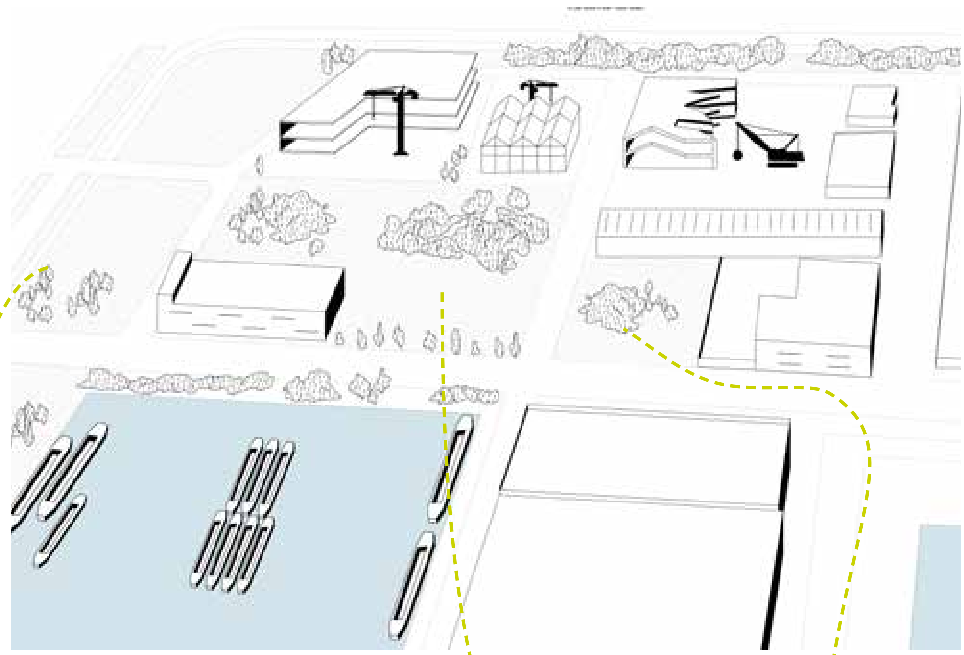
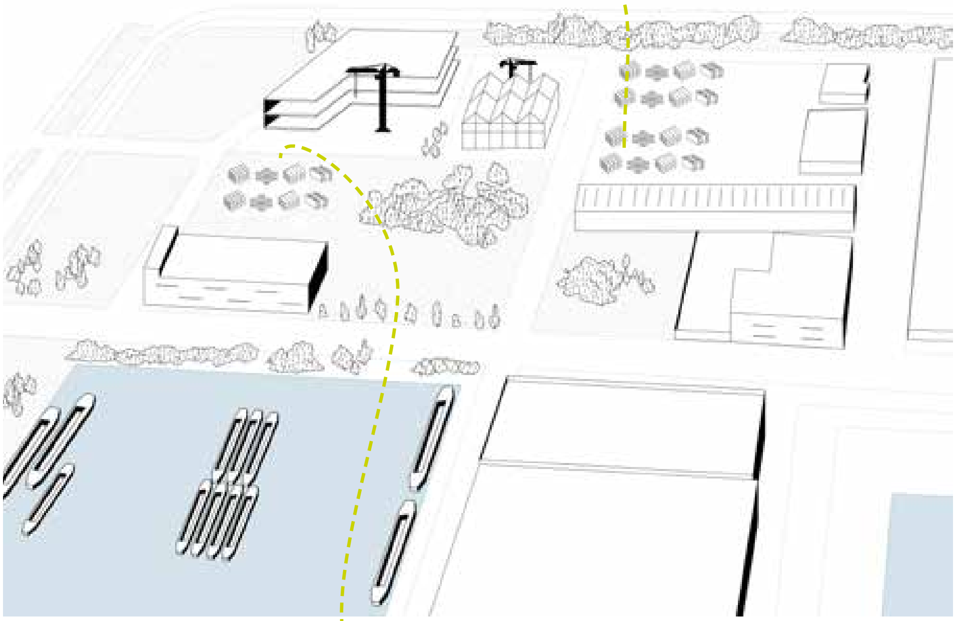


FIG 7 (top and bottom) Diagrams on spatial possibilities for land rotation Eco Innovative Solution. Source: REPAiR EU H2020 project

Green buffer zone area in between a road infrastructure and an industrial zone

Underused green area in a private industrial plot

Storage space for construction and demolition waste and reusable materials



Storage space for construction and demolition waste and reusable materials

FIG 8 Westport Area. Source: Rosa Kolkman. Found at Eva de Klerk http://www.evadeklerk.com/en/experimenteer-kavels-westpoort/

FIG 9 Ruigoord, Amsterdam. Source: Wikipedia. Found at https://upload.wikimedia.org/wikipedia/commons/6/67/Ruigoordfromsky2a.jpg

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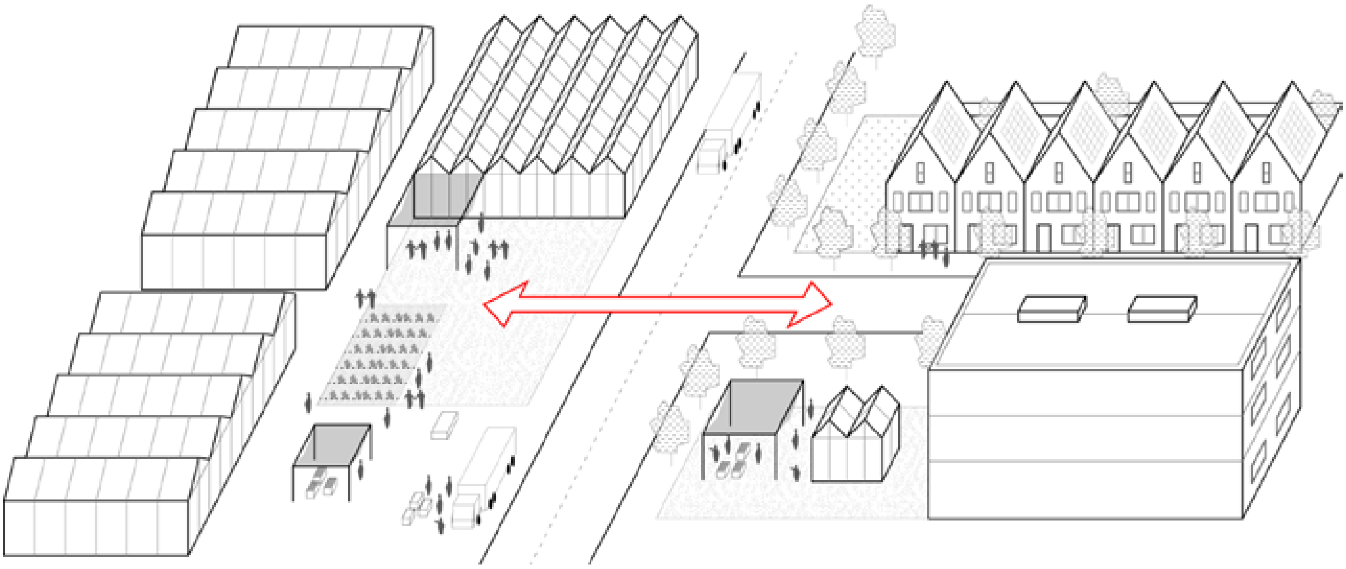
REPAiR (2018) Deliverable 3.3 Process Model, Annex Spatial Analysis AMA

Reuse of empty glasshouses

Category of outcome: Policy
Owner of the EIS*: REPAiR



Idea

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

While production of food and plants from glass houses has increased in the Netherlands during the last years, companies tend to be bigger in size and fewer in number than in the past (Wageningen Economic Research, 2018) (See Fig 7). Size of glasshouses has also increased to accommodate bigger production, leaving many small glasshouses empty or underused. These are nevertheless well connected to the infraestructure network and offer a great opportunity to include similar or alternative uses that can help connecting the rural and urban landscapes.

Glasshouses that are close to urban areas provide the ideal conditions to implement urban farms and social farming projects, in which people are able to grow their own food. They could also be part of smart food districts initiatives or green care services, such as horticultural nurseries or storage areas and selling points for organic production carried out in near by areas. In order to implement these agriculture related services, policies should be oriented to encourage green start-ups to use these spaces.

New and alternative uses could also be implemented in underused glasshouses. Smart food districts may need small research facilities, as well as multi-use spaces in which local stakeholders meet (e.g. schools groups, neighborhood associations, etc.). New uses could be related to temporary housing or recreation facilities. In order to include these activities, changes should be made in urban planning policy.

Current process

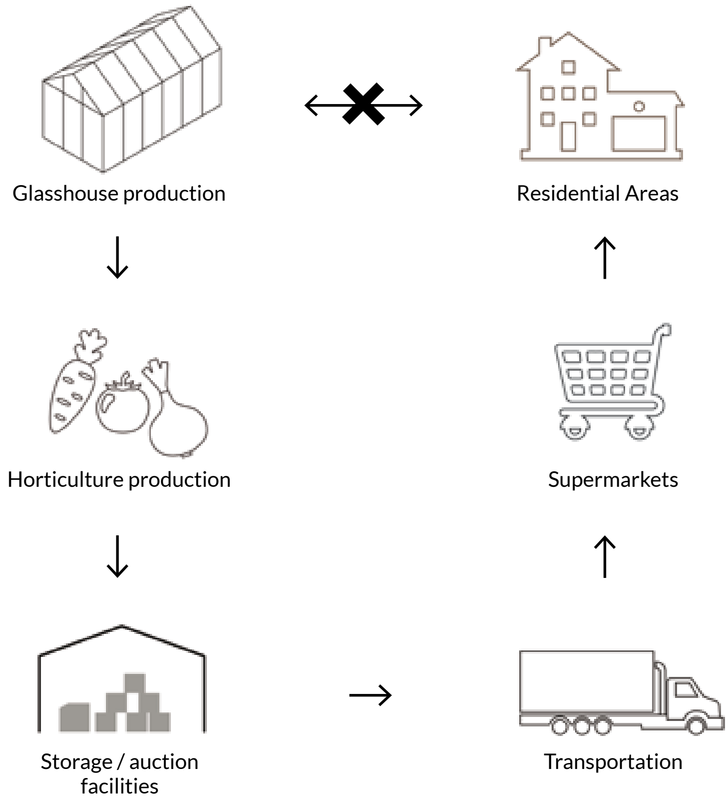
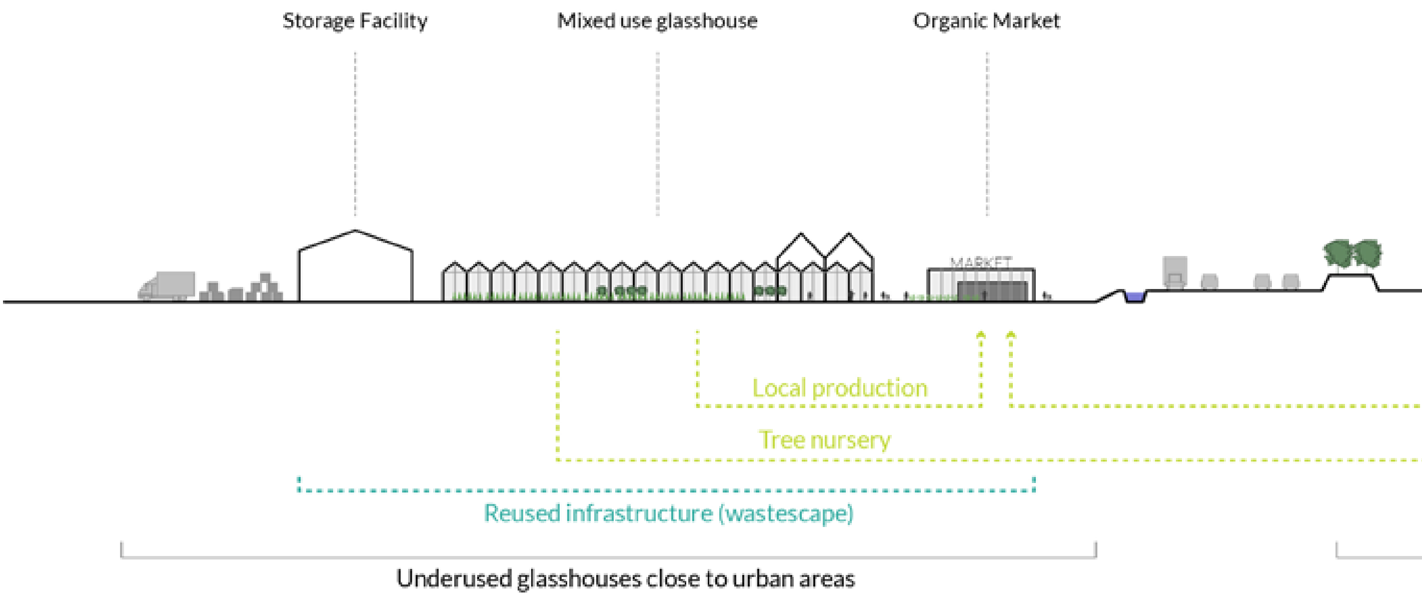


FIG 2 Process diagram of current situation. Source: REPAiR EU H2020 project.
FIG 3 (bottom) Process Section of EIS. Source: REPAiR EU H2020 project.



Proposed process

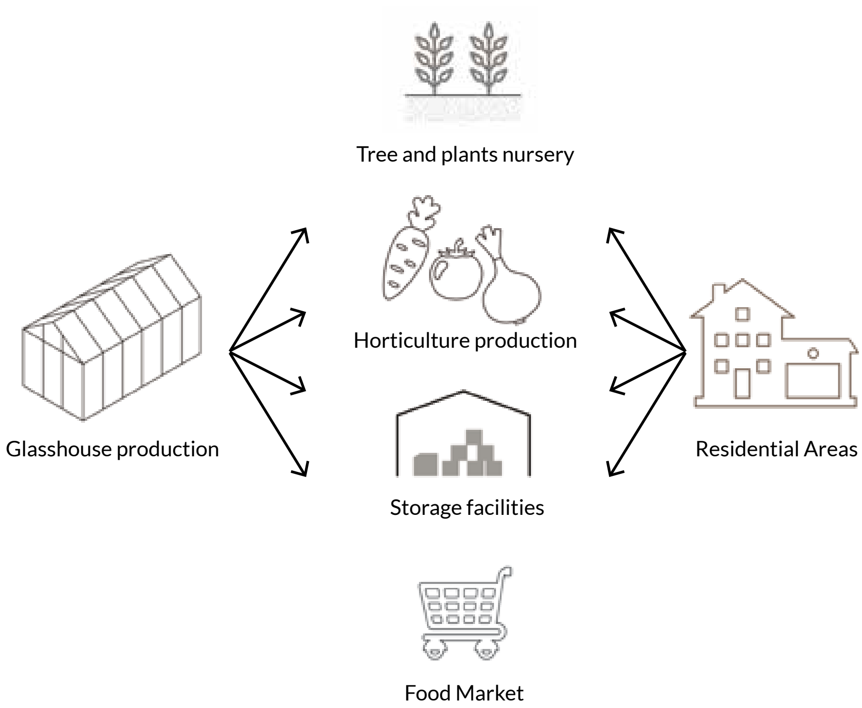


FIG 4 Process diagram of proposed situation. Source: REPAiR EU H2020 project.

Agriculture, including glasshouse horticulture production, is a strong economic sector of the AMA. The economic importance of the region globally provides also a good opportunity to this sector, being the Netherlands the second largest exporter of agrifood products in the world (Noordhoff, 2014).

Traditionally, the agriculture sector operated in the peripheral areas of the region, disconnected from the urban centers. As said before, this sector is currently under transformation, leaving on this process many underused or empty glasshouses (wastescapes). This EIS aims at using this opportunity to find new ways of using this empty infrastructure to provide new green services that make cities healthier and at the same time reconnect urban and productive landscapes.

Possible locations within AMA

Glasshouse areas close to Schiphol

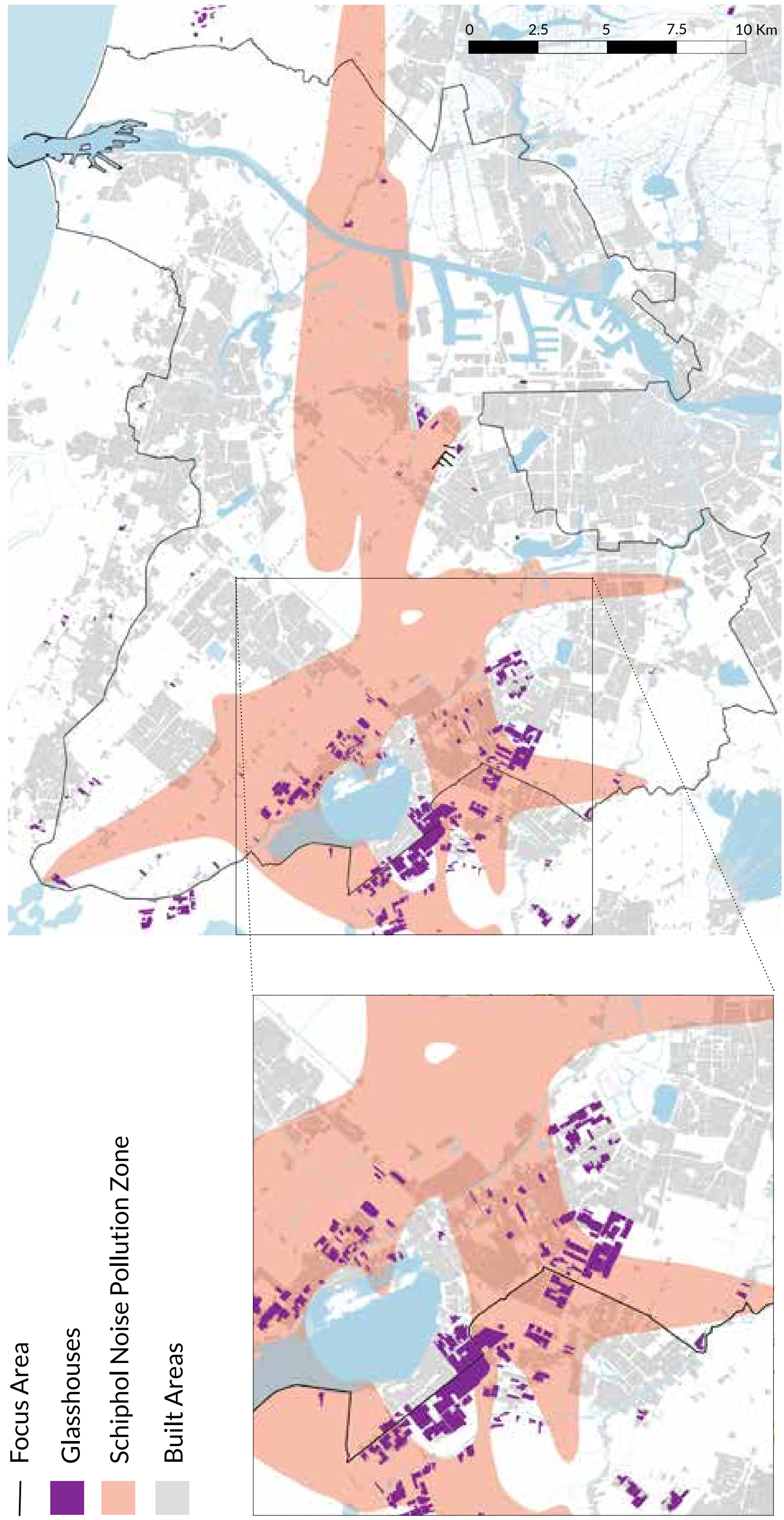


FIG 5 Glasshouses in Schiphol area of influence. Source: REPAiR EU H2020 Project. Data retrieved from Bodemgebruiksrekening voor Nederland, 2010-2012.

FIG 6 Darbey Horticulture Nursery (Norfolk, UK). Found at: https://www.royalwarrant.org/company/darby-nursery-stock-ltd

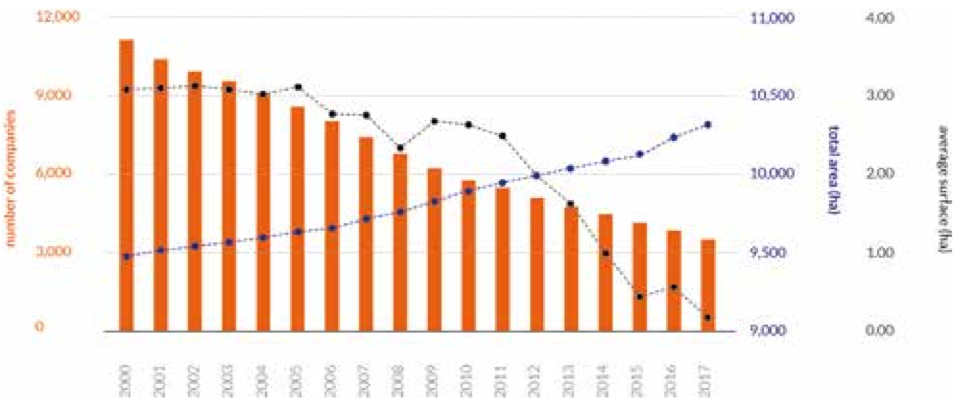


FIG 7 Number of companies, size of glasshouse area and average size of companies through time in the NL. Source: Wageningen Economic Research. Data from CBS Landbouwtelling. Found at https://www.agrimatie.nl/SectorResultaat.aspx?subpubID=2232&sectorID=2240

The land around Schiphol airport is an area of opportunity to implement this EIS. On the one hand, there are many glasshouses, from which many may get vacant due to their small size. On the other hand the area is very well connected to infrastructure and industrial services. Besides, the proximity and accessibility to and from the city of Amsterdam and many other small towns in the periphery of the city makes it a good location to implement social farming projects or green care services.

These glasshouses are nevertheless under the noise regulation areas, due to Schiphol's air traffic. Some alternative uses, such as temporary housing or recreational areas, are currently restricted under planning regulations. In order to bring these areas closer to urban centers, some of these restrictions should be reviewed.

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Wageningen Economic Research (online resource) Statistics on Greenhouse business sector. Found at https://www.agrimatie.nl/ (seen on October 23rd, 2018)

Some of the images used for the process diagram were designed by Katemangostar / Freepik (https://www.freepik.com/)

Transformation of wastescapes into stepping stones for biodiversity

Category of outcome: Policy; Environmental
Owner of the EIS*: REPAiR

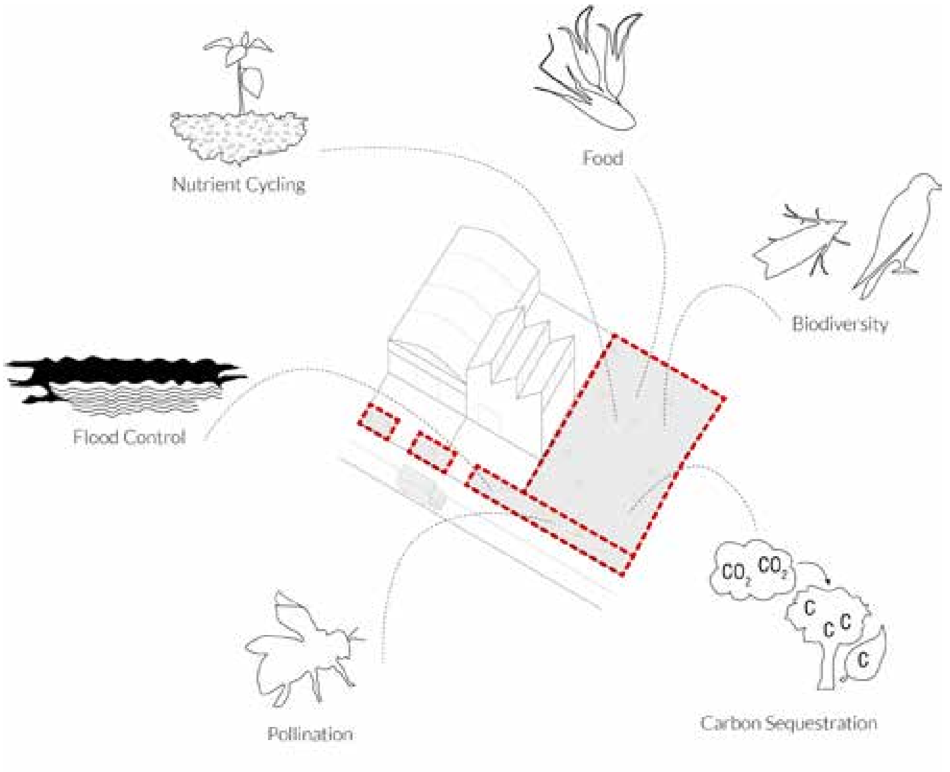


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Green buffer zones along roads and train tracks, or green vacant land in industrial areas are often seen as abandoned, empty land or areas getting "ripe for development". This land, nevertheless, has great ecological value and potential. The ecosystem services that it could provide are immense. Growing plants remove carbon dioxide and other particles from the air, green and vegetation areas are safe passages and home for animals and insects, trees clean flowing water, etc.

Current habitat loss and habitat fragmentation are the main causes for natural problems (Forman, 2008). Due to industrial agriculture and human activities, biodiversity in the AMA has decreased. One way to increase biodiversity would be to use potential land in green buffer areas as stepping stones. According to Forman (2008), these are small sequential patches used by animals to cross a less-hospitable area.

Urban regions are complex ecological entities and depend on local ecosystems and their services to survive (Marcus, Berghauser & Gren, 2014). Understanding and changing the interactions between human and ecological processes that occur in the AMA, would bring environmental, but also economic resilience to the region.

Current process

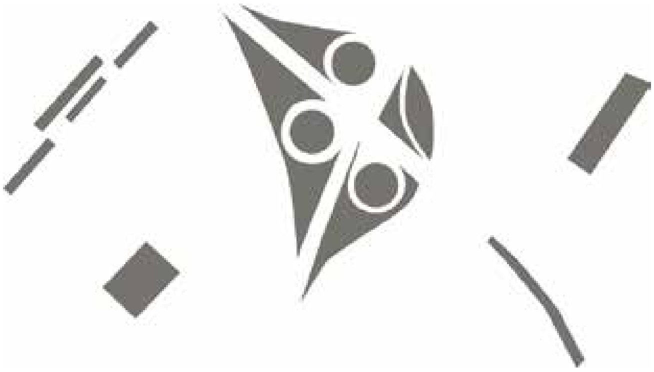
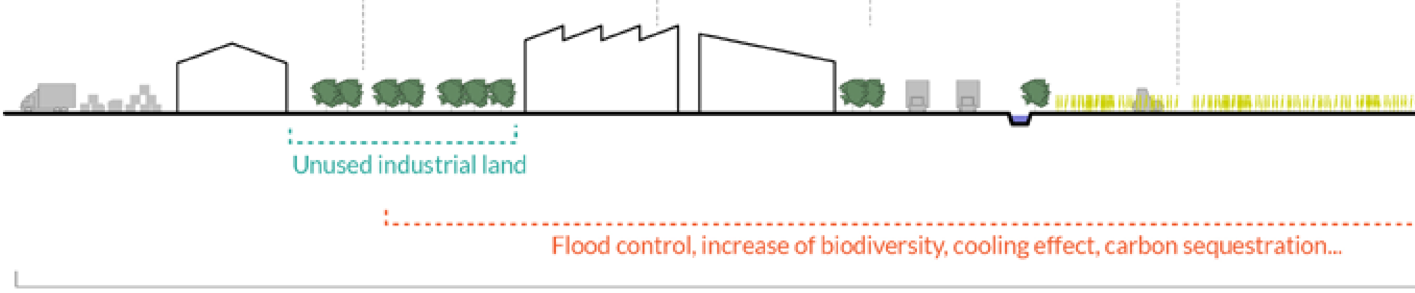


FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.
FIG 3 (bottom) Process Section of EIS. Source: REPAiR EU H2020 project.

There are many patches of land in the AMA that have potential to host flora and fauna: road and train track buffers, underused land close to industrial and agriculture areas, etc. Nowadays, these patches are seen as isolated areas and empty spaces (Fig. 2).

Using them in a different wat would change this perception and help understand their environmental potential. For that, these portions of land should be classified according to their size and environmental qualities (soil, topography, etc.).

If designed according to their environmental potential, these patches of land could be used as stepping stones, or connections for the fauna and flora to pass through the region (Fig. 4). Spatial land planning for protection and management can provide additional benefits that improve the persistence



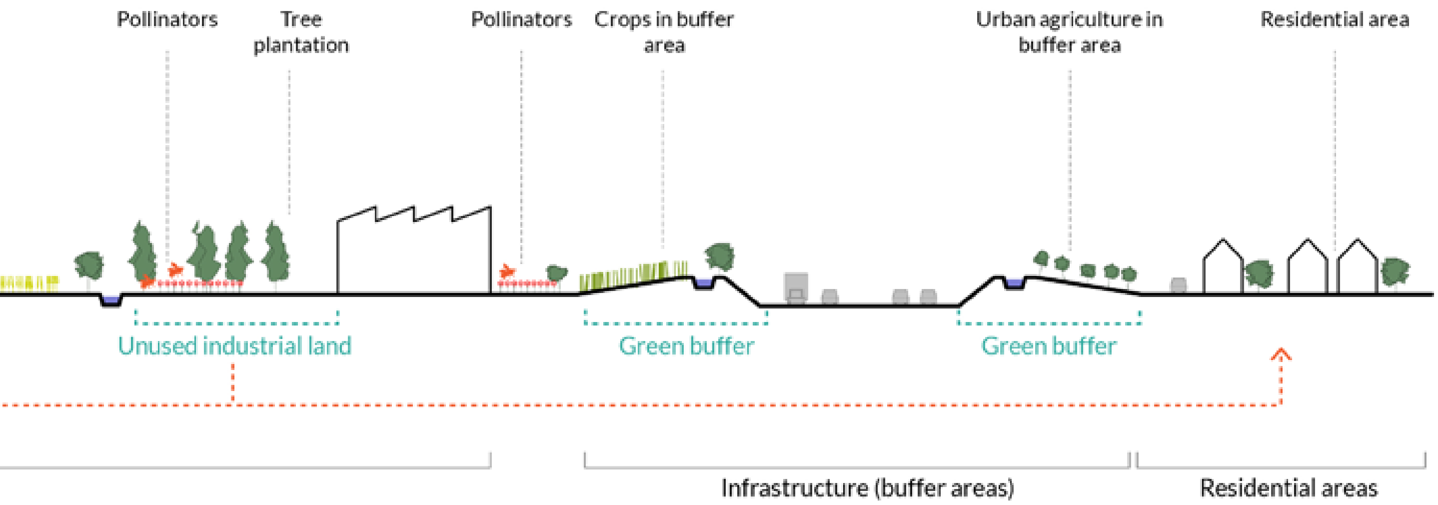
Proposed process

FIG 4 Diagram of proposed situation. Source: REPAiR EU H2020 project.

of species on small patches. This would also bring benefits to urban areas, such as cooling down temperatures, carbon sequestration, flood control, food provision, etc.

The development of urban regions affects ecosystem processes both directly and remotely through land conversion, use of resources, and generation of emissions and waste. Those changes, in turn, affect human health and well-being (Alberti et al, 2003).

This strategy could be linked to existing planning policies, such as urban green belts, open space plans or existing environmental networks, such as Natura 2000, or it could also be applied through compensation of industrial activities.



Possible locations within AMA

Areas close to Amsterdam City Limits

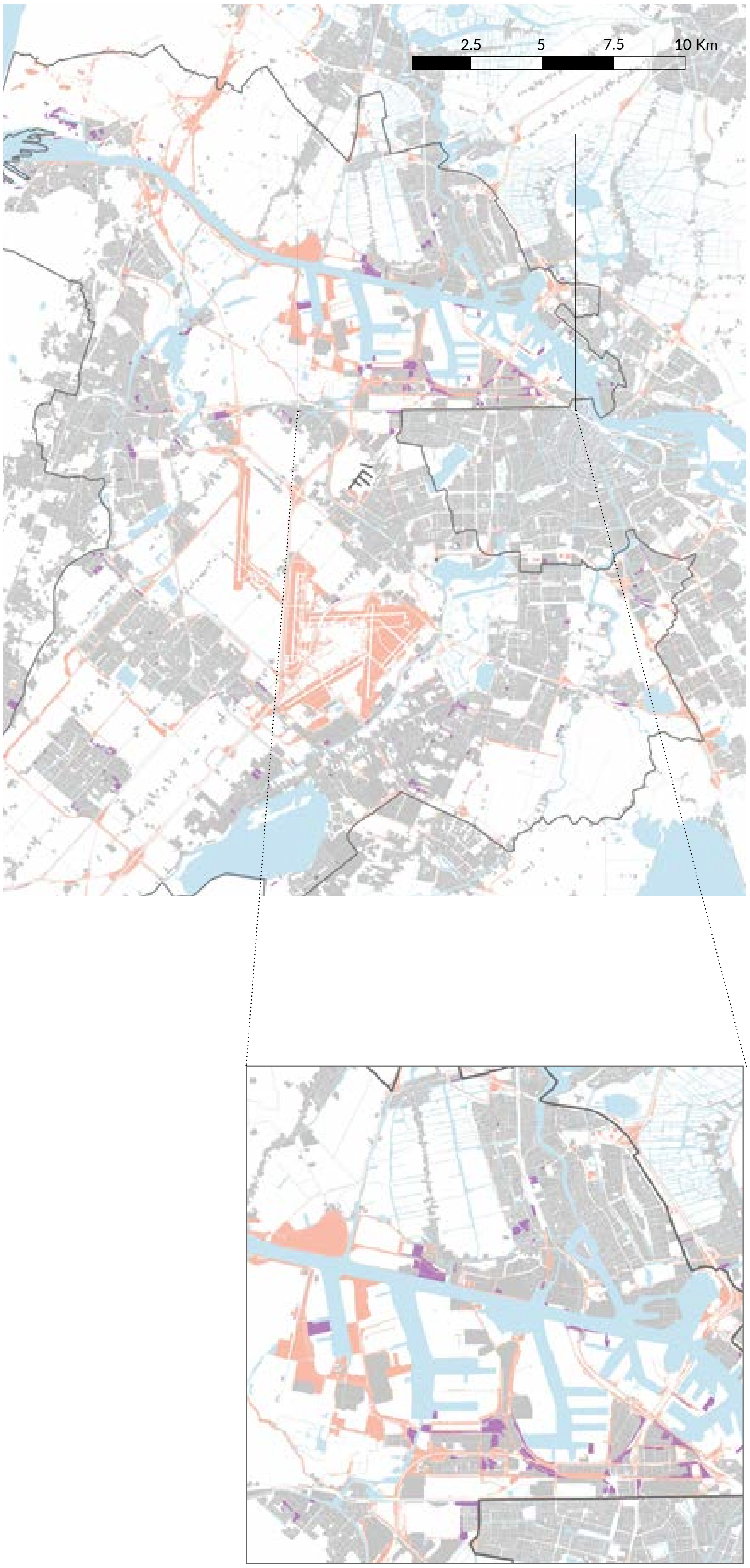


FIG 5 Empty areas, buff-erzones and wastescapes in AMA. Data: REPAIR EU H2020 project

Focus Area
Built Areas
Drosscapes*
Land without current use

* Bufferzones and empty areas around infrastructure

FIG 6 Industrial Agriculture and road infrastructure in the AMA. Source: Google Earth

Industrial agriculture in the AMA has decreased the biodiversity of the region importantly. The area is crossed by big infrastructures that consume land and create discontinuities in the landscape. Although the best situation for environmental connections is to have a continuous green corridor or surface for organisms go through and develop, the second-best way to provide connectivity is with stepping stones.

As seen in Fig. 5, the AMA has a great potential to create these stepping stones' connections and make it possible for organisms to go through a large territory.

Sources

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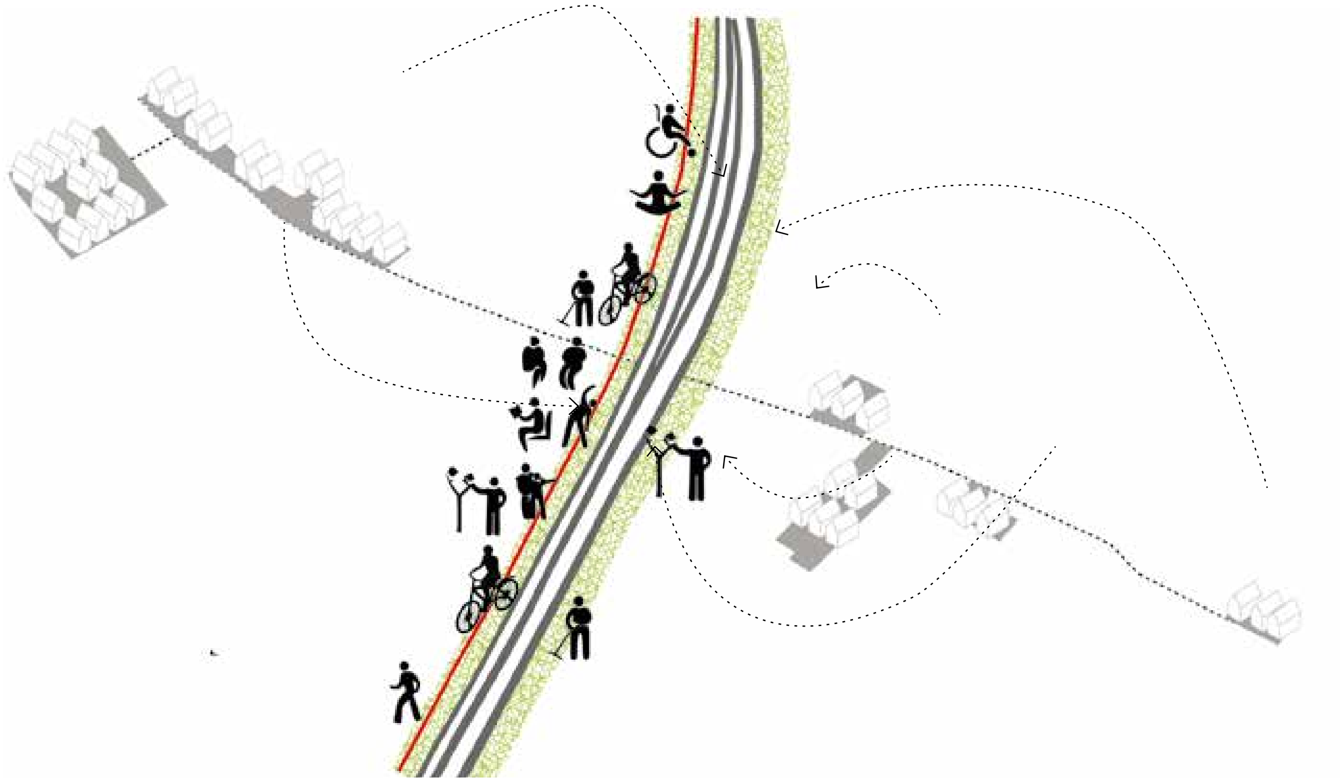
Transformation of green buffer zones into areas for leisure activities

Category of outcome: Policy
Owner of the EIS*: REPAiR



Idea

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

In the Netherlands, the land in proximity to highway, rail and airport infrastructure is subject to considerable restrictions. Consequently, it may result in a neglected portion of the territory and a physical disruption of the urban fabric where no permanent program is allowed.

This solution aims at taking advantage of this underused space to allow for development of temporary activities for communities living close by. This EIS is also related to the solution "Transformation of wastescapes into stepping stones for biodiversity". Although some ecosystem services, such as fostering biodiversity, may not be completely compatible with human activities, it would be interesting so understand the role of all the buffer zones and green patches as an integrated network.

The solution is not a conventional design, but a strategic proposal for a green network. For the implementation of this network, policy would have to align the different interests of stakeholders: Environmental agencies (protection of land and biodiversity), Dutch Ministry of Infrastructures (management of

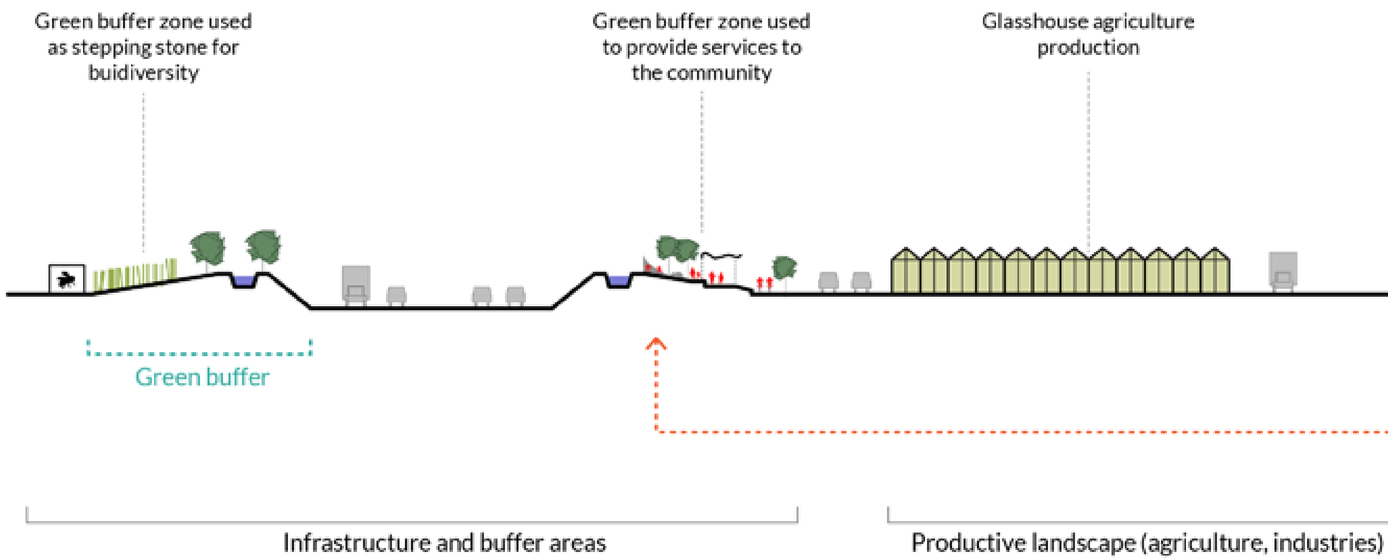
Current process

In order to develop buffer zones, changes have to be made in policy to allow temporary uses and human activities. These areas, along infrastructure networks are not always accessible to communities. Therefore, those buffer zones close to existing residential areas should be prioritized.

