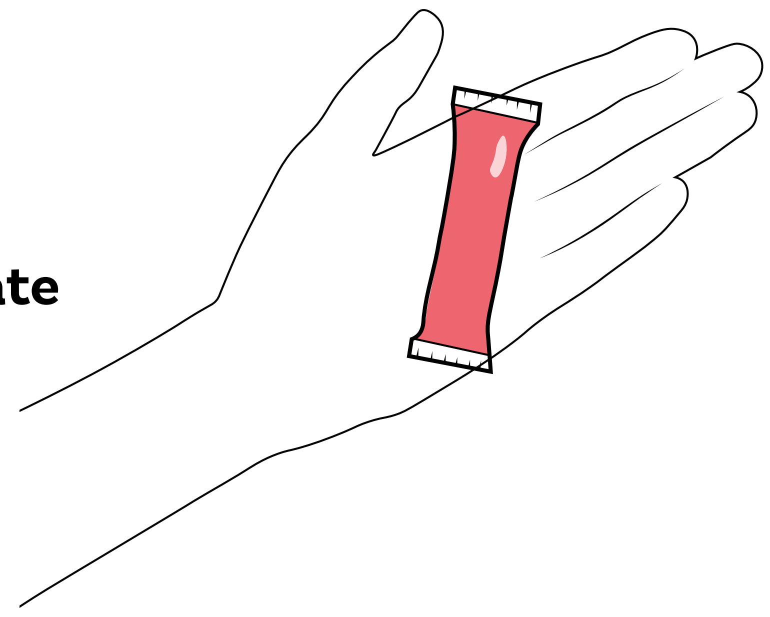
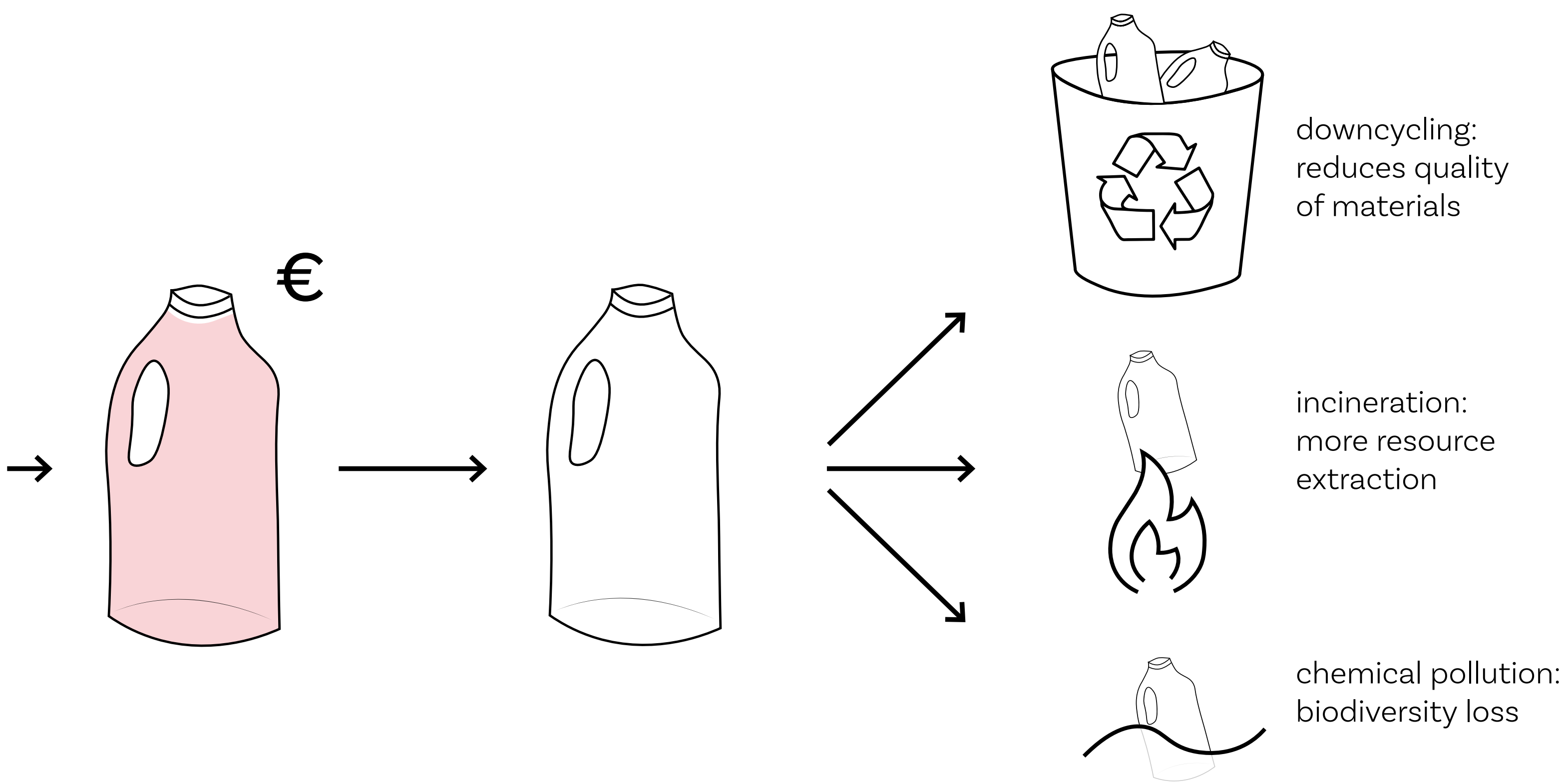
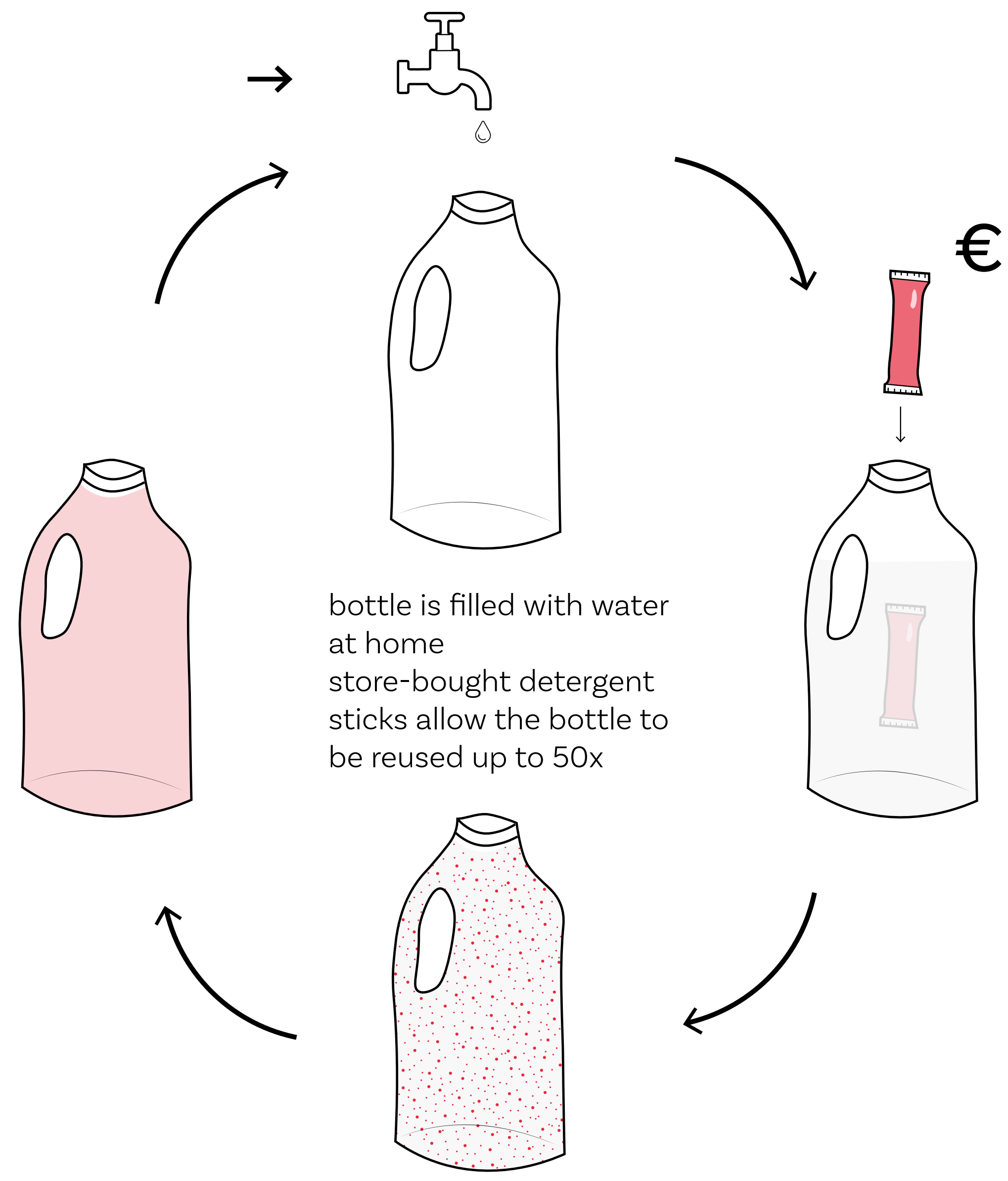
1 | IDEA : SOLUBLE SOLUTION

