Agropark in the Noordoostpolder

exploring the possibilities

foto: Lilli Linkola

June 2009

INDUSTRIAL ECOLOGY
INNOVATIVE BY NATURE

TU Delft Delft University of Technology

Universiteit Leiden

PREFACE

Before you lies the report *Agropark in the Noordoostpolder: Exploring the possibilities* from the students of the Masters program in Industrial Ecology. This report was written in the context of the course Industrial Ecology Applications. It is a feasibility analysis and preliminary design of an agropark in the Noordoostpolder region in the Netherlands. The project was commissioned by Transforum, an innovation platform that offers sustainable perspectives to the Dutch agricultural sector, and was performed in the period of April-June 2009.

We gratefully acknowledge the participants in de Noordoostpolder, Gijsbert Korevaar and Pieter de Wolf for their useful input and coaching.

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ABSTRACT

This report contains a first exploration of possibilities to develop a Cradle-to-Cradle agropark in the Noordoostpolder region in the Netherlands. It was commissioned by Transforum and performed in the context of the course Industrial Ecology Applications of the Industrial Ecology Masters program. The goal of an agropark is to create new combinations of agriculture and other functions, by optimizing material and energy flows and sharing of utilities to reduce the environmental impact go provide a sustainable development.

Six agricultural entrepreneurs were involved in the project, with businesses that ranged from biological tomato and pepper production to dairy farming. First a stakeholder assessment was made, depicting all the stakeholders that can be linked to the development and exploitation of an agropark. A Stregth-Weakness-Opportunity-Threat(SWOT) analysis was made on the current situation in the Noordoostpolder. The results from this SWOT showed ample opportunities for agropark development. Then, a design of an agropark was made using a backcasting approach. Due to the geographical spreading of the involved entrepreneurs, the design focused on the development of two regions within the Noordoostpolder. The design contains four different phases that correspond to different time frames. The design was founded upon several elements in stead of one key element to increase its resilience. A second SWOT analysis was made on the design, as well as a short economical evaluation. Further, an implementation path for the design was constructed.

The research resulted in a clear number of possible agropark connections. Both SWOT and economical analyses showed that an agropark in principle is technological, economical and societal feasible. A lot of attention has been paid to the implementation of an agropark and the overcoming of societal hurdles. It is advised that a coordinator is assigned and that a management system is established to coordinate the project. We recommend that further research should be focused on a more detailed economic and technologic analysis and design.

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OVERVIEW

The first chapter introduces the project. In the introduction, the goal and scope of the project are discussed. Next, the research methodology is described. Then, in Chapter 2, the participants in the project are introduced and a stakeholder analysis is conducted. Chapter 3 continues with a SWOT analysis of the current situation. In Chapter 4, a preliminary design is presented, including a small economical assessment and a SWOT analysis of the design. In Chapter 5 we present an implementation path and the conclusion and discussion, as well as further recommendations are given in Chapter 6.

foto: Marlies Meijer

1. GENERAL INTRODUCTION

1.1 INTRODUCTION

The goal of this research project is to conduct a first exploration of possibilities to develop a Cradle-to-Cradle agropark in the Noordoostpolder. Our main research question was:

> *Is it possible to establish and exploit a Cradle-to-Cradle agropark in the Noordoostpolder?*

The term "agropark" is a rather new idea based on the concept of eco-industrial parks and the definition of an agropark is still evolving. In this report we use the definition we created together during our research. We marked several key phrases in bold:

> An Agropark is an agricultural system of relationships of **businesses** and **people** in **close proximity**. It aims to reach a more (socially, environmentally and economically) **sustainable agricultural** system, by **sharing physical flows** (materials, energy and utilities) and **less-tangible flows** (information and trust). The park seeks a **collective benefit** that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only.

The Agropark concept in combination with Cradle-to-Cradle (C2C) principles offers optimal opportunities to develop the metropolitan surrounding of the Noordoostpolder (figure 1). TransForum, working together with several stakeholders, plays an important role in the realization of the agropark in which currently cattle farms, glasshouse horticultural and agricultural companies are involved. The goal is to create new combinations of aqua- and/ of agriculture, where material flows are optimally used, environmental impact is reduced, and improved levels of animal welfare can be achieved. People, Planet, Profit/Prosperity and monitoring & evaluation are key notions in the development.

The system we evaluate consists of the streams and activities taking place on the terrain of the participants of the project. This means that any economic or physical activity that belongs to the participants is considered part of the total agropark system. If any residential buildings are using streams from the participants they are also considered part of the system. If there is a proposal for a system that includes other participants this is also within the system boundary.

Any stream or product that is sold or discarded is no longer within the system boundaries. Distribution of the products is also outside the system boundaries, at least for the short term. In the long term it might be beneficial to also include these streams. We take into account all that is needed to run the company and not the product (e.g. tomatoes).

1.2 METHODOLOGY

This research was conducted using various methodologies. Information was gathered through literature research and interviewing. The interviews, with an open structure, allowed us to gather site specific information from the participants. The interviews are included in the appendices. In Chapter 2 a stakeholder analysis is made using stakeholder mapping. The design is done using a backcasting approach. Backcasting starts with defining a desirable future and then works backwards to identify policies and programs that will connect the future to the present. A large part of this report is the result of a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. The SWOT methodology is further discussed in Chapter 3. During the entire project we kept the principles of Cradle-to-Cradle as described above in mind.

Cradle-to-Cradle (C2C) is designed for products and buildings, not in the first place for area development. It basically is a concept for a cycling production process, with a distinction between ecosphere and biosphere.
It's a radical concept; waste is eliminated in the process. It's effective instead of efficient, the emphasize is on clean processes with an added value. It is also about positive thinking, economical performance and doing the right things in stead of just doing things right.

Vision group C2C points out 5 notions (not independent principles) for C2C area development:
1) Design clean cycles in time and space, identify sources and sinks in biological, technological, financial and social cycles to create useful couplings. Identify scales where cycles are manifested.
2) Create added value in people, planet, profit and cooperation.
3) Development process is strategic and operational: Plan-Do-Check-Act
4) Use existing capital: landscape and people: Identify cycles in fast and slower layers in an area. Make use of the social energy; give space to eagerness and interest in entrepreneurship.
5) Approach area development as sustainable evolution, not as a project with start and end stage.