Recreational and environmental zones, developed along the transmission network, could be combined with leisure activities and temporary stay zones. Considering the linear shape of these buffer zones, a sequence of new bike path, linked to the existing ones, could be implemented. Platforms with street furniture, sport furniture and view-points, could also be connected to the new designed bicycle network.

If ecosystem services are to be provided in these areas, an interesting combination of both activities for communities and enhanced connectivity for small species could be community orchards or gardens. These would at the same time, provide social services for groups of people who would be interested in grow their own food or use their free time in gardening activities,

FIG 2 (bottom) Process Section of EIS. Source: REPAiR EU H2020 project.



Proposed process

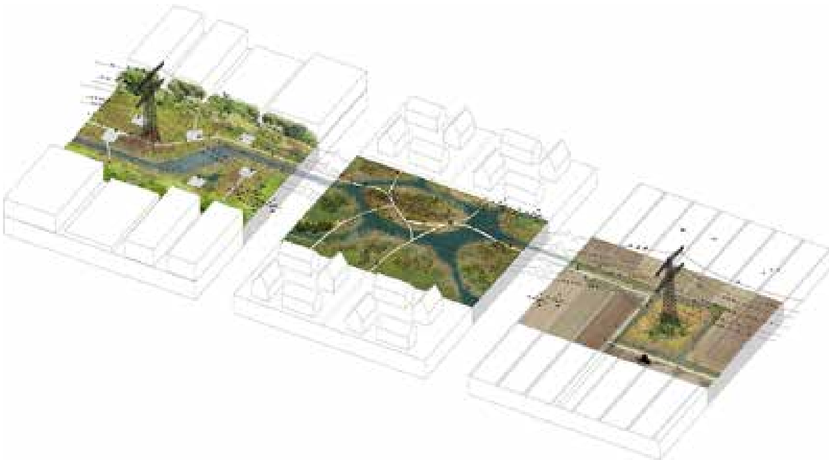


FIG 3 Exemple of possible transformation of unsed green buffer zones in leasure facilities. Source: Lola Architect http://lola.land/projecten.php?id=70

on Wastescape

Possible locations within AMA

Areas close to Amsterdam City Limits

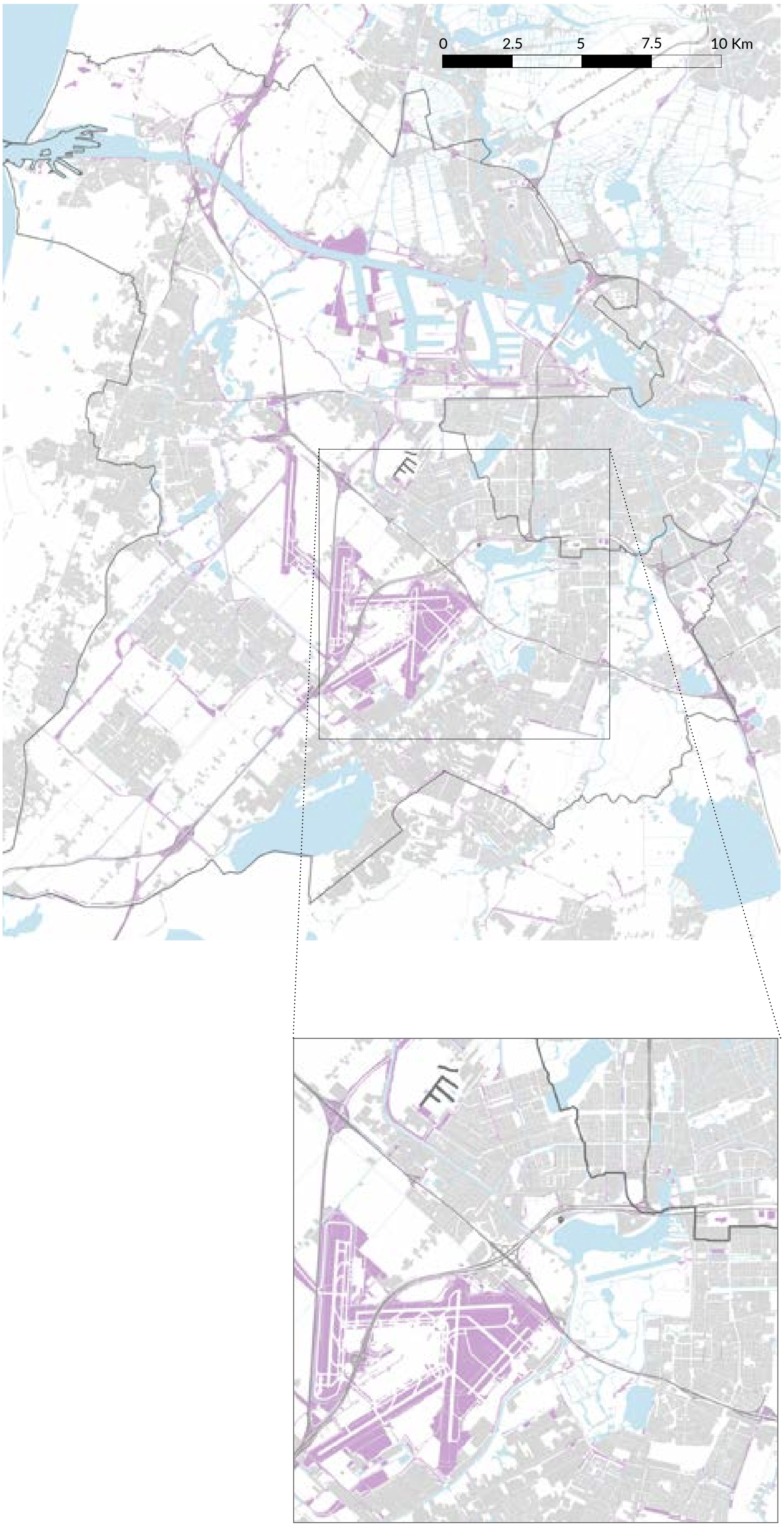


FIG 4 Bufferzones and wastescapes in AMA. Data: REPAIR EU H2020 project

Focus Area
Highways and roads
Built Areas
Buffer Zones

* Buffer zones and empty areas around Schipol airport infrastructure

FIG 5 Buffer zones and road infrastructure in the AMA. Source: Google Earth FIG 6 {Accessed November 2018]

Many residential areas are already connected through the road network to these buffers zones along infrastructure. These, nevertheless, poses also a problem in term of coexistence of traffic and people. For this reason, bicycle and walking paths should connect the existing communities with the buffer zones. In other cases, like in fig 4 (1, above), the buffer zones are already in contact with residential areas. Even in these cases, a policy change is needed in order to be able to implement temporary and human activities in infrastructure buffer zones.

According to the result of the PULL workshop hold in Amsterdam on September 2018

This solution is very relevant in relation with the loss of biodiversity in the AMA urban landscape. This solution is potentially applicable in buffer zones next to motorways, railway lines and energy infrastructure.

Different actors might be interested to develop this solution such as: Owners of the land, mainly the Dutch government - Dutch Ministry of Water Management and Infrastructure, Wageningen University, Landscape architects. Moreover the development of this solution could attract funding from several organisations (e.g., Stichting EIS, Funds 818) and also from the

Re-purposing vacant offices for affordable housing

Category of outcome: Political

Owner of the EIS*: REPAiR (TUD, Metabolic)

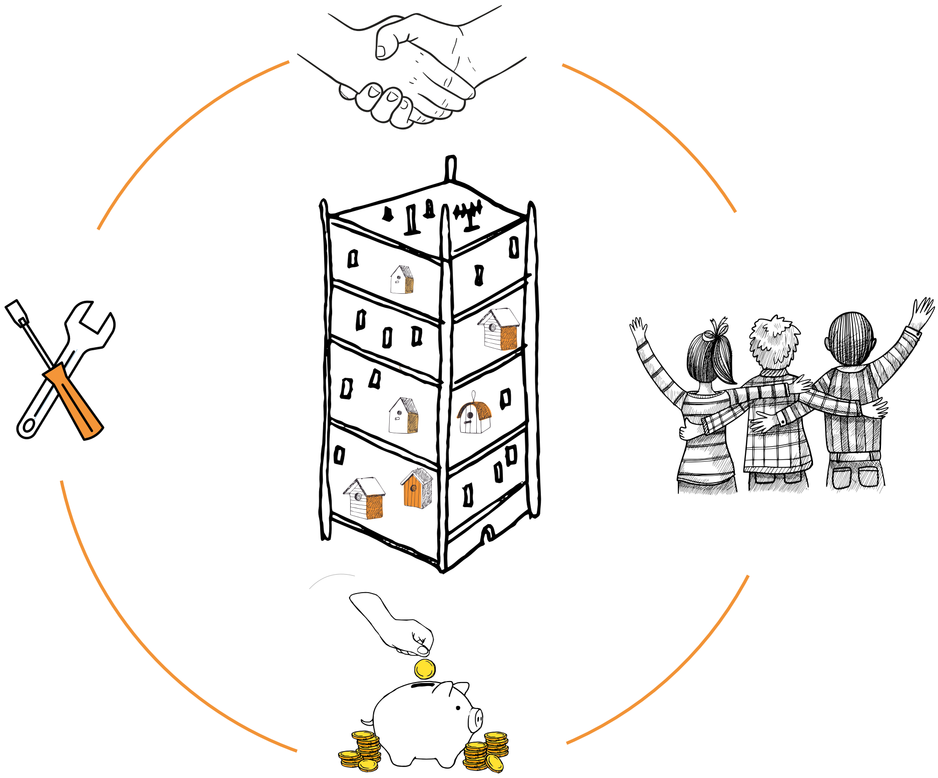


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea*

Repurposed offices offer a solution to the increasing demand of housing for young people in urban environments. The continuous influx of students are to a great extent the driving forces behind an unmet demand for housing in cities. As the demand for housing grew, office spaces across western cities have become increasingly vacant due to ill-fated real-estate investment speculation (Remøy & van der Voordt, 2014). The rate of vacant offices in the MRA has increased over the last years. In 2014, this amounted to nearly 17%. Half of these vacancies are structural, meaning that they have been empty for over 3 years (Circle Economy, 2015). In order to optimize the use of space within cities and consolidate density there lays great opportunity repurposing vacant offices them to provide housing for young people. The degree to which office spaces can be physically transformed proved to be one of the highest determining factors of success. Relevant factors enabling the transformation of outdated offices for the young include the adaptability of the office spaces .

* *See page 135 for the complete description of the solution*

Re-purposing vacant offices for recreational activity for local community

Category of outcome: Political, Social, Legal

Owner of the EIS*: REPAiR (TUD, Metabolic)

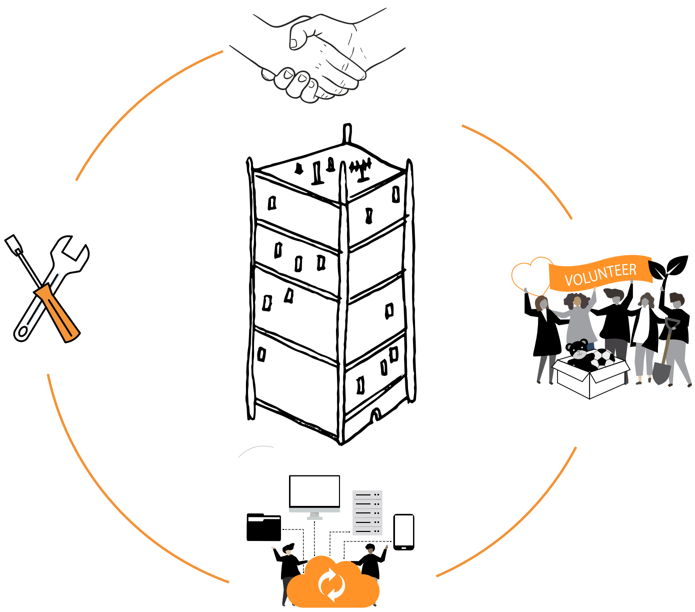


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea*

As explained in the previous EIS office spaces across western cities have become increasingly vacant due to ill-fated real-estate investment speculation (Remøy & van der Voordt, 2014). The rate of vacant offices in the MRA has increased over the last years. In 2014, this amounted to nearly 17%. Half of these vacancies are structural, meaning that they have been empty for over 3 years (Circle Economy, 2015). In order to optimize the use of space within cities and consolidate density there lays great opportunity repurposing vacant offices them to provide space to engage the local community . The degree to which office spaces can be physically transformed proved to be one of the highest determining factors of success. Therefore, this solution aims to propose a new business model.

• Throughout an online platform, managed by municipalities or even start-up empty abandoned offices and commercial buildings are offered for neighbourhood or community activities. In exchange, owner will have a lower taxation. Moreover the EIS could facilitate community engagement in social activities, like: exhibitions, university courses,urban agricultural will keep these areas alive.
This solution could be interesting for building developers that prefer to find alternative temporary solution to houses. The solution can be applied in the city centre of Amsterdam, port area, Haarlemmermeer.
The possible actors to be involved are: municipality, local community, owners of the dwellings or buildings, developers, architects, museums, artists, green business clubs,

**Regarding the change of policies and process and the description of the entire solution see page 135*

Beyond INERTia. Circular supply chain for CDW

Category of outcome: Economic, Technological, Environmental, Legal

Owner of the EIS*: UNINA Living Lab

Idea*

Beyond INERTia strategy introduce a set of EISs to trigger specific weak points in current supply chain of recycled aggregates from production to reuse and, then, to create services aiming at improving the recycling and recovery of CDW. To prevent illegal dumping and promote regeneration of wastescapes. Beyond INERTia aims at intercepting CDW flows of small producers and prevent unauthorized disposals. For that, it provides for increasing of places where is allowed to bring CDW, reducing transports burden for users. The Strategy also considers CDW from Special Waste flows. In this case it is necessary to consider the whole supply chain triggering those rules that do not facilitate Recycled Aggregates spreading in the market. Therefore, EISs of Beyond INERTia Strategy facilitate:

- Enabling selective demolition improving of CDW separation and flow quality;
- Avoiding illegal dumping;
- Recovering of materials from mixed rubble in municipal solid waste;
- Implementing regional action "regional mark of Environmental Sustainability" for recycled aggregates;
- Providing inert waste for local uses and facilitating a short supply chain

Beyond INERTia acts on weak points of CDW supply chain, activating practices to operationalise circular economy and to create conditions for wastescapes prevention and re-mediation. Six punctual elementary EISs have been designed:

1. NMR. No more rubble: incentives to companies that make Selective demolition
2. INERTIA FACEP. Free collection Eco-Points for CDW from Urban Waste, disposed by little producers. It can be integrated with INERT LAB.
3. INERT LAB. It is a Laboratory to: separate inert waste from mixed CDW, sort, process and sell them to sector companies.
4. ARC. Activation of Regional Sustainability Certification for Recycled Aggregates from Inert Waste.
5. B€ST. Putting the item and price of "Recycled Aggregates" in tender specifications.
6. SHAPES. Using recycled aggregates in backfilling operations for new morphologies of terrains along roads and around recycling areas.

** This is a summery of the EIS elaborated by UNINA team. For the complete solution please see REPAiR Deliverable 5.3.*

Current process

CDW represents the most substantial waste flow in Italy, being the 40% of the total Special Waste (SW) flows. If we analyse production of hazardous and non-hazardous SW flows, it is evident that production of non-hazardous SW is mostly due to Construction and Demolition sector. In Campania region CDW amounts to 43.3% of total regional waste production.

Production of CDW can result from at least four sectors:

1. Construction and demolition activity;
2. Unauthorised construction and demolition activity;
3. Domestic "Micro renovations" made on own account;
4. Other activities.

In accordance to paragraph 3 of article 189 (Waste Cadastre) of Legislative Decree n.152/2006, only Institutions and Companies that produce hazardous waste and those who produce non-hazardous waste, with a number of minimum ten employers, are due to the annual single model of environmental declaration (MUD). That is the main reason why is not possible to have a complete information about non-hazardous SW from all free MUD sectors and small companies with less than 10 employers. Inert waste from UW are a very small part, it seems that the most is not traceable. This lack of information in part correspond to shadow flows.

CDW have two possible destinations:

1. Recovery of material for production of base layer for roads;
2. Disposal in landfill for inert waste.

In Italy there is a huge quantity of extraction of sand and gravel and simultaneously a similar quantity of inert waste produced per year. The large quantity of material produced in numerous quarries is one of the reasons behind the low reuse of CDW. According to ATECAP (the Italian associations for concrete), the main critical issues in supply chain of recycle of inert waste are bureaucracy, illegality and non-application of some laws. Very few producers use recycled aggregates for backfilling operations and for the production of concrete. Price is not the main factor limiting the use of recycled aggregates. Reasons for not using recycled aggregates are the following: very fragmented offer, products available not everywhere; limited knowledge of the technical characteristics; high price of transports; incompatible properties of some recycled aggregates with technical standards; lack of demand, etc. Regional and general issues concerning CDW in Naples focus area, have been discussed with local actors during the fourth PULL meeting. They can be linked to different points of the whole process of CDW management, that can be summarised as follows:

- Selective demolition, although introduced at a regulatory level in 2013, has never been adopted;
- Secondary raw material (Materia Prima Seconda - MPS) stored in the company does not have a good market and does not meet the requirements of the tender dossier;

- The process of demolition and disposal must be designed from the beginning;
- The form of recycling of some aggregates can be linked to specific territorial projects, such as the reconfiguration of illegal territories or the safety of territories (for example where there is risk of flooding), determining the construction of a new landscape;
- It could be possible to use door-to-door containers for disposal of CDW.

Eventually, during the three PULLs meetings in Afragola, focused on Wastescape, citizens and local actors from Afragola, Caivano and Casoria

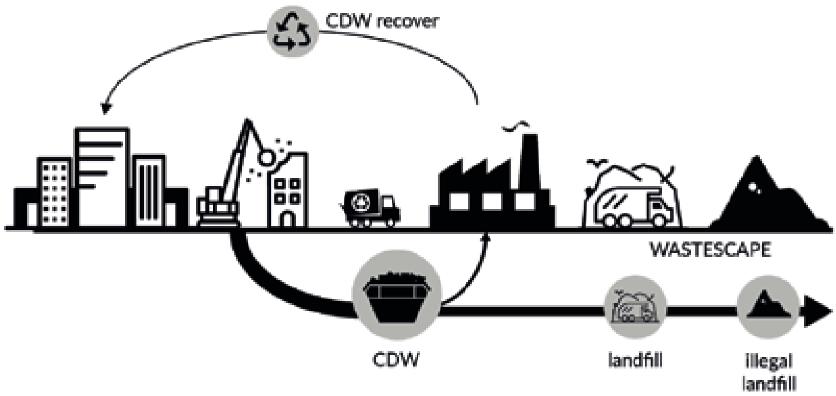


FIG 1 Current Situation of CDW in Campania Region, Chiara Mazzarella, UNINA team, 2018

highlighted the emergency of CDW related to urban dysfunctions, mainly caused by illegal dumping along roads and in some points of peri-urban area. The main problem of unauthorised disposal in terrains and along roads is mostly caused by individuals and small companies. Considering CDW from UW and SW we have two different but interacting categories of issues. Households CDW constitutes a tiny part according detected flows, but they are the origin of a big feature of shadow flows that are dumped in wastescapes. Compared to backwards hierarchy of actions for waste management, it is clear of how our list of critical issues define a weak supply chain in CDW management for recycle aggregates production/reuse. Eventually, during the three PULLs meetings in Afragola, citizens and local actors highlighted the emergency of CDW related to urban dysfunctions, mainly caused by illegal dumping along roads and in some points of peri-urban area. The main problem of unauthorised disposal in terrains and along roads is mostly caused by individuals and small companies.

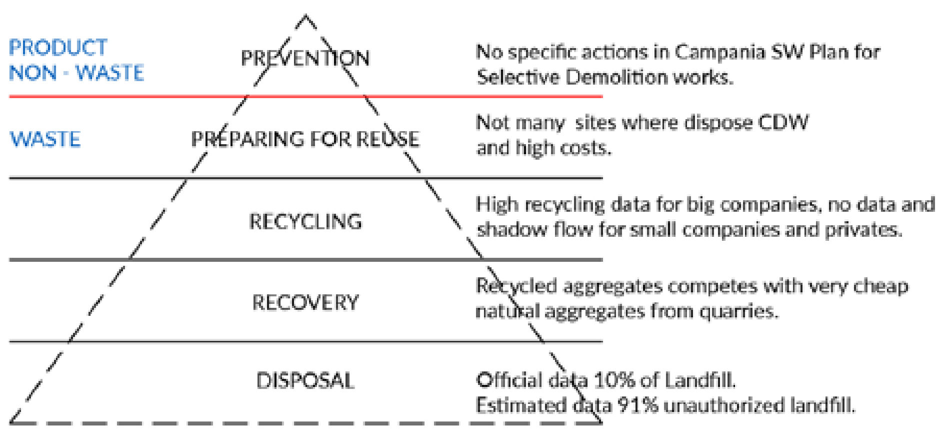


FIG 2 Backwards Hierarchy of CDW Current Situation in Italy and relative main critical issues in Campania Region, Chiara Mazzarella elaboration, UNINA team 2018.

Future process

Beyond INERTia aims to address the weak elements of supply chain process considering local dysfunctions in inert waste recycle and trigger elementary EISs. As the main part of CDW flow consist in inerts, the objective is to make shorter the circular supply chain and production of certified Recycled Aggregates (RA) production. RA supply chain is more sustainable than Natural Aggregates, both because of environmental aspects, avoiding natural resources depletion, and for social and economic ones; in fact, for the same production, RA supply chain can generate 30% of more employment.

Elementary Eco-Innovative Solutions

Considering the critical issues described in the above pyramid, the set of EISs proposed aims at reversing the pyramid by improving from Prevention, Preparation for Reuse, Recycling and Recovery to Disposal.

Eco-Innovative Solution	Objectives
3.1 NMR. No more rubble. Incentives to companies that make Selective demolition.	Enable Selective demolition introduced at regulatory level in 2013.
3.2 INERTIA POINT. Free collection Eco-Points for CDW disposed by little producers. Can be integrated with INERT LAB EIS.	Increase collection points of CDW in the area to reduce transports and avoiding illegal dumping.
3.3 INERT LAB. Integrated Lab joint with free collection Eco-Points to: separate inert waste from mixed CDW, sort, process and sell them to sector companies.	Recovering of inerts from mixed rubble and rescuing them from landfill.
3.4 ARC. Activation of Regional Sustainability Certification for Recycled Aggregates from Inert Waste.	Selling of good recycled aggregates to construction companies for reduce extraction of aggregates quarries.
3.5 B€ST. Put the item and price of "Recycled Aggregates" in tender specifications.	Introduce specifications would facilitate the use of RA in public and private works, as proposed by Legambiente.
3.6 SHAPES. Using recycled aggregates in backfilling operations for new morphologies of terrains along roads and around recycling areas. *linked to EIS 2.5	Using class C recycled aggregates and reduce extraction of natural materials for backfilling operations.

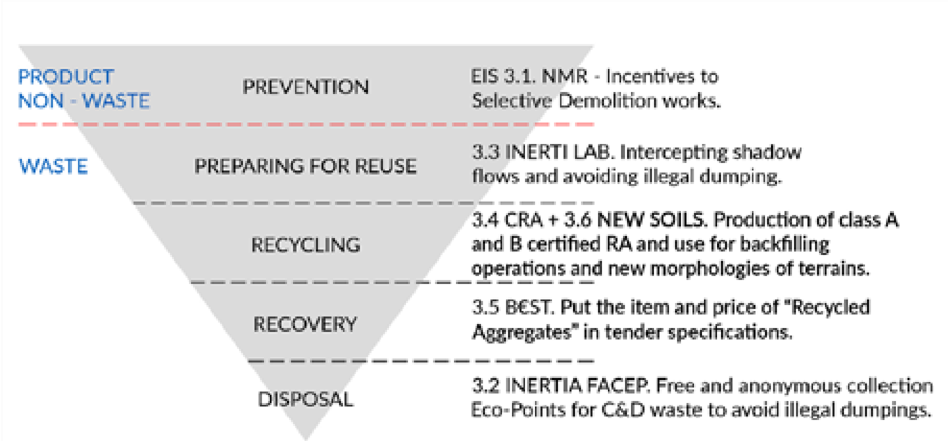


FIG 3 Beyond Inertia Strategy and EISs in Waste Hierarchy according to Waste Framework Directive (2008/98/EC).Chiara Mazzarella elaboration, UNINA team, 2018.

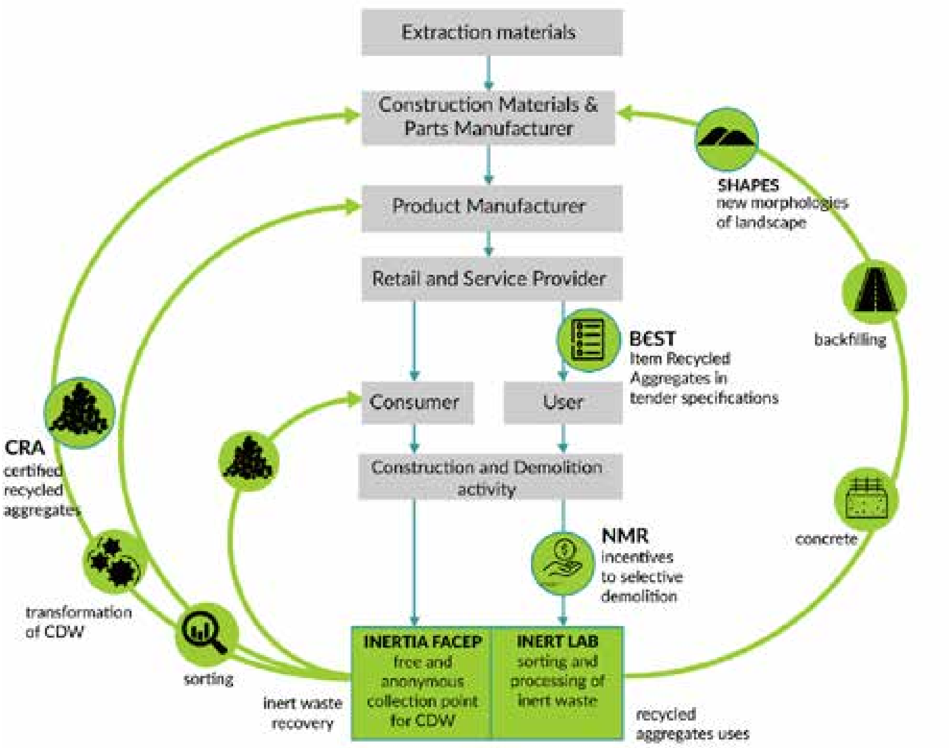


FIG 4 Circular process scheme of Beyond Inertia Strategy and EISs. Chiara Mazzarella, UNINA Team, 2018

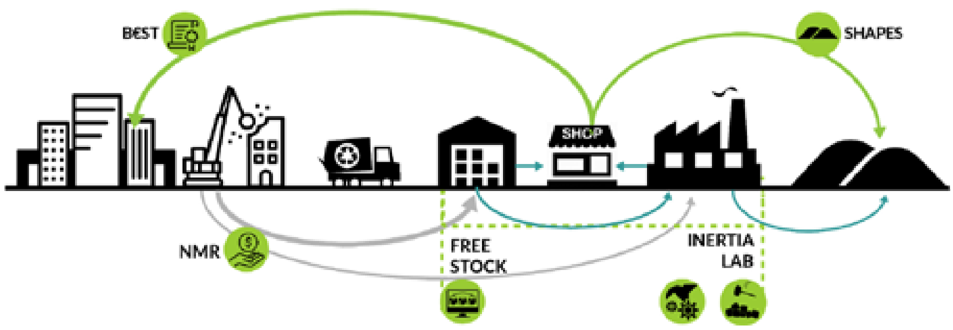


FIG 5 Systemic section of Beyond INERTia EISs. Chiara Mazzarella, UNINA Team, 2018

Scope for Knowledge Transfer of Beyond INERTia to the AMA

FIG 6 Knowledge transfer event in Amsterdam: discussion with stakeholders on the transferability of EIS from Naples. Marcin Dąbrowski

EIS:	**Beyond INERTia**
Transferability from Naples to Amsterdam	Low
Transferable elements	The least transferable EIS from Naples, mainly due to cultural differences and different organisation of disposal. Only some of the ideas behind this EIS were deemed transferable (e.g. providing support for handling CDW by individuals and support for informal waste collection from individuals engaged in small-scale construction work).
Adaptations needed to transfer the EIS	Collection would need to happen through a network of neighbourhood collection points. Digital support tools could provide accurate and real-time information on the material to reuse at different collection points.
Key barriers for transfer	First barrier related to the different organisation of the flow of CDW, with hardly any illegal dumping problem and predominance of companies (as opposed to individuals) in the construction sector, having well organised processes to dispose of their waste. The second barrier related to the limited availability of space for storing CDW, making accessibility of collection points a challenge. Finally, a legal barrier: lack of quality assurance and liability for the recovered materials making the operation of the EIS unlikely in the Dutch context.
Potential location in the AMA	Unspecified, however, the such CDW collection points would have to be more local and decentralised than in the proposed solution for Naples.
Actors to be involved	All actors involved in the CDW flow, from architects, builders, waste management companies, to users.

RECALL: REmediation by Cultivating Areas in Living Landscapes

Category of outcome: Economic, Environmental, Technological and Legal

Owner of the EIS*: UNINA Living Lab

Idea*

Reclamation of polluted soils and water, and restoration of the former agricultural tradition to promote new forms of circular economy for the wastescapes located into the MAN. Furthermore, this EIS seeks to promote an improvement of the employment situation involving the local community in the agricultural activities.

Potential Impacts

Restoration of traditional agricultural crops and consequent improvement of the identity of the area; improvement of the employment situation of the local community; possibility of activating territorial labs to promote a circular use of the crop and water involved in the remediation process.

** This is a summery of the EIS elaborated by UNINA team. For the complete solution please see REPAiR Deliverable 5.3.*

Current process

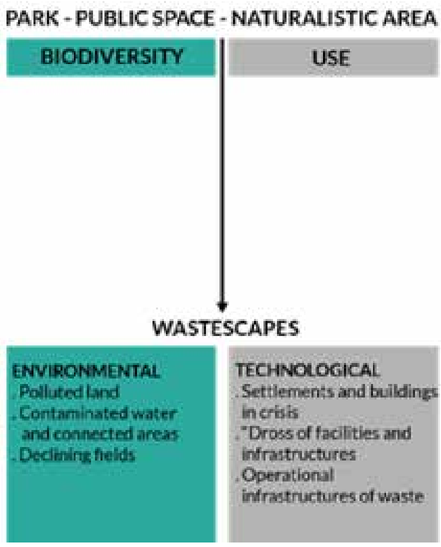


FIG 1 Linear scheme of the current situation of the wastescapes. Valentina Vittiglio & Libera Amenta, UNINA Team, 2018

The development of this EIS started from the analysis of the current linear situation of the wastescapes of the MAN, where conditions of environmental and social decline, inaccessibility and disuse come to light (Fig.1). The EIS adopted has as a starting point the specific and original features of the site. In fact, historically, Italy has been the second world producer of hemp after Russia; the majority was produced in Campania, and specifically in the provinces of Naples and Caserta. Here the cultivation of hemp was one of the dominant agricultural activities until the late 90s and constituted one of the main means of sustenance, characterizing urban and agriculture elements. For these activities, the Regi Lagni rivers were (and still actually are) essential infrastructures. Moreover, the Regi Lagni rivers were intensely exploited and consequently also heavily polluted.

FIG 2 Systemic section of the Eco Innovative Solution Valentina Vittiglio, UNINA Team, 2018

Future process

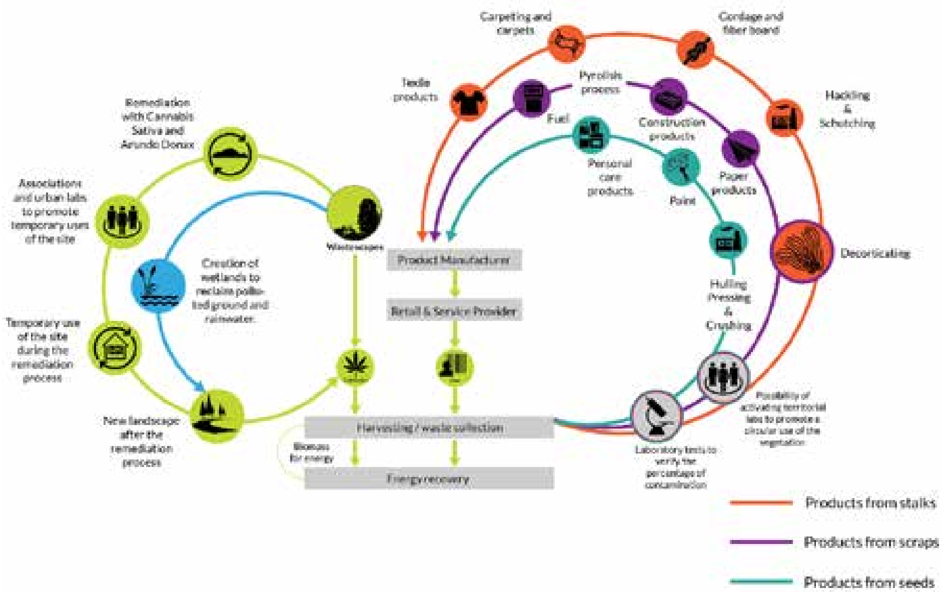


FIG 3 Circular process scheme on the circularity of wastes-capes during and after the remediation process. Valentina Vittiglio, UNINA Team, 2018

To decontaminate the soil, this EIS proposes the use of phytotechnologies to be implemented with some agronomic proposals related to typical cultivations suitable for that purpose. In particular, the EIS considers the use of Cannabis Sativa (hemp) and Arundo Donax (cane), in accordance with what emerged during the PULL. Cannabis Sativa is a hyperaccumulator (Fig.2), thus it is able to collect and tolerate high concentration of heavy metals from polluted soils. It has been used in the treatment of water and soils contaminated by heavy metals, in particular of Copper (1530 mg kg - 1), Cadmium (151 mg kg - 1) and Nickel (123 mg kg - 1), radionuclides, and aromatic compounds (hydrocarbons and PCBs) (R. Ahmad, Z. Tehsin, S. Tanvir Malik, S. Ahmad Asad, M. Shahzad, M. Bilal, M. Maroof Shah, S. Ali Khan, 2016). In addition, after harvesting the hemp once elapsed a period of six months, the EIS proposes the use of Arundo Donax, a perennial cane, sowed simultaneously with hemp, in order to continue the reclamation process. This EIS also foresees, in the long term, the creation of wetlands with phytodepurating vegetation in which allowing the overflow of the water of the Regi Lagni rivers, in case of heavy rains. This long-term solution can also have a positive effect on the reclamation of the polluted river water and rainwater. Nowadays these are not treated by any means, being absorbed directly from the ground or flowing into the sewer system. In sum, among the expected positive impacts of the solution, there is the possibility of contributing to the purification of the Regi Lagni system, but also of decreasing the flow of rainwater into the sewer, re-using it for agricultural purposes (e.g. irrigation) or for recreational purposes.

Phytechnologies, including phytoremediation and phytodepuration, are good and sustainable alternatives to the traditional remediation methods both in economic and environmental terms. They allow gradual extraction of pollutants from contaminated matrices and the reduction of diffuse pollution directly on site, biomass production, improvement of soil and water quality and of ecological and landscape features. Phytodepuration "is a

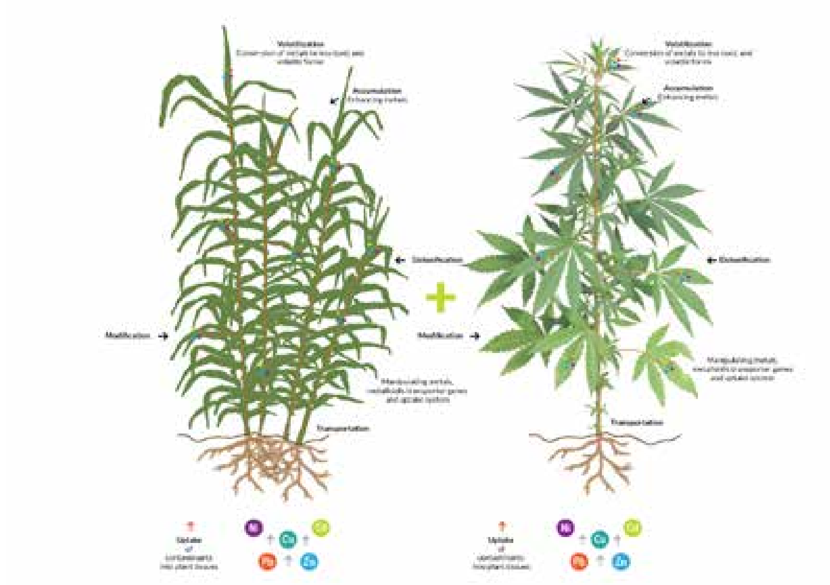


FIG 4 Phytoremediation process for contaminated soils with Cannabis Sativa in combination with Arundo Donax. Valentina Vittiglio, UNINA Team, 2018

system aimed to the waste water treatment based on biological, chemical and physical-chemical processes characteristic of aquatic environment and wetlands" (ISPRA 2012, p.13). Phytoremediation "is the use of plants to partially or substantially remediate selected contaminants in contaminated soil, sludge, sediment, ground water, surface water, and waste water. It utilizes a variety of plant biological processes and the physical characteristics of plants to aid in site remediation" (EPA 2001, p.1).

According to the principles of sustainable development, phytoremediation and phytodepuration take advantages from the selective capacities of the root system to extract pollutants from the ground, without harming the environment. However, they require longer time to decontaminate the site compared with the traditional techniques (Fig.3). In this sense, over a ten year-period - during the remediation process - with this solution, we propose that the site could be used temporarily welcoming initiatives supported by local associations and citizens promoting the activation of urban labs and, to avoid the contact with the polluted soil, the installation of a winding walkway aimed to a safe use of the site (e.g. in De Ceuvel project in Amsterdam). After harvesting and laboratory testing to evaluate the level of contamination of the crop itself, the different parts of the hemp plant could be reused (Fig.4). Specifically, from stalks, seeds and leaves derive textiles, paper, construction materials, body care products, animal bedding, mulch and compost. The most used part is the fibre, one acre of hemp produces 3 – 8 tonnes of dry fibre and 3500 liters of methanol, while fuel derives from scraps through the pyrolysis process. The high biomass production (one acre of hemp cultivation corresponds to 10 tonnes of biomass), the large plasticity, which allows hemp to be grown under a wide variety of agro-ecological conditions, and the possibility to use its biomass in non-food industries, make this species attractive for phytoremediation. Therefore, its use would allow, beyond the reclamation of the soil and the recovery of a historical crop, to obtain social and economic results thanks to the possibility of using the product in artisanal activities, triggering new forms of circular economy. Using hemp within the remediation process of wastescapes allows to place them in a circular perspective thanks to the reuse of the space and to the possibility of implementing local production supply chains, associations and experimental laboratories (Fig.5). In addition to the direct and indirect benefits of the phytotechnologies, the use of hemp within the remediation process may have relevant and positive environmental, economic and social impacts.

Evaluation model

Environmental benefits

Beyond its effectiveness in supporting phytoremediation process, hemp cultivation could provide other environmental advantages as listed below:

- First of all, the absorption of carbon dioxide four times higher than that assimilated by trees. Its use in the construction field does not involve any change for these properties. If the traditional construction accounts for 30-40% on the carbon dioxide emissions, the lime and hemp production supply chain is carbon negative. A ton of hemp straw is able to absorb 325 Kg of CO_2.

- Hemp is a producer of biomass fuel which requires a low specialization both in the cultivation and processing of all plant products. This relevant side may help to minimize the consumption of fossil fuels and their impacts on Earth. However, even we are considering it in the description of this solution, this is not the primary objective of the solution since it appears to be anyhow a end-of-pipe solution, outside of the scope of REPAiR.

- With regard to the hemp bio-plastic, it is completely biodegradable. This is a good response to the problem of the presence of plastic in the oceans. The Word Economic Forum (WEF, 2016) explains that currently there are 350 million tonnes of plastic in the oceans. Within 2050 instead the plastic will exceed by weight the marine wildlife.

- Currently, at global level, only 5% of the paper is made from annual plants like hemp but an increase in this production could help to reverse the deforestation.

- A reduction in the use of pesticides and herbicides and a low water consumption because hemp does not require them for its growing

on Wastescape

Economic benefit

Growing and cultivation of hemp on contaminated soils could have positive implications also in economic terms (Fig.6). The scheme below reports costs and incomes obtainable from the cultivation of hemp on one hectare of soil namely from ten thousand plants. According to an estimate based on the cultivation and subsequent sale of hemp straw and seeds, it emerges clearly that the gross average income per ha equal to twice costs, excluding those related to the labour force.

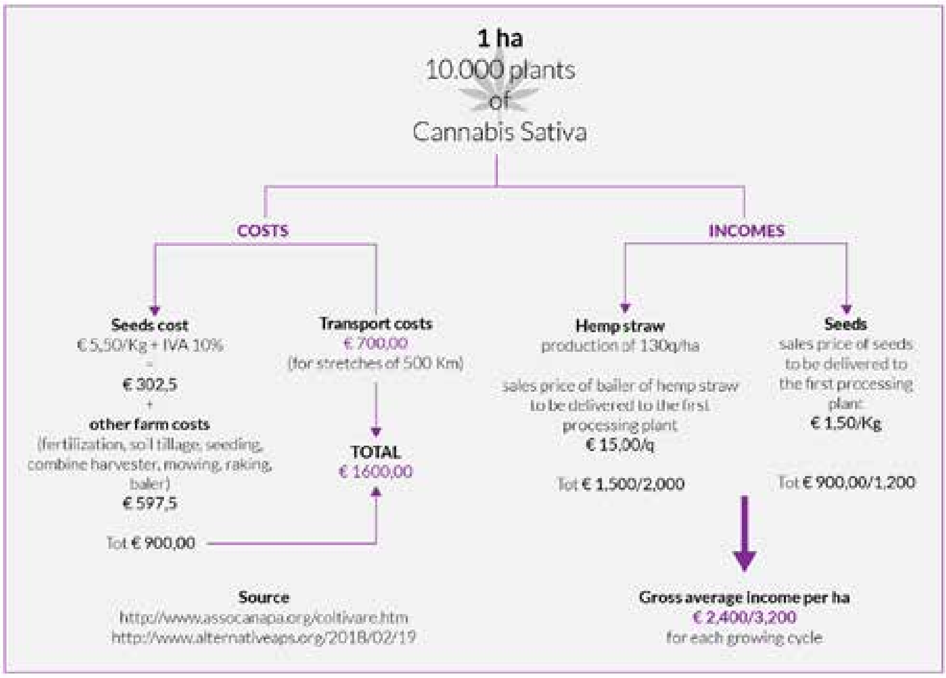


FIG 5 Approximate estimate of costs and incomes derived from hemp cultivation. Valentina Vittiglio, UNINA Team, 2018
FIG 6

Social benefit

Compared to other crops, like wheat, hemp leads to more regional employment per Hectare. Actual figure are 800 jobs on 10,000 farms (4 times as much as wheat per Hectare), 2,000 jobs at 1st processing stage (5 times as much as wheat per Hectare) in around 100 companies. Specifically, the hemp cultivation requires 8 working hours per Hectare, twice as much as wheat (4 hours) due to the greater harvesting required and, during the primary processing stage, 2-3 times more workforce.