1 L of liquid to 100 ML of concentrate

Linear to Circular





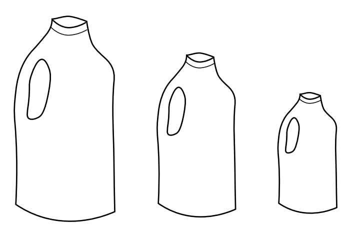


Current system > bottle usage per year

=

Soluble Solution system > bottle usage per year

=



WATER

IS THE NUMBER ONE INGREDIENT OF EVERY DETERGENT SOLD TO HOUSEHOLDS

(BETWEEN 80% TO 90%)

REDUCTION OF WEIGHT

=

LESS STORAGE, TRANSPORT & STRAIN ON COSTUMER

IDEA

The biggest contributor to plastic waste is the packaging sector, much of it single-use food wrapping.

There are recycling systems in place. Some make use of a collecting system that incorporate credit to encourage returning. The return rate for 25 eurocents deposit is likely to be around 90% and for 10 eurocents deposit anywhere between 85% and 80% in the case of supermarket returns only. However, with additional return systems, this number might increase further.

Other systems rely solely on the sense of responsibility of the public. In the Netherlands, this is the case for most packaging, or bottles, used for cleaning agents and personal hygiene products. These containers are primarily made of PET and can be recycled easily. The collection is done through street containers rather than deposit points in the supermarkets.

Although the majority of these systems work quite well, they are built on the idea of recycling. According to the Ladder of Lansink, reuse is considered more circular than recycling as there is presumably less energy used in the process.

Reuse > Recycling

Soluble solutions aims to change the existing system for cleaning agents, with the potential for expanding the system into other sectors, by using concentrated sachets made from algae or seaweed. The sachets would be dissolved in water by the customer and the used bottle could constantly be reused. The aim of the concept is to reduce plastic waste, in order to minimize resource extraction and environmental pollution.

In addition the new system would require less weight, leading to a reduction of transportation emissions and costs, as well as less storage space and strain on the consumer.

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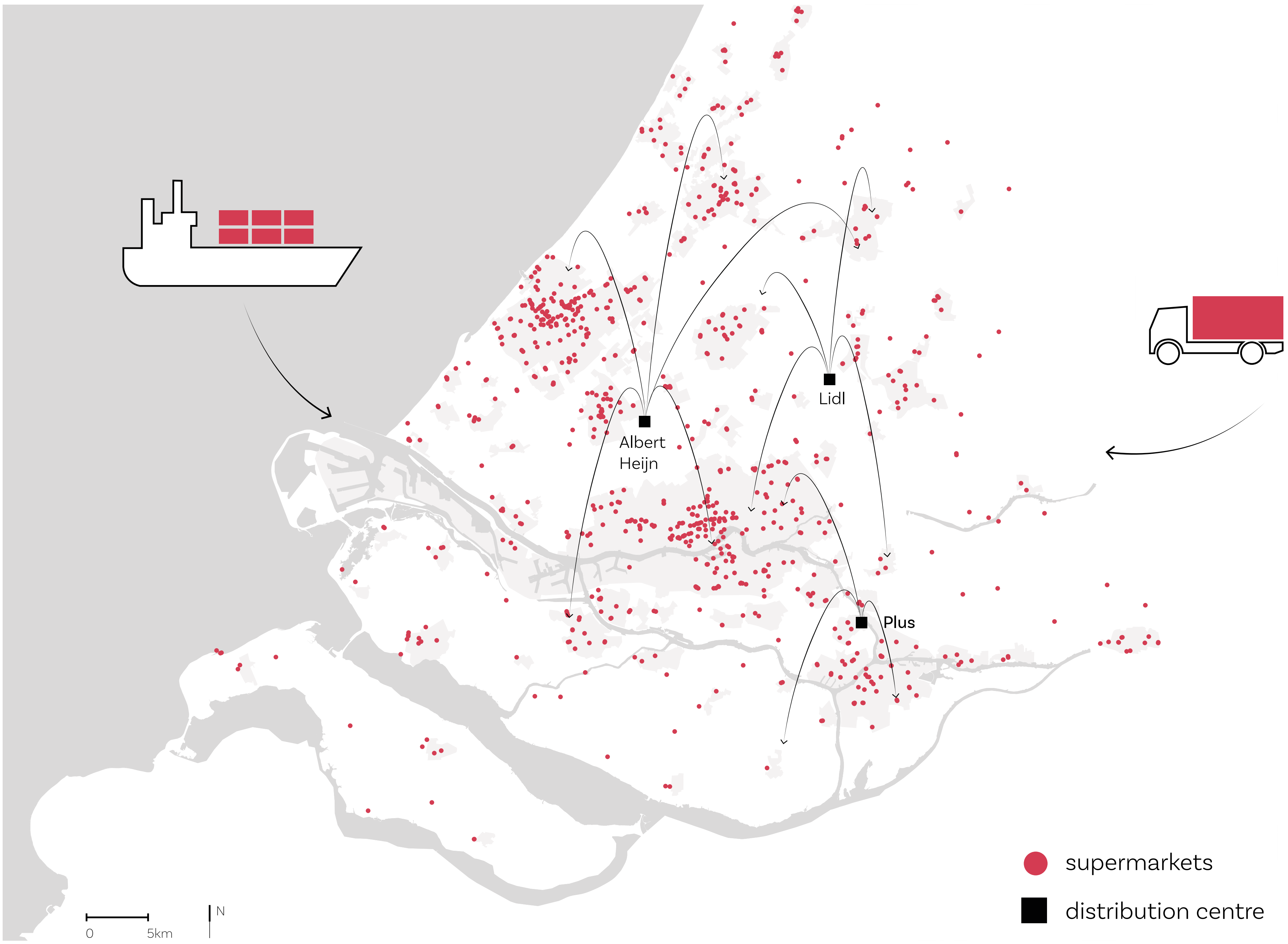
2 | REPRESENTATION MODEL - SPACE & WASTE

Reduce SPACE
As illustrated on the map, South Holland has a large number of supermarkets and distribution centres. The products displayed in these supermarkets take up a large amount of space. Also, this is even more evident when we consider all the distribution centres connected to them. The solution that is presented with Soluble Solution aims at reducing the space taken by each individual product.

This can have multiple benefits:

Reduce shelter space and thus increase the portfolio of products which can be displayed in the supermarkets. This would potentially lead to more turnover/m2 of space in the supermarket.

Reduce the transport costs associated with less weight and reduced space. More sachets could be sent at the same time thus resulting in a reduced number of transport miles.



Reduce WASTE
As illustrated in the map, South Holland has a large number of recycling facilities. The objective of decoupling the use of the detergent to the use of plastic bottles would eventually result in a decreased stream of plastic bottles (either recycled or incinerated).

In this perspective, the implementation of a sachet solution would result in a lower input of plastic bottles needed for cleaning purposes and in the long run in a reduction of recycled and incinerated plastic. This would have a direct effect on the environment as well.