2. STAKEHOLDERS

Six entrepreneurs are participating in the agropark project. The following paragraph introduces them. The subsequent paragraph contains a stakeholder analysis placing the participants in the larger context of stakeholders.

2.1 Participating entrepreneurs

Kwekerij A. Baas
Kwekerij A.Baas is a pot and bedding plant nursery, located in the village of Ens and a direct neighbour of Ruud van Schie B.V. and Kwekerij Wouters. The size of their greenhouses is 20 ha and these are heated by two combined heat and power facilities (CHP) on their premises with a combined output of 2.7 MW. There is no data on gas use. The company does not have any biological waste.

Kwekerij Wouters
Kwekerij Wouters is a pot and bedding plant nursery, located in the village of Ens and a direct neighbour of Ruud van Schie B.V. and Kwekerij A. Baas. The size of their greenhouses is 20 ha, these are heated by a wood burning furnace and a CHP of 1.5 MW. The wood burning furnace can deliver heat equal to burning 680 m^3 natural gas per hour, in the months March through May the demand for heat is equal to

burning 1000 m^3 natural, in those months, the CHP delivers the remaining heat. In total 2.800.000 m^3 natural gas is used per year. In the other nine months of the year the wood burning furnace has an overcapacity, of which a part is sometimes sold and distributed to Ruud van Schie B.V.
The company does not have any biological waste.

Ruud van Schie B.V.
Ruud van Schie B.V. is a biological tomato and pepper nursery, located in the village of Ens and a direct neighbour of Kwekerij A. Baas and Wouters.
The vegetables are grown in two separate greenhouses with a combined size of 8 ha and the greenhouses yield approximately 20 kg peppers / m^2 and 40 kg tomatoes / m^2. Ruud van Schie B.V. uses 3.000.000 m^3 natural gas and 640.000 kWh (8 kWh/ m^2/year) electricity per year to heat and run the greenhouses. The rainwater is used for water the plants and cooling the greenhouses during summer by means of nebulisation, when the amount of rainwater is insufficient surface water is used. The remaining biomass of the plants is collected by a special company, but is contaminated with nylon thread which is used to support the plants.

Koomen Bloembollen V.O.F.
Koomen Bloembollen V.O.F. is a flower and bulb grower, located in the village of Ens. He is approximately 500 meters away from Ruud van Schie B.V. and Kwekerij A. Baas and Wouters but is separated by a very busy four lane road. The size of the company is fields of 50 ha and greenhouses of 4 ha. Koomen uses 170.000 m^3 natural gas and 350.000 kWh electricity per year. Surface water is used for showering the bulbs and flowers. During summer, when the greenhouses are not used for growing flowers, the heat from the greenhouses is used for drying the bulbs. The company produces approximately 300 m^3 of bulb waste.

De Sjalon
De Sjalon is a cooperation of four agricultural entrepreneurs which are located in the villages Bant, Espel and Ens. The combined size of their lands is 94 ha. A mixture of seed potatoes, wheat and several vegetables are grown. Irrigation is done by normal rainwater. A total amount of 3700 m^3 of natural gas and 15 m^3 of propane gas is used. Total electricity use is about 95.000 kWh