In the light of these considerations, it is easy then to understand the value of this crop in terms of employment both for citizens and local enterprises.

Elementary Eco-Innovative Solutions

The strategy has been divided as follows in order to provide an easily and immediate reading of the EIS and the objectives that each one propose to reach.

EIS	OBJECTIVES
1.1 Use of Phytotechnologies to reclaim wastescapes, taking advantage from typical cultivations like *Cannabis Sativa* and *Arundo Donax* in order to strengthen local identity.	This approach is more sustainable than the tradition remediation methods with a considerable reduction of the impacts on the territory. The willingness to employ local crops aims to strengthen the local identity and rediscovering what once was a theyalth for the Region.
1.2 Creation of wetlands with phytodepurating vegetation in which to flow and reclaim the contaminated water of river basins and canals and the polluted rainwater for irrigation purposes in order to reactivate the historical agricultural vocation of the sites.	This EIS has twofold purposes. First of all, the reuse of water for irrigation, secondly the presence of a naturalistic area allows to improve the landscape quality of the site and to contain the hydrogeological risk.
1.3 Activation of urban living labs to promote different uses of hemp and temporary uses of wastescapes during the remediation process.	Urban Living Lab, through the involvement of stakeholders, are useful to promote temporary and innovative uses, besides the hemp, during the remediation process declining them on the real and practical needs of the local communities
1.4 Support to the extensive cultivation and hemp grown involving local enterprises for its process, according to the principles of short circular supply chain, improving local employment.	An extensive cultivation and production of hemp could contribute to lower the level of unemployment providing also work for small local companies. Hemp cultivation is also an opportunity to discover ancient works once the main source of income on the territory.
1.5 Activation of local associations supporting hemp cultivation (linked to the EIS 1.4)	Activation of local associations is more relevant to promote, defend and disseminate hemp cultivation and its uses in the various production sectors. In addition, associations represent the needs of the farmers and the enterprises against regional, national and international institutions involved in the management of agricultural and industrial production. Moreover, local associations encourage and develop the research aimed to support hemp cultivation and its uses with a focus on the environmental and human safety (linked to EIS 1.4).

Scope for Knowledge Transfer to the AMA

EIS:	**RECALL**
Transferability from Naples to Amsterdam	High
Transferable elements	Highly transferable and suitable to deal with polluted soil in the wastescapes in the AMA. Practically the entire EIS was considered suitable for transfer, albeit with some extensions and adaptations to fit the local context.
Adaptations needed to transfer the EIS	There is a need to accommodate the competing land uses, given the high pressure on land in Amsterdam and its region. One option identified was to combine hemp production with other functions such as recreation landscapes or energy production. A related adaptation proposed entailed a periodic rotation of hemp production on a plot with solar panels and combination of species. Another adaptation proposed was to link to the existing businesses that could use hemp products (e.g. paper industry in Haarlem, creative industries) and consider development of hemp-based body care products.
Key barriers for transfer	Geographical and economical and (to a degree) also cultural: strong competition for land in the region (and predominance of other uses for the wastescapes, e.g. for airport expansion or housing development) and possible cultural associations with cannabis, a recreational drug.
Potential location in the AMA	Polluted and vacant industrial land in strategic spots for future urban expansion, especially in the port, areas in the noise contour of Schiphol airport (temporary basis), Greenport areas on a longer-term basis.
Actors to be involved	Municipalities, Schiphol airport, hemp products companies, other local economic actors (paper industry, 3D printing, etc.), other parties that have 'claims' on the land in question (energy companies, housing associations, developers).

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on Construction & Demolition Waste

Circular Tendering

Category of outcome: Political, Economic, Social and Legal

Owner of the EIS*: REPAiR (TUD and Metabolic)

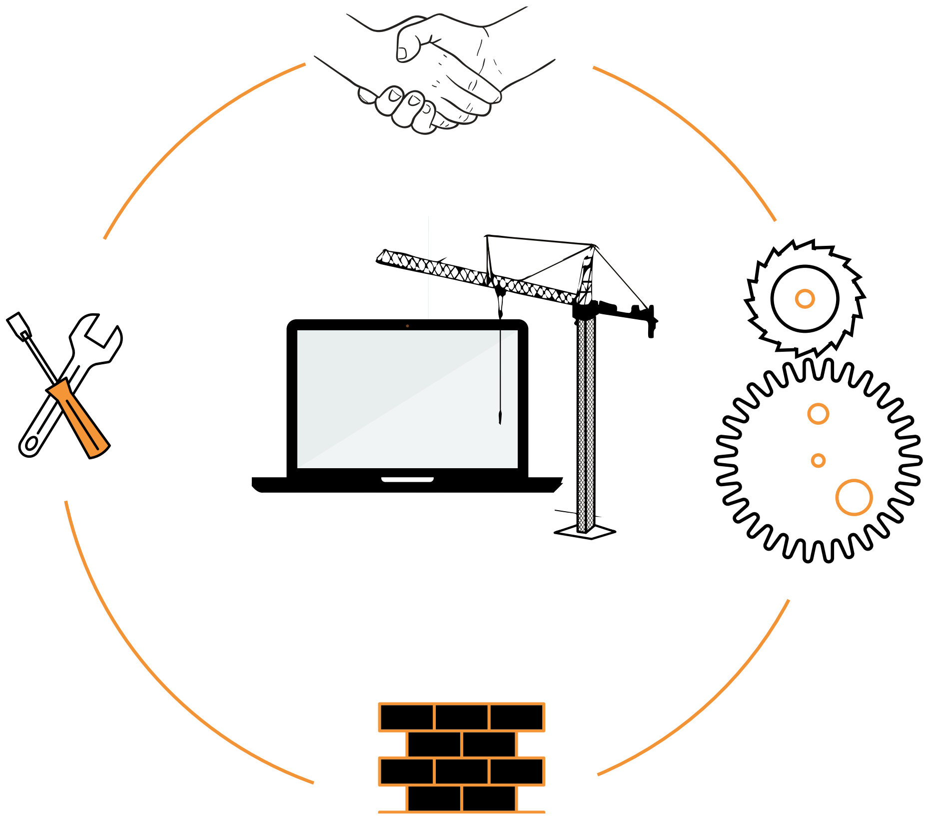

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Limiting Construction and Demolition Waste (CDW) starts before the actual construction phase. The possibility of reusing materials at high-value after demolition is largely dependent on how the building or infrastructure was designed and build in the first place. Making the shift to circular building will allow us to limit CDW while also decreasing the overall impact of the construction sector on the environment. Circular building can be defined as a process for the design, construction and demolition of a building that incorporates not only the high-value use and reuse of materials and, an adaptive and future proof design, but also takes into account the ambitions for sustainability in relation to energy, water, biodiversity and ecosystems on a larger urban area scale (Source: Roadmap Circular tendering, Gemeente Amsterdam, 2018).

This EIS focusses on circular tendering procedures that provide tools to assess the extent to which the proposed construction processes, materials and building types comply with the principles of circular building. Municipal governments and other landowners can make a large impact by formulating criteria for circular building- and area development in their tendering procedures. Furthermore, new procedures require the development of innovative pathways that make shift from a linear development process to an innovative pathway that includes all different types of actors throughout the entire cycle of urban development.

Current process

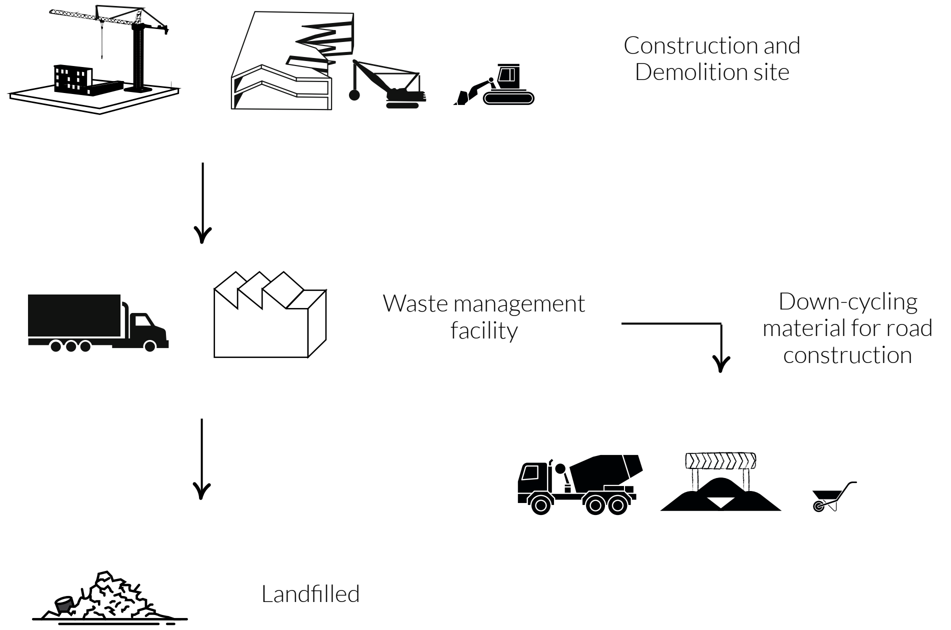

FIG 2 Current process diagram. Source: REPAiR EU H2020 project.

The way buildings and infrastructures are designed plays a key role in the possibility of regaining materials at high value use at the end of their lifespan. A large part of the CDW generated in demolition processes is currently down-cycled instead. This is largely caused by uncertainties in regards to the quality of the materials or its properties and damage caused by the demolition- or fabrication processes. This could be avoided if buildings were designed for disassembly and the used materials were labelled and registered in a database (Gemeente Amsterdam, 2018).

We should, however, take more into account then just the impact from retrieving materials. We should take it further and also include the embedded impact of choices of materials and process over the entire life cycle. Think about how much water is used in the production of concrete, but also the emissions caused by transportation of building materials over the entire construction process. The transportation of building materials was responsible for 20% of all road traffic in the Netherlands in 2015, and is heavily dependent on fossil fuels (96%) (Circle economy, 2015). These decisions that are made quite early in the design process for example by architects sometimes motivated by the aesthetics of certain materials rather then their embedded impacts.

Construction projects are often given out through tendering processes. Brackmann and Verlinden-Bijlsma (2011) define tendering as a transparent process of procurement where the client objectively awards the contract to the contractor who meets the requirements asked, and gives the best offer. The current process for tendering is linear and involves different actors at different phases of process starting with design and production of materials and ending with demolition. Finally, it is important to take into account that there is also a difference between redeveloping the existing built environment and developing new neighbourhoods from scratch. There is, however, a shift emerging in which more stakeholders are involved from the start of the process and circular building requirements are integrated.

Proposed process

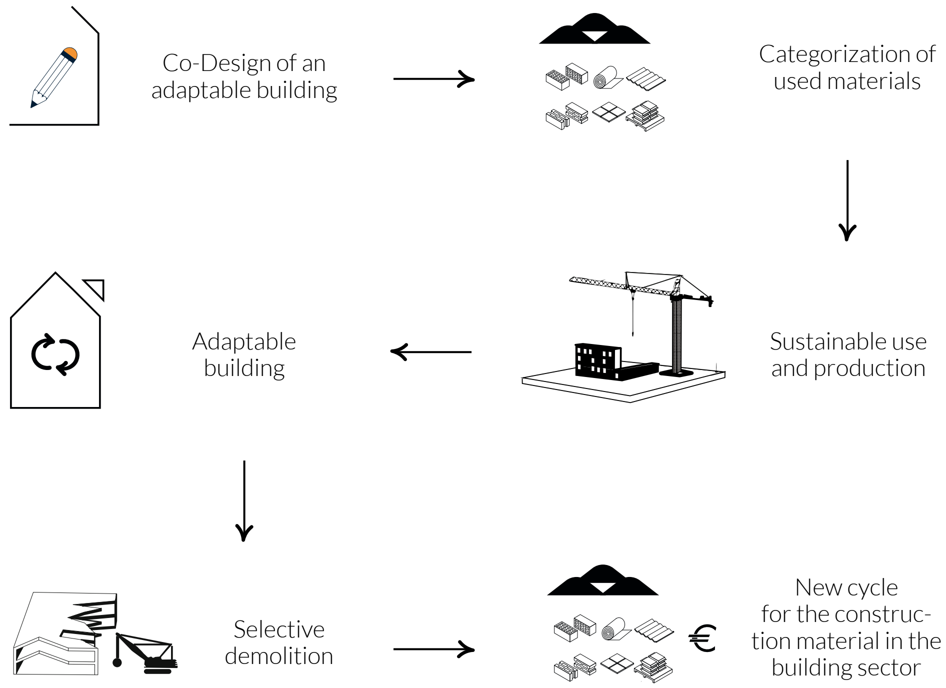

FIG 3 Proposed process diagram. Source: REPAiR EU H2020 project

Developing a circular tendering process requires both including requirements for circular building as well as creating a more integral process for area development. De gemeente Amsterdam has in collaboration with Metabolic and SGSSearch (2017) developed a framework for circular land tendering. In this roadmap requirements for circular building are presented. The requirements are divided over five themes (energy, adaptivity and resilience, ecosystem services and biodiversity, materials, and water). For each of these themes ambitions based on four principles were formulated that can be used as a decision making hierarchy for choices for circular building. The four principles are:

1)Reduce demand for materials, energy and land

2)Synergising, exchanging and cascading

3)Sustainable production and procurement

4)Smart management of resources and process.

Furthermore, the actual tender should be developed to facilitate integration of stakeholders involved in different steps in the construction cycle. Circular tendering should include a process that embraces shared responsibility and aims, sharing of property, and a collaboratively developed idea of circular asset or urban area development. There is already many experimentation with including different stakeholders throughout the entire process. For example, having a developer act as a chain director, aligning and facilitating communication between the different actors. This would also foster innovation in the chain (RWS, 2015). Activities within a circular tender procedure could include a collective setting of ambitions before starting a competitive dialogue (where commitment of all partners is important, and other than a market consultation) or a broodfonds for innovation: open source sharing of innovation. Which parties to involve in the process is specific to the area that is to be developed, but could include stakeholders such

as land-bank or tax office. Implementing circular tendering requires space for experimentation, process- and production agreements, integrating new solutions such as a material bank or a bouwhub, fostering trust between different involved stakeholders and involving them throughout the entire process and flexibility.
One of the main issues in circular building tenders is the changed ownership situation after completion of a project and its relation to organizational business models (Rampersad, 2016). Ownership and business models need to be taken into account besides the setting of circular criteria and targets in tenders. Real estate investors or (house) owners can potentially no longer own certain building materials, systems or parts, but instead lease these products. This might influence their willingness to invest in circular buildings. As an example, it might mean that investors or owners lease the building ventilation system against a certain premium, while an installation company or technology providers owns and maintains the leased product. In accordance, this means is that these companies must change their business model, and need to define where they can add value and make a return on investment in the design, construction, management/ownership and demolition process of buildings. Moreover, this requires close collaborations between all sorts of actors and closing leasing agreements. Also this might change the role of real

Relevance

According to the results of the PULL workshop hold in Amsterdam on September 2018, this solution is relevant for the local stakeholders. The process should be mapped, identifying stakeholders in all steps of the life cycle, and defining possible consortia

The co-design of this solution can initiate innovation towards more circular design, connects to existing ways of working but with more circular ambitions, standardizing the process

Construction and Demolition waste is produced everywhere in the process, during the design or during construction (on-site) potentially after completion, end of building life cycle.

The solution can be applied at all construction sites, plots with existing buildings or new developments

The solution could be a business case on a project level for each party involved, especially through collaboration money can be saved and value can be created. For example, leasing of services, shared responsibility but not ownership (of building or service and materials). Specific parties could be developers, material banks, could pension funds or other investors invest in the materials

Finally for a better result and implementation of this EIS policy changes are needed. In particular it is necessary a political support + ownership rights essential for the involvement of municipal service companies, revised building regulations (building decree).

Possible locations within AMA

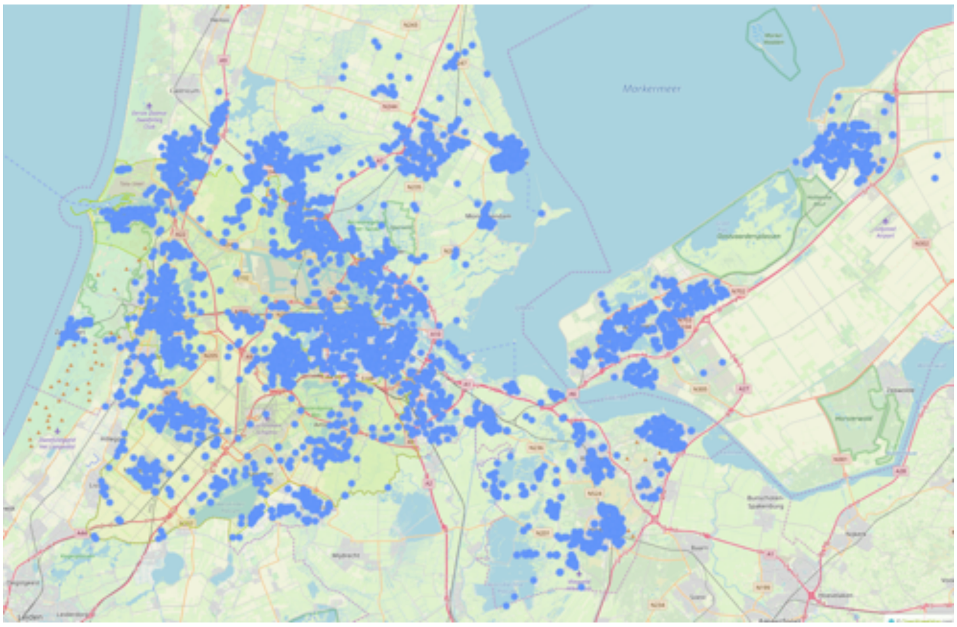

FIG 4 Location of the possible actors involved in the solution Source: REPAiR EU H2020 project

The municipality of Amsterdam has already started made steps in circular tendering by developing a roadmap circular tendering in which detailed criteria for circular building were determined on five areas (materials, energy, climate adaptivity and resiliency, water and ecosystems and biodiversity) (RWS, 2015). There are many different stakeholders involved in this tendering procedure since it is basically everyone that is involved in circular construction.

Such as: municipalities, all parts of the construction supply chain, like builders, constructors, developers, investors, housing associations (private) potentially energy service companies, water service companies etc, waste companies, all parties that play a role in the process or in the material development and recycling.

Reference

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Open and secure materials exchange

Category of outcome: Political, Economic, Social and Technological

Owner of the EIS*: REPAiR (TUD team and Metabolic)

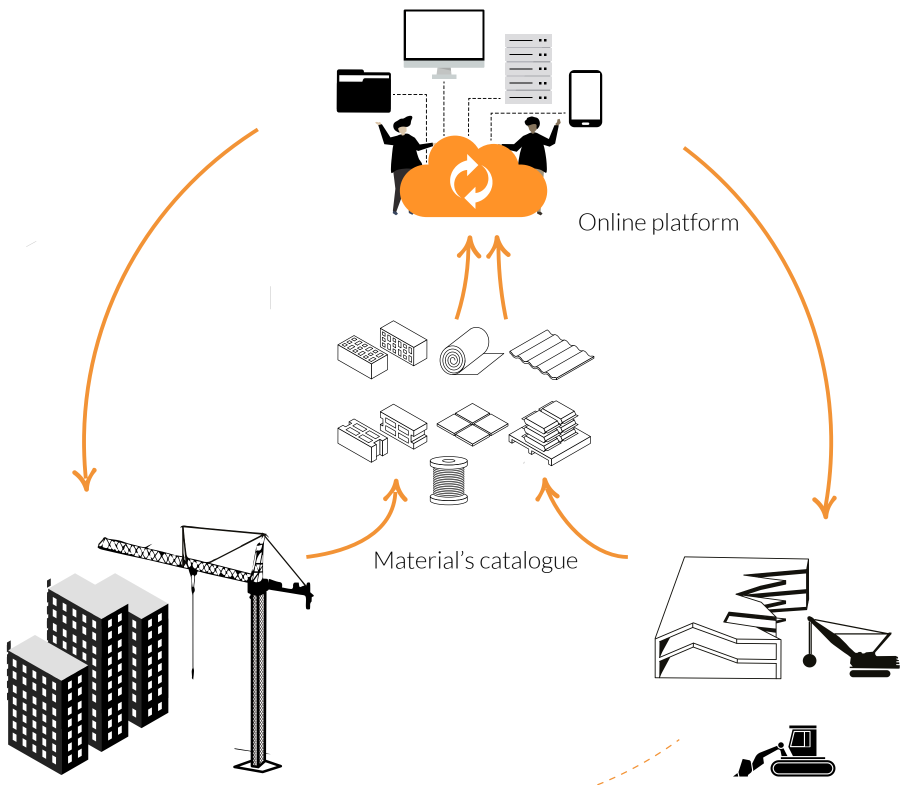

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

The proposed solution focuses on developing an interface for material exchange for the construction sector. The online platform can bring supply and demand of materials together and align them based on their location (Zhu, 2014). The solution should shift the economy towards the inner loop (see Ellen Mcarthur Diagram), which would prevent materials going to incinerators or landfill. The platform should facilitate the offers, documentation, and communication between interested parties. A logistical hub is required for temporary storage, as not all construction and demolition can be temporally aligned. (Circle economy, 2018). An existing material exchange is Environmate[1], a platform that is merely used by smaller parties.

Open and secure data availability and a data platform are a prerequisite for successful implementation of such a platform. Information on the building and the quality and specifics of the material are key (Circle economy, 2018). Another important possible drawback is that the International Financial Market currently is the only entity setting the price of building material.

1 https://www.enviromate.co.uk/marketplace

Current process

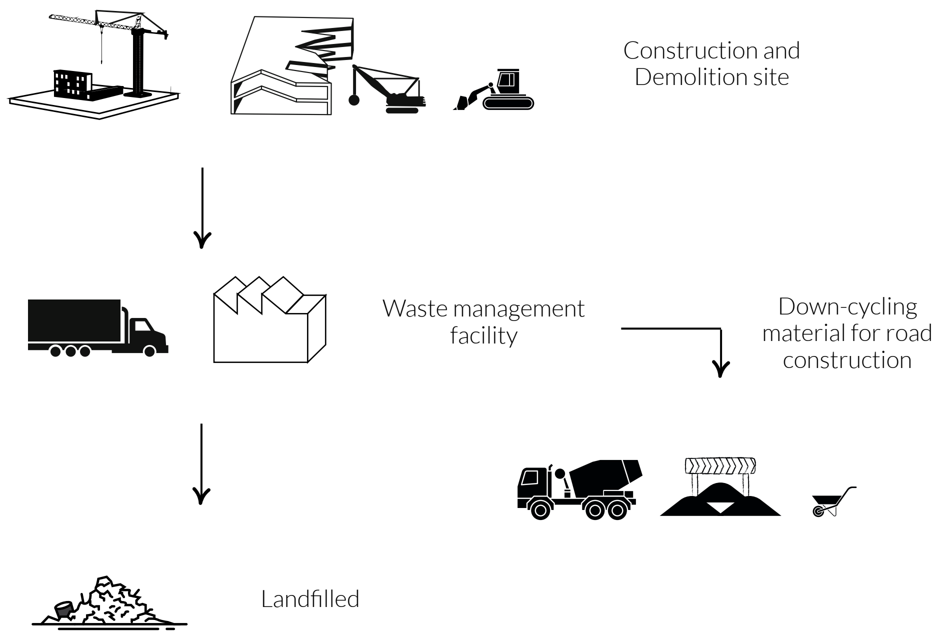

FIG 2 Current process diagram. Source: REPAiR EU H2020 project.

The construction sector is responsible for approximately 40% of the total waste stream of Amsterdam. Although the majority is recycled this is often at a lower value as street gravel, or even send to an incinerator (Circle Economy, 2018). Less than 5% of the materials used in the construction sector are secondary materials.

Proposed process

We can see each building as a material bank. When a building is taken apart, these materials will become free to the market. A platform for material exchange is a particularly suitable mechanism for building materials with a long life cycle, and stimulates supply and demand dynamics through the sale of individual components on the platform (Leising, Quist, & Bocken, 2017, p. 9).

An online platform with location data could bring supply and demand of (building)materials together. Instead of using a physical market, the construction sector could use the online platform to sell or buy materials. Cross-sectoral exchange would also be possible as different types of sectors could take part in the platform depending on the materials they are offering or need.

Furthermore, the platform can contribute to the materials being re-purposed to the highest value possible instead of being down-cycled to road gravel, or even worse, send to incineration or being disposed at landfill. The material flows generated by building materials take the 'material bank' as point of departure, which is the building or infrastructure construction. Depending on the disassembling qualities of the materials stored in the structure, a certain level of value can be retained. After sustainable demolition and appropriate sorting of material components these individual elements can be sold or leased through such a marketplace. This could be the within the construction cycle but it could also be cross-sectoral.

Some important prerequisites are ownership structures, policy, participation of stakeholders, cost and data availability. The producers of the material can retain ownership until the material is sold. In terms of the price of the materials, a possible drawback is that the International Financial Market currently is the only entity setting the price, and positive impact is not guaranteed. Also, an open and secure material exchange platform is dependent on the contribution of all stakeholders. Governments, banks, home- and building owners should accept the EIS to fully live up to its benefit.

Existing policy instruments facilitating the open and secure material exchange as aforementioned operate succinctly with online platforms which collect, store, and disseminate information readily to parties operating within the material loop.

Finally, quality of information is an aspect that needs to be improved, using BIM (Building Information Modeling) in a pre/post situation could help to develop trustworthy data sources. Legislation would be another necessary input for the BIM. The value distributor collects information about the financial and environmental value of materials, using an LCA (Life Cycle Assessment). An open interface should be developed to give information about where materials can be found. Financing and loans have to comply with legislation, which is another challenge when developing and implementing this solution.

Possible location in the AMA

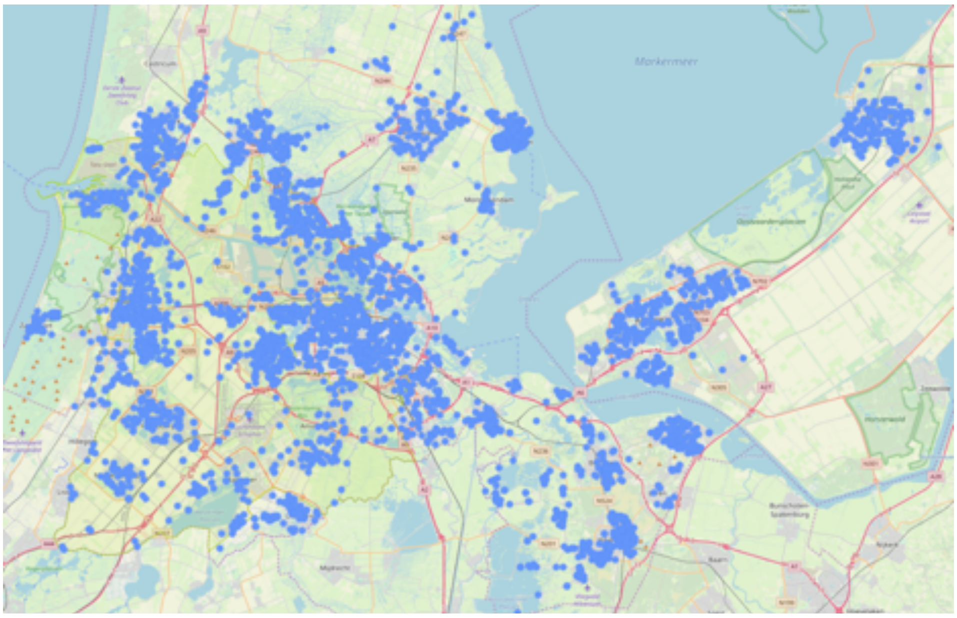

FIG 3 Location of the possible actors involved in the solution Source: REPAiR EU H2020 project.

The platform does not need to exist physically to store the materials as the exchange may occur independently from the platform in order to optimize efficiency, space, and reduce costs. Highlighting several case studies demonstrate that discerning features of a successful exchange platform are offering a limited range of material types and securing that potential interested parties can establish contact independently. The platform should facilitate the offers, documentation, and communication between interested parties.

List of the activity that might be involved , already existing in the AMA (see map)

F-4110 Development of building projects
F-4211 Construction of roads and motorways
F-4120 Construction of residential and non-residential buildings
F-4221 Construction of utility projects for fluids
F-4399 Other specialised construction activities n.e.c.
F-4391 Roofing activities
F-4222 Construction of utility projects for electricity and telecommunications
F-4291 Construction of water projects
F-4299 Construction of other civil engineering projects n.e.c.
F-4212 Construction of railways and underground railways?
F-4333 Floor and wall covering
F-4329 Other construction installation
F-4332 Joinery installation
F-4213 Construction of bridges and tunnels
F-4339 Other building completion and finishing
F-4311 Demolition
E-3811 Collection of non-hazardous waste
E-3812 Collection of hazardous waste

Reference

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Zhu, X. (2014). GIS and urban mining. http://www.mdpi.com/2079-9276/3/1/235/pdf [Accessed October 2018]

Microalgae bio-asphalt

Category of outcome: Technological

Owner of the EIS*: Loo Wai, Alexis KY Oh, Arjang Tajbakhsh (TUD)

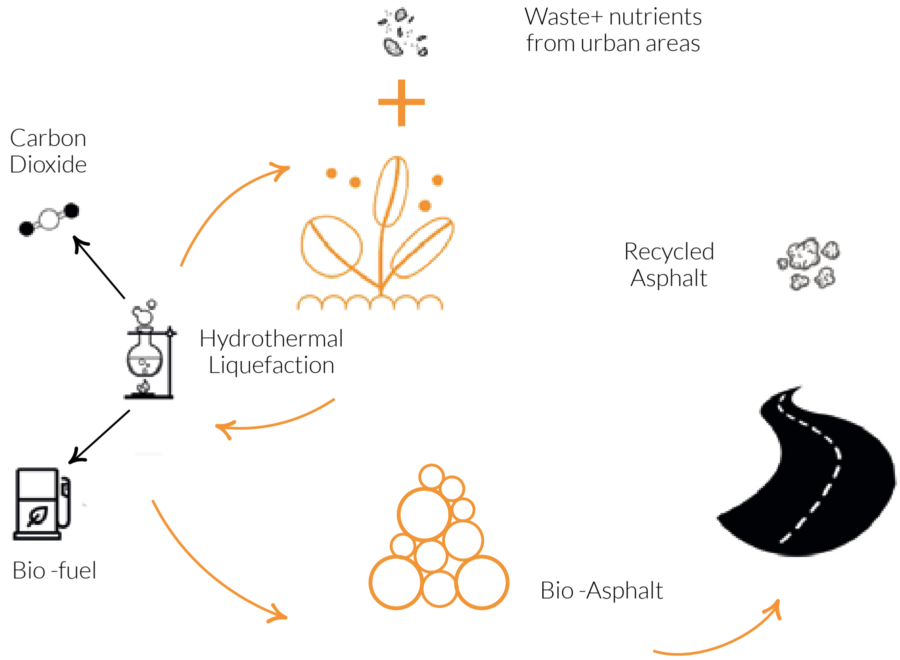

FIG 1 Idea diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2017)

Idea

This EIS propose an alternative for conventional asphalt based on microalgae. This bio-asphalt proves to be an effective and sustainable solution for road construction and could serve as a viable alternative for asphalt based on petrochemicals (Audo et al., 2015). Asphalt products derived from biological processes (bioasphalts) have been explored as a possible replacement of petroleum based asphalts. Studies with crop based bioasphalts prove that both the short and long term functional properties of traditional asphalt can be replicated with bioasphalt (Gosselink, 2015). However, the use of crops for this process requires arable land which will ultimately compete with food production. New research from France indicates that the hydrothermal liquefaction of microalgae can produce bioasphalts of comparable performance (Audo & Paraschiv, 2015). The bio-composite feedstock required for the bio-asphalt can be produced at high rates throughout all the seasons, yields a high biomass production, and unlike other bio-asphalt, the solutions does not interfere with human food production (Chailleux et al, 2012). Bioasphalt production using microalgae is beneficial as it can be tailored to consume a wide variety of resources from CO2 to biomass (Abdel-Raouf & Al-Homaidan, 2012). In an urban environment, it can tap into a large network of urban biomass flows. Currently, biomass flows such as sewage waste and food waste are either composted or incinerated (Jonkhoff & Kooij, 2012). While composting is beneficial as it upcycles resources back into the food chain, it is rarely performed in large scale as it is both resource and time intensive. Incineration, on the other hand, downcycles biomass in their lowest form in an inefficient manner. The use of microalgae consumes these biomass flows and produces beneficial products such as bioasphalts as well as biofuels, which can be integrated in existing biofuel networks (Abdel-Raouf & Al-Homaidan, 2012).

Current process

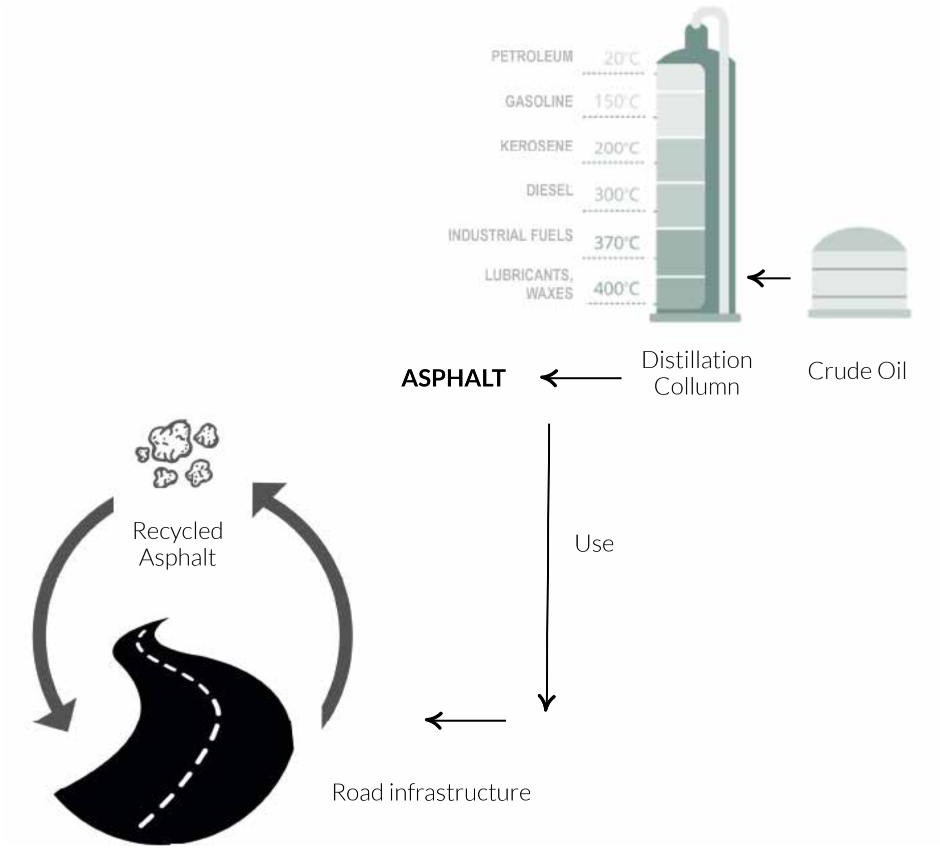

FIG 2 Current situation. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2017)

Asphalt, also known as bitumen, is a common petrochemical product used predominantly as a road construction material. It is mixed with aggregate particles such as sand or crushed gravel, where it acts as a binder to create asphalt concrete. While it provides many benefits, asphalt used as road construction material is not without its disadvantages. For one, it is a petroleum product and thus non-renewable. Even though old asphalt can be easily recycled, new asphalt mix still requires 30-70% virgin asphalt and continues to be an open material loop (Federal Highway Administration, 2016). In addition, the performance of asphalt varies depending on the underlying petroleum oil composition which is difficult to control. This can cause binding issues which require increased maintenance and thus more material use.

Another concern with regards to asphalt is their environmental and health impacts. Asphalt contains many toxic chemicals such as polycyclic aromatic hydrocarbons (PAH) which are known carcinogens (Irwin, 1997). During the application of asphalt cement on roads, the material is liquefied through the application of heat. This releases these PAHs as well as other toxic compounds into the surrounding which is harmful for workers that deal with these products on a regular basis.

Proposed process

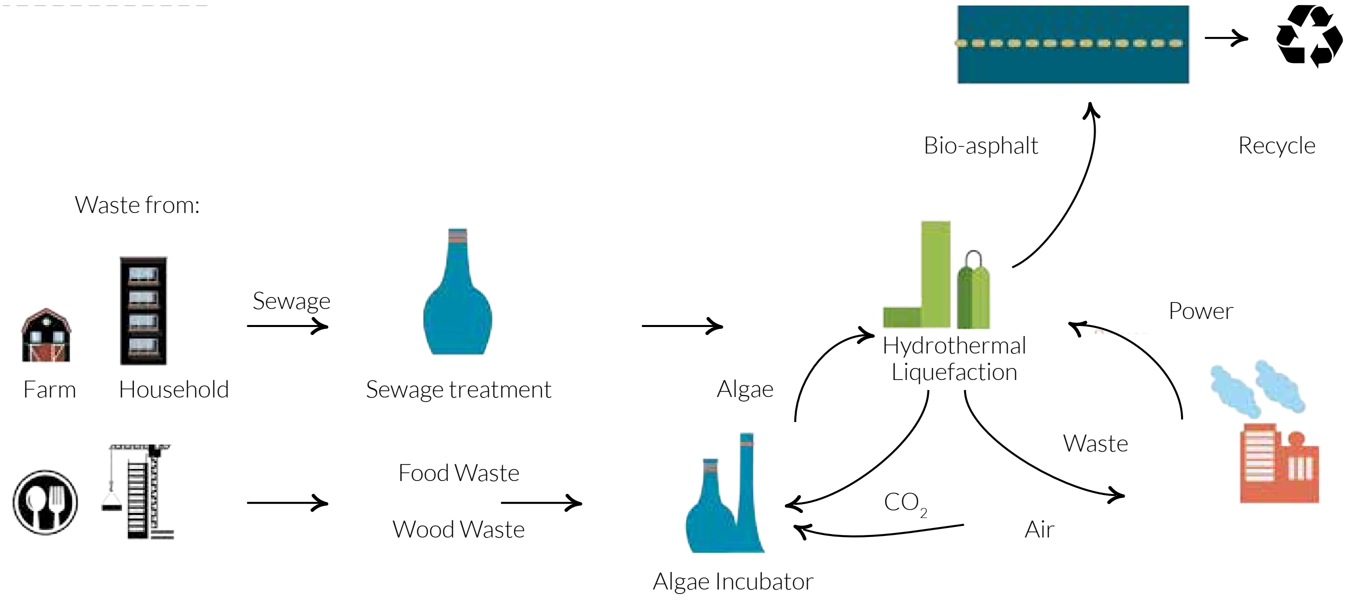

FIG 3 Diagram of the proposed changes in the process. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2017)

Asphalt products derived from biological processes (bio asphalts) have been explored as a possible replacement of petroleum based asphalts. Studies with crop based bio asphalts prove that both the short and long term functional properties of traditional asphalt can be replicated with bioasphalt (Gosselink, 2015) New research from France indicates that the hydrothermal liquefaction of microalgae can produce bio asphalts of comparable performance (Audo & Paraschiv, 2015). The traditional asphalt supply chain is linear, with the exception of recycling at the end of life. However, due to material degradation and dissipation, virgin asphalt will always be required. Bio Asphalts close this loop by ensuring that raw materials are from renewable sources and the dissipated wastes can break down safely in the environment. Like their petrochemical counterparts, end of life bio asphalts can also be recycled. The microalgae are the sole bio-composite and are produced through a process of hydrothermal liquefaction (Audo et al., 2015). During this process, the residue of microalgae is collected and transformed into a liquid substance with road-binding properties (Audo et al., 2015). The physical properties of microalgae asphalt closely resemble petroleum-based asphalt due to its black, viscous, and hydrophobic nature. Further studies demonstrate that microalgae provide similar qualities compared to petroleum-based asphalt. The viscoelastic properties of microalgae bitumen is measured between -20 and 60 degrees Celsius (Bujoli, 2015). Additionally, the bitumen retain under 100 degrees Celsius cohesive qualities sufficient to support mechanical load and relax stresses (Audo et al., 2015). Scientific research is yet to determine the duration of microalgae bitumen's retention of cohesive properties. Microalgae can be produced on non-arable land (Chailleux et al, 2012), and a handful of experiments are being carried out to produce microalgae on a semi-industrial scale. Various different photobioreactors are considered to facilitate semi-industrial production, which includes raceway ponds, tubular systems, and vertical flat panel systems (Vree, 2016). Demand increases for microalgae as its lipids are extracted increasingly for uses in biodiesel or cosmetic products. Hence, cultivating microalgae is expected to gradually decrease in price in the coming years if industrial production gains traction (Vree, 2016). After harvesting algal biomass the products can be transformed into bitumen on site or transported to designated facilities. Deriving bitumen from microalgae runs through a twofold chemical process. At first, the lipids from the microalgae are extracted by Soxhlet extraction. Hereafter the microalgae waste undergoes a hydrothermal liquefaction procedure, in which under pressurized water the yield transforms into a bitumen. Overall this procedure has demonstrated a 55% conversion efficiency (Audo et al., 2015). Subsequently, the yield can be readily distributed to road construction sites to be applied to granulates as bio-asphalt.