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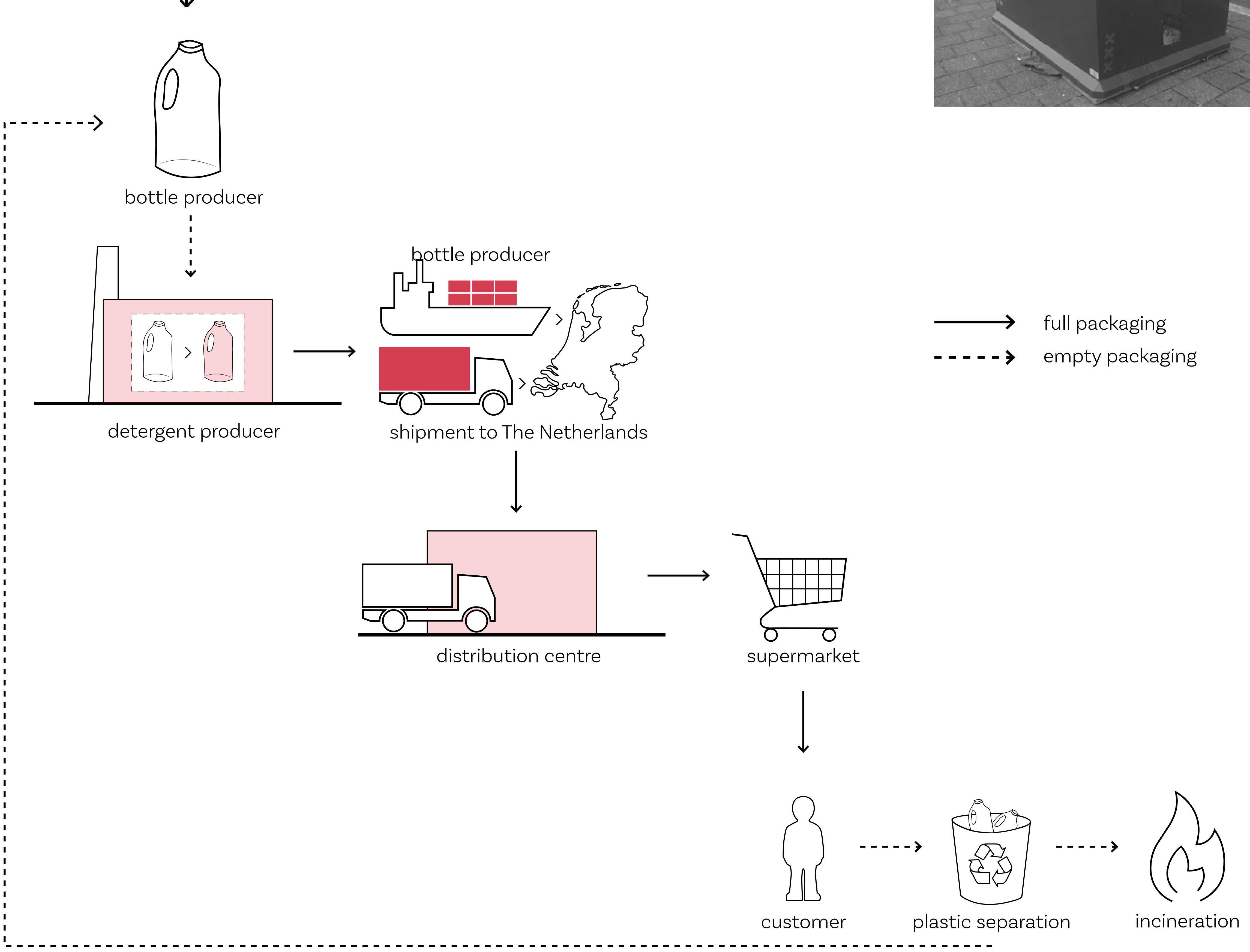
3 | PROCESS MODEL - URBAN DISPOSAL & RECYCLING SYSTEM

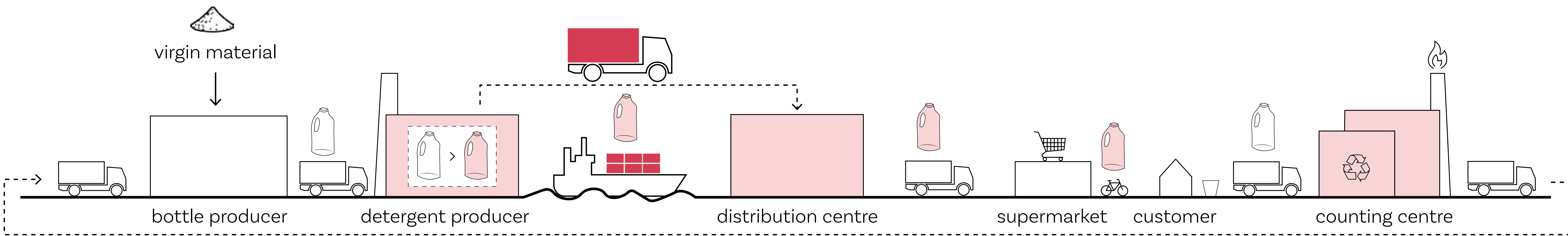
The bottles with detergent are filled abroad and shipped to The Netherlands.



Current process

Empty PET bottles are currently produced by third parties (different from the detergent producer) and then shipped to the detergent producer. Detergent producers tend to use a small variety of bottles for their products, the bottles do differ mainly in size and only little in shape. In their facilities, they fill up, label the detergent bottles and then bundles them together into pellets which are shipped (road/sea) to big distribution centres located in the Netherlands. From here, the pellets are dispatched to smaller distribution centres belonging to the different supermarket chains.

Based on their demands, supermarkets then get supplied with the products they need. Customers select the desire dproducts which are then disposed of in the dedicated recycling bins. From here the municipality collects the plastic bottles, bundles them in big bags and hands them over to contractors who will either chop them into plastic flakes, which are then reused by the plastic producers for new bottles. Part of the plastic is incinerated instead.



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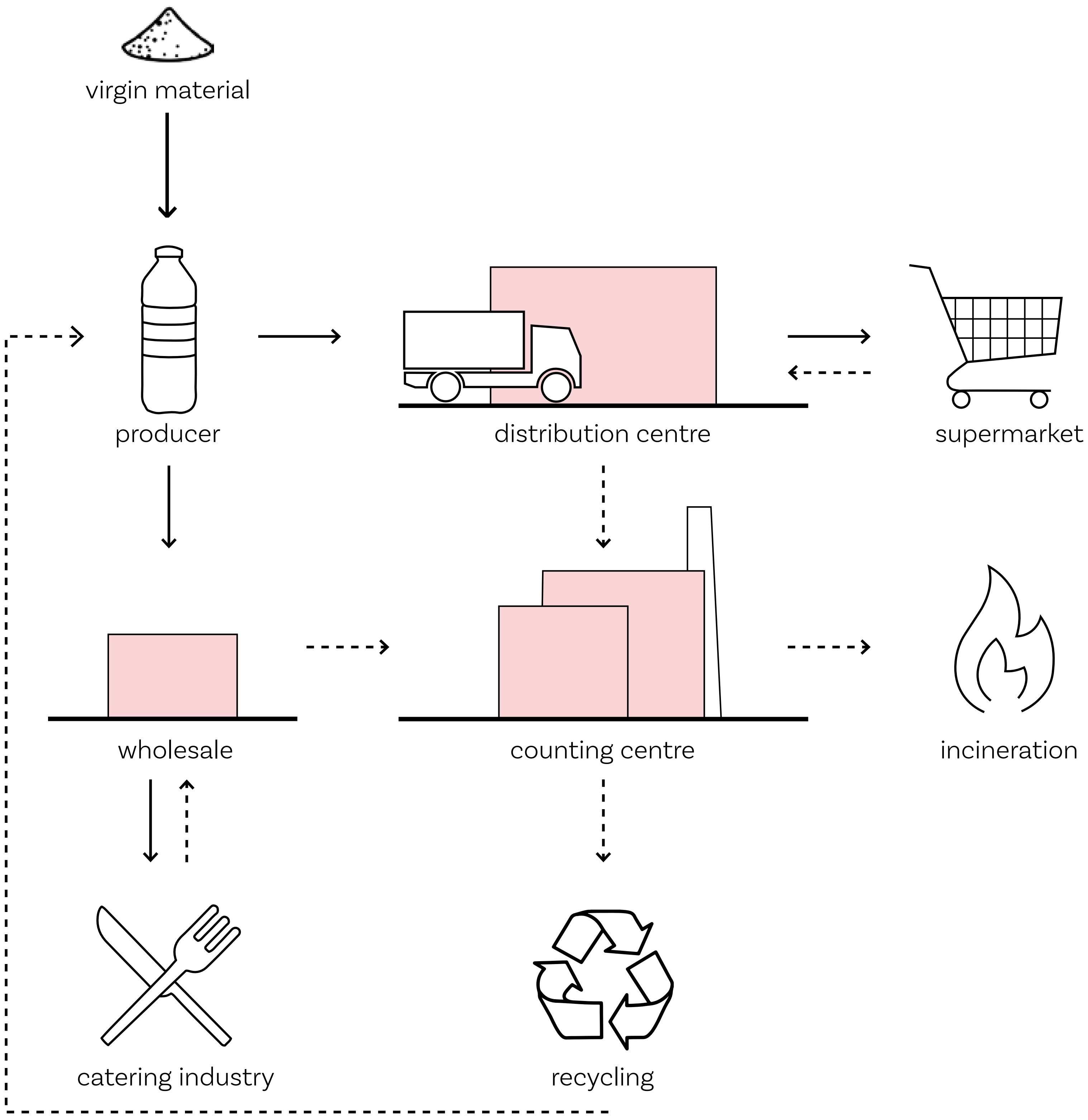
3 | **PROCESS MODEL -** STATIEGELD SYSTEM

There is no system in place for the return of plastic detergent bottles. There is, however, a PET return system in place in The Netherlands, which works with credit (statiegeld)

The Netherlands has a very efficient plastic collection system in place. the system is named Stichting Retourverpakking Nederland (SRN) and it facilitates the collection of plastic bottles in/by supermarkets. More information is provided below. The reason why this system is illustrated here is because the solution presented in this paper could at a later stage expand to adjacent markets (drinking bottles) and use the SRN system for implementing the adoption of hard plastic bottles in conjunction with the sachet solution presented here. It is therefore interesting to present the workings and mechanisms of the SRN system.



full packaging
empty packaging

Process
There are two different deposit return logistics systems for large PET bottles.