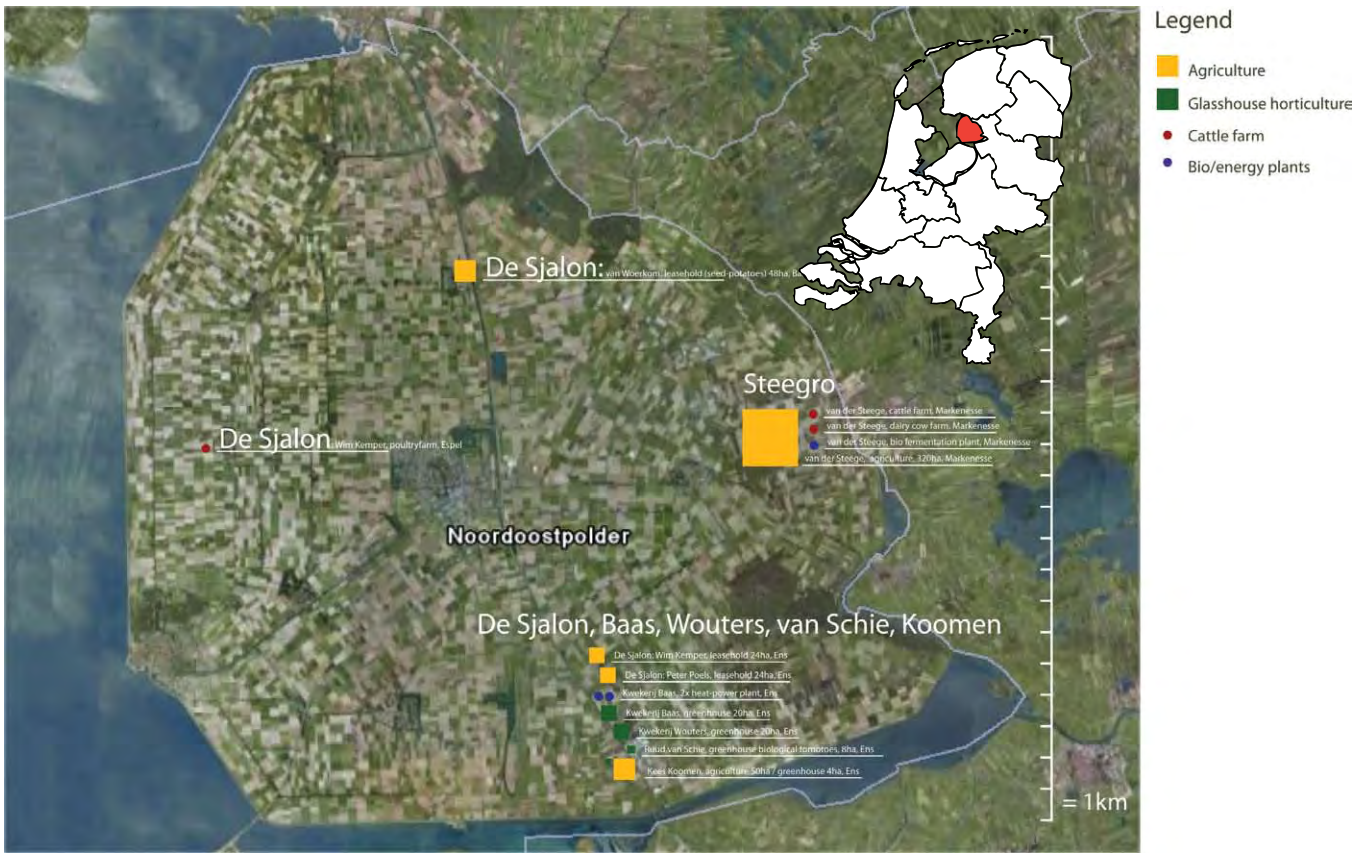
STEEGRO
AGRARISCH ADVIES, BEMIDDELING EN VASTGOED

Steegro B.V.

Steegro B.V. is a dairy farm with approximately 400 cows and 400 young cattle, located in the village of Markenesse. A bio-digester on site is used for heat and electricity generation. The manure from the cows are 30-40% input of the digester, the remaining 60% comes from energy crops like maize or unions. 1000MWh is annually produced, this is for 85% feed back to the grid, the remaining 15% is used to run the digester and the dairy farm. At this moment the heat produced by the digester is not used.
Approximately 100 litres of water is used per day per cow, ground-surface (spring) water is used for this.

In general, neither of the etrepreneurs uses the CO_2 that is emitted during the combustion of natural gas. This is mostly due to the nature of their businesses. Pot and bedding plants production, for instance, does not benefit from higher CO_2 concentrations.

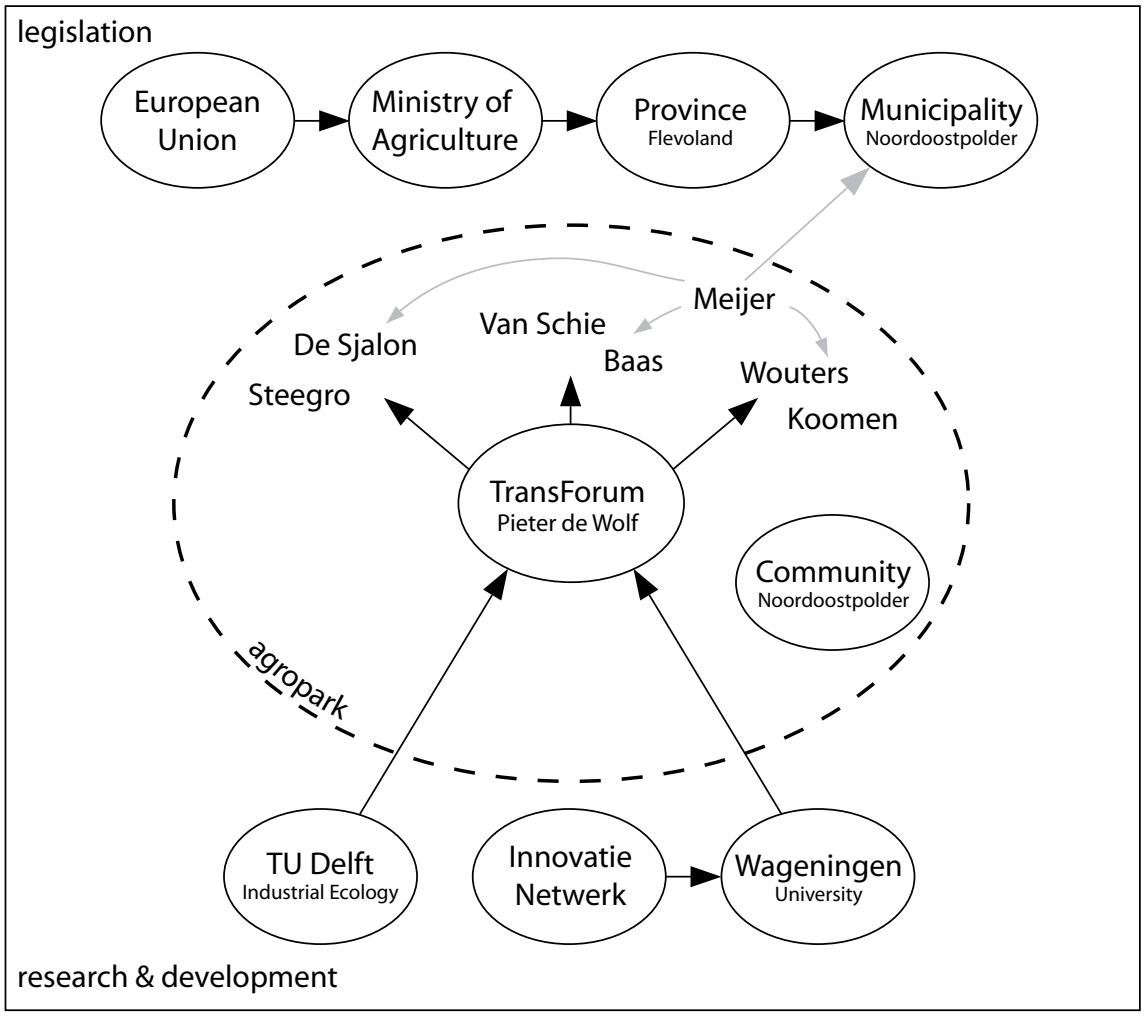
Figure 2.1 Area Noordoostpolder in the Netherlands & the location of the different participants



2.2 Stakeholder analysis

The figure below is a stakeholder map. This map shows the current stakeholders of the agropark Noordoostpolder. On top the stakeholders on the legislative side are depicted. In the middle, the direct stakeholders and actors in the agropark are shown. The bottom of the figure shows stakeholders in the research and development area and the arrows represent the present communication and contacts whitin the stakeholders.

Figure 2.2 Current stakeholders of the agropark



Below all stakeholders shown in the figure are elaborated on.