Possible locations within AMA

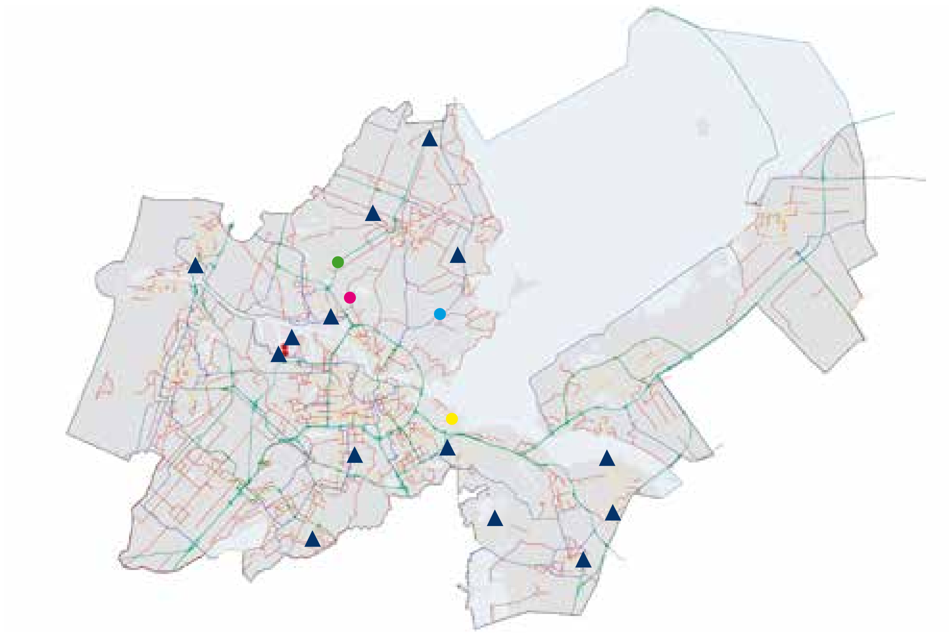

FIG 4 Map of the potential location in which implement the solution. Cases selected according to the current types of road infrastructures

In order to produce bioasphalt, a specialized facility will be required with equipment such as microalgae incubators and hydrothermal liquefaction vessels (Audo & Paraschiv, 2015). The best place to build such a facility would be near sewage treatment facilities in order to decrease transportation costs and potentially implement an industrial symbiosis network. The production cycle of microalgae on an industrial scale involves (artificial) sunlight exposure and water, in a CO_2 rich environment. Installations have been proved to be sustainable, resource-efficient, and ecologically-friendly, and can be automated. These production facilities can be readily located within the vicinity of where there is demand.

Asphalt encompasses a significant portion of the surface area of the Amsterdam Metropolitan Area. For this analysis, the different types of roads were mapped and their lengths calculated using GIS software. It is important to note that while the majority of asphalt concrete is used on roads, a significant amount is also used in other places such as roofs, parking lots and airports. These demands of asphalt concrete were not considered in the analysis.

There are currently two asphalt concrete mixing facilities in Amsterdam Noord. These require asphalt and gravel to be brought in from oil and gas

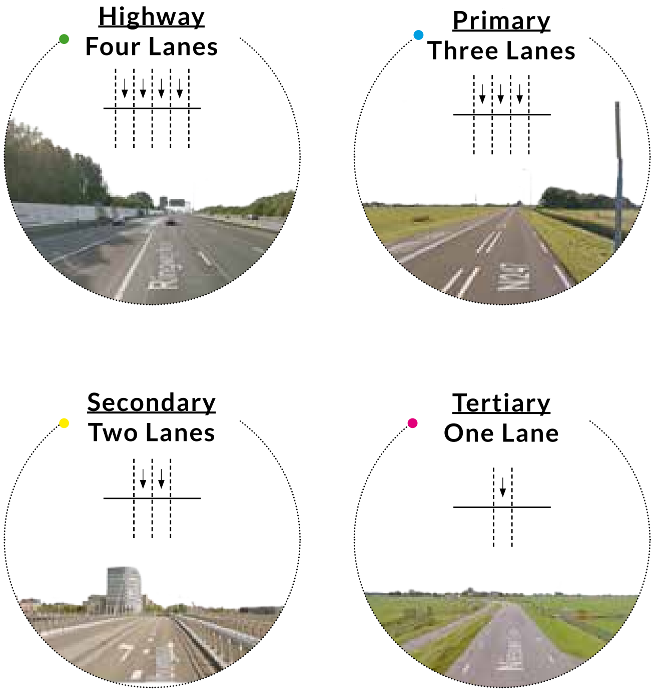

FIG 5 Different types of road infrastructure sections suitable to experiment the solution

refineries outside of the AMA boundary, presumably from Rotterdam. Here the asphalt is mixed with gravel and the resulting asphalt concrete is distributed throughout the city.

The other important process is the production of sewage waste. In the maps above, the location of the city's existing sewage treatment plants has been highlighted. It is interesting to note that a major water treatment facility, Amsterdam-West is located within close proximity to the two asphalt mixing facilities in the Westpoort region of the AMA. The region is characterized as industrial with no residential spaces located near the sewage treatment and asphalt mixing plants.

References

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Eco-SEE wall panels

Category of outcome: Technological

Owner of the EIS*: ECO-SEE Consortium: University of Bath (UK), ACCIONA Construccion (ES), University of Aveiro (PT), Bangor University (UK), BCB Lhoist (FR), BRE (UK), Claytec e.K. (DE), Envipark (IT), ModCell (UK), Fraunhofer IBP (DE), Greenovatel Europe (BE), Indian Institute of Technology Delhi (IITD) (IN), Nesocell (IT), SKANSKA (UK), TECNALIA (ES), Wood Technology Institute (ITD) (PL)< Kronospan (UK), Black Mountain (UK)

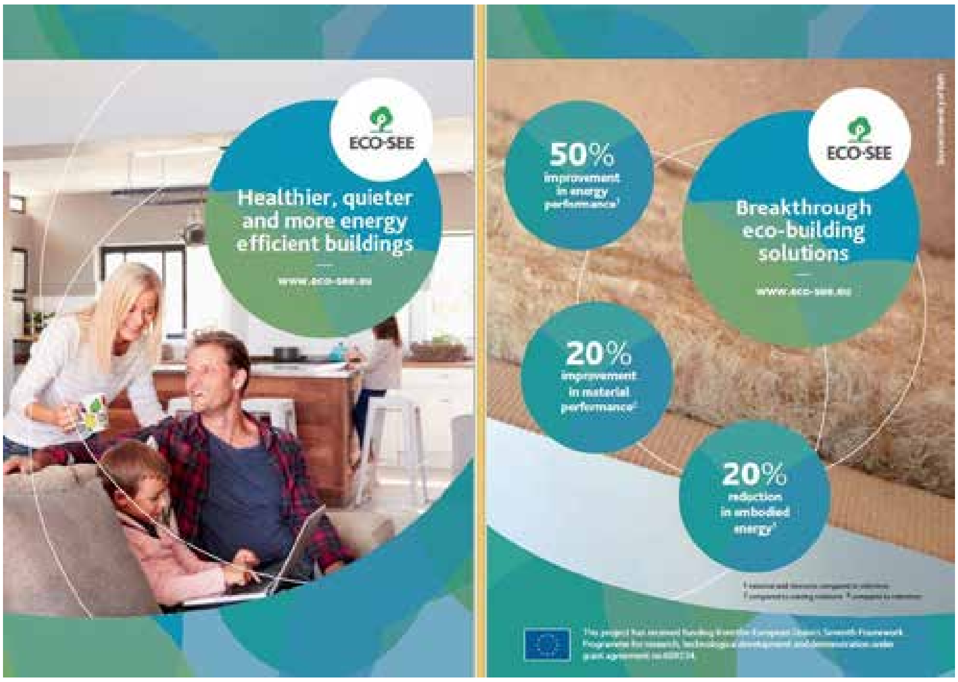

FIG 1 Idea diagram. Source: http://www.eco-see.eu

Eco-SEE wall panels are a new type of insulation panel based on ecological materials. The wall panels are composed of a wide-range of bio-based materials selected due to their natural insulation qualities. Among others, eco-materials used in the production of Eco-SEE walls are sheep's wool, cellulose, hemp-fibers for the purpose of insulation, and for permeable and hygrothermal purposes clay and lime plasters (Cordis, 2018). Innovation in the field of insulation material is geared toward improving indoor energy retention and indoor air quality, and providing a solution for unsustainable resource consumption. Conventional walls are generally composed of non-recycled and unsustainable materials, such as concrete walls. Research has demonstrated that the application of Eco-SEE wall panels reduces energy consumption by 50% compared to conventional wall materials such as timber or masonry sourced materials (Cordis, 2018). Using Eco-SEE insulation could potentially reduce the use of high impact materials and could decrease energy use by providing sufficient insulation.

** http://www.eco-see.eu*

Current process

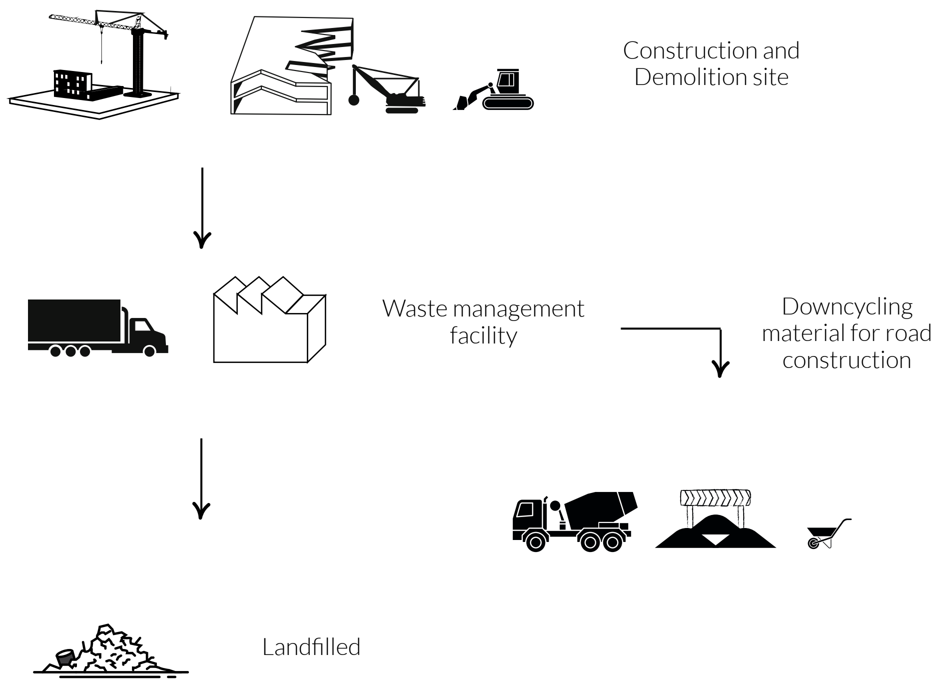

FIG 2 Diagram of the current situation

There are a wide range of conventional insulation materials on the market such as industrially processed EPS foam or Polyurethane rigid foam (derived from petrochemicals) , or more natural forms such as cork slab, rock wool or cellulose fibre. All insulation materials have high environmental impacts due to the materials and fossil fuels used in the production process, but also the inability to reuse the products at high value at the end of their life. The highest impact on the environment is caused by the industrially produced insulation materials (Bribián et al., 2011).

Proposed process

FIG 3 Source: Pe�ur, I. B., Štirmer, N., Milovanović, B., & Bijelić, N. (2012, January). Eco-Sandwich Wall Panel System, the Sustainable Prefabricated Wall Panel System Made of Recycled Aggregates. In Green Design Conference. (p.2)

ECO-SEE has harnessed the power of nature and the unique characteristics of natural materials to develop new products capable of significantly improving indoor air quality. As well as harnessing the power of nature, ECO-SEE has performed cutting edge scientific research to develop novel chemical processes capable of enhancing indoor air quality. Constructing Eco-SEE wall panels involves the collection of base materials and coatings, and assembling the wall lining, frame, and the insulation materials.

Eco-SEE wall panel production method fabricates their panels on site in a threefold stage process. Initially, the composite resources can be collected. Both the internal and external layer consist of wall liners composed of photo-catalytic lime, clay, and photo-catalytic timber boards. The internal layer contains timber softwood and sheep wool, the external layer contains timber with hemp fibre or nesocell cellulose. The external layer is coated with external cladder to provide weather protection. When Eco-SEE walls need to be re-purposed or disassembled most of the parts can be recycled or reused while continue to meet future industry requirements (ECO-SEE, 2018).

Possible location in the AMA

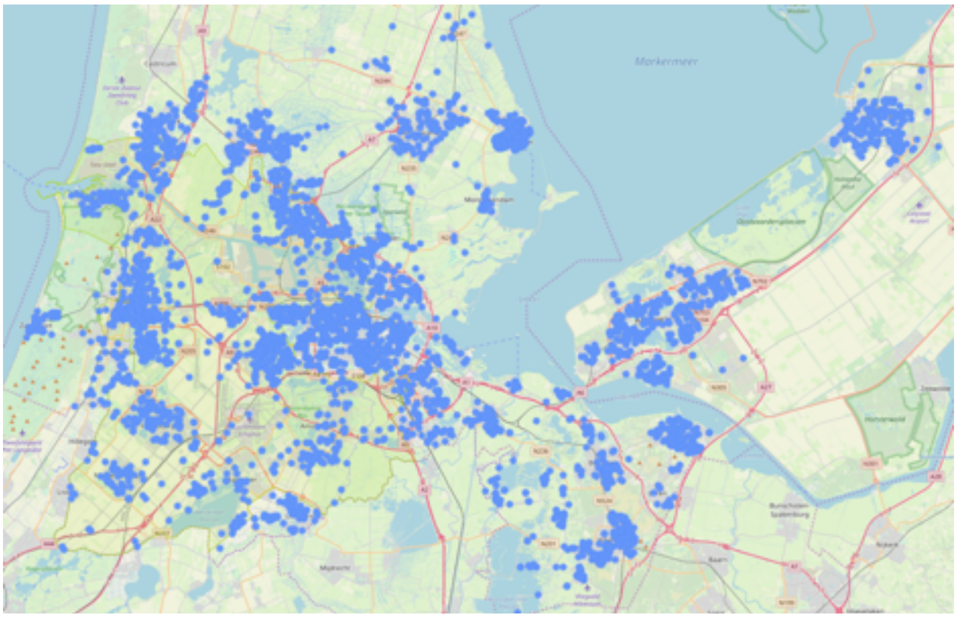

FIG 4 Maps with the location of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project

List of the activity that might be involved , already existing in the AMA (see map)

Floor and wall covering activities

Treatment facilities and disposal of non-hazardous waste

Collection services of non-hazardous waste

Industries specialised in recovery of sorted materials

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Website

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Cross-sectoral platform for open source innovation and sharing

Category of outcome: Political, Economic, Social and Legal

Owner of the EIS*: REPAiR (TUD team and Metabolic)

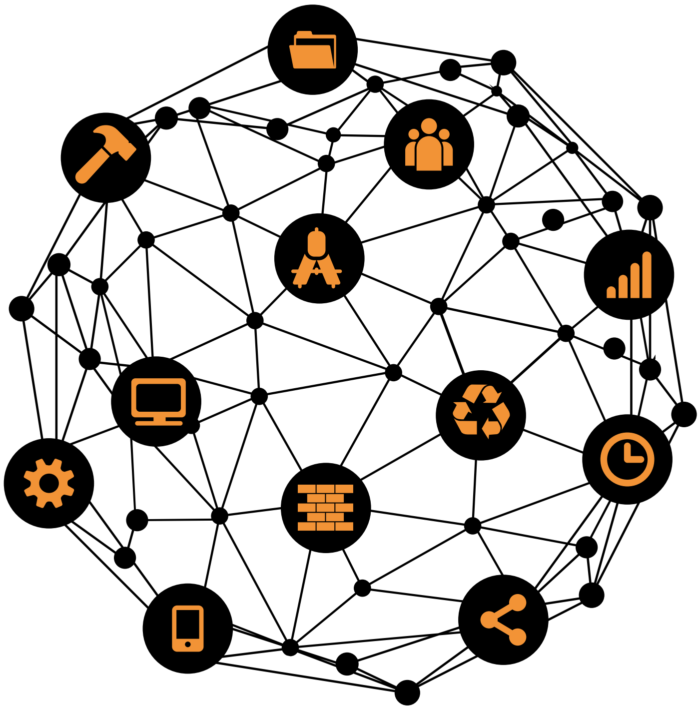

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

This EIS proposes a platform for cross-sectoral open-source knowledge exchange to share specifics in regards to innovative materials and processes within the construction sector, but also cross sectoral. The platform should be developed to share information across sectors, and could be initiated on a metropolitan area scale before being developed on a national or international scale. The platform should be cross sectoral, and should not only include information about innovative building materials, but also about innovative processes and new techniques for demolishing, designing, manufacturing and logistics amongst others.

The cross-sectoral material- and process platform will contribute to developing bigger markets for materials, and by cross-linking different sectors, reduce storage time. As a drawback, there are administrative obstacles for implementation, such as high complexity and uncertainty about who should be in charge of the system. To develop the platform for all sectors, stakeholders of different industries should be involved. Public parties should be involved to promote the platform – to stimulate and facilitate it, and private parties should be involved to create and innovate.

Current process

Sharing knowledge is crucial to further the transition to a circular construction sector and question like what is circular building, what are the right materials to use and what is the embedded impact of certain innovative materials?

However, the the construction sector is highly fragmented. With different players having responsibility and expertise over different parts of the process and the competitive nature of the sector, it has proven challenging to collect new knowledge and share this between different players within the sector and between other sectors. This results in different stakeholders "reinventing the wheel", ultimately slowing down the transition to a circular sector (Dave & Koskela, 2009).

In the past, knowledge sharing in the construction sector has led to competitive advantage, therefore certain legislation has been placed on EU level that limits the exchange of certain aspects of information (RWS, 2015).

There are already some platforms that exist, such as the Healthy Materials Lab that collects information on new materials and their impacts. A dutch example is that of the concrete sector, where different four public and fifty private construction companies have made a deal to share innovation, knowledge and collaborate to minimize CO2 emissions (MVO, 2018). Althought the agreement is there, they are lacking an actual platform for sharing.

Proposed process

An online knowledge exchange platform could contribute significantly to accelerating the transition to a circular building sector, as it facilitates sharing information about innovative building and construction materials, and processes. The online platform should be open source and available for everyone. This requires wide participation of stakeholders as well a their will to share information. Governmental parties could play a central role in providing incentive (e.g. financial benefits) fostering participation, taking ownership over the platform and pushing wide adoption (RWS,2015).

The platform should not only include the specifics of innovative materials but also focus on new processes and their potential for impact. The platform could be focussed on national scale but this could also be broader (EU level). It could be linked to suppliers as well.

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Introducing Circularity Measures into the BREEAM standard

Category of outcome: Political

Owner of the EIS*: REPAiR (Circle Economy, DGBC, Metabolic, TUD and SGS Search)

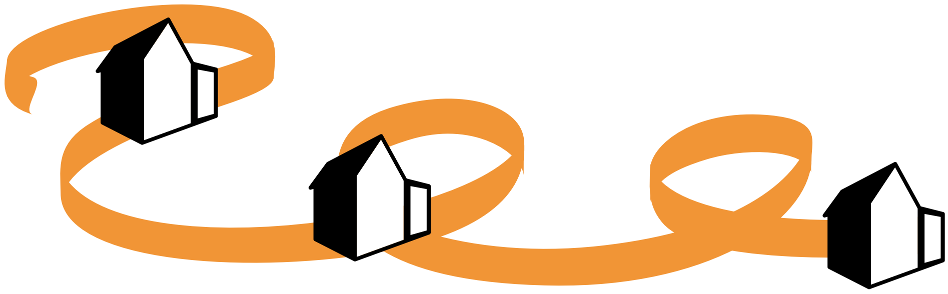

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

The idea of this EIS is to accelerate the transition to the circular built environment by integrating strategies and indicators for circular building into (global) standards for sustainable building such as BREEAM. In August 2018, Circle Economy, DGBC, Metabolic and SGS Search have collaboratively developed a framework for integrating circular criteria into BREEAM Standards. In their report they state that although sustainability frameworks have pushed the construction sector forward, some circular criteria, such as design for disassembly and repurposing of buildings and materials are missing. Integrating circular economy principles can push for solutions to further develop and improve sustainability frameworks from both material- and system perspectives.

Current process

Since its establishment in 1990, BREEAM has been developed to being the leading standard in developing sustainable master plans for building, area development and infrastructure. Interesting is that this tool has been developed by the development and construction industry itself to benchmark sustainable buildings for investment purposes amongst others. It is a voluntary certification method that works based on market logics, and supports the delivery of more sustainable buildings alongside governmental regulations. Other standards are the LEED standard and the WELL (more focussed on health) standard.

The BREEAM certification approaches sustainability integrally through nine different themes:

1) management
2) Health and wellbeing
3) Energy
4)Transport
5)Water
6)Materials
7) Waste
8)land use and ecology
9) pollution.

It has four different types of certification in regards to different scales and phases. These are building, area development, In-use, and demolition and disassembly. A certification allows you to get access to certain subsidies and funding opportunities.

In the Netherlands, almost 8 million m2 was certified under the BREEAM-NL certification in 2017 (BREEAM, 2018).

Proposed process

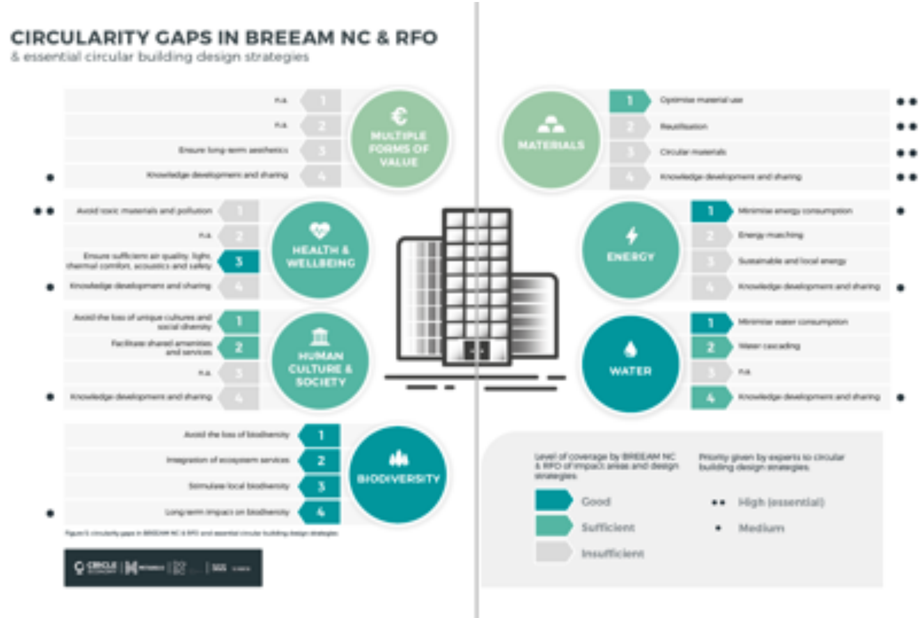

FIG 2 Source: Circle Economy, DGBC, Metabolic and SGS-search (2018), A framework for circular buildings, indicators for possible inclusion in BREEAM, Amsterdam. pp. 22-2

Although the BREEAM standard approaches sustainability holistically by not only focussing on sole topics such as energy or waste but by addressing nine different topics holistically, there is still room for improvement. In this new process indicators and criteria for circular building are integrated in the standard. The research by Circle Economy, DGBC, Metabolic and SGS search takes the framework for circular land tendering as a point of departure to set up strategy framework for designing and constructing circular building and uses this as a basis to conduct a Gap analysis of the current BREEAM framework. The report further elaborates on specific indicators.

References

Circle Economy, DGBC, Metabolic and SGSsearch (2018), A framework for circular buildings, indicators for possible inclusion in BREEAM, Amsterdam https://www.circle-economy.com/wp-content/uploads/2018/10/A-Framework-For-Circular-Buildings-BREEAM-report-20181007-1.pdf [Accessed October 2018]

Re-purposing vacant offices for affordable housing

Category of outcome: Political

Owner of the EIS*: REPAiR (TUD, Metabolic)

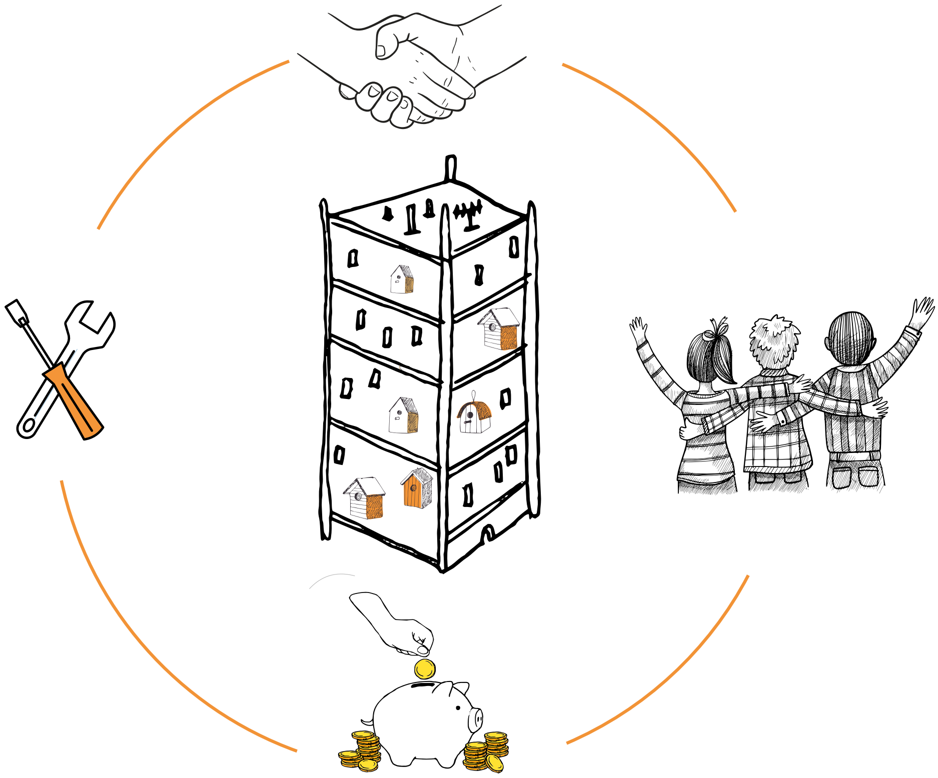

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Repurposed offices offer a solution to the increasing demand of housing for young people in urban environments. The continuous influx of students are to a great extent the driving forces behind an unmet demand for housing in cities. As the demand for housing grew, office spaces across western cities have become increasingly vacant due to ill-fated real-estate investment speculation (Remøy & van der Voordt, 2014). The rate of vacant offices in the MRA has increased over the last years. In 2014, this amounted to nearly 17%. Half of these vacancies are structural, meaning that they have been empty for over 3 years (Circle Economy, 2015). In order to optimize the use of space within cities and consolidate density there lays great opportunity repurposing vacant offices them to provide housing for young people. The degree to which office spaces can be physically transformed proved to be one of the highest determining factors of success. Relevant factors enabling the transformation of outdated offices for the young include the adaptability of the office spaces .

Current process

Remøy and van der Voordt (2015) describe four strategies for property owners to deal with vacant office buildings: consolidation, renovation or upgrading, demolition and new-build, and conversion to new functions. Whereas renovation and new-built are cost intensive and timely, conversion can provide is less time intensive and can provide social and economic benefits. Most property owners currently choose for the first option, consolidation, waiting for the property to regain value, and demand to grow. Also, the number of offices which have been constructed with repurposing objectives in mind are limited as office space developers consider office space investment more lucrative.

This solution already exists in Amsterdam, for example Camelot[1], Ad-Hoc[2] and Anti-kraak[3]. The actual practice is very relevant for real estate developers and owners of buildings and offices. However, as it is, this practice has several limitations due to the commercialisation and scarcity of dwellings.

FIG 2 Example of temporary house in an unsed office building in London: Source of the pictures https://thespaces.com/shed-homes-coming-central-london-rents-starting-300-month/; http://www.whitehouse51.com/shed-homes-inside/19/the-shed-project-offers-micro-homes-inside-vacant-london/

1 https://nl.cameloteurope.com/antikraak-wonen
2 https://www.adhocbeheer.nl/woonruimte/antikraak-wonen
3 https://www.rochdale.nl/aanbod/overig-aanbod-huur/anti-kraak/

Proposed process

In the new process, vacant offices can be transformed into housing. The success of this process requires some adaptation in zoning, financial models but also the physical adaptability of office spaces. The term 'change-of-use adaptability' has been referenced as a crucial instrument which should inform briefing and designing office spaces (Van der voordt, p. 390).

In particular in order to be relevant and to be extended to the AMA, the practice aim to address a specific target of people/social group (in particular middle class young people) and to stimulate a new type of housing policies.

Within this EIS particular locations could benefit in an earlier stage from this solution like empty buildings near public transport nodes and safe areas in the AMA.

In order to tackle the special issue and simultaneously address the social issue of the lack of affordable housing in Amsterdam, the solution intend to not generate a different private business model but to stimulate a more public or semi public service. Therefore considering the necessity to include a new planning policy, the main change is to start to perceive the service as non-profit products. In practice this consists of removing the commercial part from the solution by including it in governmental housing policies.

Possible location in the AMA

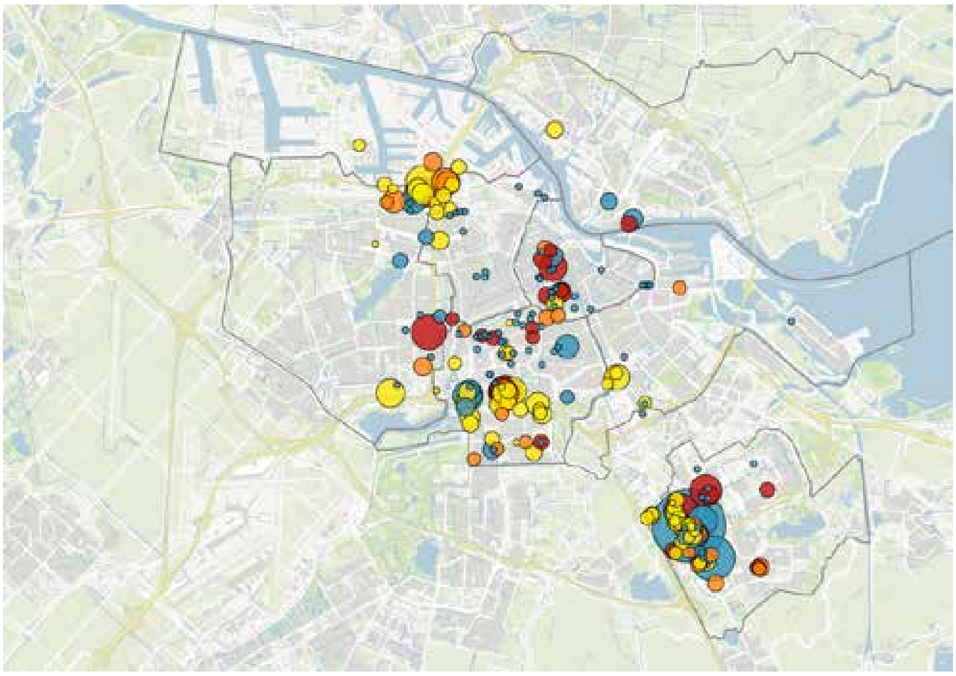

FIG 3 Map of vacancy and Transformation in Amsterdam. Source City of Amsterdam https://maps.amsterdam.nl/leegstand_transformatie/?LANG=en [Accessed November 2018] Map out of scale

The municipality of Amsterdam is currently already working to facilitate the transformation of vacant offices to other functions. They have developed a map (see figure above) where all vacant offices can be found (Het Parool, 2016). In 2018, the Metropolitan Region of Amsterdam has converted more than 500.000 m2 of offices into housing. The amount of existing vacant offices has decreased from 17% in January 2016 to 13% in the first half of 2018 (Nul 20, visited October 2018).

100% Vacant office with no transformation
Between 50% and 100% of vacant office
Up to 50% of vacant office
In search of transformation

Reference

Remøy, H., & van der Voordt, T. (2014). Adaptive reuse of office buildings into housing: opportunities and risks. Building Research & Information, 42(3), 381-39

Website

https://www.nul20.nl/recordaantal-kantoren-metropoolregio-amsterdam-omgezet-woningen [Accessed October 2018]

Amsterdam komt met meldpunt voor leegstaande kantoren, Het Parool, 16 juli 2016, https://www.parool.nl/amsterdam/amsterdam-komt-met-meldpunt-voor-leegstaande-kantoren~a4339288/ [Accessed October 2018]

City of Amasterdam Website https://maps.amsterdam.nl/leegstand_transformatie/?LANG=en

https://thespaces.com/shed-homes-coming-central-london-rents-starting-300-month/;

http://www.whitehouse51.com/shed-homes-inside/19/the-shed-project-offers-micro-homes-inside-vacant-london/

Re-purposing vacant offices for recreational activity for local community

Category of outcome: Political, Social, Legal

Owner of the EIS*: REPAiR (TUD, Metabolic)

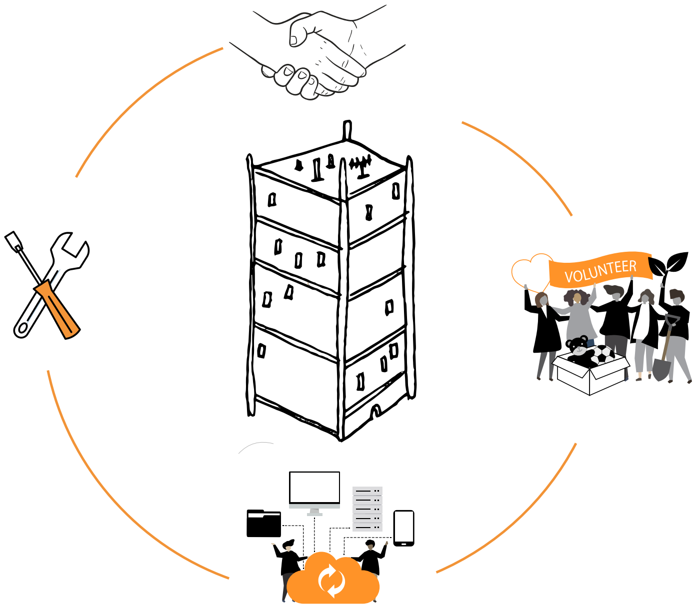

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

As explained in the previous EIS office spaces across western cities have become increasingly vacant due to ill-fated real-estate investment speculation (Remøy & van der Voordt, 2014). The rate of vacant offices in the MRA has increased over the last years. In 2014, this amounted to nearly 17%. Half of these vacancies are structural, meaning that they have been empty for over 3 years (Circle Economy, 2015). In order to optimize the use of space within cities and consolidate density there lays great opportunity repurposing vacant offices them to provide space to engage the local community . The degree to which office spaces can be physically transformed proved to be one of the highest determining factors of success. Therefore, this solution aims to propose a new business model.

• Throughout an online platform, managed by municipalities or even start-up empty abandoned offices and commercial buildings are offered for neighbourhood or community activities. In exchange, owner will have a lower taxation. Moreover the EIS could facilitate community engagement in social activities, like: exhibitions, university courses,urban agricultural will keep these areas alive.
This solution could be interesting for building developers that prefer to find alternative temporary solution to houses. The solution can be applied in the city centre of Amsterdam, port area, Haarlemmermeer.
The possible actors to be involved are: municipality, local community, owners of the dwellings or buildings, developers, architects, museums, artists, green business clubs,

Regarding the change of policies and process see the previous solution page 169

Establishing a circular construction market for re-furbishing projects

Category of outcome: Political, Legal, Technological

Owner of the EIS*: REPAiR (TUD, Metabolic)

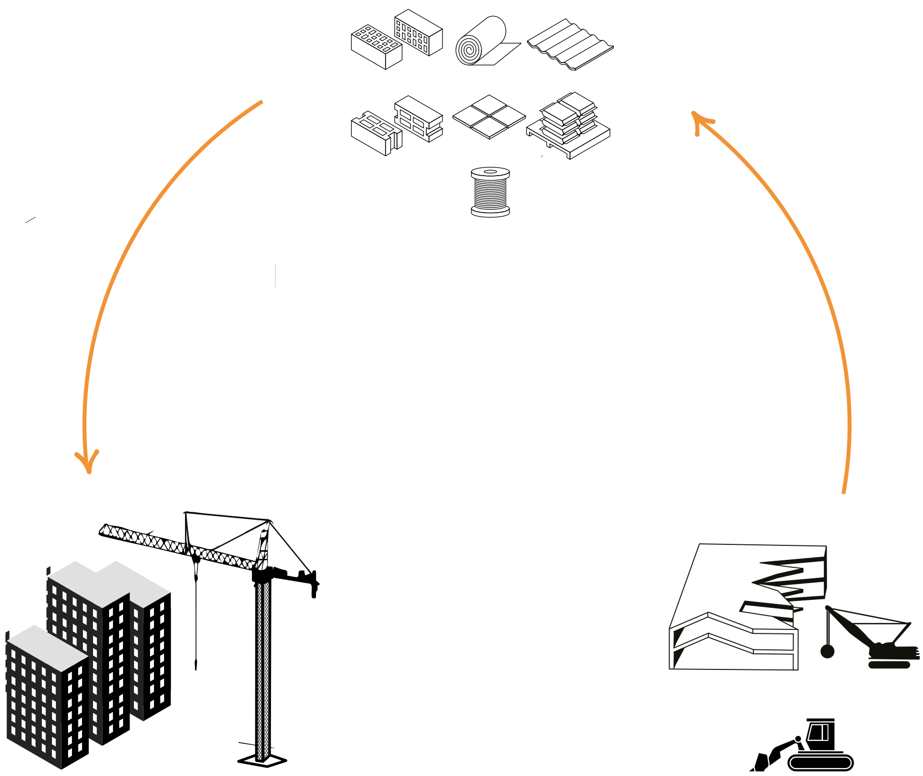

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Cities represent an enormous urban mine of building and construction materials. Using used materials in refurbishing projects can pay a key role within the construction sector and its transition to a circular state. The idea of this EIS is that a product, components, or materials are restored to a good state where they can be (re)used for new projects or renovation. To successfully reuse construction and waste materials, a shift needs to be made to seeing them as useful quality materials. In 2015, only 3-4 % of the materials used for construction of new buildings and infrastructures were secondary (RWS, 2015).

A physical marketplace could incentivize players in the construction sector to sufficiently supply and buy circular materials, and ultimately promote refurbishing projects and prevent the use of virgin materials in those projects. This does not only require new methods for logistics of waste collection, it also require a central place for these refurbished materials to be offered.

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Current process

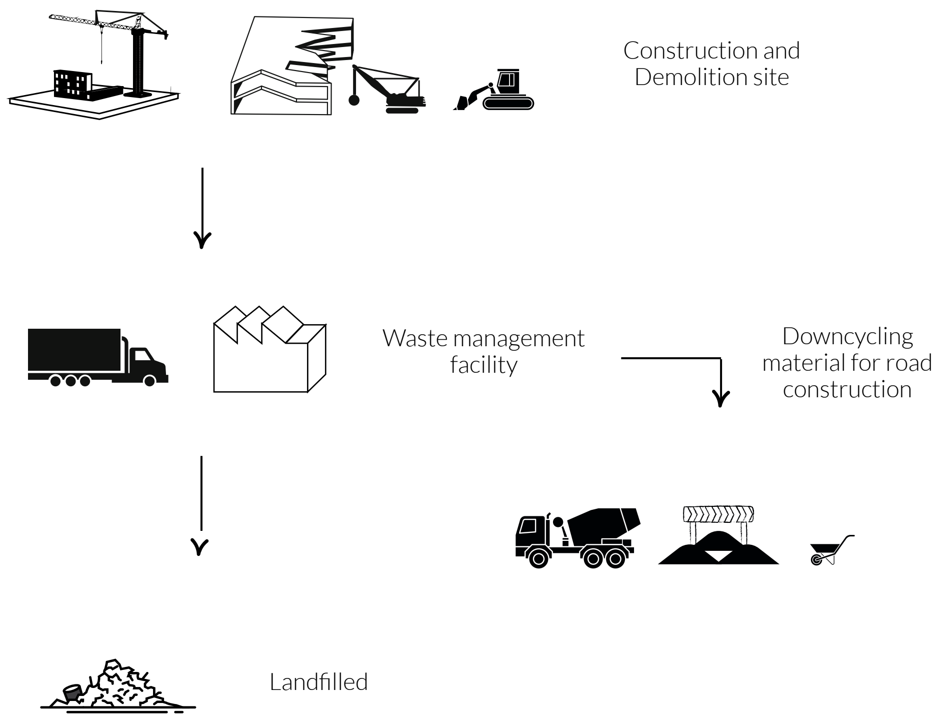


FIG 2 Current Process model diagram Source: REPAiR EU H2020 project

The construction sector accounts for a great percentage of waste. In the Netherland, the sector is responsible for generating 40% of the overall annual waste (Provincie Noord-Brabant, 2018). The sector also is a heavy user of virgin materials. Globally, infrastructure and buildings account for 60% of the total amount of materials used annually (Hawken et al., 2013). Furthermore, more than 50% of all metals consumed are used in buildings including valuable metals like steel, copper, aluminium and zinc (Beers et al., 2007).

Nevertheless, the Netherlands is a front runner when it comes to circular construction. Over 90% of all materials derived from demolition are recycled. This, however, most often means down cycling as foundational materials for roads (Kadaster Ruimte en advies, 2011). Very small percentages of the materials used in construction projects are secondary, this percentage will have to increase drastically to make the future sustainability goals such as a 100% circular construction sector in 2050 (Transitie agenda circulaire economie, 2018).