For the vast majority of bottles (540 million) one system with several supermarkets. (SRN)

Aldi and Lidl each have their own closed system. The number of Aldi and Lidl bottles is estimated at 111 million. Aldi and Lidel sell private labels wich are nto sold in other supermarkets. For example, Aldi sell a unique 1.75 l bottle which i only recyclable at Aldi itslef. (RVM)

The schematics above shows the dominant deposit system (SRN system). The solid black arrows represent the physical flow of full PET bottles, the dashed arrows represent the empty bottles.

The supply chain is hereafter illustrated below:

1. The supply chain starts with the producer which delivers the full bottles to distribution centers, from which supermarkets are supplied.
2. The consumer buys the full bottles and returns them empty to the supermarket.
3. The empty bottles are packed together after being taken by the bottle machine and deposited into transparent plastic bags.
4. These bags are sealed and returend to the distribution centers
5. From the ditrbution centers, the bag are transported to the sorting center * (Telcentrum)

For the catering industry:

1. Producers supply wholesalers with the products
2. Wholesalers provide these to the different catering industries
3. Once the bottles are used these are collected in smaller bags (about 70 bottles)
4. The bags are transported to the wholesaler
5. The wholesaler rederictes the bags to the sorting center*

*In the sorting center the bottles get counted (via the barcode). The system records how many bottles of any brand of soft drink comes from which supermarket or wholesaler. After counting, the bottles are sorted between transparent/colorful and transported the recycling installation.

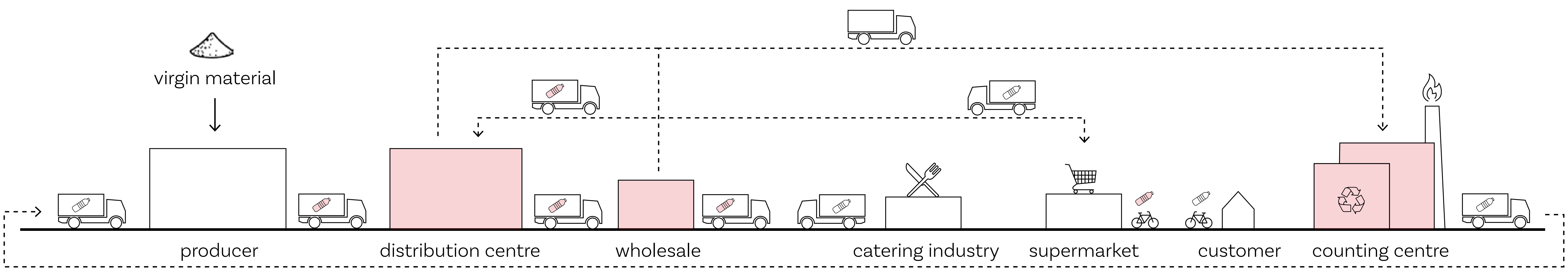
The central element in the whole supply chain is the Stichting Retourverpakking Nederland (SRN) system

SRN is responsible for responsible for collecting a fee + deposit from participating producers and importers and to facilitate the following process:

1. SRN collects the deposit from participating producers and importers of bottles
2. Producers and importers charge this deposit onto supermarkets when selling them bottles
3. The deposit that supermarkets pay to producers is passed on to the consumer.
4. When the bottle are recycled, the deposit is paid back to the consumer and the supermarket is reimbursed by the SRN (based on the counts in the sorting centers. Supermarkets receives as much as is recycled)

RVM instead works in the following way :

1. At Aldi, the bottles are immediately compressed after collection in the deposit machine (Reverse Vending Machine) RVM
2. At Lidl, the bottles are directly put in the transparent bags.
3. For both systems no sorting center is currently in place.



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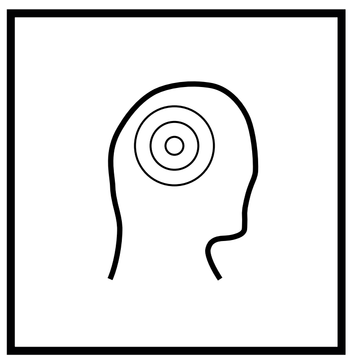
4 | EVALUATION MODEL

SOCIAL INDICATOR

- ENVIRONMENTAL AWARENESS THROUGH VISIBILITY OF PRODUCT



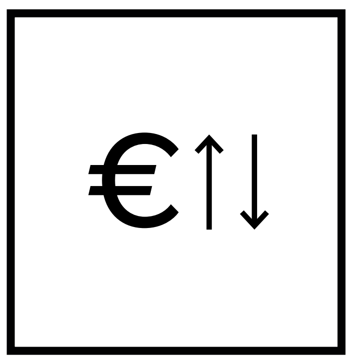
The approach would be to engage a large variety of people from different social backgrounds by selling the products in supermarkets and also online platforms.

This is meant to create awareness of the consumers, providing them with a viable solution to the problem of plastic waste and resource management. This is meant to change consumer behavior in a participatory way.

Working together with an existing and well known brands, makes the product more recognizable.

ECONOMIC INDICATOR

- COST ASSUMPTION SCHEME



REDUCE COST ↓

- Storage space: the concentrate inside the pouches is around 0.1l compared to a 1 liter bottle of liquid cleaning detergents. This would lead to space reduction for storage space of 80% to 90%.
- Transportation costs would be reduced in several ways: 1) there would be no waste collection and transport to the recycling facility. 2) there would be no additional transport ways, despite the new production system.
- Less overall packaging

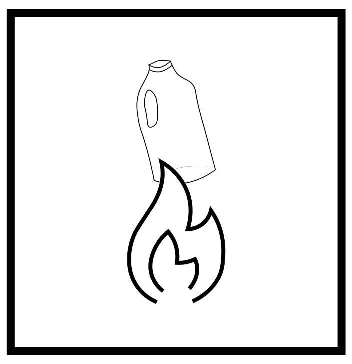
ADD COST ↑

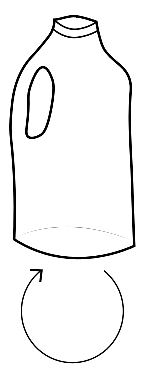
- Management costs of new reuse system
- Less profit due to the product being more concentrated. public perception of the amount is different (cannot ask the same price)
- Dissolvable packaging might be more expensive

This would lead to an overall reduction in transport and storage cost of 80% - 90%.

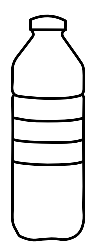
ENVIRONMENTAL INDICATOR (1)

- RESOURCE REDUCTION OF VIRGIN MATERIALS
- REDUCTION INCINERATED PLASTIC





Reuse of the bottle is encouraged as the detergent itself does not come with a bottle.



Possibility to use any bottle to mix detergents
(e.g. empty water bottle)

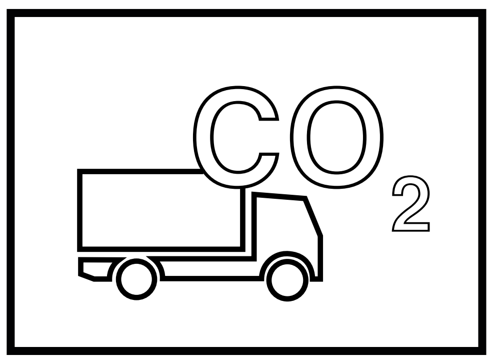
65% of PET is recycled -> we assume that 30% of it (7890t) is incinerated or lost to the environment
by reusing bottles, the amount of plastic waste is reduced

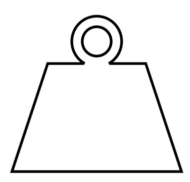
CO2-footprint for producing 1 PET- bottle (Kg CO2-eq./PET-bottle) -> 0.431

CO2-footprint of incineration of PET (KG CO2 eq./Kg of input) -> 2

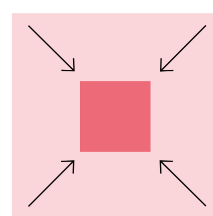
ENVIRONMENTAL INDICATOR (2)