Local companies: the interviews tell us that the companies want to benefit this economic crisis to innovate themselves toward a better tomorrow. As money is tight, companies tend to be more risk averse, little resources are available for investments and short pay back periods on proposed innovations are required more than ever. The four adjacent companies in Ens (Wouters, Koomen vanSchie,

Baas) vaguely know each other, Steegro and De Sjalon are positioned further away from the others. Meijer has a variety of contacts within the community. We think there can be a pioneer's role for him to build trust within the community, as well as being a voice to the municipality.

Transforum: an innovation foundation that aims to provide a more sustainable perspective for the Dutch agro-sector and green spaces by searching for and experimenting with new value propositions.

Pieter de Wolf: involved in Transforum project "De Sjalon" and connected to Wageningen University department of Collective Entrepreneuring, De Wolf has been the initiator of the project and contact person for possible participants.

Innovatie Netwerk: installed by the Department of Agriculture as an independent entity, it develops sustainable breakthrough concepts for entrepreneurs in agriculture, fishery and food industry, which are then executed by participants themselves.

TU Delft Industrial Ecology: a group of MSc students, dealing with sustainable development through dematerialization and closing of process loops, develop an initial design for Transforum's project, which functions as a basis for further development by Transforum and the participating companies.

Wageningen University: being closely linked to Innovatie Netwerk, Pieter de Wolf and the Department of Agriculture, it has an advising role to De Wolf, which may be expanded on in the future development of the project.

3. SWOT

This chapter describes the SWOT analysis of the current situation in the Noordoostpolder. First a short introduction on the SWOT methodology is given. Then, the outcomes of the SWOT analysis are presented. Finally, the SWOT analysis is interpreted.

3.1 SWOT methodology

A SWOT analysis consists of four elements; Strengths, Weaknesses, Opportunities and Threats of a certain system. Strengths and Weaknesses are generally considered to be within the system boundaries and Opportunities and Threats are assessed outside system boundaries. The outcomes are listed in a table.

3.2 SWOT outcomes

In this part the suitability of Noordoostpolder as a location for an agropark is looked at. The result will be strengths and opportunities that work in favour for the future agropark and that have to be stimulated. Also weaknesses and threats will come forward, which have to be handled carefully to reduce of eliminate them, or turn them into opportunities. A distinction is made between influences within the Noordoostpolder area and the context of this system. Further distinction is made between social, geographical and technological parameters.

STRENGTHS	WEAKNESSES
Social	
The involved entrepreneurs are willing to share information and are open to discuss new options [appendix 2-5]	There is a low level of trust between entrepreneurs and knowledge holders because of insufficient communication. This is caused by a lack of management. [appendix 2-5]
All farmers have a vision from what they want to reach by participating in the agropark project [appendix 2-5]	There is some hesitation in cooperation and sharing information among certain entrepreneurs who are in a competitive field with each other [appendix 2-5]
	Agricultural entrepreneurs appreciate their individuality. This counteracts to the communal feature of an agropark which is a big factor for the park being a success. This causes a lack of knowledge on activities and sources of other farmers [ref. 3.1] [appendix 2-5]
Geographical	
Close proximity of ENS entrepreneurs [ref. 3.2]	Large distance between Steegro in Bant to entrepreneurs located in Ens and Markenesse [ref. 3.2]
	The occurrence of seasonal traffic jams due to seasonal increased transport of goods (tulips/ tomatoes). This causes inconvenience for the inhabitants of the area and unsafe situations occur (especially in spring with heavy traffic from Wouters and Baas). [ref. 3.3]
	Housing and businesses in agricultural region (villages excluded) are not connected to the sewage system. Next to this, a proper policy for waste water from agricultural businesses is not present due to different legal systems (Outer area has provincial policy, urban area has local municipality policy etc) [ref. 3.3]

OPPORTUNITIES	THREATS
Social	
Knowledge is available in the Netherlands, for development and implementation of the agropark	Local municipality is conservative instead of progressive towards innovation and the development of the Noordoostpolder that do not fit the 2030 vision [appendix 2-5] [ref. 3.4] Society might be resistant to a more industrialized agriculture in the Netherlands [ref. 3.1]
Geographical	
(Future) improvement of the infrastructure will create possibilities of more effective transport and improve accessibility of region, businesses and communities; In 2012 a new road (2 lanes) must be ready. [ref. 3.3] [ref. 3.4]	Noordoostpolder is part of the protected heritage of the Netherlands [ref. 3.5]
The absence of a sufficient sewage system supports innovations to use this stream optimal (for example: a septic tank) [ref. 3.3]	The absence of a water buffer for storm water. Increased building on agricultural land can cause problems with water management [ref. 3.3]
There is a possibility to use the earth's heat, but test drills are necessary to determine the structure of the soil [ref. 3.3] The location is close to the IJsselmeer lake, and could bring export possibilities.	The waterways in the agricultural system (ditches) are 150 m apart and are almost impossible to relocate. Most new greenhouses are broader than 150 m, meaning difficulties of building new greenhouses. [ref. 3.3]
Technological	
	The gas supply system is used to its maximum. There are no additions possible, only with changes/ modifications to supply system [ref. 3.3] The electricity supply system is used to its maximum. In 2007 only a small addition of max. 1 MW was possible [ref. 3.3]

3.3 SWOT INTERPRETATION

As can be seen in the tables above, there is an incentive from the side of the entrepreneurs to start an agropark. Improvement of the infrastructure makes this plan attractive for them. Another important advantage for this agropark is the availability of knowledge in the Netherlands for a lot of technologies that are needed for the agropark. The weaknesses and threats of the current situation can be used as an argument to start building the agropark. For example, the gas and the electricity supply systems are used at full capacity and this is a threat for the businesses of the farmers and greenhouse owners. This can be an incentive for improvement and whilst working on that, other connections can be made between the entrepreneurs. This also gives an opportunity for new entrepreneurs to start their business in the region. However, to be able to make a start in this project, the hesitation of the entrepreneurs for cooperation and information sharing needs to be tackled by a good management institute.