Proposed process

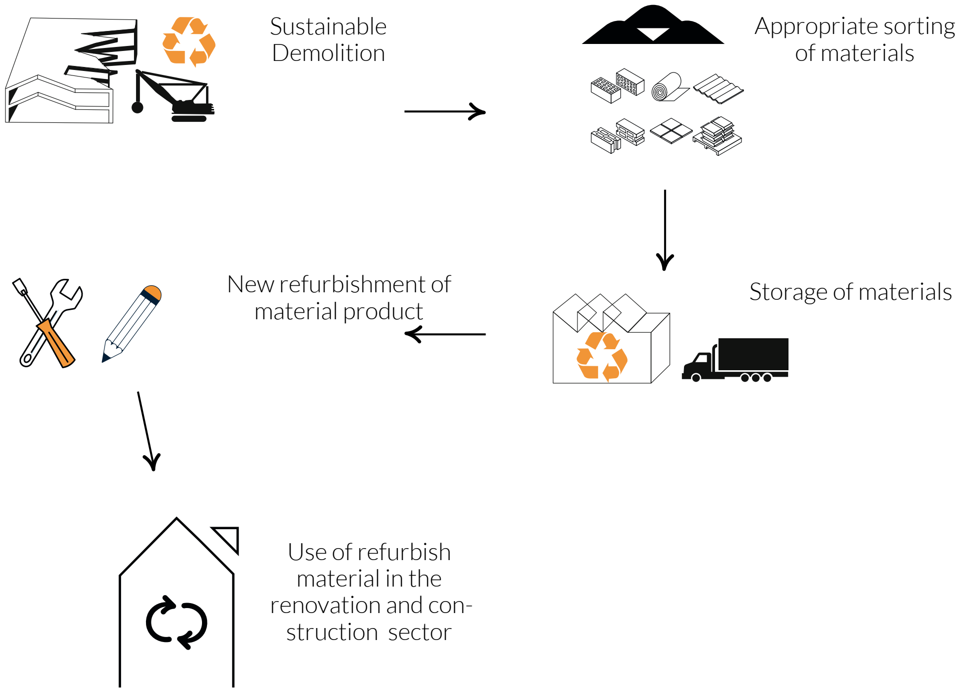


FIG 3 Process model diagram, Source: REPAiR EU H2020 project

Establishing a circular market for refurbishing projects will make secondary products widely available for different players in the construction sector, from large scale projects to smaller scale refurbishment projects. Instead of taking virgin materials from nature, in this case the urban mine will be used as the material source for projects.

Depending on the disassembling qualities of the materials stored in the building, a certain level of value can be retained. After sustainable demolition and appropriate sorting of material components these individual elements can be sold or leased through such a marketplace. While the producer of the materials retains ownership, the developer and designer in close coordination with the clients can fabricate a refurbished material product.

A physical marketplace for secondary products will provide an alternative for conventional marketplaces where virgin materials are sold.

Reference

Hawken, P., Lovins, A., & Lovins, H. (2013). Natural Capitalism: The Next Industrial Revolution. Routledge.

Leising, E., Quist, J. & Bocken, N. (2017). Circular Economy in the building sector: Three cases and a collaboration tool. Journal of Cleaner Production, 30, 1-14.

Transitieagenda circulaire bouw, Report (2018)

Greening up the city

Category of outcome: Technological

Owner of the EIS: Rosanne Stel and Haoge Gao

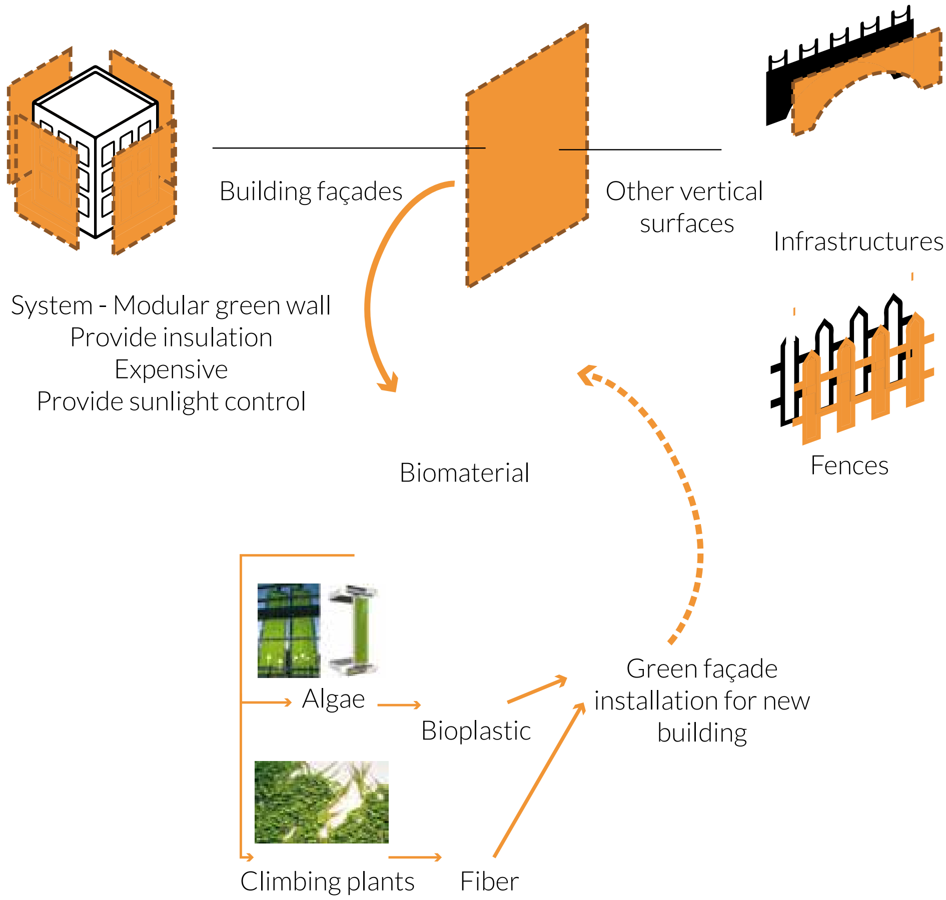


FIG 1 Idea diagram Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Idea

"Greening Up" solution aims to generate an alternative construction technology that simultaneously address the problem of construction and demolition waste and the reduction of greenhouse gases, air and noise pollution in the form of the application of green façades. Two types of green façades are used: green façades of climbing plants, and green façades from algae. There are currently two buildings worldwide (date: june 2018) with algae façades. Because of the energy production and absorptive function of the algae, this is seen as a future building material (Wilkinson, 2016). Besides that, research has shown that it is possible to produce bioplastics from dried algae (Hempel et al. 2011) which gives the façades multiple functions.

Green façades from climbing plants are already used frequently (Kohler 2008). The new part within the concept of this project is to use the harvest from the climbing plants to make fiber. The combined opportunities from the climbing plants and algae are used to design a circular system where the harvest of one facade will be the base of the construction of a second facade, this will result in a growth in green elements within the Amsterdam Metropolitan Area, Therefore the solution aims to contribute to the reduction of construction and demolition waste

Proposed process

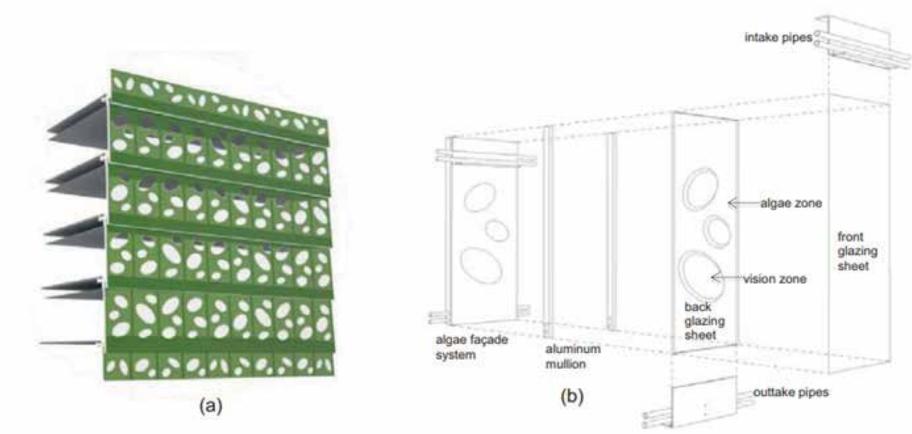


FIG 2 Algae Systems. Source : Arup.com. (2018). SolarLeaf. [online] Available at: https:// www.arup.com/en/ projects/s/ SolarLeaf

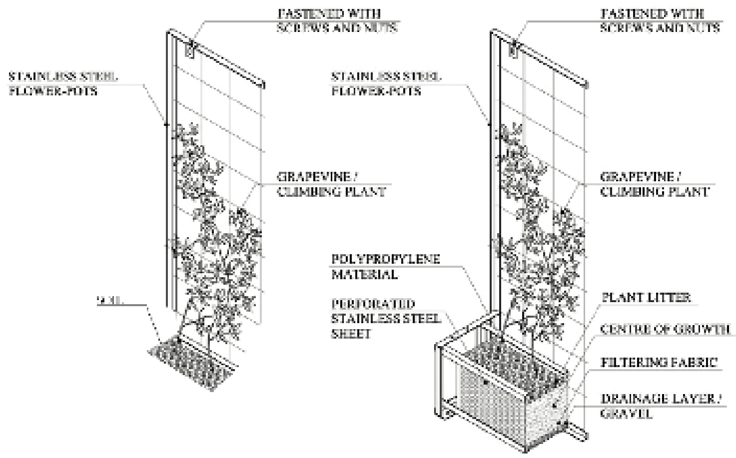


FIG 3 Green wall systems (with fl ower-pots) Sourc:e: Kmiec, M. (2014). Green wall technology. Technical Transaction Architecture 10-A , pp. 47-60.

Application of algae as part of a building system facade has recently been introduced as replacement of large glass surface in the building facade. The advantages of this facade system include good thermal performance structural integrity, and an algae cavity that modulates solar gains over the entire year. It reduces greenhouse gas emission and creates a sustainable energy system. Besides this, the algae facade can be used as bioreactor. The bioreactor absorbs CO2 from the indoor or outdoor air to grow the algae and releases more oxygen during photosynthesis process because algae are photoautotrophic organisms (Poerbo et al. 2017). However the main goal “Greening Up” is to use the biomass to make plastic, if there is more algae produced than needed for the plastics, this biomass can be used as biofuel because the effi ciency of algae biofuel is about four times greater than typical biomass (Kim 2013). The primary type of algae used in the algae facade system is Chlorella Vulgaris, which produces 0.02-0.20 g/L/day of biomass (Kim 2013). This production is stimulated by a moving water or air stream through the panels from where the algae can absorb the CO2 to grow. Holes in the panel prevent the facade to become fully dark and limit daylight in the building. Within this innovative solution, biomass of the algae in the green facade can be harvested daily. The harvesting rate of the panels can influence dynamic sun shading. Frequent harvest means transparent façades and limited harvest means darker façades because of higher density of algae in the panels (Snijders & Bilow 2013).

Various types of bioplastics can be produced from algae, 1 kg of polyhydroxybutyrates plastic requires 4.3 kg of dry microalgae biomass which is mor than the2.5 kg of glucose needed for 1 kg (Rahman & Miller 2018).

Proposed process

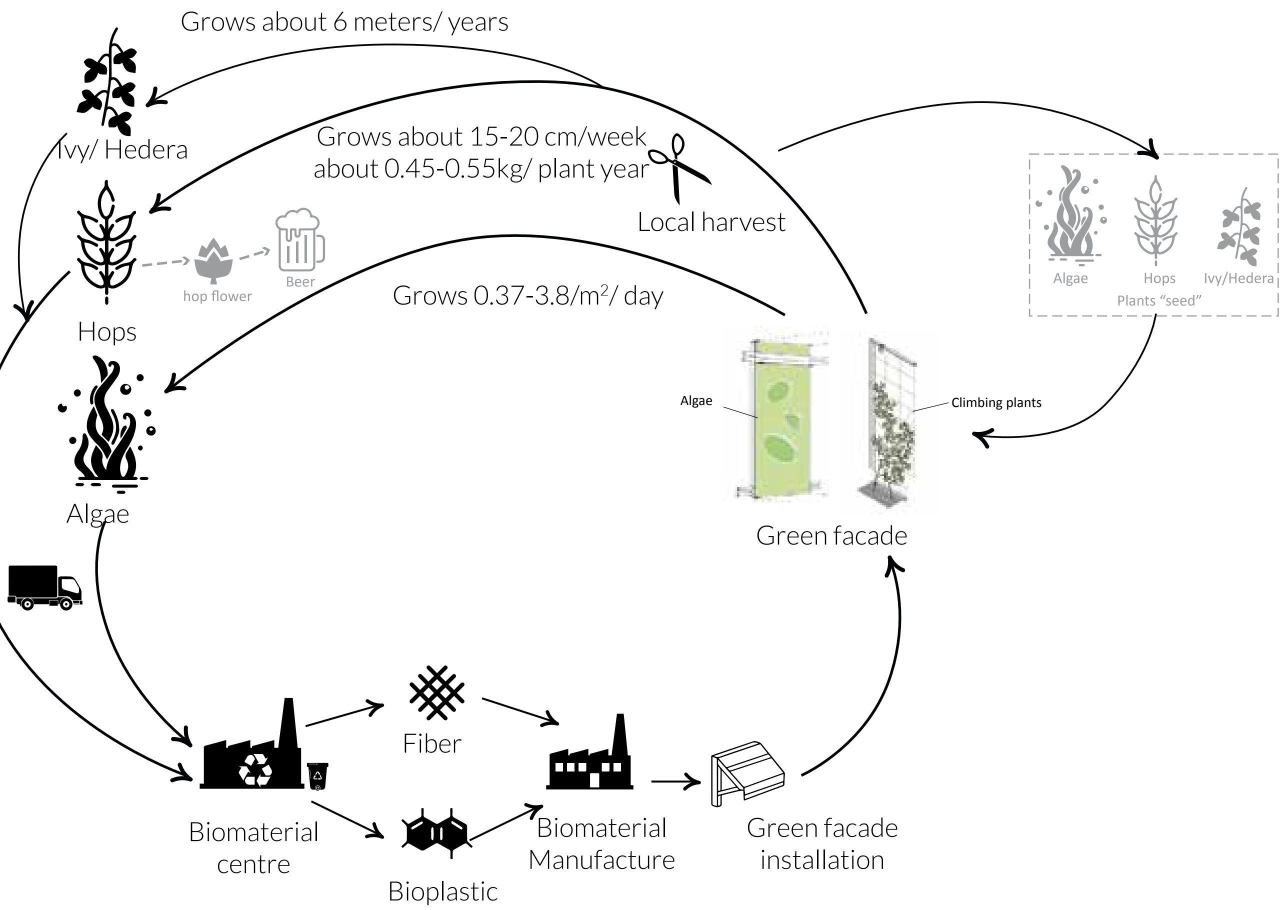


FIG 4 Process model diagram Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

On the green façades biomaterial is grown (stems and leaves from climbing plants and algae). This biomass can be used to produce parts of new façades. The first panels will be made from existing materials. However, the ambitions to grow the construction parts from the harvest of the existing green walls. So hedera and hop from the green wall will be harvest and manufactured to fiber which can be used to produce parts of the green facade, for example the grid. The bioplastic, from the harvest of algae facade, can be used for the construction of new parts of a new algae panel, for example the boxes or tubes which are used to stimulate a water stream in the panels.
If the green façades can be made from materials of other green façades, the material flow is closed. The growing frequency of harvesting the increasing amount of façades and transform these materials into bioplastics and fibers will result in a new economic stream and new labour. The impact on the environment because of the production of the current green façades will be minimized, as steel (which is used for the traditional construction of the grid) has a large impact and is not used anymore within this concept. However the economic scalability of the bioplastic production capacity of the system versus the current fossil alternative has still to be investigated in depth. Today this solution is not yet economic convenient.

The circular use of materials from the green façades will involve new stakeholders for the harvesting, production and installation of the façades.

Evaluation model

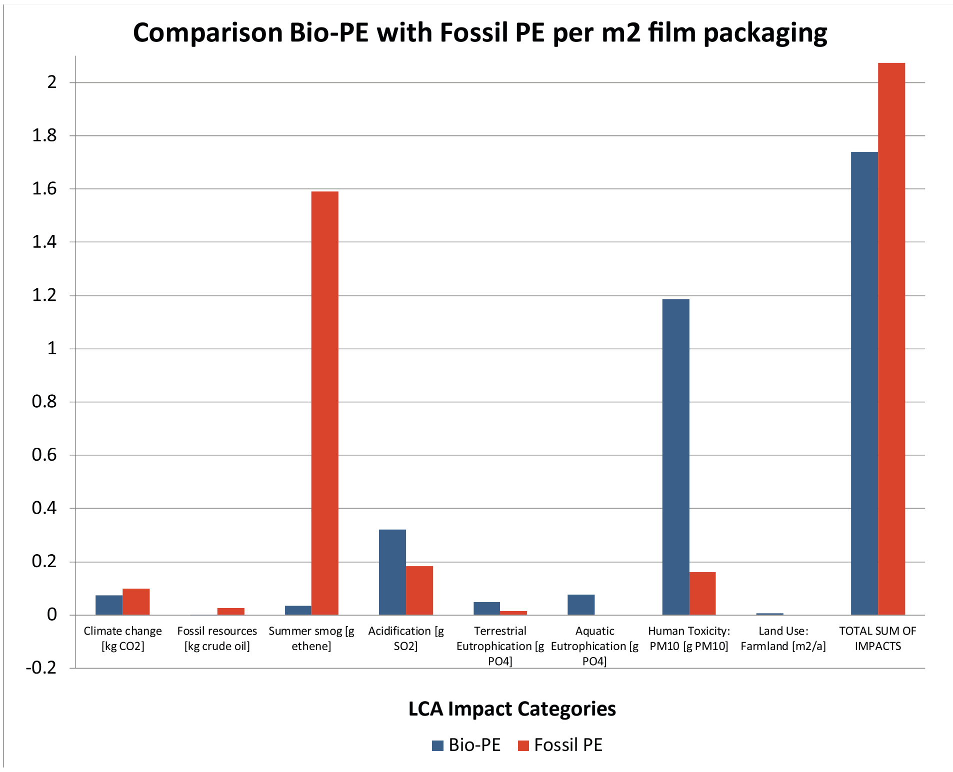


FIG 5 Comparision of fossil PE and Bio BE Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Production new material per 1m²	Production of material on facades	Regenerative Ratio of facades: based on weight of facade structure (04) of 7kg/m2
Hop	1 kg/m²/year	Per year, 0.14 m² of new facade
Hedera	22.5 kg/m²/year	Per year, 3.2 m² of new facade
Algae	18.7 kg/m²/year	Per year, 2.67 m² of new facade

FIG 6 Table representing Productivity and use of different green facade plants. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

LCA

The green façades with local harvesting form a closed loop. This closed loop has an impact on various categories: social, economic and environmental.. One option to measure the impact of materials or products is to performs Life Cycle Assessment (LCA). Within the literature, there is no LCA performed of green façades constructed of fiber or bioplastics from the harvest of algae panels and green façades with hop and hedera as climbing plants. As example, an existing research about the comparison of standard and green façades is used as reference. To get some insight in numbers, a comparison is made between bioplastic and fossil plastic used for film packaging and numbers from an LCA about green façades.

Comparative LCA on standard and new green façades

An LCA was conducted by Ottelé et all. (01) comparing the environmental impact of various types of green façades and living wall systems over their entire life cycle. The results of the LCA show that there are significant differences in the environmental impact of the various systems. The most important factor causing these differences is the material involved for the supporting structures of the green vertical systems (Ottelé et al. 2011). A standard indirect green facade supporting structure is made with stainless steel. The largest environmental impact of this system is caused by this choice of material. Steel has a large impact due to the mining of iron ore and highly energy intensive production of steel. Next to this, the life span of the material is also important, as it determines when and/or whether the material needs to be replaced, hence causing a larger environmental impact. Looking at the new green façades it can be seen that "Greening Up" contains much more sustainable choices of materials, and therefore a lower environmental impact in comparison with the traditional system. The new green façades produces biomass (algae, hedera helix and hop), which serves as an input for producing new green façades.

LCA on production of bioplastics

There is no research (yet) available about the comparison of regular plastic from fossil fuels with plastic from algae. To give some guidelines and get numbers, a research is used where bio-based polyethylene (PE) plastic from sugar cane is compared with fossil PE plastic (Detzel et al. 2013).

Within this research the different phases of the life cycles are compared-within ten impact categories. As can be seen in the figure 1, these categories are taken together in one figure to compare the fossil PE life cycle impact with the biobased version. The bio-PE has a high impact on human toxicity. The biobased plastic in our case, made from algae has less impact on human toxicity because there are no chemicals released in the environment as is within the sugar cane to help it grow, so the total impact will even be smaller than in the figure

LCA comparison impact categories

Other indicators that were taking into account are: noise pollution, air pollution, urban heat impact, and visual / health. The green facade influences these factors in a positive way by absorbing various emissions and as a consequence lowering the temperature within the surroundings. The ten impact indicators of Detzel, Kauertz and Derreza-Greeven are specific for the LCA. To make our product more practical and understandable, four relevant other impact categories are determined: noise pollution, air pollution, urban heat island impact, and visual/ health impacts.

In general it can be said that the green walls (hedera helix, hops and algae) have positive effect on the following categories:

-Noise pollution is reduces the street sounds;

-Air pollution is reduced because the green façades absorb fine dust;

Possible location in the AMA

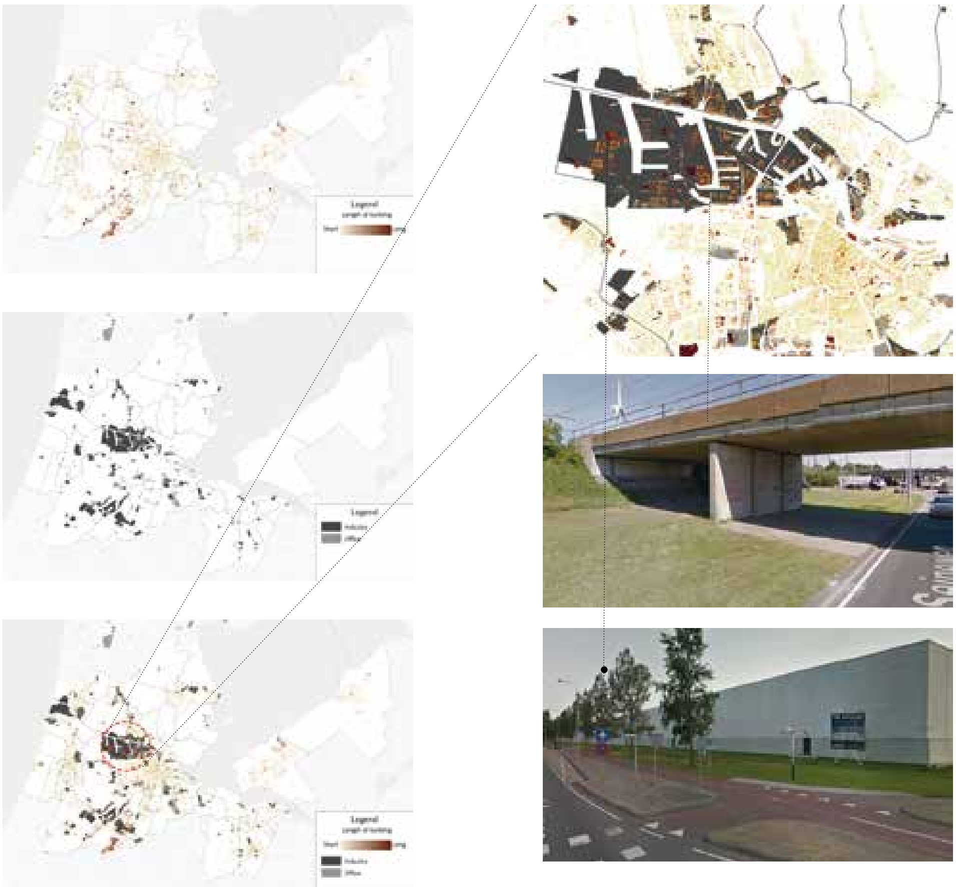
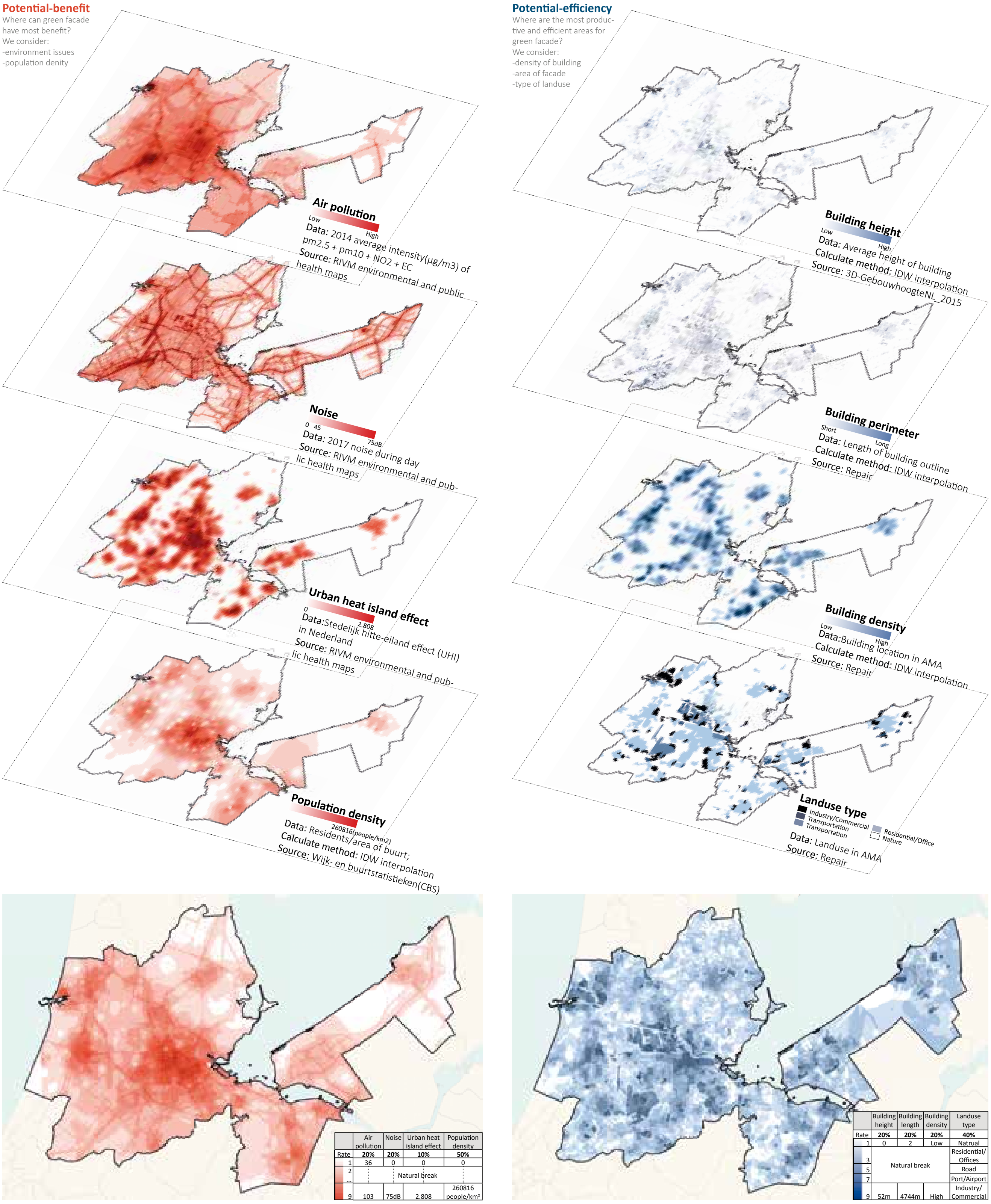


FIG 7 On the left side (from top to bottom) Map representing the lengths of the facade. Ma representing industrial and commercial area. Map representing the potential focus point on the solution. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 8 On the right Map representing a focus area in which implementing for the solution. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018).
FIG 9 Bottom right picture of potential building on which implement the solution . Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018).

AMA has set several ambitions for 2040 regarding green areas. The denser the buildings within the AMA, the greater the need for the water-storing, air-purifying and heat-insulating functions of the green (Gemeente Amsterdam 2017). Because of this, there is a stimulation of additional parks, roof gardens and the use of green façades on new and existing buildings. Apart from the area Westpoort, all sub areas have been awarded a green budget from the AMA with a total of €55 million to apply on green solutions between now and 2040. These budgets are partly applied by the development of the Municipality itself and partly by awarding subsidies to (particular) green initiatives. In particular within the AMA, it is expected that the port of Amsterdam will benefit from the international growth in freight transport This will result in growth of the industrial areas and expanding of residencies from the city center to the borders of the city for people working in the industrial areas. These areas are required to contain green roof gardens or green façades (Gemeente Amsterdam 2017). The solution requires locations with long closed façades to produce the maximum of new material on high scales to start the production of fiber and bioplastic. So the industrial area in the north west part of the city of Amsterdam could be an efficient location for the start of this project. After this location is used for the production of a lot of new façades, the products of the harvest can be used to apply green façades in the city center on the polluted areas so the living quality could be enlarged by the absorption of toxics by the green façades. Within the vision of 2025 it is emphasised that the public areas need more green (Gemeente Amsterdam 2017). This could be realised with the application of green façades on the various public areas. The application of “Greening Up” will be beneficial for the municipality because it stimulates a circular flow of materials and more green within the area.



	Air pollution	Noise	Urban heat island effect	Population density
Rate	**20%**	**20%**	**10%**	**50%**
1	36	0	0	0
2 ...	⋮	Natural break	⋮	⋮
9	103	75dB	2.808	260816 people/km²

	Building height	Building length	Building density	Landuse type
Rate	**20%**	**20%**	**20%**	**40%**
1	0	2	Low	Natrual
3	Natural break			Residential/ Offices
5				Road
7				Port/Airport
9	52m	4744m	High	Industry/ Commercial

FIG 10 In red the maps of the benefit at the landscape level. In blue the potential efficiency of the solution at the territorial level. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Reference

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Land Rotation

Category of outcome: Political; Legal

Owner of the EIS: REPAiR

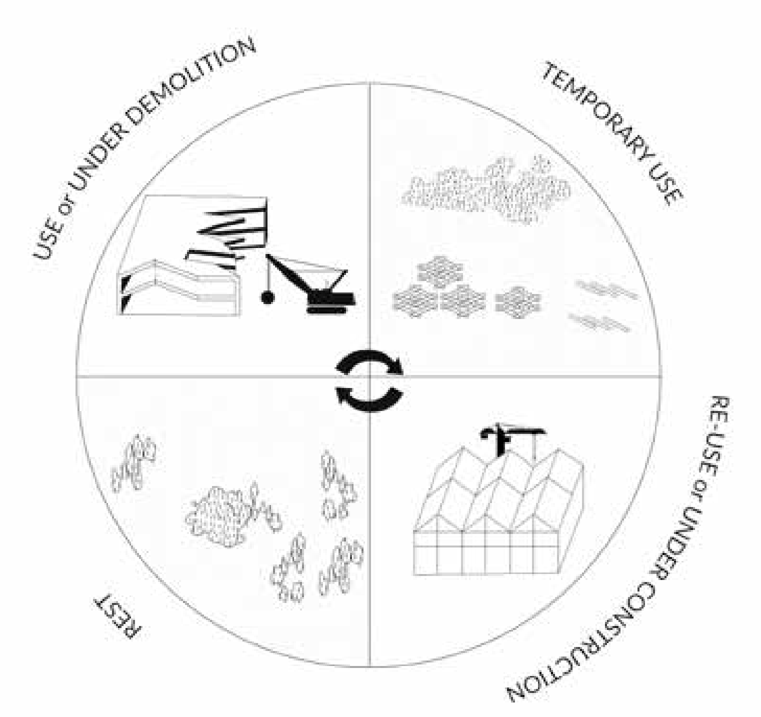

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

This EIS uses land rotation to free up space that could be used a as temporary storage for building materials. Every day, The logistics of building materials are heavily responsible for a large portion of the total road use leading to both congestion, fossil fuel based and pressure on the air quality.

Implementing a hub for construction materials close to a construction- or demolition project will limit the amount of trips to the sites, as these materials could be brought at the same time. It could also help match supply and demand of secondary building materials since these don't almost match on a temporal scale. Building hubs require space which is not always available in cities. Land rotation could provide the solution. Instead of having a central location, building hubs could also be temporary, using land that is available at a certain location at a certain time. This solution follows the scheme of rest-and-use rotation system that is similarly employed in agriculture land for crop rotation (see Fig 1).

According to Ludema & Merriënboer (2016), implementing measures for smart building logistics such as a hub for building materials could lead to a decrease of CO_2 emission of 35% and limit construction related trips by 45% for the entire construction and demolition sector.

* *See page 67 for the complete description of the solution*

MYC Block

Category of outcome: Tecnological

Owner of the EIS*: Ankita Singhvi and Lou Krabshuis (TUD)

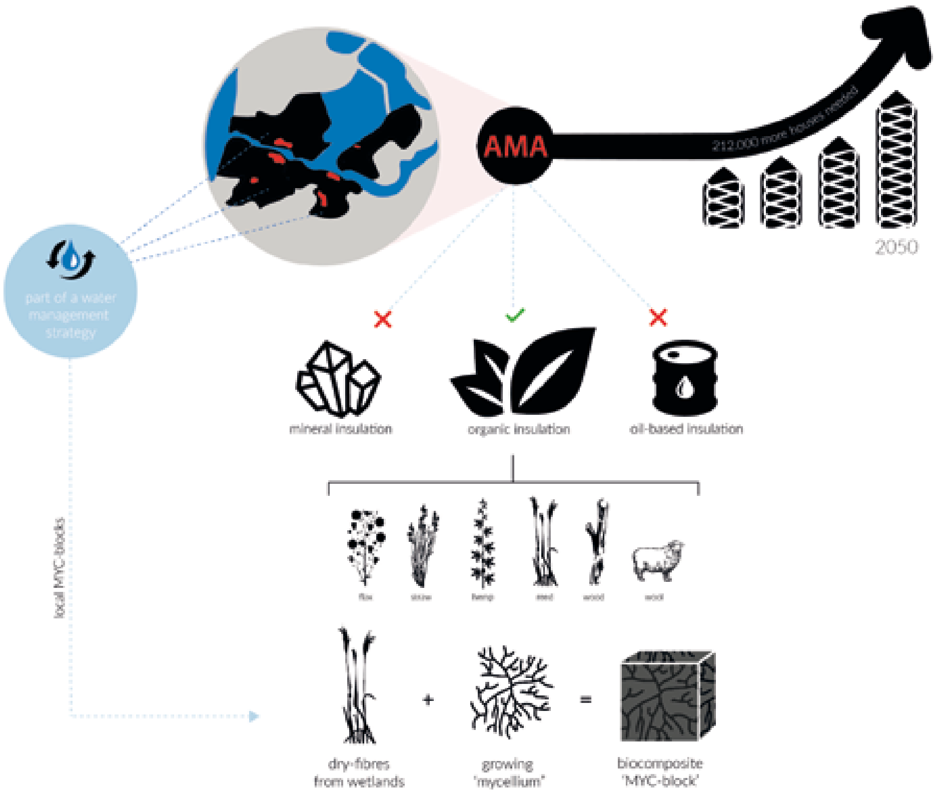

FIG 5 Idea diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Idea*

MYC block solution propose a building insulation material made out of plant fibers and fungi as an alternative. This material is a biocomposite that is self-growing, renewable and can be locally produced (Ecovative, 2018; Klarenbeek, 2018; The Living, 2018). The biocomposite is produced as follows: plant fibers are harvested, they are processed (cut and sterilized, no chemical treatment), then they are collected in molds and fungi is grown around them as the 'glue'. This is then baked to strengthen the bonds between materials and kill the organism, creating a strong biocomposite. For the plant fiber we propose the plant fiber phragmites australis (reed) because it is suitable to the local climate, has a high yield, does not need fertilizers or chemicals to grow in wetlands and has low labor and machine costs (Smit et al, 2012). For the fungi, only the vegetative part of a fungi (mycelium) is needed to act as the binding for the biocomposite. Dried mycelium forms a strong, organic material that is water-resistant to a certain point, fire-resistant and mold-resistant (Ecovative, 2018). It can be transformed into various applications as a construction material, like: insulation material. The solution propose the local growth of the biocomposite (within the AMA region)in agricultural underused land or "wastescapes" alongwaterways, rivers and lakes.

* *See page 43 for the complete description of the solution*

on

Food Waste

From Bread to Beer

Category of outcome: Technological

Owner of the EIS*: Brussels Beer Project

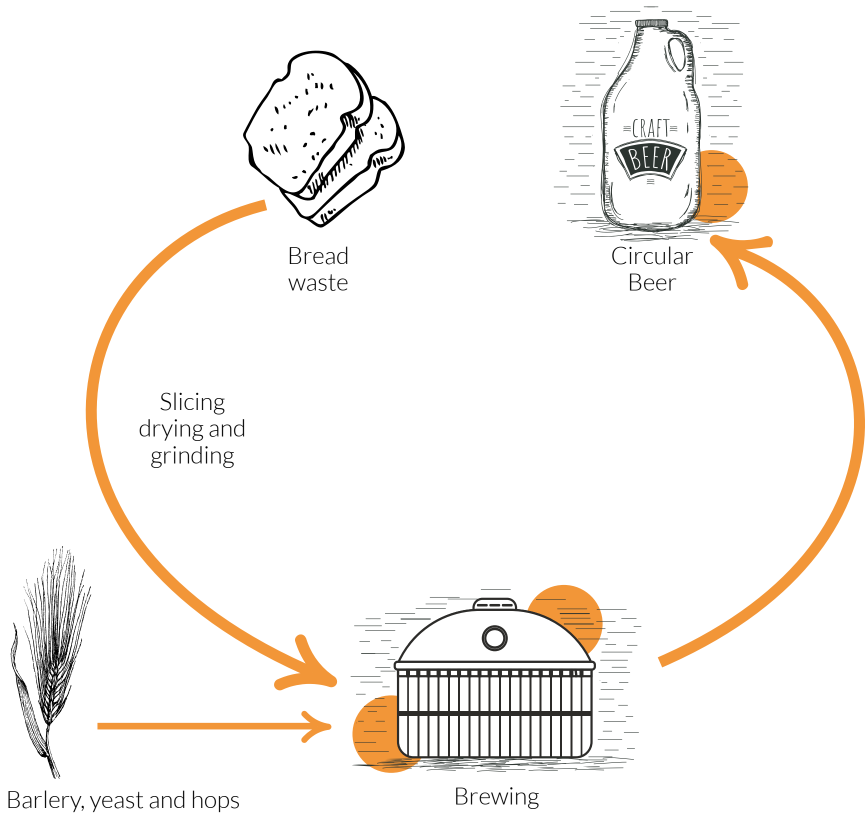

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

The core elements of this new solution comprise in a single solution, covering technology design and equipment supply for food waste, namely waste bread.
The solution proposes to collect and convert discarded- unsold bread from supermarkets, grocery shops and bakeries and to use it to replace a third of malted grain used beer brewing.

Typically, beer is made from a simple mixture of water, yeast, hops and barley (or another similar grain), very similar to the composition of our daily bread daw. Making beer out of bread isn't new – its history stretches back 4,000 years to a time when brewers and bakers worked together. However, in modern time this connection was lost.

Nowadays successfully experiments in Brussels and London showed how within this solution new beers could adopt bread that otherwise would go to waste.According to circle Glasgow report (2016) by using one and a half slices of bread per bottle, a brewery can produce a beer that reduces barley usage by nearly 30%. This change in recipe can contribute to tackling the food waste flow and the negative environmental and energy impacts of the agricultural industrial sector.

**https://www.beerproject.be/en*

Current process

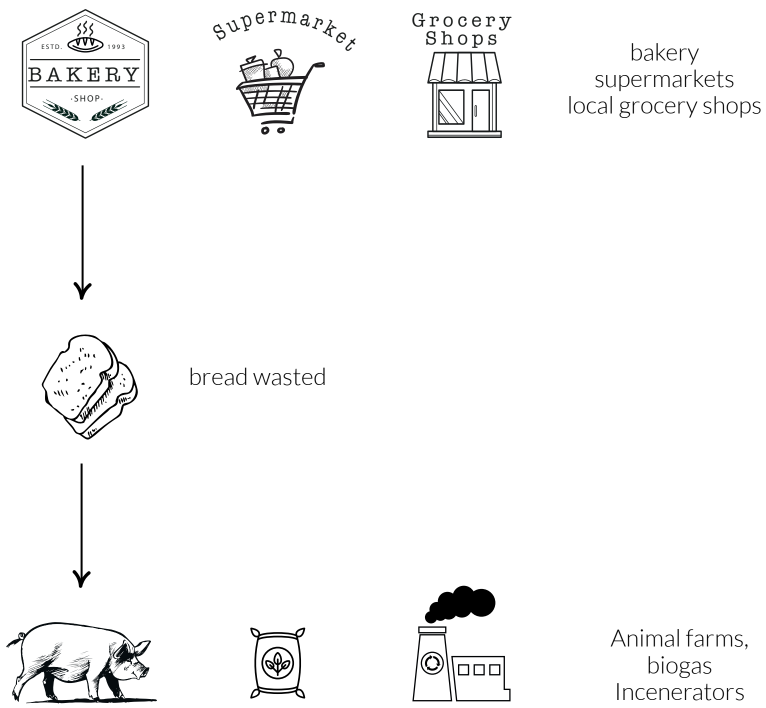

FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.

Within Europe Bread is invariably one of the top-3 wasted food. According to BroodNodig (2015) report in the Netherlands alone, within our household waste, we throw away 435 thousand loaves daily, accounting for 127 million kilos of bread per year, while SBI (Stichting Bakkerij Imago) estimated that, in 2009, about 140 million loaves of overproduction and bread was returned to supermarkets. Considering these numbers, the Wageningen University & Research (WUR) calculate that the 15% in the chain of production to consumers is lost. Usually, most of the unsold bread from the supermarkets is used for the most part as animal feed. Some also finds its way either to the biogas production or to incinerator facilities. Although the unsold bread is partially reintroduced in the production chain, this is a lost in sustainability.