- REDUCTION IN CO2 EMISSIONS THROUGH TRANSPORT





less weight
(no water)



less volume
(no water)

The CO2 emissions during transport of products can be reduced due to the absence of water in the product 250 km as average distance , mix of transport (freight, rail, sea)

CO2-footprint for all transported PET bottles in South Holland (assuming an average transport distance of 250km) -> 7,924,542

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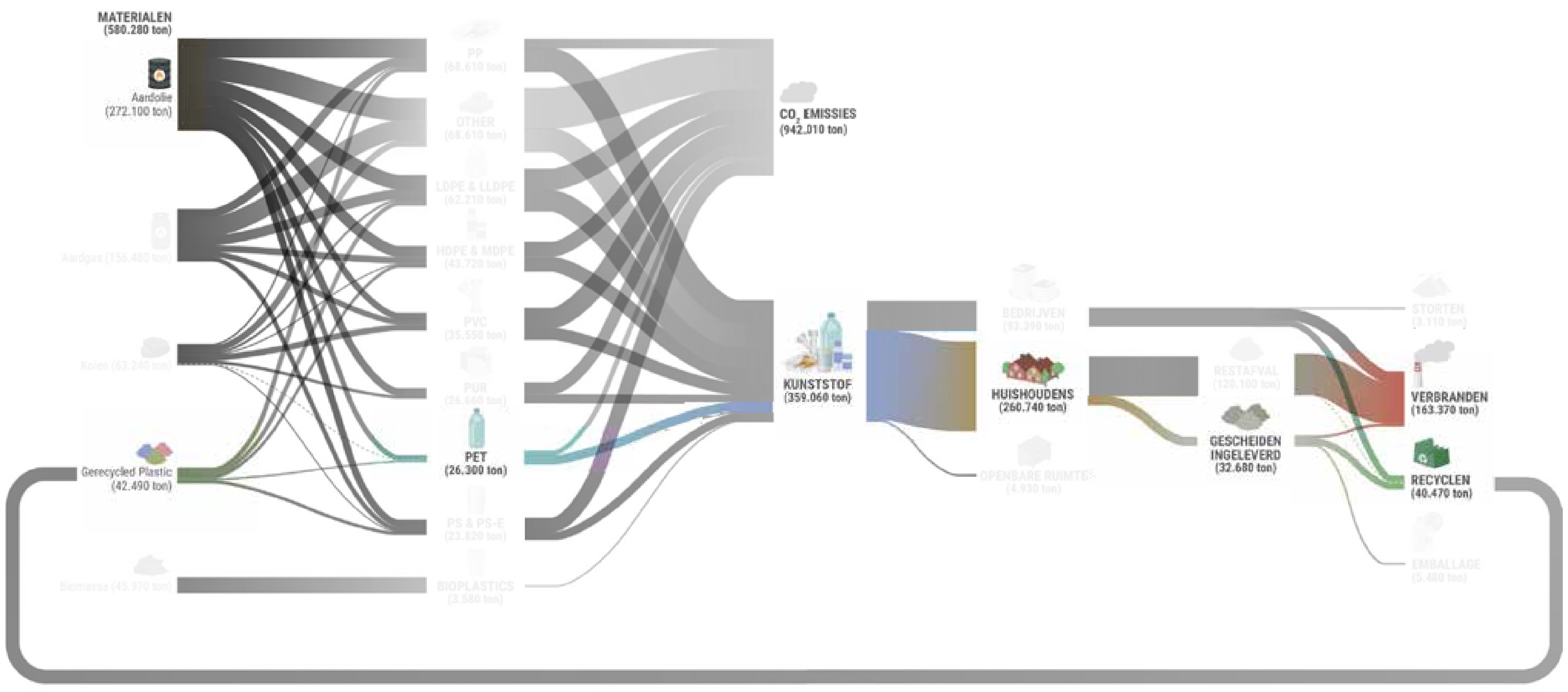
4 | EVALUATION MODEL

For the evaluation of our solution, we have used the material flow analysis of South Holland (see figure). The analysis focuses on the PET bottle stream highlighted in the figure.



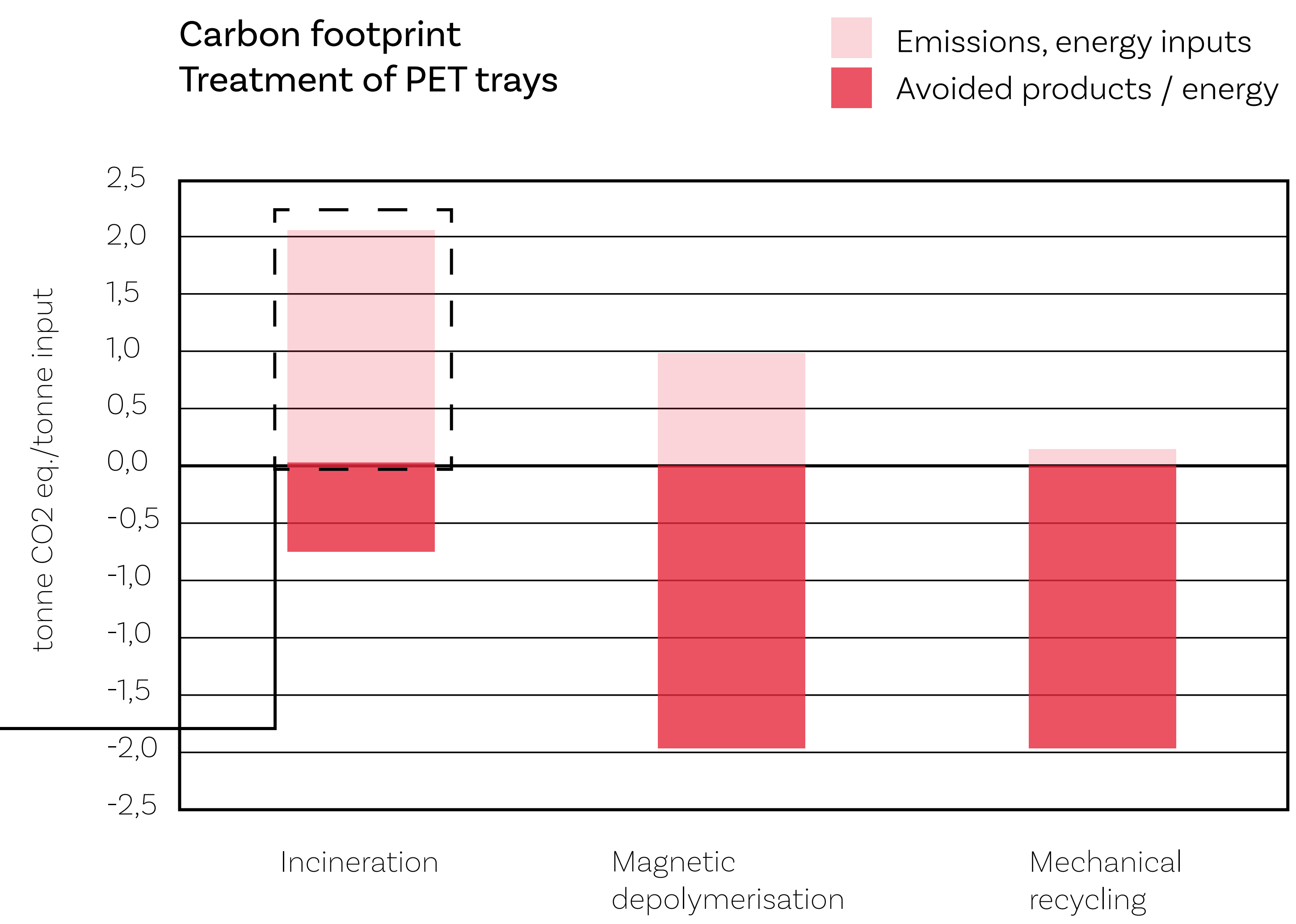
Overall reduction parameter
Our system assumed a yearly reduction in the input of PET equal to 1%. This means that the solution aims at reducing in 10 years the total flow of PET plastic by 10% (a reference to year 0).

Virgin PET emission
To quantify the reduction in terms of CO2 emissions, we assumed that the production of virgin plastic has an impact of 0.431 Kg CO2-eq./PET. We assessed the current CO2 emissions for generating the bottles and we applied a yearly reduction of 1%.

Incineration of PET
To assess the reduction in CO2 emission due to reduced incineration, we assumed that only 30% of the current PET output is incinerated. We found out that the current impact of incineration equals 2 T CO2-eq./T input. Once we determined the current emissions, a yearly reduction rate of 1% was applied.

Transportation
We did also run an analysis of the CO2 emission that will be reduced due to the reduction in the weight of our new product. To do this we first estimated the current mass of PET bottles transported and we multiplied this by the average emission of transport (average distance 250 km by freight, rail, sea) which equals to 9.58 Kg CO2/T 250Km. We then applied a reduction of 1% also to this stream and we plotted the results over a 10 year period.