4. DESIGN

This Chapter describes the preliminary design that has been made for the agropark. The design is separated into four different phases. These phases are described in section 4.1-2. Besides the design itself, economical feasibility and implementation are important aspects. The economic feasibility of several elements are estimated and discussed in section 4.3. This is followed by a SWOT analysis of the preliminary design.

4.1 INTRODUCTION

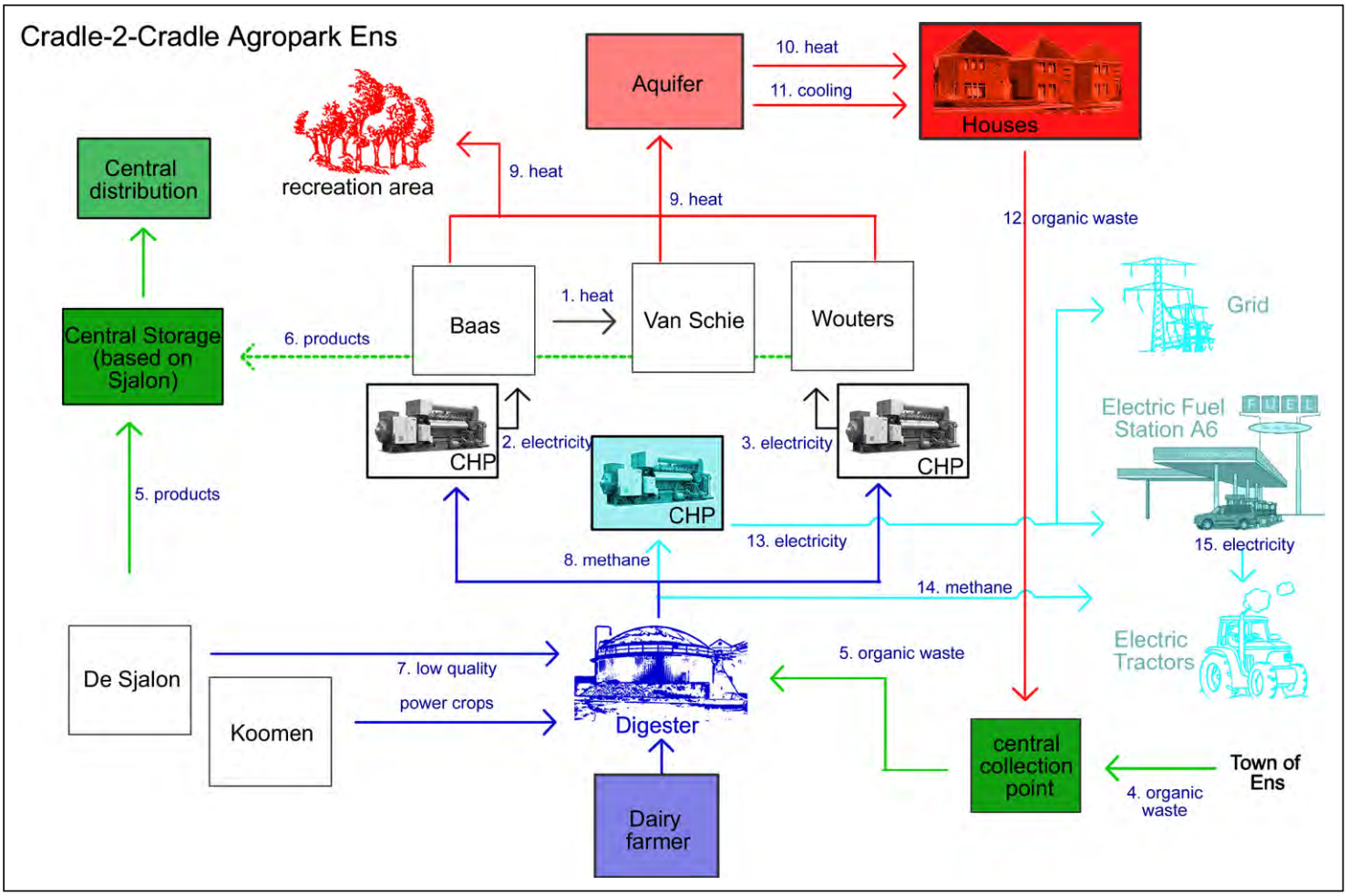
To make a comprehensive design we decided to work in timeframes. The current situation is the point from departure. From there we introduced short term solutions (1 year), a scenario based on the development of a period of 5 years, 10 years and one for 15 years from now. By the introduction of new functions, the design is expanded and eventually discharges in a situation where the participants getting more dependent of each other by making use of each others waste-, by-products and facilities. In a very early stage we decided to make a distinction between the design of Ens and that of Markenesse (housing Steegro's facilities), because we saw no need of making tight couplings between these areas. Using the backcasting methodology (by defining a desirable future and then working backwards to identify policies and programs that will connect the future to the present) the design is shaped. We started with the following ambition for 2025.