Proposed process

The process of converting bread to beer consists in seven steps:

1. Collecting unsold-waste breads from local bakeries, supermarkets, local grocery shops.
Eventually these shops could also function as collection centres for unsold- waste bread from household. However, in this case, they should also provide a quality check of the collected bread.
2. Distribute the collected bread to the specific brewery. The transportation should be organised by the brewery
3. Once arrived in the brewery the bread has to be dried in oven at approx-

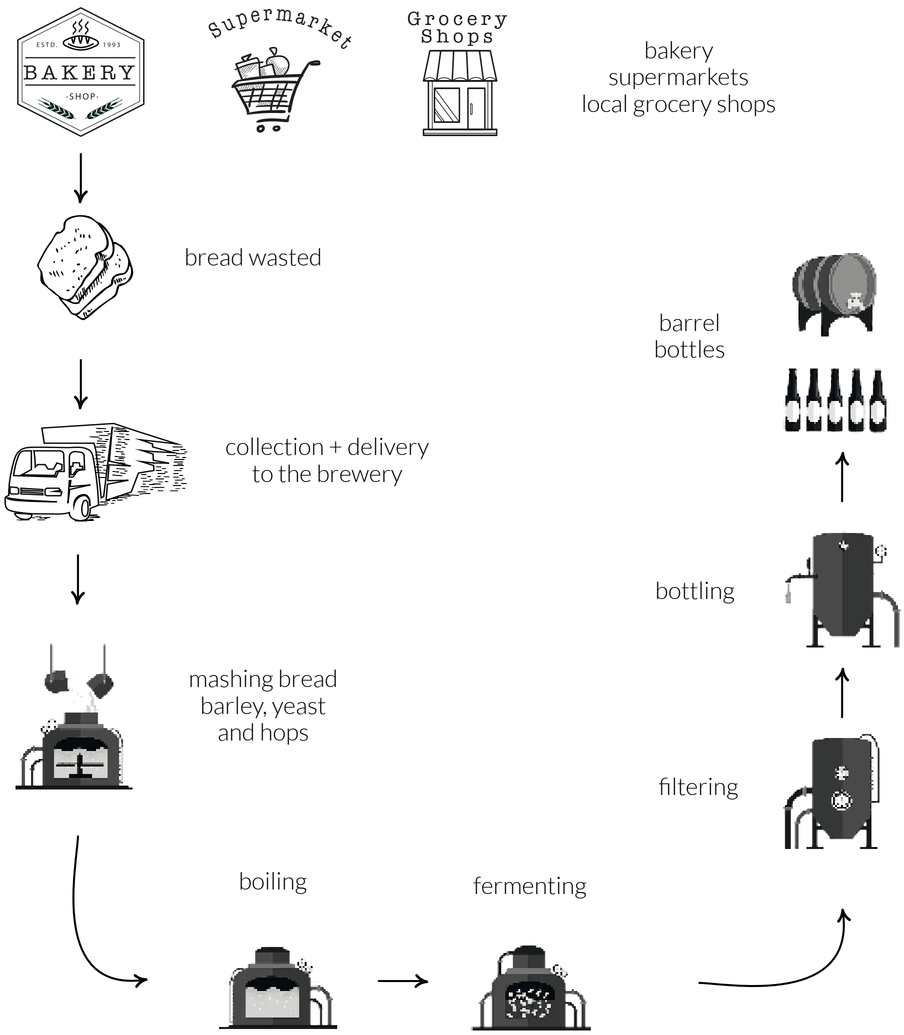

FIG 3 Diagram of proposed situation. Source: REPAiR EU H2020 project.

imately 90°C for about 1h. Time and temperature will vary depending on your oven (toast https://www.toastale.com/toast-ale-recipe/).
4. After draying the bread has been mashed. The resulting grains are steeped in 15.7L of water at 67°C and mix. The naturally occurring enzymes in the malt convert the starches in the grain into simple sugars. Although some of the barley malt has been replaced with bread, in this process new malt is still required for the enzymes. Grain bill: Pale Malt 3.5kg, Dried crumbed bread 1.5Kg (equivalent to 2.5kg fresh bread), CaraMalt 150g, Munich Malt 150g, Oat Husks 500g. 5. Later the liquid should be drained from the bottom of the mash tun (lautering), while rinsing the grains with 78°C water from the top to extract additional sugars (sparging). For approximately 25L of liquid, it should be necessary 20L of water.
6. At this point of the process of creating beer from waste bread, the liquid should bring to the boil and integrated with hops. Quantity and types of hops depends from the type of beer.
7. After at least 90 minutes of boiling the liquid should rest, cool at the temperature of 20°C and ferment at the temperature of 18°C for at least 7 days. Only after that other hops should be added to the fermentation process.

Possible location within the AMA

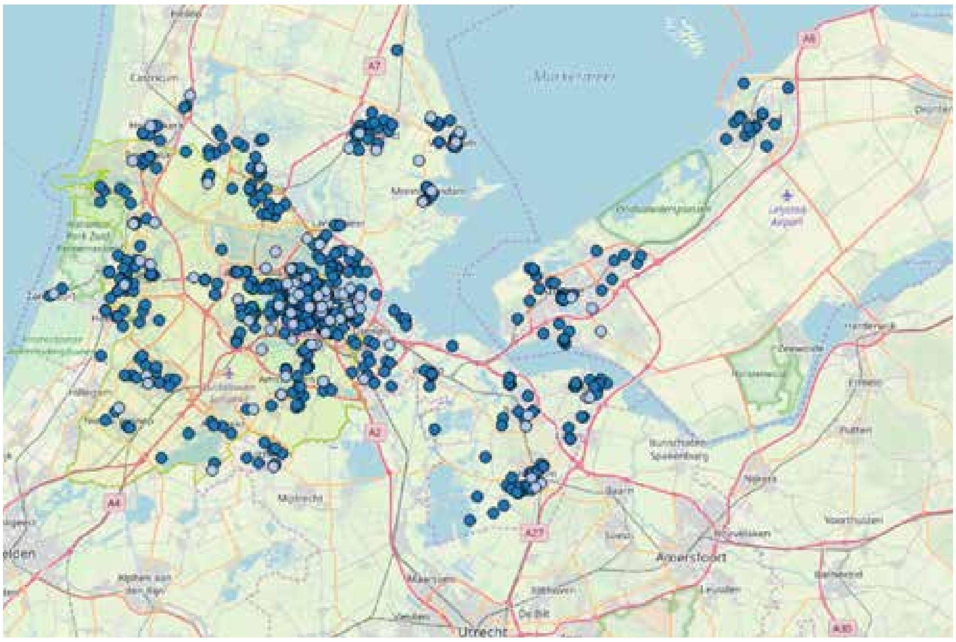

FIG 4 Maps with the locations of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project.

- Manufactures of bread, Manufactures of fresh pastry goods and cakes (dark blue)
- Manufactures of beer (light blue)
- Manufactures of malt (orange)

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https://www.ellenmacarthurfoundation.org/case-studies/brewing-beer-from-surplus-bread

https://www.livingcircular.veolia.com/en/eco-citizen/changing-bread-beer

http://www.nowastenetwork.nl/interview-turning-unsold-loaves-bread-into-cakes-and-cookies/

https://www.toastale.com

Example of implementation: the case of Brussels and London

FIG 5 Image of the process of transforming bread into beer. Source: https://www.beerproject.be/en

The previously described solution is already happening at the local scale in AMA, however this solution could be upscale in order to be more significant. Similar solutions are already developed in Brussels and London. In both cases it has been already an successfully experiment. According to the website of MacArtur foundation the Brussels Beer Project was the first company that in 2013 resurrected the ancient practice with their Babylone batch and sell their own crafted beer.

Two years later, the Belgian brewers shared their insights with the British company Toast Ale for this first foray into beer from bread.

"Bread is one of the most wasted food products. This is an ancient solution that is totally scalable"

Tristram Stuart, founder of Toast Ale

Through the idea of his founder, Toast ale start-up was able to create a new business model to recycle waste bread into beer. Firstly the Toast ale model actively shares the basic bread to beer recipe. By adapting the original recipe to local bread available and brewing traditions, the British start-ups gathers and collaborates with different local breweries. Secondly the UK model bases on the idea that financial earnings shouldn't disappear to shareholders, but instead should continue circulating to further the cause. As a result, 100% of the profits go to NGO that works to address food surplus and food waste issues across all stages of the food chain in western countries.

The model proposed by Tristram Stuart was so successful, that was awarded with several prizes, the latest one was the Great Taste Award 2018.

BIO-BEAN. From waste coffee ground to biofuel

Category of outcome: Technological

Owner of the EIS: * Bio-Bean Ltd. Power by coffee

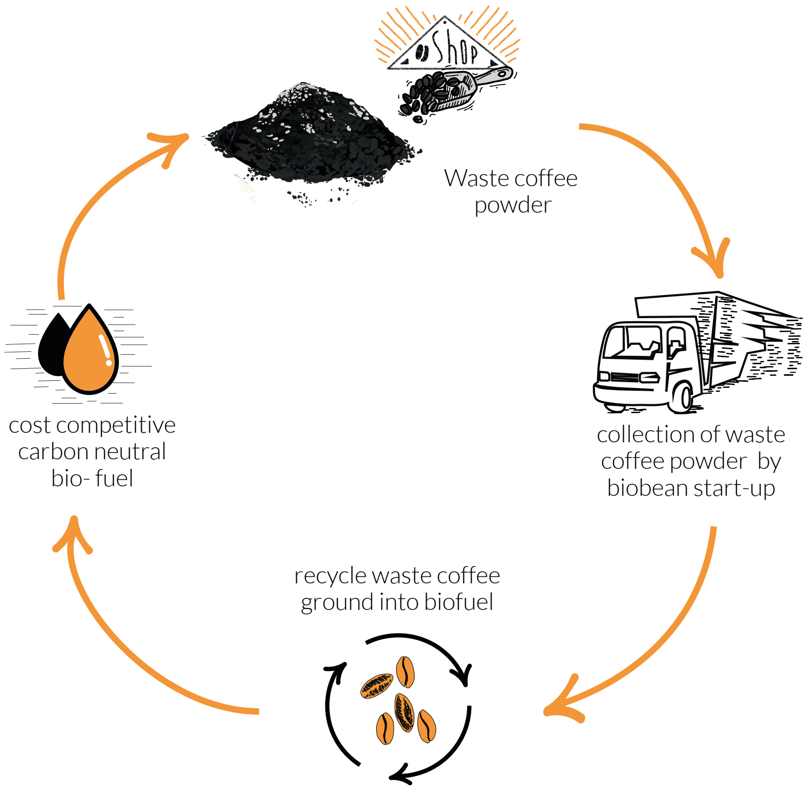

FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Bio-bean is an Eco Innovative Solution that addresses food waste deriving from coffee ground: turning coffee waste into renewable energy.

The Eco-innovative solution aims to offer a service and a product.

• at the service level: the solution works with specialised waste management companies to collect coffee waste from shops, factories, offices and household. Selected shops, located in specific positions, would function as collection points coffee waste coming from household. This service enables to verify the quality and quantity of the waste coffee and for the producers of coffee ground to dispose of their waste responsibly and eliminate associated costs.
• at the product level: the EIS processes the waste coffee ground into biofuel biomass briquettes, barbecue charcoal, biodiesel and pellets through a technology partially developed in London.

According to the London bio-bean start-up, nowadays, there is no large-scale recycling system established to extend the product life of coffee. Therefore, with a holistic perspective the solution aims to shift the coffee supply chain from a linear system to a circular one, recycling waste coffee grounds into renewable energy and bringing environmental and social value to future business practice.

**http://www.bio-bean.com*

Current process

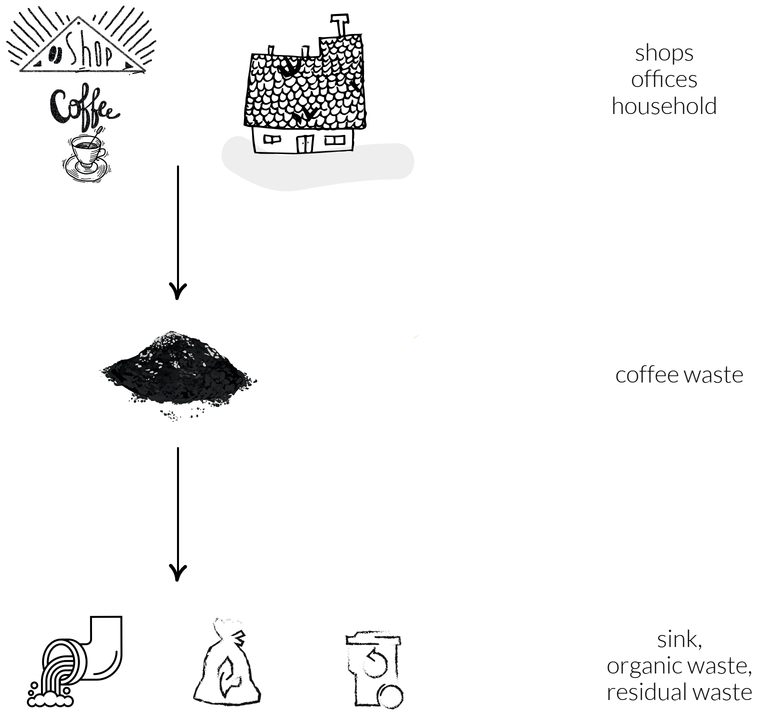

FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.

Coffee is one of the most consumed drinks in the world, according to SUEZ company with more than 1,500 cups drunk every second.

The Netherlands is the world's fifth largest consumer of coffee, where the average annual consumption of coffee is 8 kilos per inhabitant, and coffee is the second most consumed drink, after water (Smith 2017). However, throughout the entire chain of coffee almost the 99,8 % of the biomass is going to waste (CBS 2007).

The Netherland nutrition centre (2014) clearly define coffee ground as unavoidable food losses. This food loss, deriving from shops, factories and household is mainly collected together with organic waste and residual waste, however when we talk about household waste, coffee ground is mainly discarded through the sink (68%) while only the 12% amongst organic waste, and 15% amongst residual waste.

Proposed process

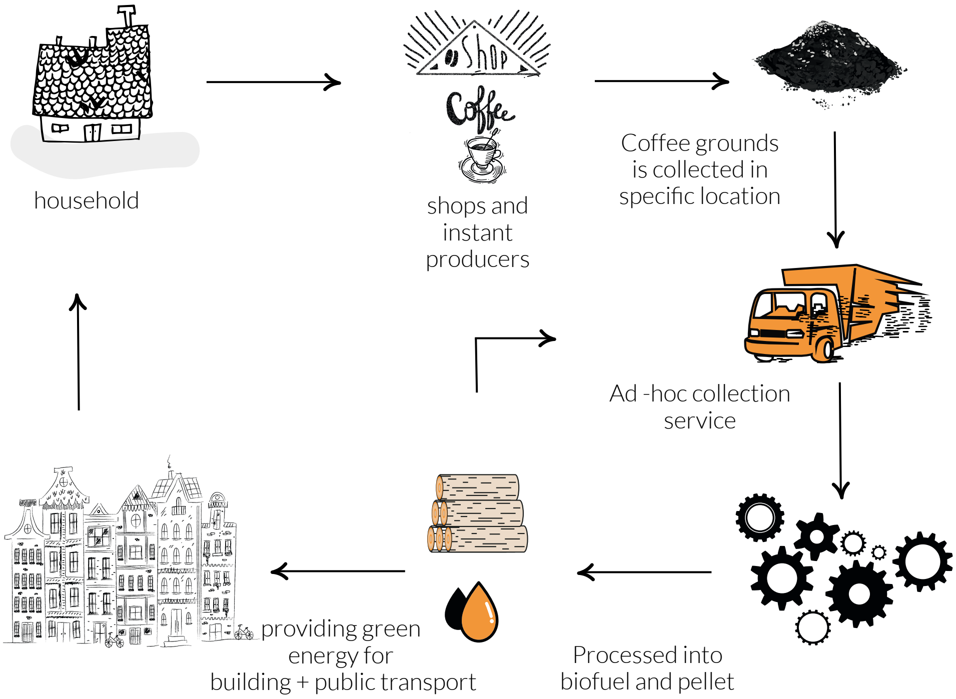

FIG 3 Diagram of proposed situation. Source: REPAiR EU H2020 project.

The "bio bean" dutch company/ start-up collects coffee grounds from shops, factories, coffee service shop and household waste. Regarding household coffee waste, selected shops, located in specific positions, would function as collection points. Within the proposed EIS, the start-up, in collaboration to waste management companies, should provide a specific collection and deliver service. Consequently, the collected waste ground should directly be delivered to the start-up processing plant. The supply of a collect a delivery service has a threefold advantage:

-a better control of the quality of the coffee waste

-on- call collection service and therefore avoiding polluting unloaded journey

-a spin-off business model

When the coffee grounds arrive in the processing plant, the waste is then re-purposed into advanced pellets and biofuels throughout a procedure that is 100% carbon-neutral (Biobean Startup). No scraps are left behind, following the premise that there is no such thing as waste, only resources in the wrong place. Nowadays, the pellets created in this process have nearly twice the energy value of wood, while extracting biodiesel in this way saves space on farmland that can be used to grow food crops.

Possible location within the AMA

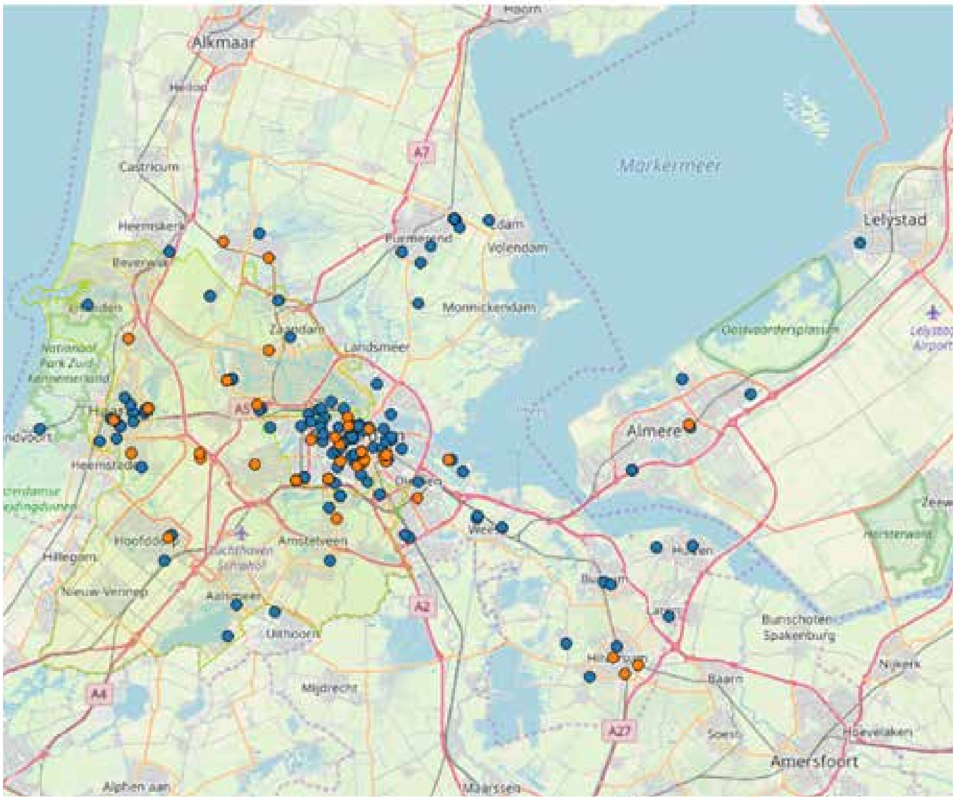

FIG 4 Maps with the locations of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project.

- Wholesale of coffee, tea, cocoa and spices
- Restaurants and mobile food service activities
- Processing of tea and coffee

Example of implementation: the case of London

FIG 5 Image of the process of transforming coffee into biofuel. Source http://www.bio-bean.com

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Food Waste Insect Protein Tanks

Category of outcome: Technological
Owner of the EIS*: Huadong Zhu (TUD)

FIG 1 Composting Protein Tank. Source: Enterra Feed Corporation, 2018

Idea

A great deal of perfectly good food is never eaten and gets thrown away in household rubbish bins. Large quantities of food are also lost in harvesting, storage and transportation. Around 88 million tons of food are wasted annually in the EU, with associated costs estimated at 143 billion Euros. According to the self-assessment, an average of 21.2 kg of food per year and respondent is wasted in the Netherlands. Out of this, 11.6 kilograms on average are solid food and 9.6 liters are liquid foodstuffs (2.6 liters of dairy products and 7.0 liters of other liquid foods). In locations where no separation of organic waste takes place, the residual waste consists out of around 40% of organic waste. In the Netherlands all residual waste is incinerated, which is the most unfavorable form of waste processing. Food waste is not just a waste of money. It also wastes valuable resources like water, soil and energy.

Black soldier fly (BSF) larvae are especially good at recovering proteins from food scraps. When larvae grow into BSF, they can be harvested and used as high protein composition fodder. 1 gram of these insects can yield 2.4kg of protein after 18 days. High percentage of calcium and protein makes BSF suitable for fish, poultry, and pig feed markets. The cost of producing meat, fish and soy bean meal as feed for animals accounts for 70% of the production costs of livestock (van Huis 2013). BSF, on the other hand, are comparably high in nutrients and are already part of the natural diets of pigs, poultry and fish, making them an ideal feed alternative (Rumpold & Schlüter 2013b).A BSF protein farm needs 180 square feet of flies to process 1 ton of organic waste per day. There are nevertheless smaller tanks in which BSF process 15 kg of waste per day in 1 square meter. These sizes are suitable to be used for residential areas and domestic waste.

Current process

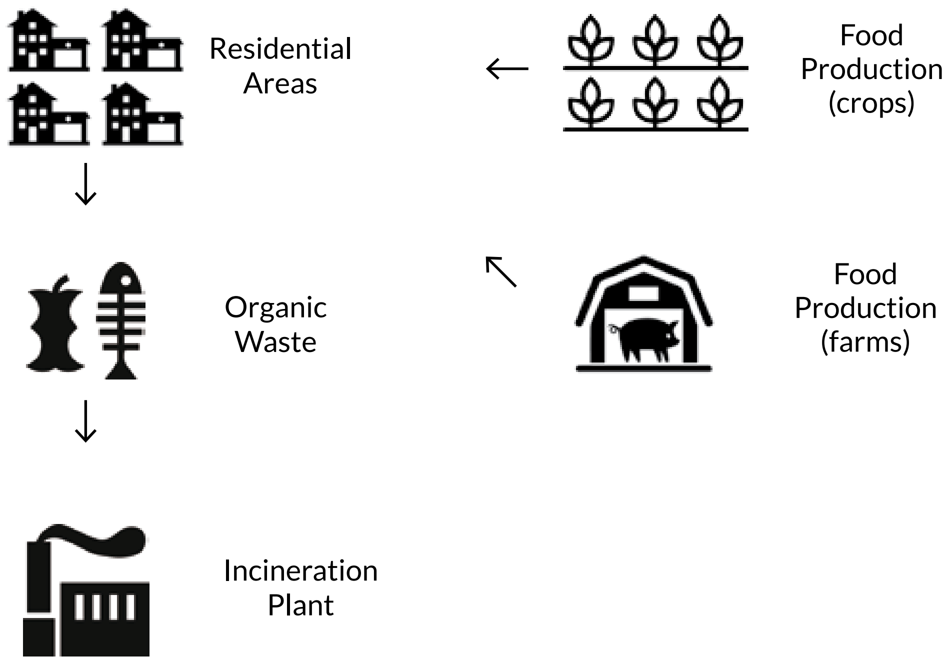
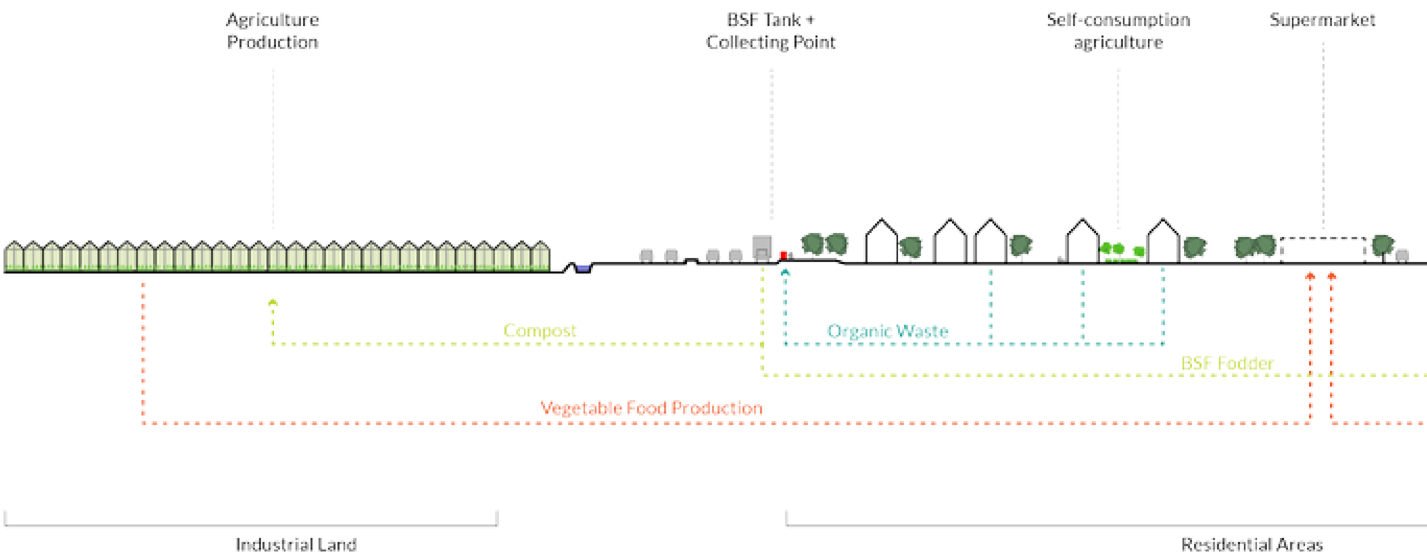


FIG 1 Current process diagram. Source: REPAiR H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)
FIG 2 (bottom) Systemic Section. Source: REPAiR H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

As it was mentioned before, most of the waste in the Netherlands is incinerated. Even though energy is produced in this process, it has many negative impacts, such as high CO2 emissions and waste of resources. In this linear process a high amount of resources is consumed for food production. Soy bean fodder is often brought from far away countries, such as Brazil, producing CO2 emissions and high transportation costs.

Biodigestors and composting units are never the less sometimes also used for organic waste management. In both, bio-gas and compost are produced. Though being more environmentally friendly, these processes are usually organized centrally and thus creating many logistic challenges within the region.

Using BSF protein farms close to residential areas would add value to do-



Proposed process

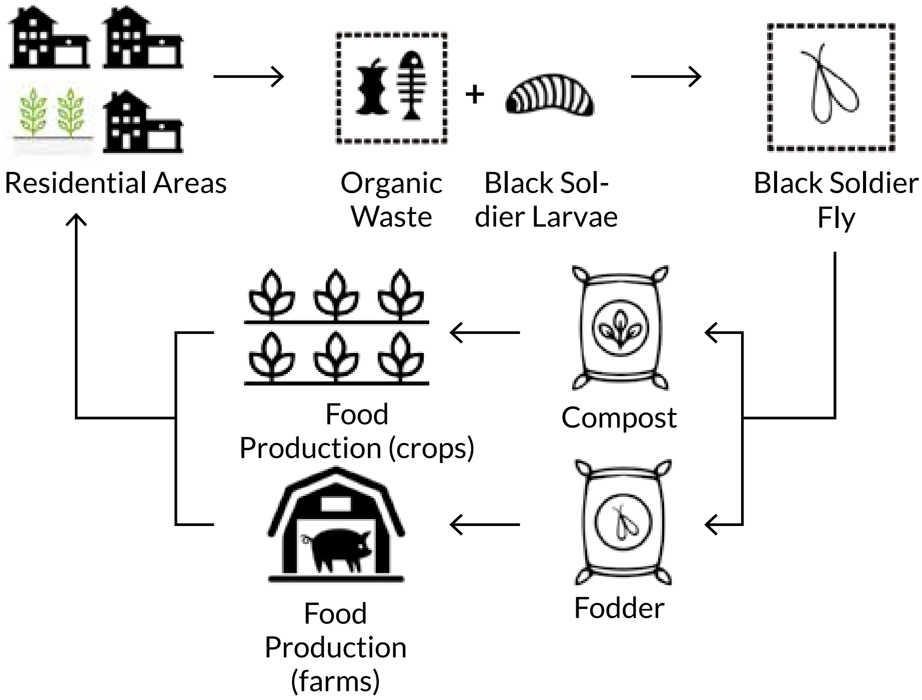
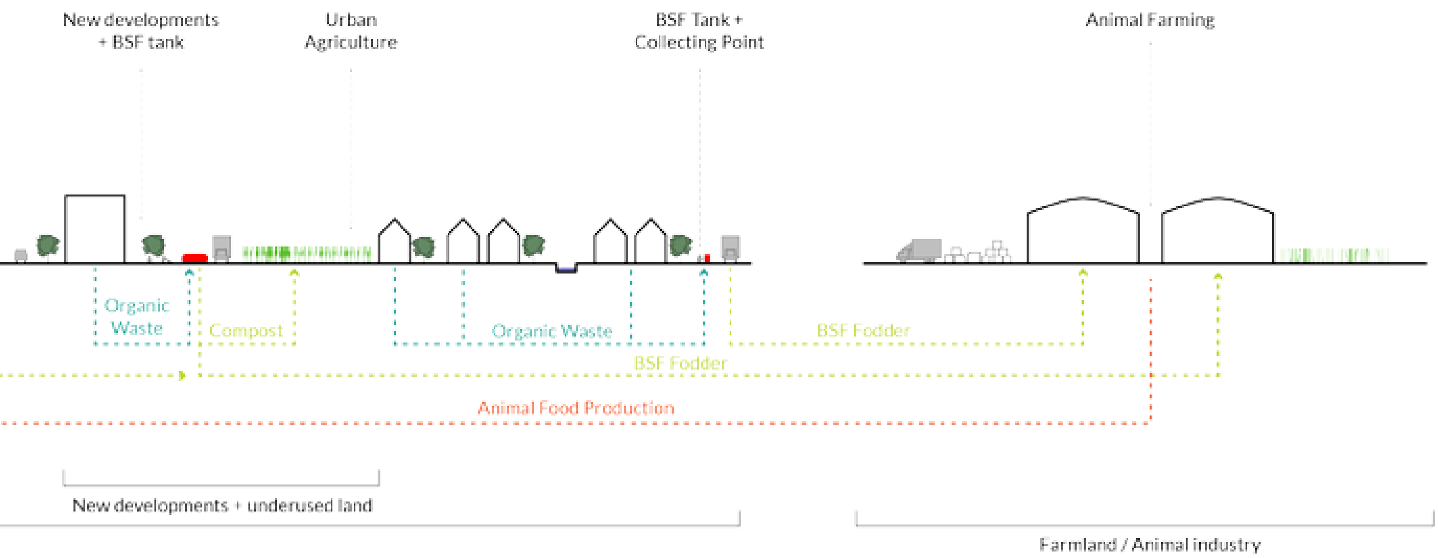


FIG 3 Proposed process diagram. Source: REPAiR H2020 project. Based on Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

mestic food waste by locally producing fodder (BSF) and compost, both used for food production. Connecting the two ends of these processes could help to close the loop and create a circular flow. Taking into account the large quantities of organic food waste in the Netherlands, large quantities of high-protein fodder could be produced, saving transportation and production costs to the farming industry.

Depending on the amount, size and location of the BSF farms, compost and fodder could be collected by farming companies or agriculture producers. Also, local compost production could enable urban agriculture processes within residential areas. For this, it would be important to organize the space and location of the farms, so negative effects, such as bad smells, are avoided.



Evaluation model

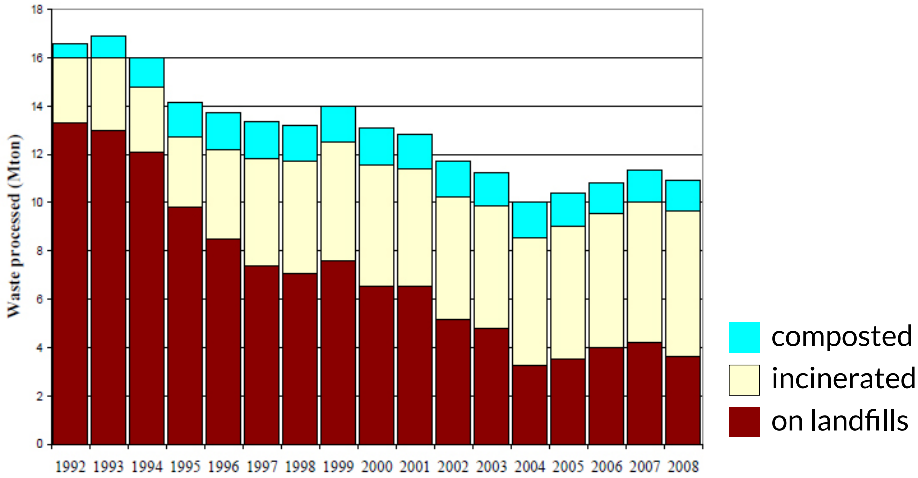


FIG 4 Types and shares of waste processing in the Netherlands 1992 - 2008. Source: CBS, 2008

Two types of evaluation indicators can be used to measure the impact of this eco-innovative solution: Environmental and economic.

Environmental Indicators

Waste Management Indicator considers the sum of all waste streams: composted waste, landfill sites and incinerated waste. Since 1992, landfilled waste has been considerably reduced in the Netherlands, whereas incinerated waste has increased (Fig 5). In addition to avoidable food waste, a share of 59.2% of food packaging waste is currently sent for recycling, while 4.9% is incinerated and 35.9% landfilled.

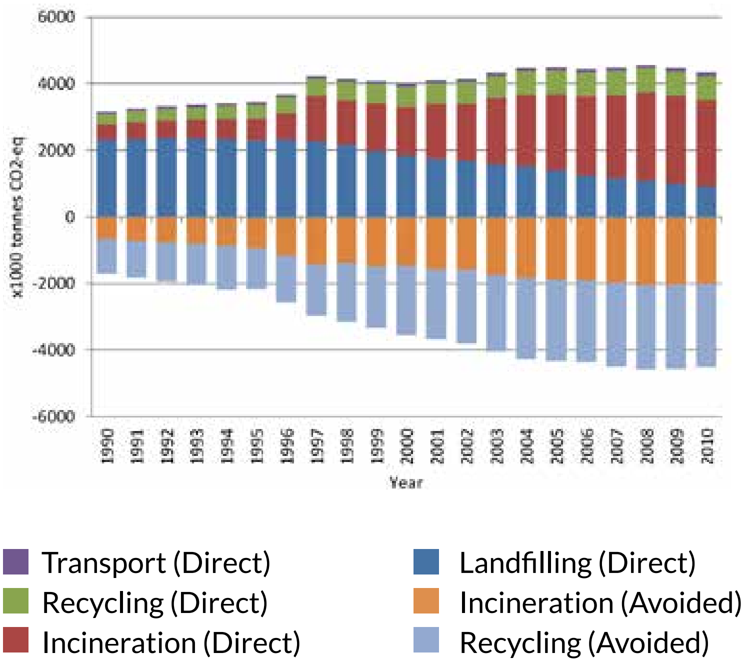


FIG 5 CO2 emissions in each waste management process per year in the Netherlands. Source: European Environmental Agency, 2013

All these waste management processes have an impact on CO2 emissions (Fig. 6). By measuring the share of each waste management process, we could also measure the impact on CO2 emissions. Nowadays, most fodder used in animal farming in the Netherlands comes from Brazil, creating huge transportation costs and CO2 emissions.

BSF protein farms are also a low-tech solution that don't require large industrial facilities and therefore reduce the amount of CO2 produced.

Environmental	CO2 emissions are reduced	Reduction in waste incineration
		Reduction in transportation emissions
		No large industrial facilities needed
	Waste Management	Reduction of waste disposed in landfills or incinerators
Economic	Fodder market	Increase of the availability and supply of biological high protein feed in the market

Economic indicators

By measuring the amount of BSF fodder available in the market we could also have an idea on the impact of this EIS.

In all cases (environmental and economic), specific data on the Amsterdam Metropolitan Region is needed to evaluate the impact of this EIS.

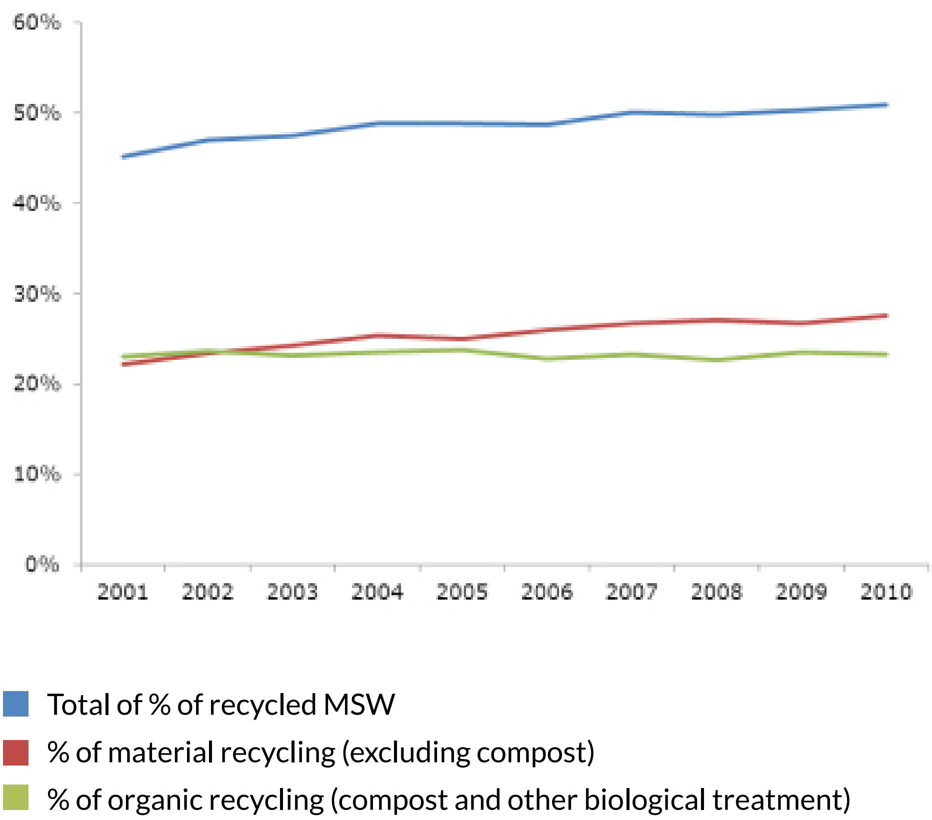


FIG 6 Percentages of Recycled Municipal Solid Waste in the Netherlands. Source: Eurostat, 2012

Possible locations within AMA

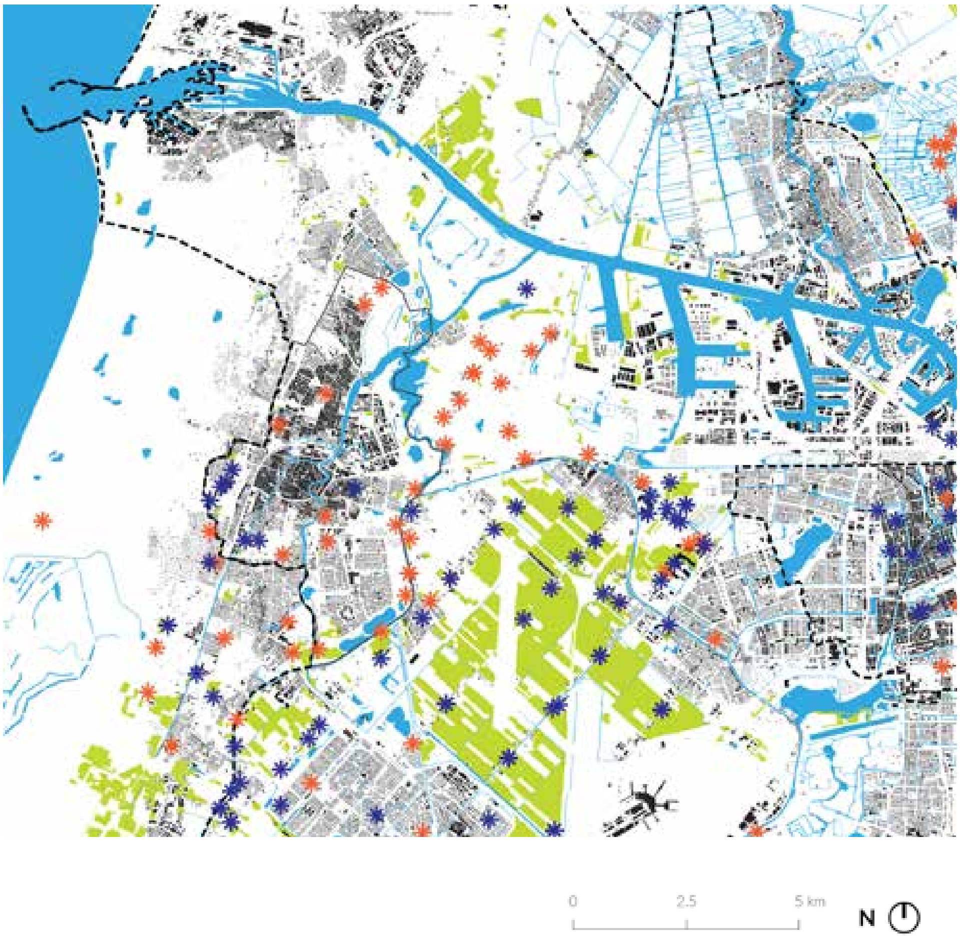


FIG 7 Potential Elements to locate a pilot project within the AMA. Source: REPAiR EU H2020 Project. Data retrieved from Orbis Europe data base and Urban Atlas (European Environment Agency)

BSF production needs organic waste. Proximity between residential areas, agricultural fields and animal production facilities would decrease transportation costs and make the process more efficient. On Fig. 8 all three types of elements are located.

High populated areas are desirable to have a high organic waste production. A possible site for a pilot project within the AMA is Haarlem, which has a relatively dense building tissue and is close to both agriculture fields and animal production facilities.