South holland adopst different recycling/ treatement techniques. For our anlysis we assumed that the non recycled fraction of PET is only incinerated. Thus, we only employed the the carbon footprint value generated from incinerating PET (see above).



Reducing CO2 emissions and plastic waste through the use of biodegradable algae foil.
Sachets will be made from biodegradable seaweed film grown in a closed pond systems. The algae absorb CO2 directly from the flue gas of various industrial processes, such as cement production. The advantage to open pond or bioreactor systems is an increase in productivity of 20 to 50 times. Furthermore, is this a compact modular system that bolts onto existing industrial facilities. One ton of algae sequesters nearly two tons of CO2 which is the equivalent of not burning 4.5 barrels of oil.

Further product information
Vegan - The algae film is vegan, gluten-free, GMO-free, and is working towards organic certification; therefore it could also be used for numerous other products including the food and beverage industry.

Efficient - The approach is resource efficient as it is fast and requires minimal land and loses zero water.
Clean — Unlike in large, open ponds, algae are grown in a fully sealed, closely monitored environment. This prevents contamination from outside sources like acid rain, radiation, floods, or birds and other wildlife.
Smog Reduction - Incl. smog-causing NOx and SOx.

Shelf ready packaging
The sachets would be sold in biodegradable cardboard Notpla boxes; these are lined with a waterproof film made of seaweed.

Pond System
Fully controlled, bio-secure, location agnostic, climate agnostic, resource-light production
2 to 5 g/L/day
2,000-3000 mT / acre
181 – 250 mT / FTE
$11k / mT (spirulina) $95k - $159k (h. pluvialis)
Easily scaled due to modular design; biosecure
Able to rationalize global supply

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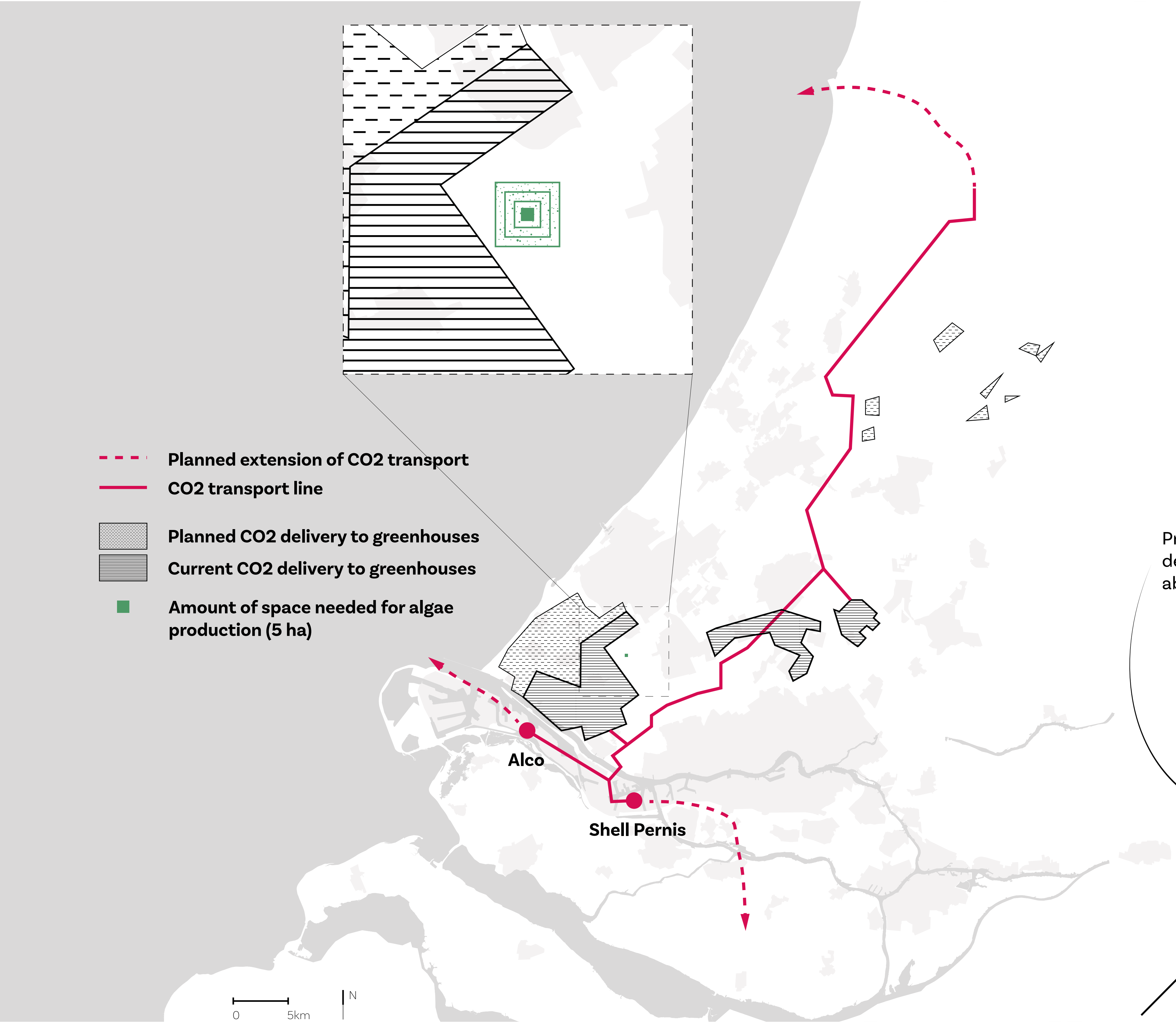
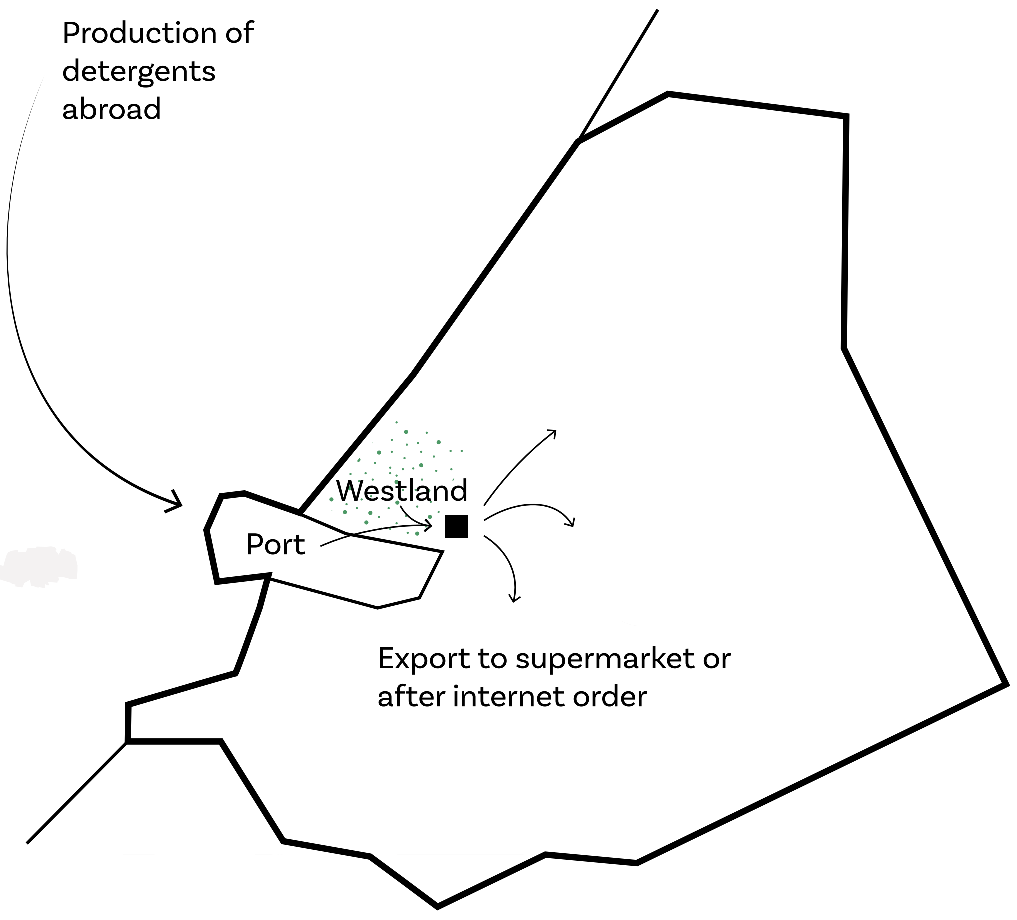
5 | CHANGE MODEL





Algae are grown in closed system ponds Here we have mapped the spatial implications of the area needed for the algae ponds. We chose the area on the North East side in Westland, since it is close to the harbor, and has direct access the CO2 pipeline coming from the industrial cluster around the harbor.