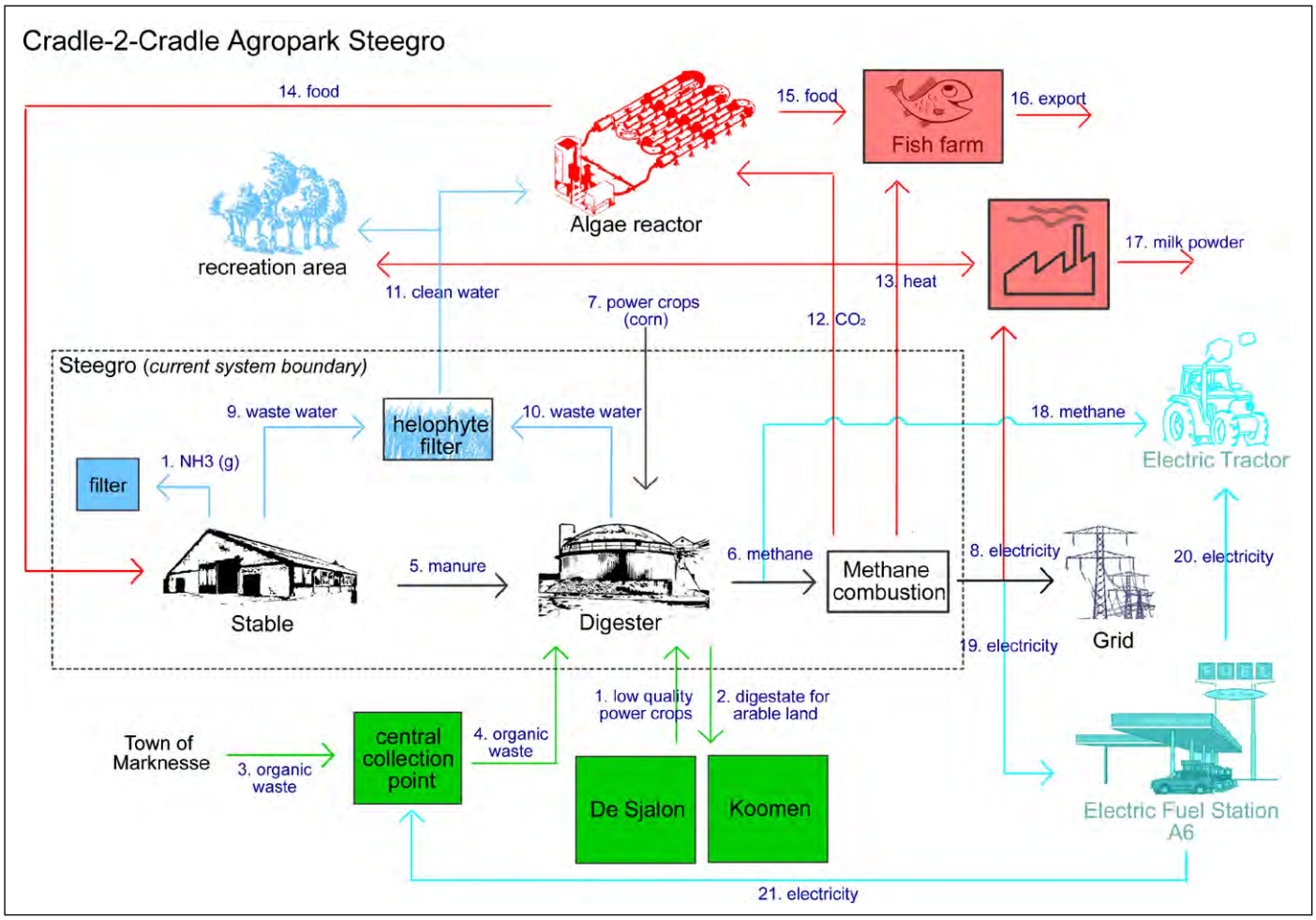
The agropark is sustainable. The park covers a range of connected companies, offering each other waste products, sharing heat/energy. The agropark is designed in such a way that it offers a large capacity to insert possible future participants. The park offers basic functions like agriculture, glasshouse horticulture, cattle farms and energy plants.

The design is fully evaluated by Arjan van Timmeren, an expert on sustainability in the build environment, associated to the faculty of Architecture in Delft. Through his feedback and our own expertise we were able to develop an interesting and realistic design for the agropark.

4.2 Design

The following figures show the design for the entire agropark, divided in the region of Ens and the region of Markenesse, which is basically a design around the Steegro company. The colours signify the different stages in the design, corresponding to the 1 (green), 5 (dark blue), 10 (red) and 15 (light blue) year scenarios. The existing companies, utilities and greenhouses are marked black.





The various steps in the design are as follows.

Phase 1

Ens

For the Ens region, De Sjalon is planning to build a storage unit. It might be possible to expand this storage area to also include storage capacity for Wouters, Baas and van Schie. Furthermore, sharing of the facility could be done during periods of low production of the participating companies. Parallel to these developments one could think of a central distribution system for the companies, maybe coupled to the central (shared) storage. Agriculture in the Noordoostpolder is growing and attracting an exporter/distributer is something that could shift attention towards the region. Furthermore, costs of transports to the west of the Netherlands are

saved.
On the basis of the interviews held with the entrepreneurs we assessed their seasonal transport peaks. From this, we concluded that there is a lot of transport between October and December. In the summer months, however, trucks are not used. We suggest that the trucks that are temporarily not used by their owners are rented by one of the other entrepreneurs for a fair price. An example is that van Schie uses the trucks of Wouters during summer. The economic benefits for that will be between 30 and 50 Euros per transport for both Wouters and van Schie, assuming a cost price of 350 Euro per transport and a normal rental price of maximum 450 Euros.

Also in this first phase, the municipality of Ens can organize collection of household organic waste (In Dutch: GFT-afval). This can than be used as an input for the digester that can be build on middle term, which is described under the header Phase 2.

Markenesse
Due to the location of Steegro, we thought of a solution close by in stead of a connection with Ens. The first phase can be a cooperation between Koomen, de Sjalon, and the municipality of Markenesse. Koomen has over 300 m^3 of waste flower bulbs. De Sjalon has sometimes low quality crops. These can be fed into the digester. Furthermore, as in Ens, a connection with the municipality can be established in order to develop a household organic waste collection scheme. This waste can then be fed into the digester. This leads to considerable savings for Steegro. The municipality can maybe collect the waste in electric/natural gas vehicles that are fuelled by Steegro in exchange for the feedstock.

Phase 2
Ens
On the middle term, a digester coupled to a dairy farmer can be built. Methane produced by the digester can be used in the CHP units of both Wouters and Baas. This will save natural gas costs. CO_2 from combustion can be used by the greenhouse of van Schie.

Markenesse
The second phase will consist of the implementation of a helophyte filter at Steegro to deal with the waste water stream of the digester. Water can then be used for, for instance, flushing stables. Ammonia from the filters the stable can be used on the arable lands. Clean water and waste heat from the digester can be used in some kind of recreation area. With Schokland close by, one could think of exploiting the tourism side of the area.