Legend

Focus Area REPAiR Amsterdam
Test Area
Building Tissue
Water

Companies located in AMA (Orbis)

Growing of crops
Animal production and mixed farming

Urban Atlas

Arable land and permanent crops

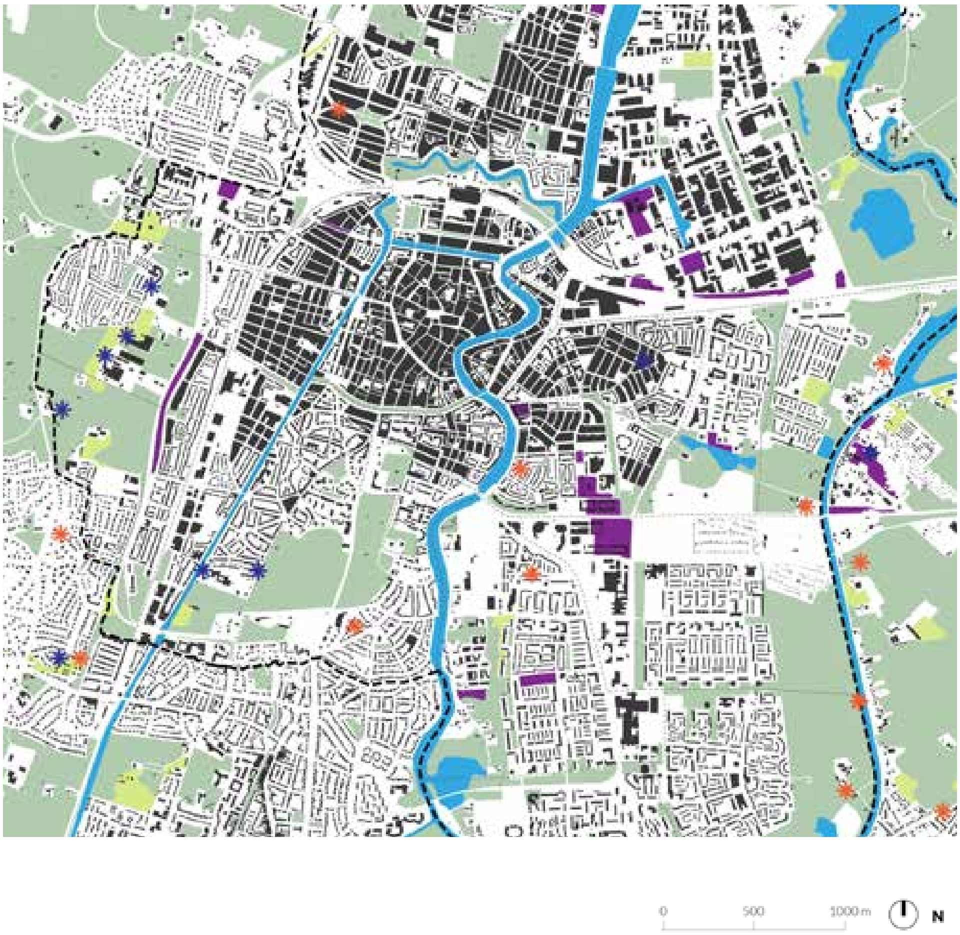


FIG 8 Potential Elements in Harleem. Source: REPAiR EU H2020 Project. Data retrieved from Orbis Europe data base and Urban Atlas (European Environment Agency)

FIG 9 Potential Locations for pilot projects. Source of the image: google earth

1000 households produce roughly 220kg of waste, which requires around 44m2 of BSFL to process (feeding rate = 5kg/m2). For that, a 25 sqm tank would be needed to process that amount of organic waste daily. Larvae take 20 days to process this waste and grow into insects, so different layers in which the compost is produced would be needed. This surface could also be divided in smaller tanks along transportation routes or residential areas.

In this map land without current use, as well as open green space, are shown. Haarlem is also an interesting place because of its proximity to food production areas, both arable land and animal farms.

Three potential places for pilot projects are located. Each of them is close to food production facilities. Relation with residential areas that produce organic waste varies.

Examples of implementation

According to the previous calculation, every 1000 household would need 25m^2 protein tank surface to digest their daily organic waste. Depending on how much organic waste is taken to the tank daily, this surface would increase. Different options are possible: One big facility in which all organic waste is processed or several 1sqm protein tanks modules could be scattered in the neighborhood. One tank would be needed for every 8-15 households, and within a 5-minute walk.

Protein tanks should serve nearby animal farms. Insects would be collected and the by-production of compost could be used on-site (urban agriculture, gardens) or transported to nearby crop-farms. The modules could be set along the main road and as close as possible to make the collection easier. Staff need to replace the insects and ship them to the nearby farms every 20 days. These tanks could also be combined with street furniture to integrate them into urban landscape, but they should not be too close to residential areas, for the composting process may produce bad smell or other negative impacts.

The applying of this model could encourage the recyclying of organic waste and could reduce the emission of carbon dioxide in comparison to incineration and landfill, which are the current most used methods. Within Haarlem, three possibilities for the location of the protein tanks are proposed.

OPTION 1: Near existing residential areas

Protein tanks could be located close to existing residential areas. Compost and fodder would be produced on-site. Compost could be used for local gardens or small agriculture production in private land. Fodder would have to be collected and taken to close-by animal farms. If tanks are located close to the infrastructure network, compost could also be collected and taken to close-by agriculture fields.

Space would be needed to locate 1sqm tank with 2 layers of composting for every 8 households (0,242 kg of waste are produced daily by one household and larvae take 20 days to produce compost).

OPTION 2: In land without current use next to new developments

Areas where new developments are carried out are many times next to land without use. Temporary projects of urban agriculture on this unused land could benefit of waste management with protein tanks. Big protein tanks (25sqm) could be implemented to deal with all organic waste from the new residential areas. Fodder would have to be collected and taken to animal production areas, but all compost could be used on-site.

OPTION 3: In food production areas

If organic waste was sorted in each household and then collected, compost and fodder production could be produced in areas close to food production. This would avoid the negative impacts of protein tanks close to residential areas. Transportation and logistic costs would still be reduced and, most importantly, the management of the protein tanks could be done by private companies that produce food.

FIG 1 Potential Location for pilot project in residential areas. Source of the image: google street view.
FIG 2 Potential Location for pilot project in land without current use next to new developments. Source of the image: google street view.
FIG 3 Potential Location for pilot project in food production areas. Source of the image: google street view

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Peel Pioneer

Category of outcome: Technological

Owner of the EIS: Peel Pioneer * and Orange Fiber**

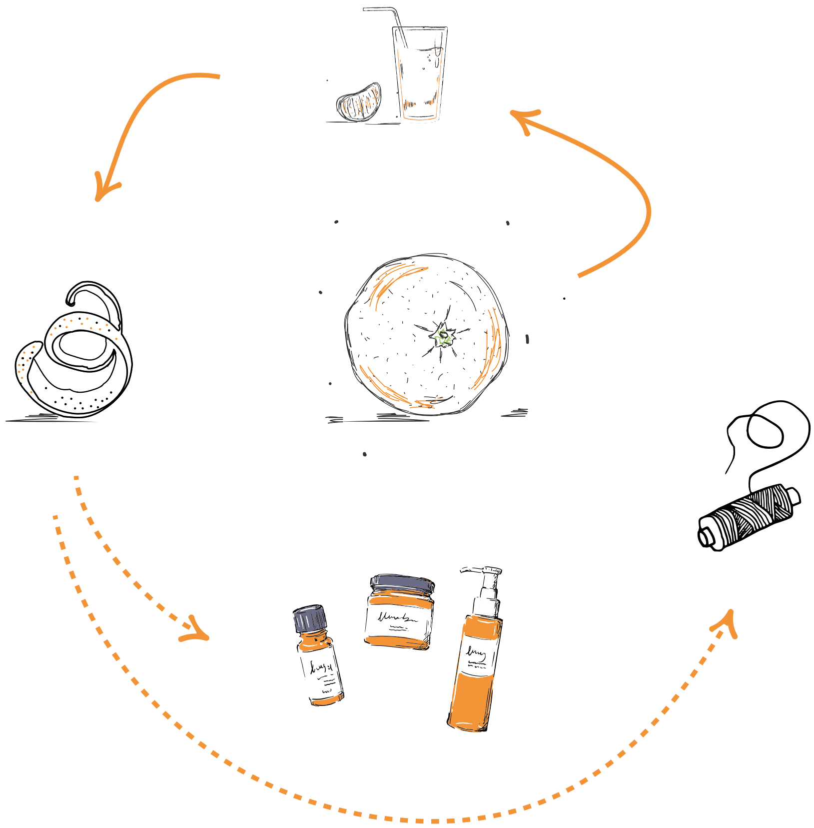


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

The solution proposes a circular solution for Converting citrus wastes into value-added products.

The processing of citrus fruits generates different type of wastes, which include solid, liquid, and distillery effluents. Solid waste consists of peels, rags, seeds, sludge, pith and other residues. Distillery effluents from these different wasted citrus components include effluents from citric acid and pectin, citrus molasses, and peel oil plants. Usually citrus wastes are often discarded in landfill or as biomass products (Sharma et al. 2017). In recent years, researchers worldwide have been focusing on developing different processing methods for complete exploitation of various citrus fruit waste products compounds, and their applications in various fields. This solution aims to extract secondary raw material (essential oil) from citrus fruit peels can be used in chemical, cosmetic, textile food and agro industries. Essential oil may be used as a natural fragrance and flavouring in foods. For example, in soft drinks and products from the (pastry) baker, such as pastry and cake. The oil is also used in cleaning products and cosmetic products. After the extraction of the essential oil, with a similar distillation process this solution aims to extract from the citrus juice by-product, pith also so-called "pastazzo," fibres for the textile industries. Therefore, it is important to treat citrus waste systematically in food industries and other areas.

* *https://peelpioneers.nl; ** http://orangefiber.it*

Current process

FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.

In the Netherlands alone, 250 million kilos of peel remain every year (Peel pioner Start up data). These are mainly orange peels and pulp.

The most common waste management methods for citrus waste are: composting, anaerobic digestion, incineration, thermolysis, and gasification (Sharma et al. 2017).

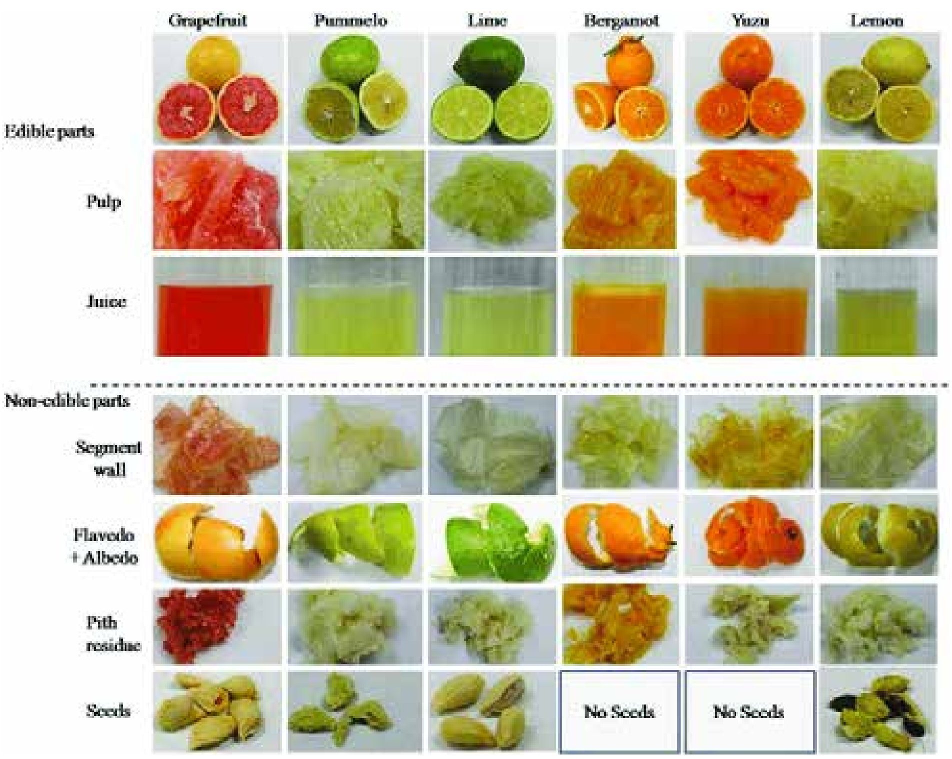


FIG 3 Edible, non-edible and waste proportions of the main citrus fruit varieties commercially grown across the globe. Source Mahato et al. 2017:308

Proposed process

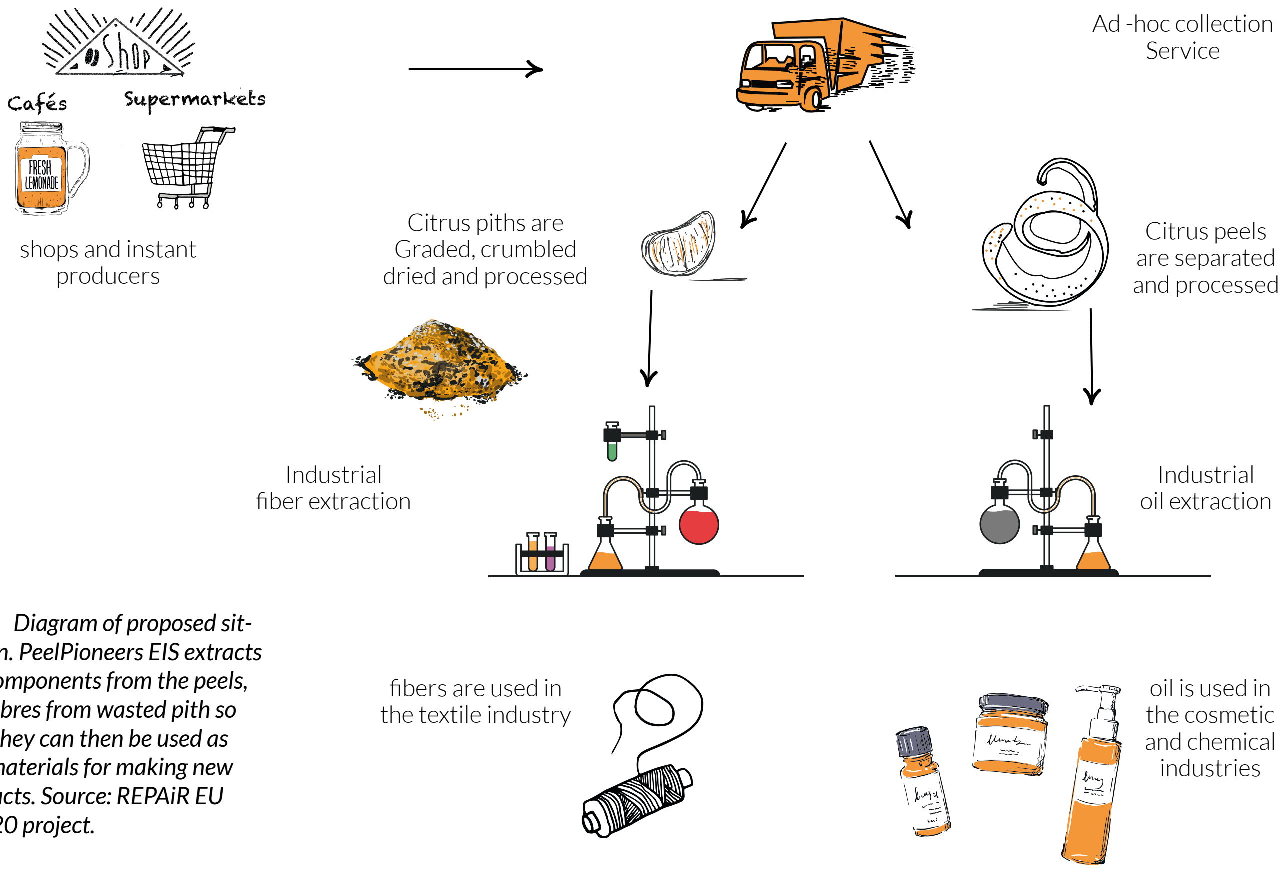


FIG 4 Diagram of proposed situation. PeelPioneers EIS extracts the components from the peels, and fibres from wasted pith so that they can then be used as raw materials for making new products. Source: REPAiR EU H2020 project.

Starting from the idea developed by the sturt-up Peel Pioneers, based in Rotterdam, the proposed EIS aims to expand the Rotterdam example into the AMA context and to upscale the project by extracting both essential oils and fibres from citrus wasted products.

The leftover components of the juice production are collected from supermarkets, shops, bars and juice industries,

The leftover is grained, and firstly all the essential oils are extracted.

The oil present in oil sacs or oil glands is located at different depths in the peel and the cuticles of the fruit. Essential oils are released when oil sacs are crushed or broken during juice extraction. The traditional method for extracting essential oils from the citrus peels is cold pressing. In cold pressing, the peel and cuticle oils are removed mechanically, yielding a watery emulsion, which is then centrifuged to recover the essential oil (Ferhat et al. 2007 in Sharma et al. 2017). Citrus waste is required to be processed sufficiently before compositional changes commence to occur. The resulting volatile oils are used for flavouring ingredients in drinks, ice creams, and other food products. Additionally, substantial quantities of these oils are used in the preparation of toilet soaps, perfumes, cosmetics, and other home care products (Mahato et al 2017). According to the number provided by the Rotterdam example approximately 1,000 kg of peels processed will provide enough detergent to clean 4,500 m2 of floor (Peel Pioner startup).

Once the oils are separated fibres could also be obtained. Cytrus pulp is drained at elevated temperature w100 C (Sharma et al. 2017), and through a chemical enzymatic extraction the fibres are extracted (Sharma et al. 2017).

Possible locations within AMA

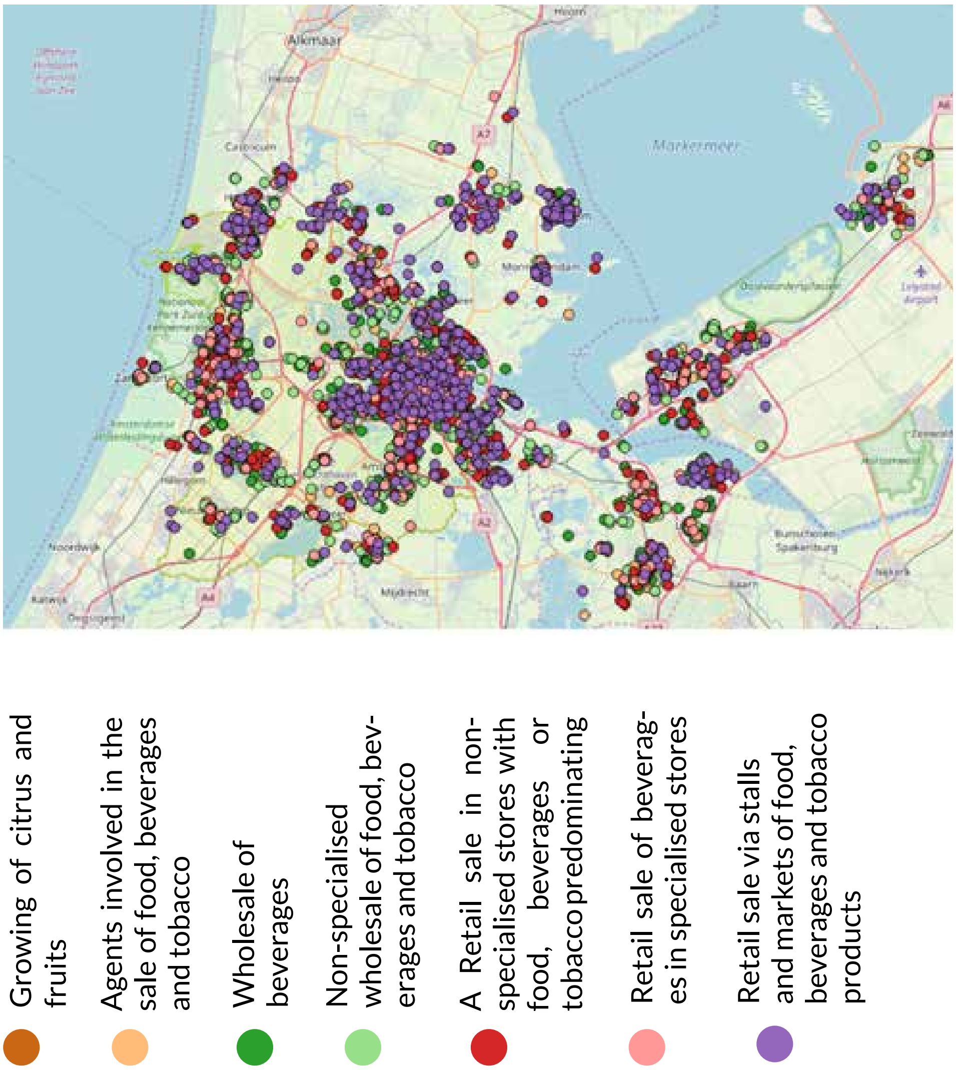


FIG 5 Maps with the locations of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project.

References

Ferhat, M., Meklati, B., & Chemat, F. (2007). Comparison of different isolation methods of essential oil from Citrus fruits: Cold pressing, hydrodistillation and microwave 'dry' distillation. Flavour and Fragrance Journal, 22(6), 494-504.

Mahato, N., Sharma, K., Nabybaccus, F. , (201) Citrus waste reuse for health benefits and pharma-/neutraceutical applications. Era's J Med Res; 3: 20–32.

Sharma, K. H., Mahato, N. R., Cho, M., & Lee, Y. (2017). Converting citrus wastes into value-added products: Economic and environmently friendly approaches. Nutrition, 34, 29-46.

http://orangefiber.it[Accessed October 2018]

https://peelpioneers.nl [Accessed October 2018]

http://www.renewiplc.com/en/newsroom/news-releases-archive/2018/05-06-2018 [Accessed October 2018]

Example of implementation: the case of Rotterdam

"International waste-to-product company, Renewi plc (LSE: RWI) is working with Dutch start-up business PeelPioneers to launch a 100% circular solution for the processing of the 250 million kg of citrus peels that are thrown away in the Netherlands each year.

Renewi will collect the peels from supermarkets and catering companies and transport them to PeelPioneers' new plant which will be based at Renewi's Son site in the Netherlands. The peels will be turned into essential oils and citrus pulp which will be used as ingredients in products such as detergents and high-quality animal feeds. The plant will be able to process between 25,000 and 50,000 kg of citrus peel each day once it is operational in autumn 2018.

Every 1,000 kg of peels processed will provide enough detergent to clean 4,500 m2 of floor, produce healthy supplementary feed for 200 cows and reduce carbon emissions by 220 kg. This is comparable with the environmental impact of 500 showers, showing the environmental benefit this circular solution brings.

In addition to these sustainability benefits, it is especially important for citrus peels to be treated in this way as they can cause problems if added to organic waste for composting or digestion. Due to this, the majority of this type of waste has historically ended up in incinerators which loses the valuable raw materials.

Business development organisation Brabantse Ontwikkelingsmaatschappij, financing foundation Stichting DOEN and ABN-AMRO have invested over €1m in Peel-Pioneers to build the new recycling plant. In the future, there are plans to process other components found in citrus peels such as cellulose and pectin into valuable products." June 2018 http://www.renewiplc.com/en/newsroom/news-releases-archive/2018/05-06-2018 [Accessed October 2018]

Fruit Leather

Category of outcome: Technological

Owner of the EIS: Fruit Leather Rotterdam * and Frumat**

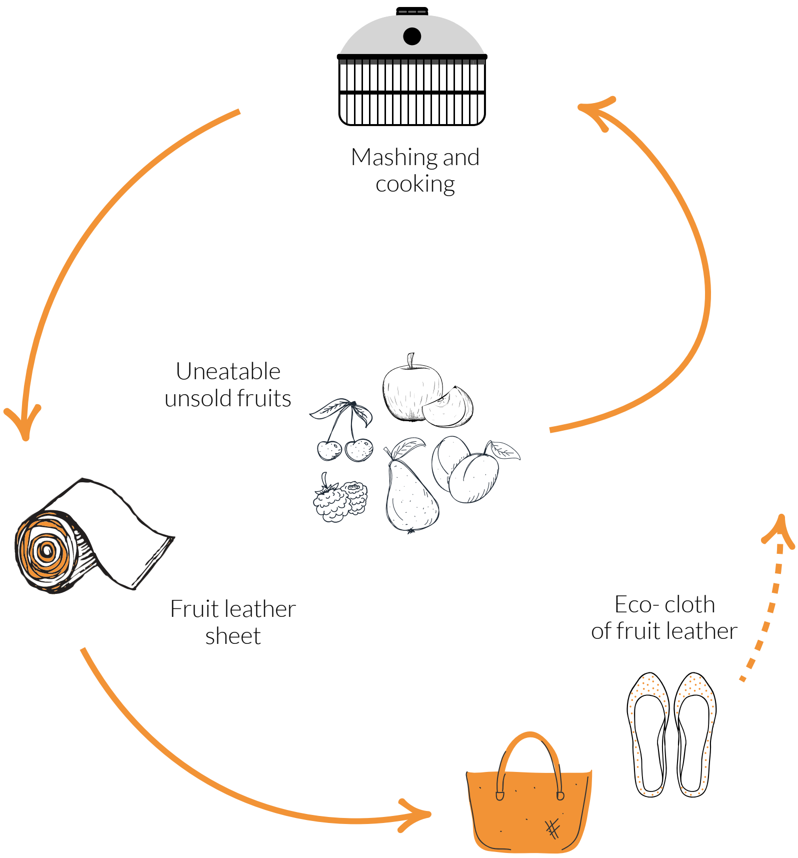


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Leather is a problematic material. Wasteful, a polluting tanning process with high environmental impact, especially if we consider the disposal of the chemical processing residuals. Fruit Leather solution aims to find an alternative to animal leather by processing fruit waste.

By collecting the fruit from fruit importers in the Netherlands, we are able to supply ourselves with a large quantity of diverse types of discarded fruit.

Using an eco-friendly process developed from companies like fruit-leather (NL), apple-leather of Alberto Volcan (IT) and Ananas Anam (UK) the discarded fruit is mixed with water apple flour and natural glue is transformed to sheets of leather-like material. The resulting material is very similar to the traditional South Tyrol "Lederhorse". Therefore, the Fruit-leather can be coated and applied to a large variety of products which tend to use traditional leather.

* *https://fruitleather.nl; ** https://www.frumat-bolzano.it*

Current process

FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.

on Food Waste

We live in a world where resources are becoming more scarce everyday. According to the food waste monitor mid term report of developed by WUR 2009 approximately 618 kgton of fruits were produced in the the Netheraland. Moreover it was estimated that approximately 1,5 –to 6.5 % of fruit is lost with the primary sector of the food (fruit) chain. To this loss we should include an extra 6% of food waste within the secondary sector (5% loss at the supermarket and 1% loss for transport to and activities at the distribution centre) (De Valk et. al 2016 ; Soethoudt and Timmermans 2013).

Once the fruit is lost, the most common waste management methods for are: composting, anaerobic digestion, incineration, thermolysis, animal feed and gasification (Sharma et al. 2017; E. de Valk et. al 2016).

Proposed process

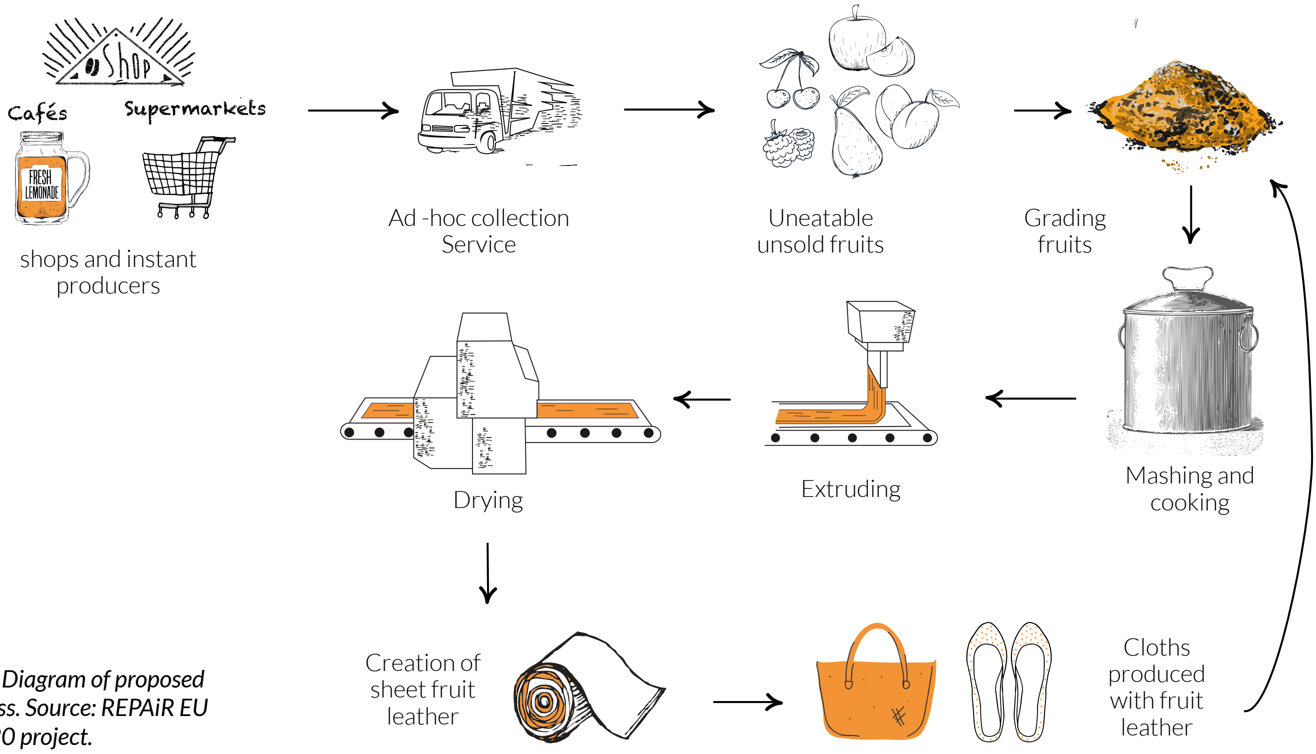


FIG 3 Diagram of proposed process. Source: REPAiR EU H2020 project.

The solution consists in the production of a new adhesive membrane based on a vegetable component, dried fruit flour, coming from industrial residuals of fruit processing and 95%-bio degradable paste. Once the fruits' leftovers are collected from industrial food industries, the fruits' wastes are mashed, cooked and dried. The mixture obtained consists of a minimum part of natural paste (5-10-15%)and the remaining part exclusively of fruit flour, bran flour, flour of nutshell residuals, potato peel flours and of all the vegetable residuals coming from industrial and agricultural processing. The percentage of paste depends on the use of the additive produced and used in various sectors.

According to the Patent of Alberto Volcan (2009) "*The blend of these two components :0-1000 micron ground apple flour, containing 72% of natural fibres, fructose and pectin, along with a vegetable binder consisting of various starches and vegetable molecules, create a new product unique in its kind.*

Research performed by TIS in Bolzano have proven that the wet-based product having an energy value of 0.6 kWh/kg) when dried has an energy value of 2.7 kWh/kg".

The dried compost is pressed (from 80 to 150 atm), glued (to obtain a thickness of 0.5 mm to 10 mm) and coloured in order to obtain a similar effect to the natural animal leather (Voltan 2009).

The proposed process is a lot cleaner then the process that traditional leather undergoes. Using natural materials, our final product is a lot less harmful to both the environment and animals.

Possible locations within AMA

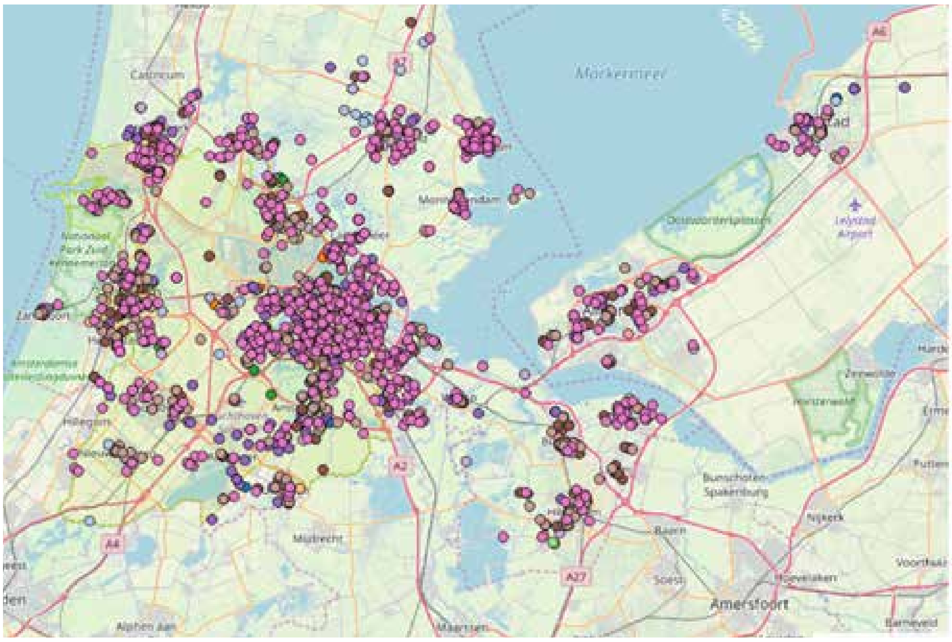


FIG 4 Maps with the locations of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project.

- Growing of grapes
- Growing of pome fruits and stone fruits
- Manufactures of fruits and vegetable juice
- Other processing and preserving fruits
- Distilling, rectifying and blending of spirits
- Manufactures of wine and grape
- Manufactures of cider and other fruit wine
- Manufactures of other non distilled fermented beverages
- Wholesale of fruits and vegetables
- Retail sale of fruit and vegetables in specialised stores
- Retail sale of beverages in specialised stores
- Other retail of food in specialised stores
- Retail sail via stalls and markets of food , beverages and tobacco products

References

Sharma, K. H., Mahato, N. R., Cho, M., & Lee, Y. (2017). Converting citrus wastes into value-added products: Economic and environmently friendly approaches. Nutrition, 34, 29-46.

Soethoudt, H., & Timmermans, T. (2013). Food Waste Monitor, Mid-term Report

De Valk, E., Hollander, A, . Zijp, M., (2016). Milieubelasting van de voedsel-consumptie in Nederland [Environmental impact of the Dutch food con-sumption] RIVM, Bilthoven

Volcan, A. (2009) Composition based on products stemming from industrial residues in the processing of fruits, especially apples, use thereof, method for processing them and products thus obtained. (Patent) https://patents.google.com/patent/US20090301347

https://fruitleather.nl;

https://www.frumat-bolzano.it

Food rescue platform

Category of outcome: Technological

Owner of the EIS: Food Rescue US*

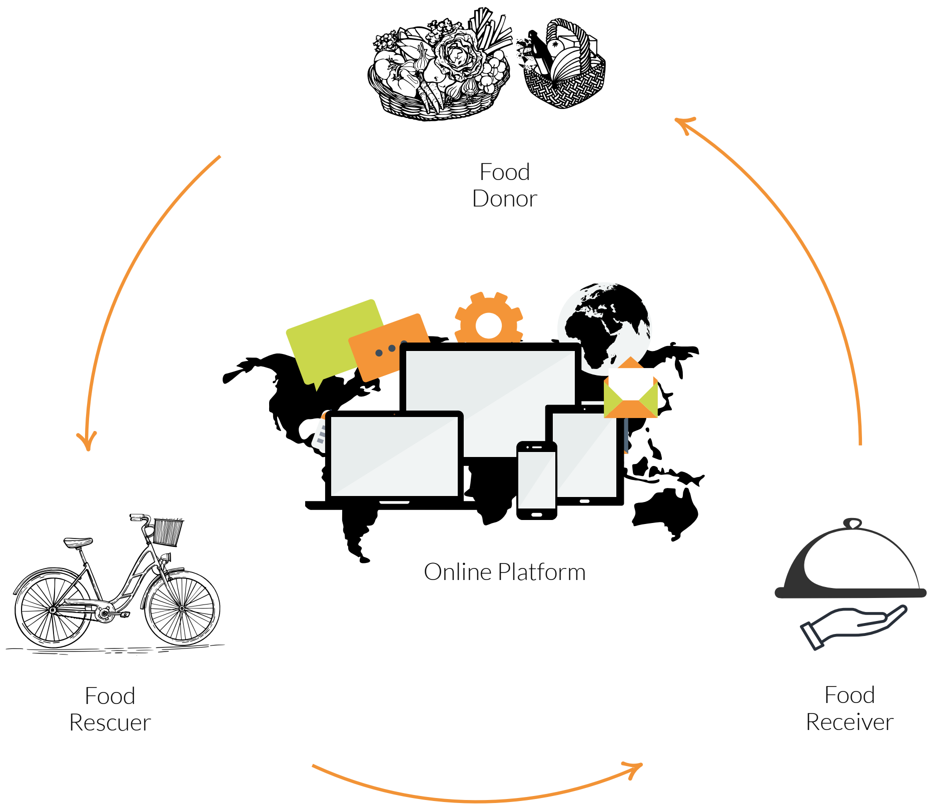


FIG 1 Idea diagram. Source: REPAiR EU H2020 project

Idea

Reducing food waste is a key sustainability challenge for the food service industry. According the Dutch organisation instock[1] around 14% of the total organic food wastage takes place in restaurants, cafés, bars, hotels, and so on. Much of this wastage is a consequence of large portions, strict food safety demands, inadequate stock acquisition. Based on the idea that there is not yet a food shortage in the Netherlands but a food logistic problem: Food rescue online platform, aims to take excess fresh food from food service industries and delivers them to NGO or other social organisation related to the food sectors via an online web application. It's an innovative and elegant solution for our busy, on-demand world. The online platform streamlined scheduling system offers participants the option to pick-up, drop-off, or receive fresh food at their convenience, alleviating the rigidity of normal food rescue schedules With the online platform three types of actors can select three types of actions associated with their roles in the AMA \

Donate: If you're a restaurant, cafes, bars.. you can prepare a list of surplus food that you would like to donate.
•**Deliver**: If you are a volunteer with a vehicle, see the complete schedule of food rescues and choose deliveries that work for you.
•**Feed**: If you are a social organisation or NGO such as a community kitchen or food pantry, you could post your needs and find food to match them.

** https://foodrescue.us ; 1. https://www.instock.nl/en/food-waste/*

Current process

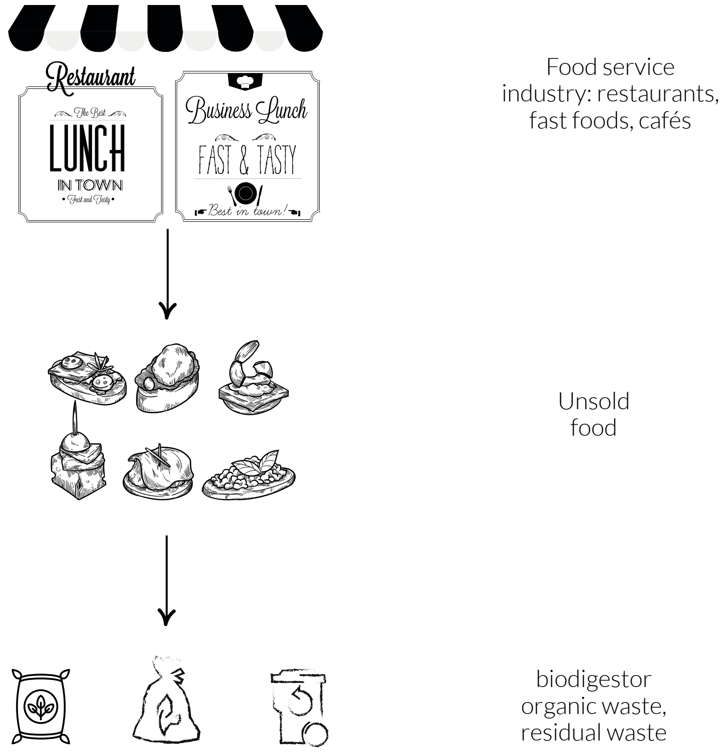


FIG 2 Diagram of current situation. Source: REPAiR EU H2020 project.

The Dutch food-service industry is composed of the following six sub-sectors: full-service restaurants, fast food outlets, cafés/bars, self-service cafeterias, 100% home delivery/takeaway and street stalls/kiosks[2]. .

The food service industry generates waste differently. One primary factor, especially in the grocery industry, is the aesthetic addiction to perfect looking food and store food.

A second factor is the obligation is to follow expiration dates. Thirdly, restaurants frequently over-prepare or over-purchase food to ensure they have enough product to feed their customers.

Generally the organic food waste is designated to landfill and\or the biodigestor-composter

2. https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Service%20-%20Hotel%20Restaurant%20Institutional_The%20Hague_Netherlands_7-6-2016.pdf

Proposed process

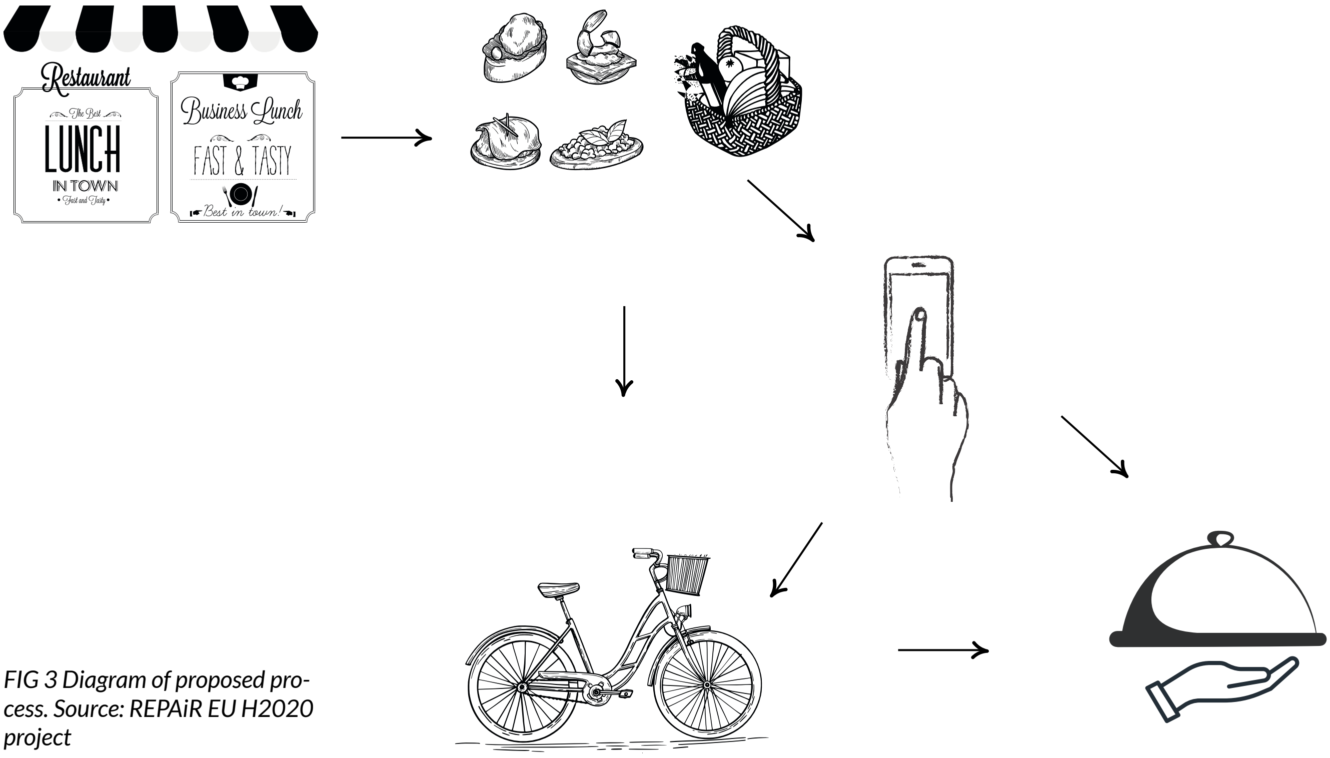


FIG 3 Diagram of proposed process. Source: REPAiR EU H2020 project

The proposed platform proposes a different approach to avoid food loss produced by the food industrial sector and to allow the redistribution of unsold food

The solution connects volunteer food rescuers with receiving agencies and food donors. Its streamlined scheduling system offers participants the option to pick-up, drop-off, or receive fresh food at their convenience, alleviating the rigidity of normal food rescue schedules.