The spacial implications are mapped for the year one, five, fifteen and thirty relative to year zero. Even though this new way of production adds additional space to the Westland region, the overall space of production facilities would be decreased. In addition, transportation costs would be reduced, since bottles are not produced on site. In the new system, this step would be eliminated by having **one centralized combined packaging and filling facility.**

The new system would have direct impact on the reduction of space across the entire supply chain including transportation, storage in the distribution centers, supermarkets and in consumers homes.

The algae ponds produce 2000-3000 metric Tonnes of algae per acre (4050m2)

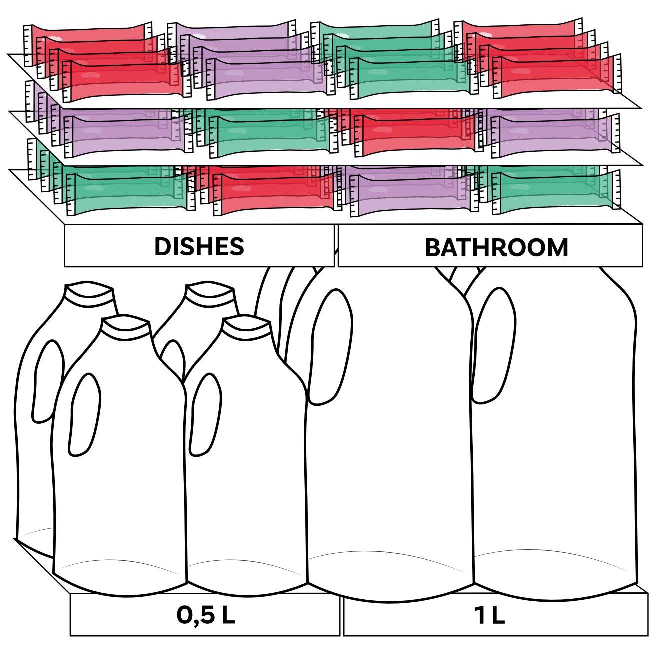
Our aim is to remove 1% of the the yearly stream of pet bottles, which currently acounts for 26.300 tons of PET.

To compensate these 1 % of plastic with algae, one would need 80%-90% less material = 26.3 tons of algae annually.

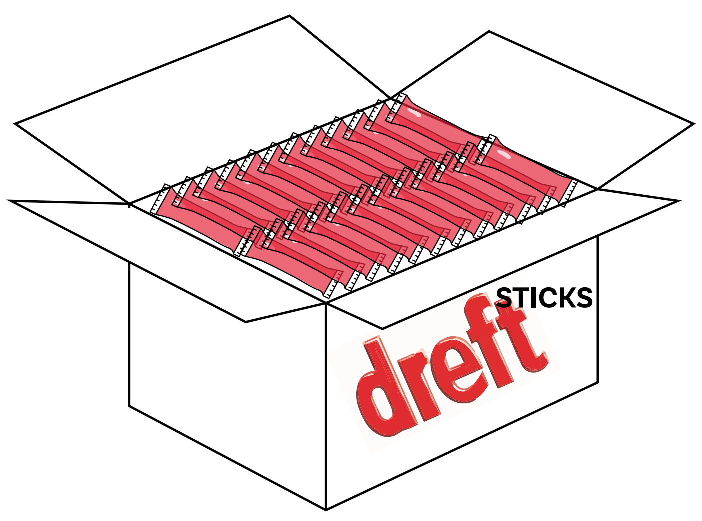
This would require 9-13 acres = 5,3 ha of algae production.

dreft STICKS

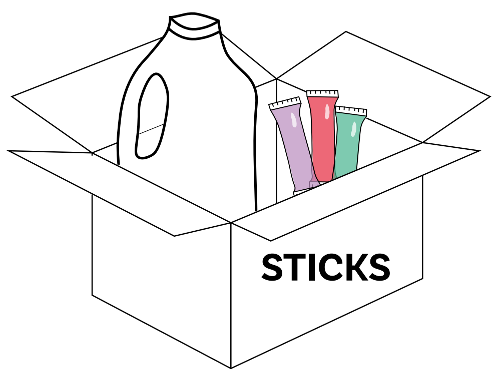
- shelf-ready packaging
- less space needed
- choice of bottle size
- visible to the public



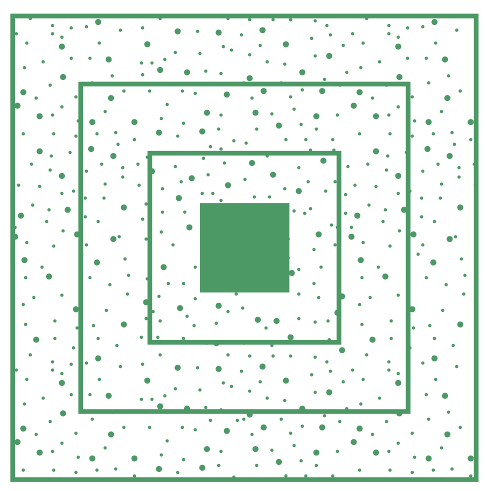
- less space needed for storage of supply
- less space needed for transport



- possibility of home delivery



CO2-SEQUESTRATION :
Year 1: 52.6 (Tons CO2-eq)
Year 30: 1,580 (Tons CO2-eq)



first year	=	5.3 ha
5 years	=	26.5 ha
15 years	=	79,5 ha
30 years	=	159 ha (2050)