Phase 3
Ens
The third phase, or long-term, will consist of the development and building of a project of 500 houses. Heat duties will be supplied trough the greenhouse that store surplus heat during summer in an aquifer. This heat can than be used for both greenhouses and houses in Ens. Electricity from the CHP units can be used

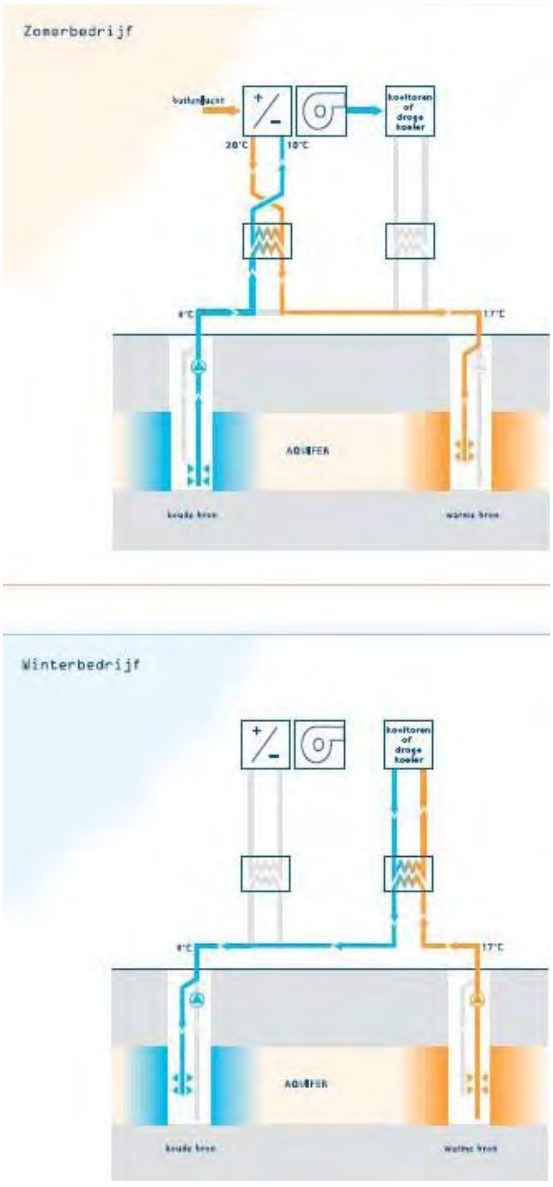
differently by either supplying the grid or fuelling electric agricultural equipment. Maybe even an electric recharging point for the entire area can be developed which is then the fourth and final stage of our design.

Markenesse

The third phase will incorporate the development of an algae plant at Steegro. CO_2 from the digester as well as water from the helophyte filter can be used for this plant. Algae can be dried and fed to either fish or pigs. It is believed that a pig farm will fit the company profile better than a fish farm, but a fish farm will probably use the excess heat of the digester better than a pig farm. This algae farm can include cooperation with Wageningen university. Algae technology is not fully developed and this would be a nice project.

In stead of the pig/algae farm we developed another variety that includes a milk powder plant, which can use both heat and electricity of the digester. The CO_2 can not be used in this scheme. Excess electricity of the digester can be used on the long term to fuel electric vehicles or for an electric recharging point.

Figure 4.1 The working pronciples of aquifer heat storage. source: [Energiek 2020, 2006]



Phase 4

With the fuel prices rising it is not unthinkable that at least a part of the Dutch cars will be electric vehicles by 2025. The Noordoostpolder is roughly between Amsterdam and the north of the country. With a highway nearby, the excess electricity from both Ens and Markenesse can be fed to an electric car fuelling station. Excess electricity could also be used directly for the fuelling of own agricultural equipment or supplied to the grid.

4.3 ECONOMICS

In this paragraph, a rough economic assessment is made on the economics of the proposed elements in the design.

Different input for biodigester

Some money on the digester at Steegro can be saved by using low quality bulb from Koomen as fuel. These bulbs are now treated as waste and are thrown away, which costs money. Instead of costing money they can fed to the digester (expressed in corn equivalent,

multiplied by 6/35 euro per liter of corn equivalent).

From Koomen: 300 m^3 waste bulbs (interview) = 300 m^3 corn equivalent
300 E3 dm^3 * 6/35 euro/dm^3 = 50.000 euro

This is not counting the costs saved on waste treatment for the low quality bulbs.

Another way to save money on the biodigester is to use municipal GFT waste. Assuming Ens has about 3100 inhabitants or about 1000 households and about 100 kg of GFT is created per household per year, this would lead to 100.000 kg, or 100 m^3 corn equivalent. This could save another 17.000 euro.

Aquifer [ref. 4.1]
One option for the emerging agro park could be the use of an aquifer. Especially near Ens, where three greenhouses could use both the warming and cooling properties of an aquifer. Using an aquifer gives a lot of savings on both heating and cooling costs and could potentially be used to warm nearby dwellings as well. Its drawbacks include that it does not generate carbon dioxide as using natural gas does. This is not that big a problem as the greenhouses do not grow fruit bearing plants which require this extra carbon dioxide, so this makes the aquifer a feasible option in that respect. Another drawback is its high investment cost. According to our calculations the payback time for such an installation is quite short for such a large and durable investment.

Assuming we take the greenhouses of van Schie, Wouters and Baas in Ens (48 ha). If an initial investment is too high, it can be installed for a smaller capacity, while reducing the deficit by burning natural gas. The money saved by the aquifer can then again be invested in expanding the aquifer or other sustainable measures.

Investment
Investing in structures and facilities costs up to €24/m^2. This is assuming the location has a suitable aquifer layer. If deep drilling is required the price might be higher depending on the circumstances. Assuming 48 ha of greenhouses the initial investment will be up to 11 million. The real price will probably be lower because the greenhouses are very close together. The maintenance costs are relatively low, about €100.000-200.000 a year for the total system.

Income
480MJ/m^2 of energy can be saved with an aquifer per year. This corresponds to about 15 m^3 natural gas/m^2 greenhouse. Assuming the price of natural gas remains as it is now this would mean 10,80 Euro/m^2 savings per year. This will probably be a bit lower as the gas prices taken are the prices for consumers. Farmers often have a contract for slightly cheaper gas. Total earnings would be at a theoretical maximum of 5 million euro. This amount will not be reached in practice due to start-up costs, lower gas prices for farmers and possible higher costs in drilling if the location is not optimal.
There will be leftover energy in the aquifer that could be sold to consumers for

extra profit. It would require an extra investment in the form of pipelines (€450/m) [ref. 4.2] and installations.