1) Donors like: restaurant, cafés, bars… can easily upload on the platform the type quantity of food that would like to offer and also the location of the food service activity.

2) When the availability of the food is online, food rescue volunteers and/ or NGO volunteers can collect the required food either by bike or by electric van. Then the food could be redistributed to organisation in need and/or organisation that ask for specific service.

On average, it takes about few minutes for our food rescuers to respond. In addition, an automatic email system inform can inform donors and feeder on the quantity of available food.

3) Through the platform social organisation or NGO such as a community kitchen or food pantry could easily ask for a delivery service, and see surplus availability of food waste.

Possible locations within AMA

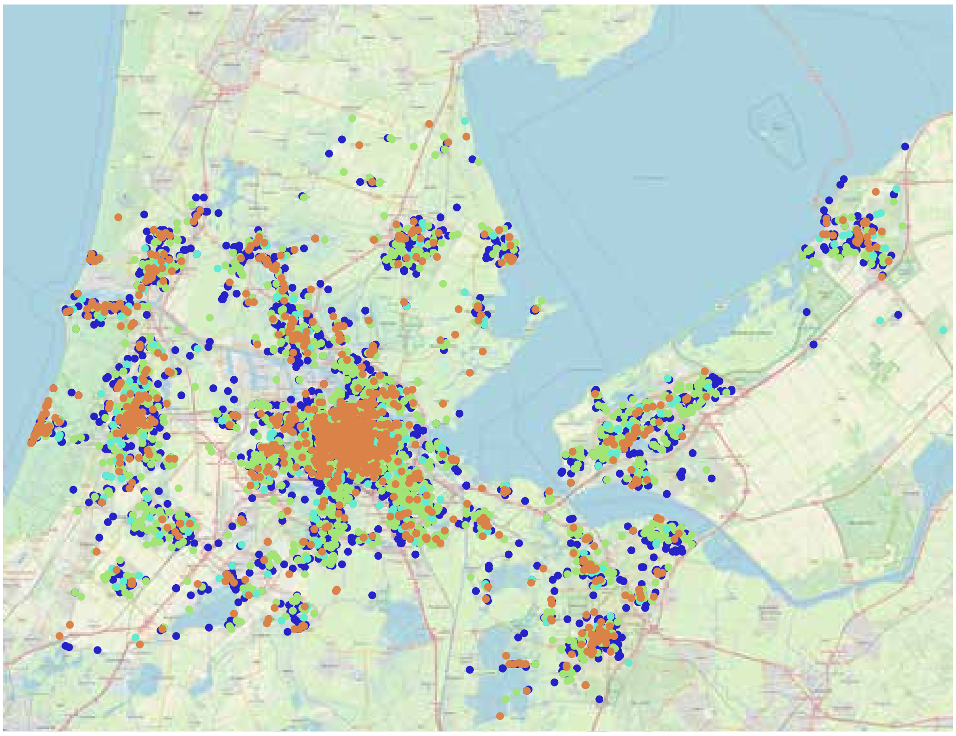


FIG 4 Maps with the locations of activities that could potentially be involved in the solution and or benefit from it . Map out of scale. Source: REPAiR EU H2020 project

Restaurants and mobile food service activities

Event catering activities

Other food service activities

Beverage serving activities

Relevance

Local stakeholder expressed:

•the urgency of reducing food waste,

• the reduction of GHG emissions,

•providing food/nutrition for those with little access to it.

In this respect the platform provide a good use for surplus food, also from an ethical and reputation perspective. Moreover this solution could serve all relevant stakeholders (suppliers, logistics and end-users), taking account of the different data needs.

Business model: financial incentives for suppliers due to lower waste fees (+ free exposure)

Policy: Food-waste reporting. Policy regarding logistics (because covering costs for logistics is the hard part in this story). Possibly subsidies.

References

Pinckaers, M. H. (2016), Report Netherlands Food Service - Hotel Restaurant Institutional. An Overview of the Foodservice Industry in the Netherlands. Available online: *https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Service%20-%20Hotel%20Restaurant%20Institutional_The%20Hague_Netherlands_7-6-2016.pdf [Accessed October 2018]*

https://foodrescue.us ;

https://www.instock.nl/en/food-waste/

Smart Biorefinery

Category of outcome: Technological

Owner of the EIS: Zhou Yixiao, Kozmo Meister, Emma Flores (TUD)

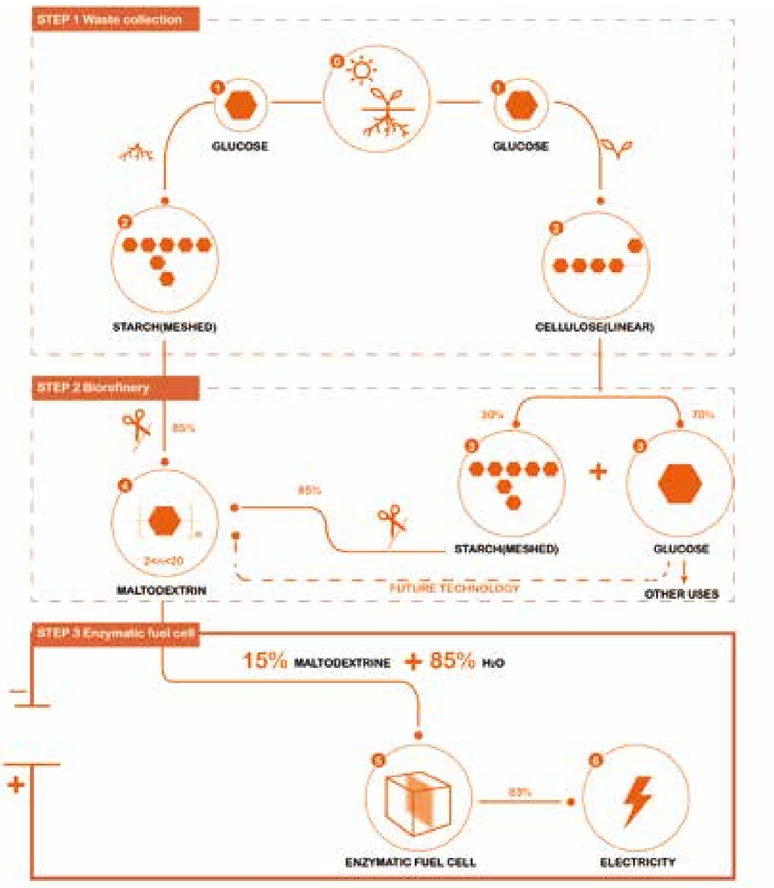


FIG 1 Idea diagram. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

Idea

Higher income countries are responsible for large amounts of food waste, the Netherlands being the largest contributor in terms of food waste per capita of the European Union (Hauser 2017). Even though The Netherlands burn most food waste for electricity production, current processing techniques are inefficient. Food waste that is not collected separately is burned together with other residual waste while separately collected waste. Recent technological developments have created novel possibilities for food waste processing in a completely safe manner. Smart biorefinery have long been heralded as a clean alternative to internal combustion engines due to their ability to efficiently convert chemical energy to electric energy. Moreover, smart biorefinery have little moving parts, require little maintenance and operate quietly. Unfortunately, fuel cells require expensive materials such as platinum, and use highly combustible fuels. In contrast an Enzymatic Fuel Cell (EFC) has all the benefits of fuel cells but doesn't rely on expensive materials or combustible fuel. Rather, it uses enzymes to convert sugar into electricity at 83% efficiency (Zhu, 2013). These sugars can easily be extracted from starchy or cellulose-rich food waste. As part of developing a circular economy, The Netherlands is looking into bio-based solutions to mitigate greenhouse gas emissions and ensure stable and renewable resources (RVO 2018:Soethoudt, H., & Timmermans, T.2013).

Current process

In the current system, household organic waste is mainly burned to produce heat and electricity (e.g. in the AEB waste treatment facility), while organic waste from companies is primarily bio-digested to produce biogas and compost (e.g. Orgaworld (NL Times 2018). The biogas can be burned to produce electricity or be transported into the gas grid (Medonza et al. 2018). While this system produces different types of energy, it is not very efficient. The AEB waste treatment facility burns the household organic waste, which lowers the combustion efficiency due to its high moisture content. Even Orgaworld, which applies specific bio-based processes to its organic waste has an efficiency of 0.4 MWhe/ton of waste. Both the biogas and composting processes break down the organic matter to smaller molecules, a process which lowers the energetic value of the organic material. Currently, organic waste management practices produce high-volume, low-quality streams, which ignore the market value of complex organic compounds (Cherubini 2010; Satchatippavarn 2016). Research indicates that low-volume high-quality streams can be produced from organic waste to fulfil demands of various industries such as electricity, heat, fuel, nutrients, bioplastic precursors, and nutraceutical products (Cherubini 2010; Satchatippavarn 2016).

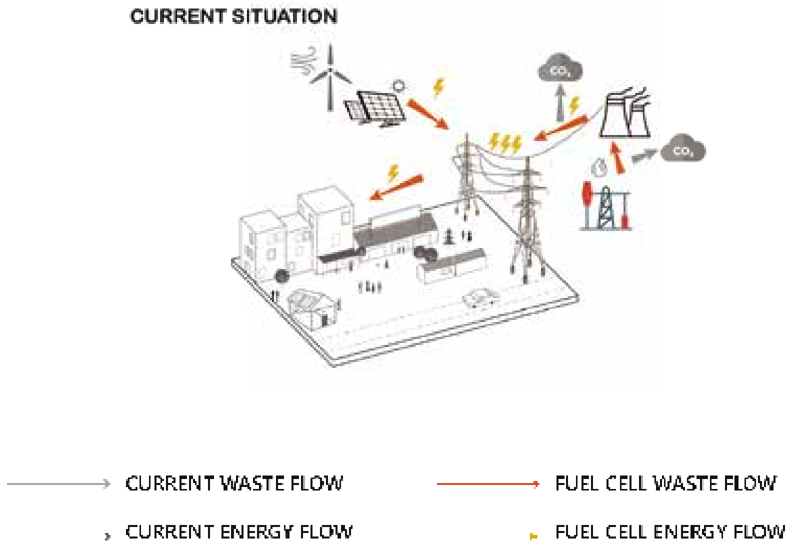
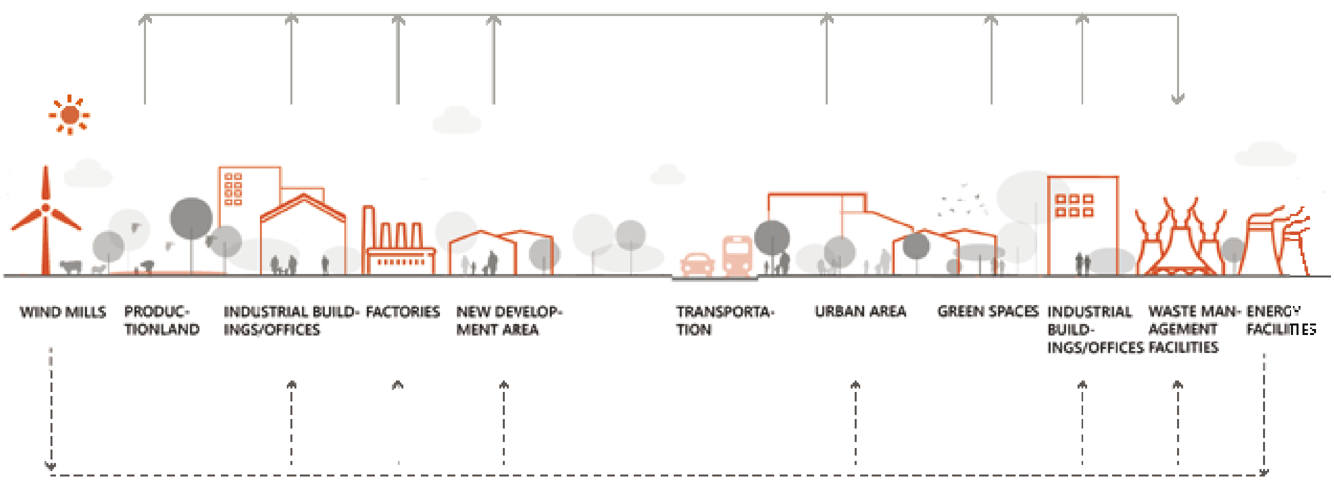
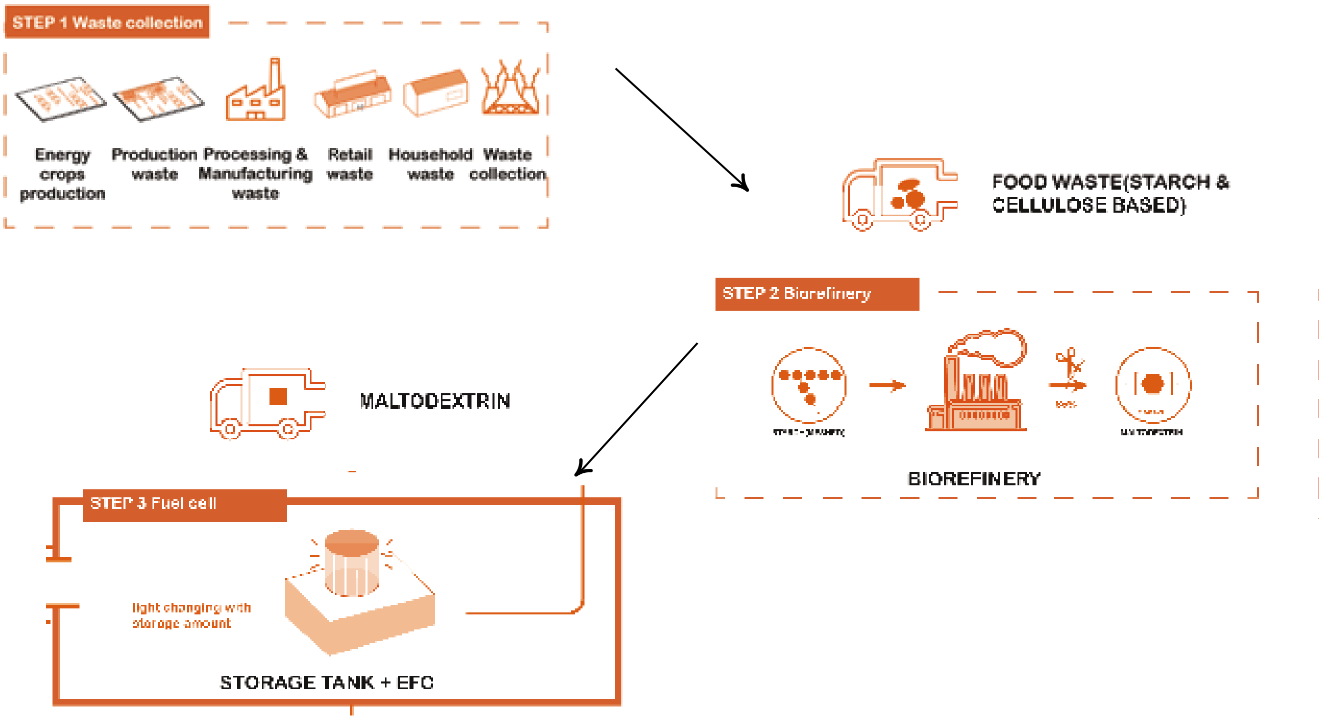


FIG 2 Diagram and systemic section (bottom) of current situation. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

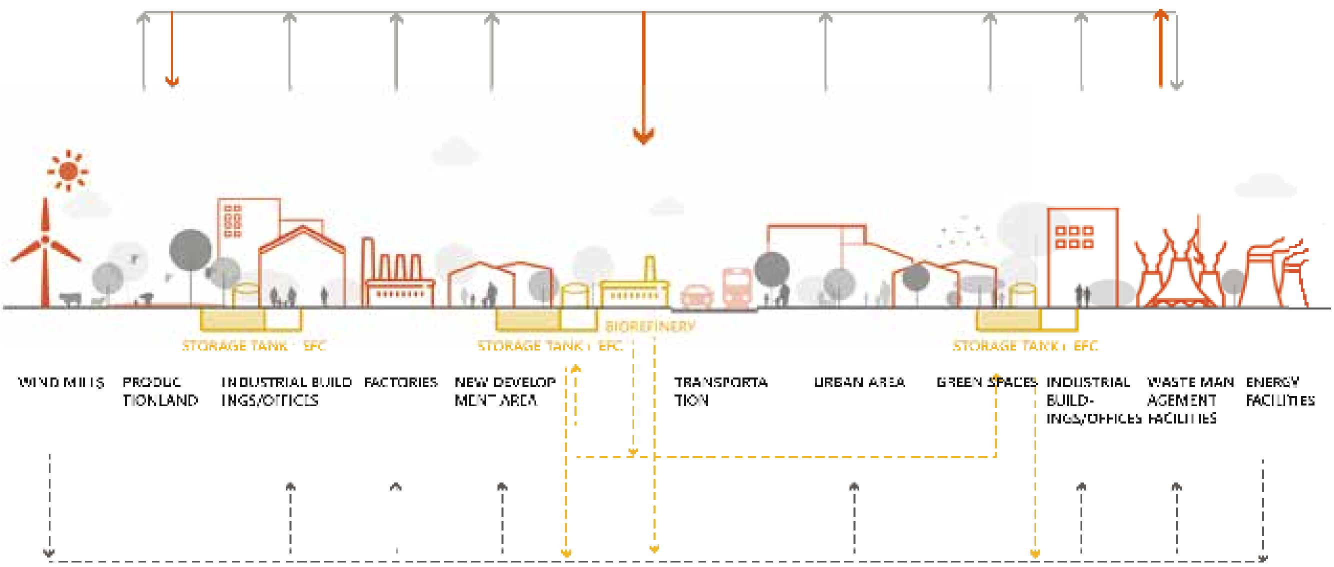


Proposed process



The proposed system uses a smart biorefinery to produce maltodextrin in a process which maintains the value of its stored energy. This allows for the efficient production of high quality, energy dense fuel for EFCs. The conversion efficiency for our proposed system is 2.65 times more than that of Orgaworld at producing electricity (1,06 MWhe/ton vs 0.40 MWhe/ton, respectively). The biorefineries will be built outside of urban areas to prevent possible odour pollution, and to allow easy access for large transport vehicles. The maltodextrin can be transported to the required areas by truck, ship, or pipeline, depending on the location and available infrastructure. The fuel cells, due to their stable, but relatively inflexible power output, will produce baseload energy for nearby industrial buildings, offices, and households. If required, they could also export electricity to the national grid.

FIG 3 Diagram and systemic section of the proposed process. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)



Possible locations within AMA

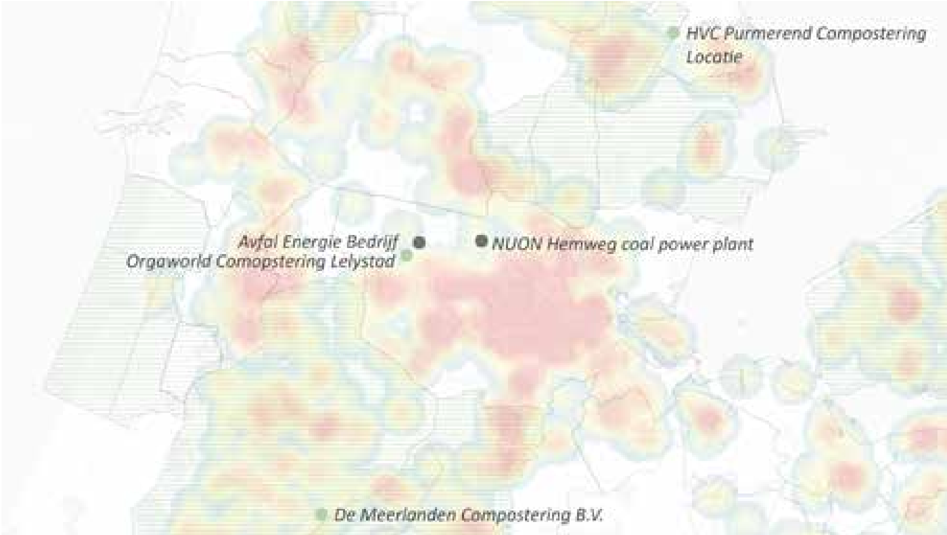


FIG 4 Map of the waste collection. Map out of scale. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

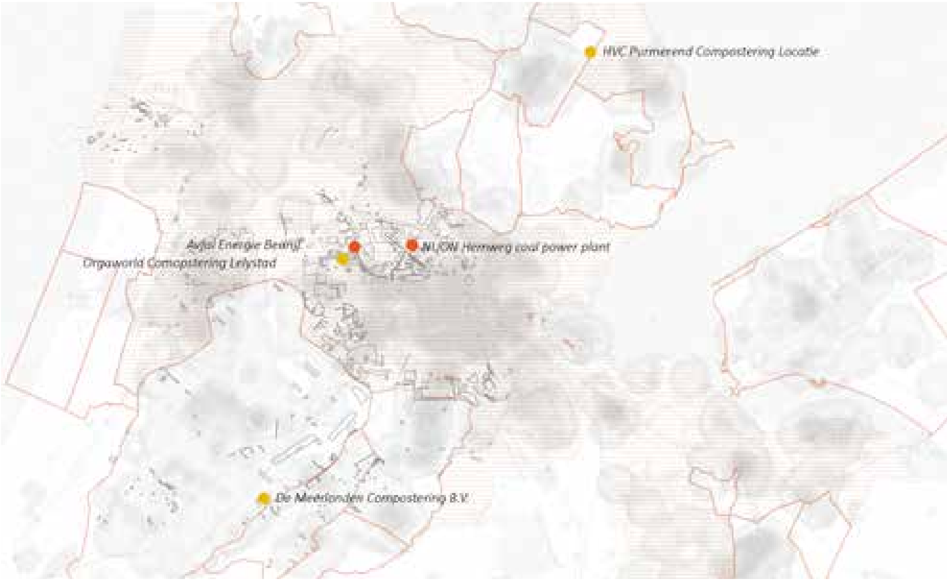


FIG 5 Map of the biorefinery's location. Map out of scale. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

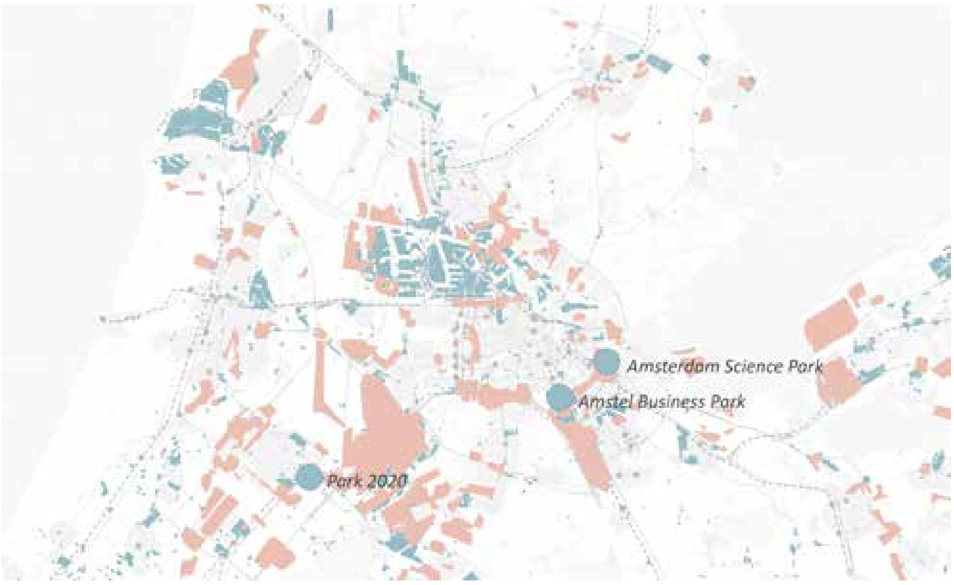


FIG 6 Map of the possible fuel cell location. Map out of scale. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

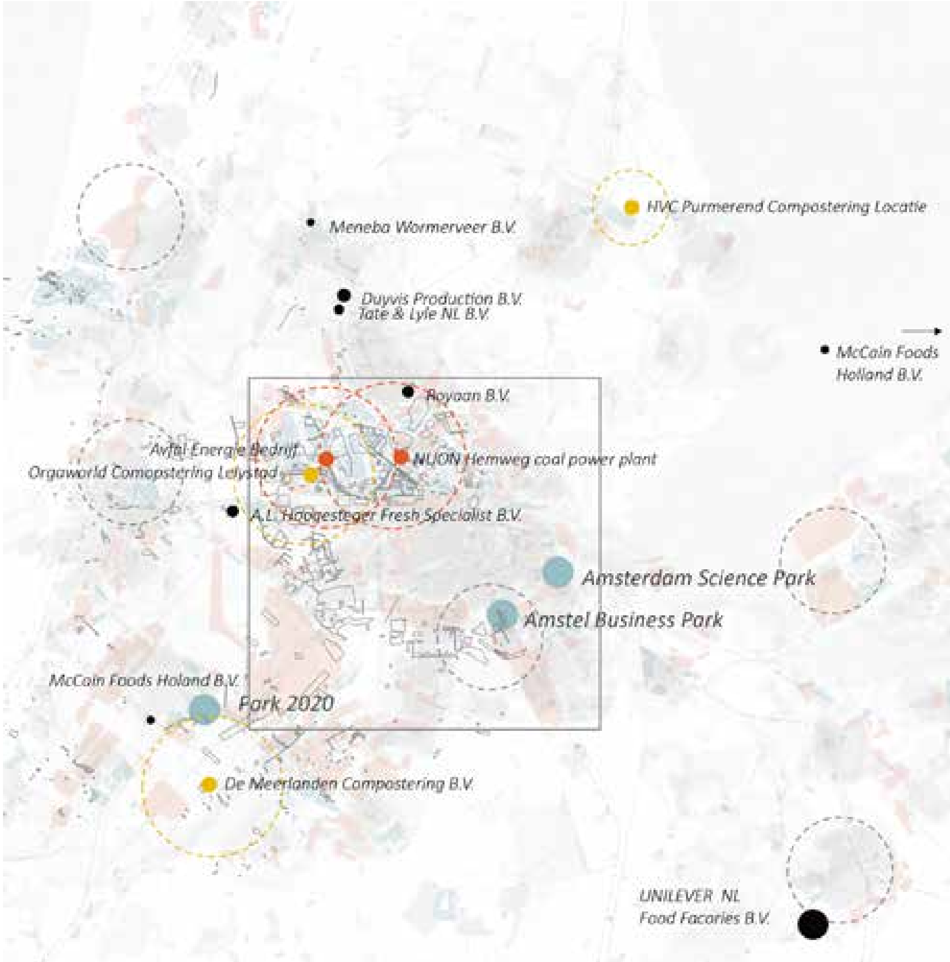


FIG 7 Map of the high potential are in which implement the solution. Map out of scale. Source: Geo-design for a Circular Economy in Urban Regions (TU Delft, 2018)

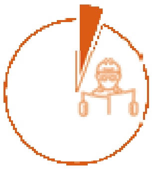
The potential can be seen already in the area where the food is produced and sold. We selected the food which is highly sugar concentrated so as to produce maximized energy. Thus, the most potential areas can be referred as bakeries and farm land which produce potatoes etc. Also, the wastescapes are valuable for future waste management. In fact, they are quite concentrated inside the study area. Together with the solar energy, wind power etc, the renewable energy from food waste batteries can really help dealing with the energy crisis in the future. Compared with other renewable energy, the EFC is much more portable and lasting in energy supply in no matter what weather conditions. So future use for mobility or others can be developed High-energy-density, green, safe batteries are highly desirable for meeting the rapidly growing needs of portable electronics. The incomplete oxidation of sugars mediated by one or a few enzymes in enzymatic fuel cells suffers from low energy densities and slow reaction rates. Here we show that nearly 24 electrons per glucose unit of maltodextrin can be produced through a synthetic catabolic pathway that comprises 13 enzymes in an air-breathing enzymatic fuel cell. This enzymatic fuel cell is based on non-immobilized enzymes that exhibit a maximum power output of 0.8 mW cm^{-2} and a maximum current density of 6 mA cm^{-2}, which are far higher than the values for systems based on immobilized enzymes. Enzymatic fuel cells containing a 15% (wt/v) maltodextrin solution have an energy-storage density of 596 Ah kg^{-1}, which is one order of magnitude higher than that of lithium-ion batteries. Sugar-powered biobatteries could serve as next-generation green power sources, particularly for portable electronics.

Evaluation model

INDICATORS

1 SOCIAL

Numbers of employees working in green energy industry in the energy sector



8.3%
of jobs in Dutch energy sector is related to renewable energy

2 ENVIRONMENTAL/ECONOMIC

Renewable energy production

12%
of the energy sources for electricity production come from biomass

3 ENVIRONMENTAL/ECONOMIC

Food waste conversion efficiency

1 ton
food waste = 0.4 MWhe
by Orgaworld

4 MULTIPLE

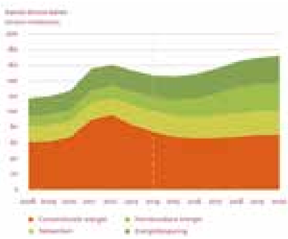
EFC space consumption

1 m²
EFC membrane = 74 m³
facility

FACTS ABOUT THE INDICATORS

1SOCIAL

Amount of full time jobs in the Dutch energy sector (2008-2020)



Currently the percentage of people working in the green energy industry is 8.3% (≈10,000 full time jobs). It is expected to grow to 17.6% (≈30,000full time jobs)in 2020, as a result of increased demand and the goals set by the EU and the Netherlands. (Energieonderzoek Centrum Nederland. 2015).

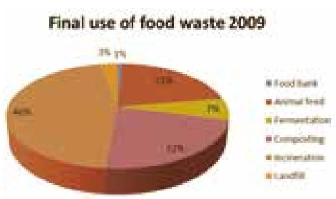
2ENVIRONMENTAL/ECONOMIC

Renewable electricity production

The 3 major sources produce 200-1,000MW per day depending on the weather conditions, as biogas is about 400MW per day, the power produced by wind and solar are quite fluctant.(Energieonderzoek Centrum Nederland 2018)

3ENVIRONMENTAL/ECONOMIC

Food waste conversion efficiency



45.6% of the food waste finds its way into the 'incineration' category in 2009 in the netherlands. (Soethoudt, & Timmermans, 2013).

Based on dietary trends, the top 5 most wasted goods are dairy, bread, vegetables, fruits, sauce and fats.

4MULTIPLE

EFC space consumption

39 ktons of waste from the household in AMA per year → 8.7 ha of EFC membrane

By collecting the data from food production/ manufacture/ processing/ retail companies in AMA, the household food waste are supposed to be 39 ktons per year, which needs 8.7ha EFC membrane to turn it into energy.

This section suggests various indicators to assess the performance of the proposed eco-innovative solution. At least one indicator is selected for every pillar of sustainability; employment in the renewable energy sector (social), the share of renewable energy production in the Dutch energy mix (environmental/ economic), and the food waste to electricity conversion efficiency (environmental/economic). The last two indicators are considered to be both related to the enviroment and the economy because they both relate to the production of CO2 in the Dutch electricity mix, and to the Dutch electricity market, and can therefore each be used as an indicator of those pillars. In addition, a fourth indicator assesses the space consumption of the EFC. Just like a hydrogen fuel cell, the EFC has a membrane which conducts the electricity produced inside the cell. It is expected that technological developments will produce more efficient fuel cells, which produce more energy per unit of membrane surface area, and require less surrounding space to house the EFC membrane, and supply the enzymes with fuel and air.

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on Food Waste

Decentralised food waste collection

Category of outcome: Technological, Social, Environmental

Owner of the EIS: Rosso Caterina and Carmen Van Maercke (KUL) and REPAiR

FIG 1 Idea diagram. Source: Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KULeuven, 2015. Marin, Julie, & De Meulder, Bruno. (2016). Antwerp City Wastescapes. Historic interplays between waste & urban development. HISTORY. URBANISM. RESILIENCE. Change and Responsive Planning., 3, 179-190.

Idea*

Hand in hand with the industrial revolution, the production of waste increased and this generated a rupture of the circular process of natural environment. The amounts exceeded the demand and since then was generally treat it at the central, city, regional and national level. The transition towards circularity required a different type of infrastructure The question then is if this is done in a sectoral way as in the industrial management and policy logic of the 20th century, or rather with an integral approach, in which the reconversion and re-qualification of the waste infrastructure is used as catalyst for local a spatial transformation. Following the studies of Rosso and Van Maercke (2015) and Marin & De Meulder 2016, this solution aims to develop a decentralised food waste collection. Based on :

1. Identification of the optimal scale for each waste flow. In particular the solution aims to define the optimal scale for the bidogredable food waste, balancing economies of scale (hence efficiency) with ecological performance. The EIS involves further the unravelling of waste flows into more specialized sorting of materials, in order to be able to engineer the most appropriate procedure and life cycle for each of them.

2. Disconnect and redirect. The process of disconnection creates new wastesheds and redirecting the new waste flows according to the optimal scale. Wastesheds, are literally sheds of waste flow. They function as natural waste management areas (per product) in the built environment.

3 Finding synergies: the overlapping of different layers of sheds generates complexity of structures and hence increases potentially their performance. These intersections and coincidences create synergies, resulting in new spatial typologies and configurations.

** For more details on this solution see other complementary solution Food waste Insect protein tanks at the page 175 and Re - Compost Land in REPAiR 2018 Deliverble 5.3 Eco-Innovative solution Naples)*

Re-Compost Land. Short supply chain of organic waste

Category of outcome: Economic, Social, Environmental, Legal.

Owner of the EIS: UNINA Living Lab

Idea*

The solution aims to the regeneration of Wastescapes, buffer areas, agricultural fields, through an innovation process which works on the short supply chain, thanks to the Regional aids to trigger the use of community composting plants. The short supply chain allows to collect and treat organic waste in the REPAiR Sample Area, in order to create, on the one hand, top soils for the new morphologies of the terrain, along the roads, and around the recycling areas, and, on the other hand, to recover the agricultural soils.

Potential Impact

The promotion of the short supply chain activates circular economy territorial loops, oriented both towards short and long-term results. The involvement of the citizens' associations allows a more sudden and lasting appropriation of abandoned public areas as pilot sites for experimenting the EIS. At the same time, the treatment of the urban organic fraction, and the identification of buffer areas (mainly along the roads) are the first steps to re-design the terrains, and to re-think at the process in order to give new quality at the marginal areas.

** This is a summery of the EIS elaborated by UNINA team. For the complete solution please see REPAiR Deliverable 5.3.*

Current process

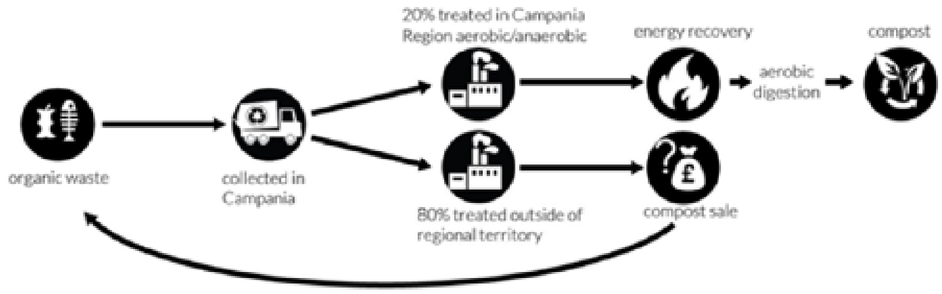

FIG 1 Linear scheme of current situation. Francesca Garzilli, UNINA Team, 2018.

More than 80% of the Organic Waste, collected in the Campania Region, is treated outside the regional territory, as totally inadequate is the equipment of active plants (only two in the whole Region). As described in the Urban Report of Waste (ISPRA edition 2017), the Campania's organic waste, from the household separate collection up to the 2016 exceed 708 thousand tons, of which only 67 thousand are treated in Campania. These two active plants treat the organic waste through an integrated anaerobic and aerobic process; they recover the renewable energies in the form of biogas/ biomethane. In order to transform this treated organic waste in compost, another aerobic process is carried out. Of these two plants, one is located in Caivano (one of the municipality in the Sample Area). The capacity of this plant is 33000 t, of which 32070 t treated wastes of which: 28400 tonnes food waste (20 01 08), 2975 tonnes of urban green (20 02 01) and 695 tonnes (other). Through an anaerobic treatment they produce 3701130 Nmc od Biogas, that are subsequently treated in an aerobic way producing 2076 tonnes of mixed compost.

The CEA (consortium of alternative energy) in Caivano, deals only with processing and not with collection of organic waste, as it is the main plant in Campania, it buys organic waste in order to give the best quality compost. Although the Campania Region has implemented a series of measure for the realisation of new plants to meet the request of the European Union, the majority of the municipalities are strongly resisting. Organic waste is collected and managed by Municipal Solid Waste and Regional Municipal Waste Management Plan (Piano Regionale di Gestione dei Rifiuti Urbani, PRGRU)..

Proposed process

FIG 2 Circular process scheme: Francesca Garzilli, UNINA Team, 2018.
FIG 3 (Bottom) Systemic section. Francesca Garzilli, UNINA Team, 2018

The peri-urban areas where the composters will be placed will be public areas, wastescapes identified during the PULL with the citizens and emerged from the studies conducted by the UNINA team. The idea is to create a short supply chain of the organic, which allows on the one hand to regenerate agricultural soils through the treatment of compost and reuse on site, and on the other hand to define new morphologies of the land with organic waste coming from the household collection and urban green waste, as grass clipping (in line with the PRGRU - Regional Plan for Urban Waste Management). The two processes will be carried out at the same time in order to then develop with different times of implementation. For this entity of territorial reconfiguration, it will take at least 20 years, but it is necessary to achieve the first concrete demonstration results from the beginning of the process. The idea is to localise medium compost plants in each municipality in order to create eco-district as catalyst of territorial reconfiguration and implementation of the supply chain. Another goal is to increase the citizens' awareness of the separate collection of waste, giving tax incentives in order to improve the waste management.

Elementary Eco-Innovative Solutions

EIS	OBJECTIVES
2.1 Medium size neighbourhood compost plant	Reduce the treatment of organic waste outside the Region, and made aware the citizens towards a circular economy.
2.2 Creation of a New Waste Eco-District	To reduce the visual impact and the negative citizens perception of these facilities, the compost plants will be located within Eco-Districts. These new plants would also become landmarks or non-landmarks, catalysts of a change process in the peri-urban territories with latent potentiality. The "New waste district" will become the propagators of new economies and new territoriality.
2.3 Production of safe and high-quality compost to regenerate agricultural soils in the surrounding of neighbourhoods compost plant.	Regeneration of abandoned agricultural land at almost Km 0.
2.4 Transformation of wastescape in peri-urban farm thanks to the short supply chain.	Wastescape regeneration, new land uses: from abandoned peri-urban land to productive land.
2.5 Allocate to new landscape morphologies part of the treated compost. (linked to EIS 3.5)	Creation of compost as topsoil for new landscape morphology thanks to the short supply chain (linked to EIS 3.5)
2.6 Tax Incentives to change food waste behaviour of households and companies.	Giving tax Incentives to families and companies that produce organic (as the shopping centre, restaurants, etc) aims to change the attitude of citizen towards separate waste collection.

Several medium-sized plants will be identified in order to promote better acceptance by citizens and local stakeholders. The aim is to link the urban and landscape regeneration of the territories with the production of waste: that is useful as well to increase confidence of the local communities in the waste treatment and to improve the quality of the separate waste collection. The size of each plant could be between 5,000 and 10,000 t / y, in order to minimise the impact on the environment. By the aerobic treatment, about 30% of compost by the organic fraction treated in the plant could be obtained. This treatment allows greater control and would help small farms that could benefit from their management. With combined anaerobic / aerobic plants, smaller than the existing plants in Campania (Caivano and Salerno) around 10,000 t / y, in addition to avoid the NIMBY effect, there could be a greater return in economic terms. If on one hand this plant allows to recover both electricity and biogas, on the other, the outgoing compost will be minimal.

Scope for Knowledge Transfer of Re-Compost Land to the AMA

FIG 4 Knowledge transfer event in Amsterdam: discussion with stakeholders on the transferability of EIS from Naples. Marcin Dąbrowski.

EIS:	**Re-Compost Land**
Transferability from Naples to Amsterdam	Medium
Transferable elements	Only some elements are transferable, due to local regulations on the use of food waste and patchy food waste collection across the municipalities. The possible transferable aspects are those related to educating and mobilising the local population and offering incentives as well as the landscape transformation idea.
Adaptations needed to transfer the EIS	Need for early separation of rural organic waste streams. Need for changes to the rules for collection and use of organic waste. Need for educating the inhabitants on how to compost and properly segregate organic waste. Composting facility needs to be close to the community to allow for education on site and for neighborhood "quality control."
Key barriers for transfer	First barrier is the legislation on organic waste in the AMA (processing someone else's waste is considered as commercial activity and it is against the law). Another key barrier is that organic waste is not collected in some of the municipalities in the AMA. Lastly, in the AMA local food culture is not prominent and most of the available food on the market is from highly industrialised production and not necessarily "local," which could limit the suitability of this EIS to this context.
Potential location in the AMA	Around parks and in suburban areas (e.g. Noord, Amstelveen), degraded land. Some stakeholders remarked that it could be applied on the highly built-up urban areas as well.
Actors to be involved	Municipalities, households, training organisations, transport companies, waste management companies, farmers.