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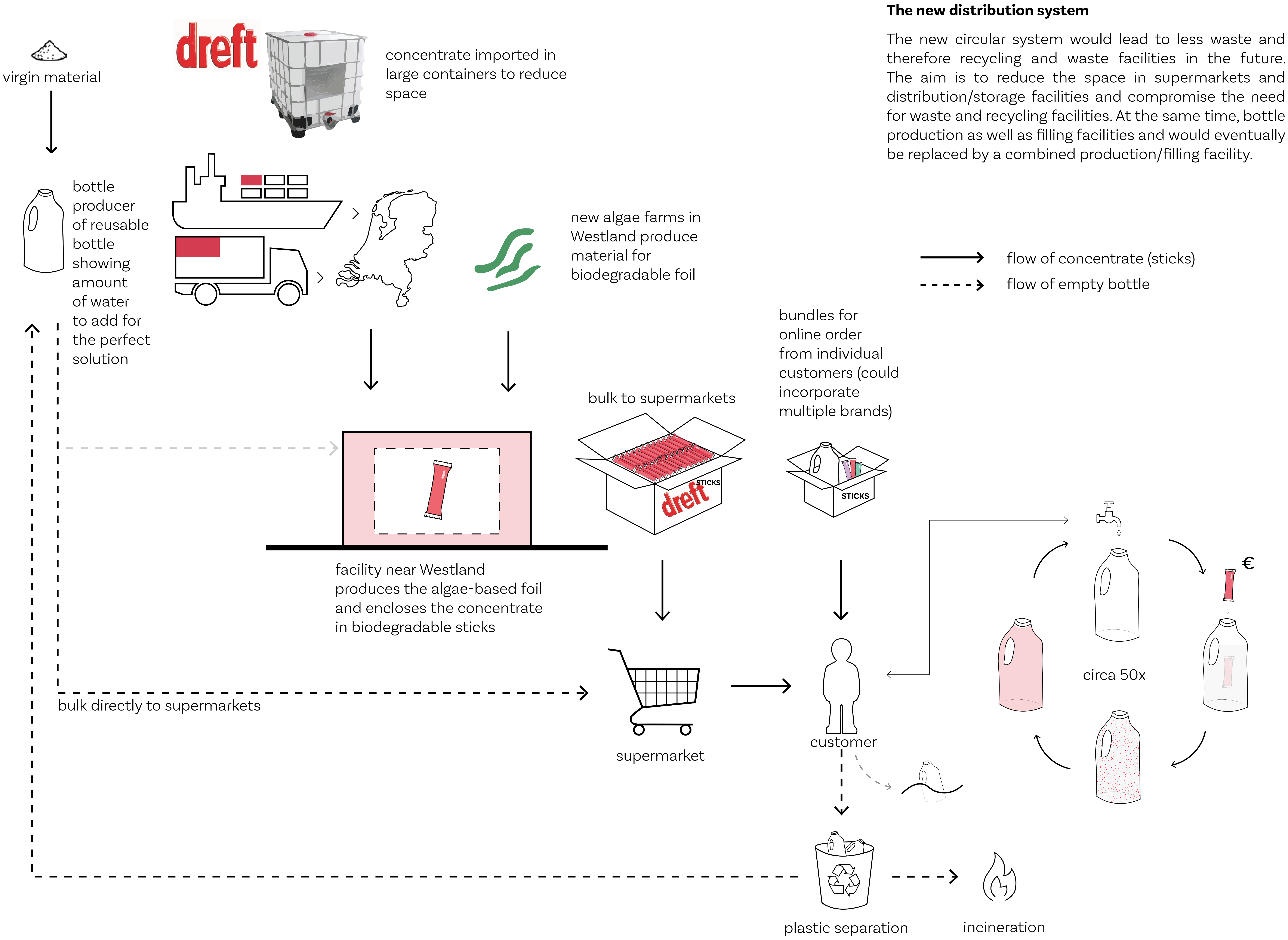
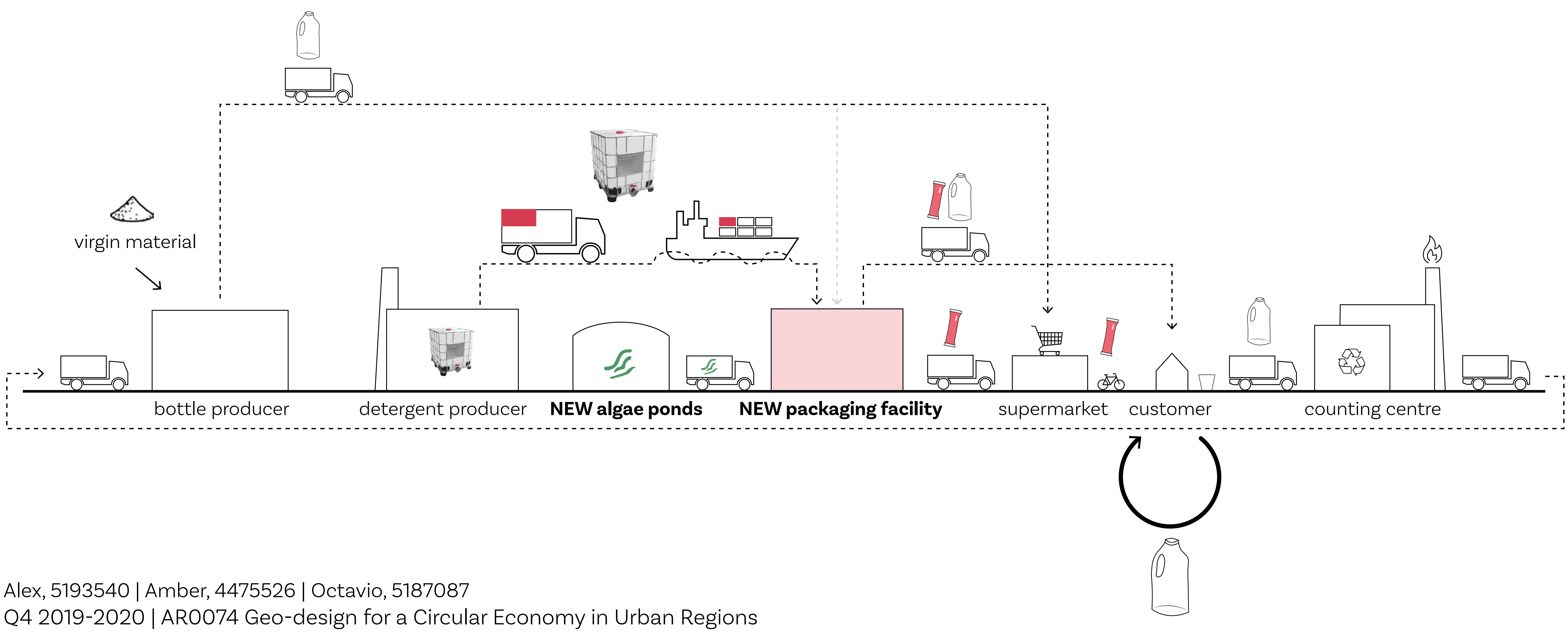
6 | IMPACT MODEL

The new distribution system

The new circular system would lead to less waste and therefore recycling and waste facilities in the future. The aim is to reduce the space in supermarkets and distribution/storage facilities and compromise the need for waste and recycling facilities. At the same time, bottle production as well as filling facilities and would eventually be replaced by a combined production/filling facility.





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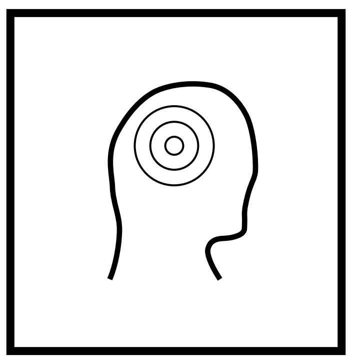
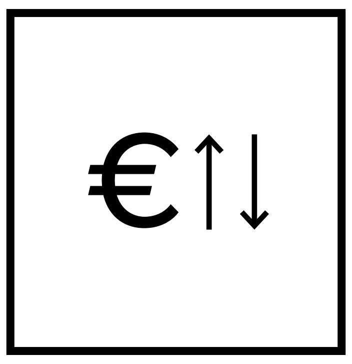
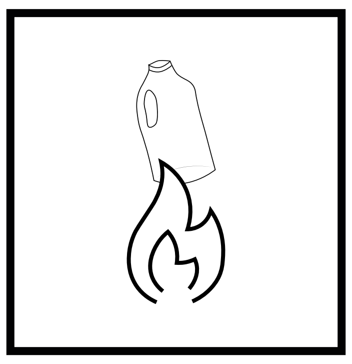
7 | DECISION MODEL



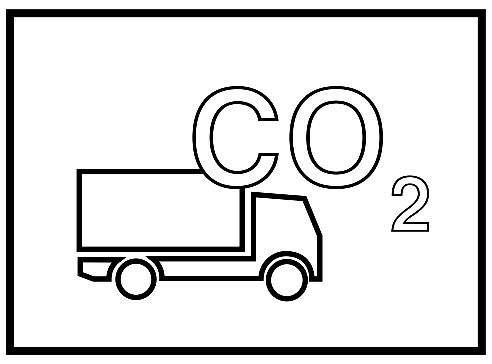
	year 1		year 10		year 30
market	Work together with one brand (e.g. Dreft) > provide service of **import, packaging & distribution** to supermarkets	>	Success of one brand attracts interest of **other brands**. System can easily be applied to a new brand	>	Other markets such as **personal cleaning and drinks** (products that consist largely of water) gain interest
consumer	Changes in packaging of the big brand are **recognized by the customer** who is already familiar with the product itself	>	With other brands joining, **public perception of packaging** is changing with the costumer now getting used to this system	>	Since the customer is now **used to the system** and aware of the environmental benefits, it will be **interested in the new products**



- retail space	Reduction in space allows supermarkets to use this free space to sell other products	**+ management**	Increase in management costs as a result of establishing a new system
- storage space	Less space taken up in storage	**+ perception of product size**	Customer likely does not want to pay the same price for a product that is 80% of the original size
- transportation cost	Bigger batches can be transported at the same time, reducing the amount of overall transportation cost	**+ algae production**	Setting up the algae production is a huge investment



	year 1		year 10		year 30
carbon footprint PET production + incinerating	The yearly production of CO_2 currently is **590,884 tonnes** **- 1%** Reduction of **5,909 tonnes** per year	>	Incremental reduction of **59,090 tonnes** **- 10%**	>	Incremental reduction of **177,271 tonnes** **- 30%**



	year 1		year 10		year 30
carbon footprint transport	The yearly production of CO_2 currently is **7,924,543 tonnes** **-0,8%** Reduction of **63,396 tonnes** per year	>	Incremental reduction of **633,960 tonnes** **-8%**	>	Incremental reduction of **1,901,890 tonnes** **-24%**

Conclusion
Based on our analysis, a 30% reduction of plastic bottles by 2050 in the area of South Holland seems a viable solution to reduce plastic waste, Co2 and economic cost as well as to create customer awareness for the natural environment.

However, replacing plastic bottles by sachets filled with liquid concentrates made up of algae would consume an extortionate amount of space in the area of Westland for algae production.

This challenge could be overcome by using alternatives to algae for the sachet film such as seaweed or PVOH (Polyvinyl Alcohol). Currently a yield of 25 tonnes of seaweed can be produced per hectare/year in climates west of Amsterdam. This would be a reduction in space of 80% compared to the production of algae and could happen in sea surface areas rather than on land. PVOH is a colourless, odorless and non toxic water soluble polymer that is made up of carbon, hydrogen and oxygen. PVOH can be produced from ethylene gas, using abundant methane as a feedstock, and acetic acid also known as diluted household vinegar. Therefore, both of these alternatives seem to be an economically and environmentally sustainable solution compared to that of algae production.

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