Payback
According to Senter Novem payback times for aquifer installations are about 6-12 years depending on the situation (depth of aquifer layer, amount off greenhouses) and age of the installation. Modern installations have a relatively short payback time. An algae-fish farm will cost about 300,000 Euros/hectare for an open pond system. Pipelines for heat transport will costs 450 Euro/meter and the investment of an aquifer installation will be expected to have paid itself in 6-10 years. After this period, however, the costs for heating will be virtually none. Especially considering rising energy prices this is an interesting option.

We have looked into some of the economics for the design. This is still at a conceptual level and needs to be investigated further. As mentioned earlier, the sharing of transport will save around 30-50 Euro's per transport. An average transport will cost about 350 Euro, whereas renting a truck is between 400-450 Euro. Mutual savings can be made by agreeing on a price of, for instance, 380 Euro. Furthermore, these small scale cooperations can be considered as excellent trust-building activities that can lay the foundation for further steps.

Figure 4.2 Biodigester at the Steegro dairy farm

Biodigestion unit
In the region of Ens, there is a dairy farmer who might be willing to participate in the program. It could be feasible for him to build a biodigester, which can be fed with waste flows of his own company (manure) and from other companies nearby. This would be really feasible for the region, because they are then able to produce their own energy, without being dependent on the volatile natural gas prices. It is an advantage for the region to have a biodigester already nearby, at the company of Steegro. This company has a lot of knowledge about building this biodigester and can provide information about installation costs, maintenance costs, resource costs and profits of the installation. It also knows all the subsidies (like MEP) that can be earned.

An option for the biodigester is to expand upon with an algae farm. The heat created by the generator of the biodigester is now lost to the environment and could well be used for an extension like this.

Investment costs are quite high at about 300.000 euro per hectare. Another drawback is that using algae for industrial or agricultural purposes is rather new, making it very important to do more research in this area before investing in it.

4.4. SWOT OF DESIGNS

In the previous chapter, the Noordoostpolder was tested for its suitability for an Agropark. In this chapter the proposed design will be tested by a SWOT analysis. The result will be strengths and opportunities, the strengths have to be used and the opportunities can be further researched. Also weaknesses and threats will be discussed, weaknesses have to be solved and threats have to be thought of for the future.

STRENGTHS	WEAKNESSES
Social	
Experience with CHP at Baas	Dependency on each other and the system for heat, water and electricity can create gaps when businesses stop with participation or go bankrupt
Dependency on each other and the system for heat, water and electricity can create dedication to each other and the system	
Geographical	
Close proximity of Baas, Wouters and van Schie [ref. 3.2]	
Common storage facility possible at de Sjalon.	
Technological	
Use of CO_2 from CHP in greenhouses	Seasonal peaks in needs for heat and electricity
Net feed of electricity from CHP to grid	
Feed of low quality crops from de Sjalon to the digester	
Heat storage in aquifer for use in winter	
Use of septic tanks for closing water cycle, purification of grey water and subsequently use for cooling and growing of crops (van Schie and Koomen) [ref. 4.3]	
Profit Improved economic resilience thanks to cooperation	
Economy of scale	
Reduced costs of resources and waste treatment	
Reduced resource use	

OPPORTUNITIES	THREATS
Social	
Flexibility of design leaves room for integration of more agricultural entrepreneurs	Regulation on use of groundwater for aquifer
Improve image to outside world (inside NL or inside EU)	Development plan from municipality for the area can block certain opportunities
Geographical	
	Physical obstacles for improving infrastructural system (transport of heat, water and electricity)
Technological	
Subsidies for investing in sustainable solutions	

As can be seen in the tables above, a lot of strengths and opportunities exist in the designed Agropark. Economical possibilities (economy of scale, reduced resource cost, etc.) create a large incentive to start with this project, as do the subsidies in sustainable development. When physical connections are made, dependency on each other and the system can create dedication to the system, so that it can be a success. Connection of streams between the three greenhouse owners can be feasible, because of the small distance in between their companies.
This dependency on each other can also be a weakness, because of the possibility of sudden stops in production due to bankruptcy or lack of faith in the system. For example some regulations on groundwater use for aquifers can be a problem for the system to start-up.

5. IMPLEMENTATION

This chapter describes the implementation path of necessary to implement the designs presented in Chapter 4.

5.1 INTRODUCTION

Setting up an agropark in Noordoostpolder is not just a matter of building the physical infrastructure, that is, to invest into the technology (digesters, aquifer, algae farm etc.) and construct the tangible material connections between the participants. Equally important is to create a knowledge, communication and organizational infrastructure. Namely, what is crucial for a successful implementation is a formation of a strong advocacy coalition that will push the development forward by mobilizing economic and knowledge resources and by lobbying permits, subsidies and favourable legislation [ref. 5.1]. First, in this chapter we will see what are the key questions in forming the intangible networks. We will point the key actions needed to create the symbiosis, including tangible and intangible relations, between the participants and we will illustrate this with an implementation path. In the second part of this chapter we will visualize the transition of the Noordoostpolder area to a sustainable Cradle-to-Cradle community.

5.2 INTANGIBLE NETWORKS AND IMPLEMENTATION PATH

By definition, an agropark is about symbiotic relationships. This brings the great benefits of an agropark, but at the same time the strong interdependency is a challenge, even as many participants might see it, a risk. The fundamental concern in interdependency is how to build trust among the participants. Trust is not a thing that can be build deliberately by some single actions, it results of a solid network, shared vision and good experiences. We point here that the participants do not only need to trust to each other but also to the agropark as a whole. Therefore, good networks for learning and communication are needed. Below we elaborate on four/five key actions needed for realizing the intangible and successive tangible infrastructure of an agropark in the Noordoostpolder.

1. Creation of shared vision of the agropark and aligning expectations
First step towards an agropark is to confirm and strengthen the engagement of all participants. This a primary thing that can build up the trust in the early phase of the project. Also, one of the evaluation criteria for an agropark, states that there has to be a strategy for long term development. Throughout the research we have noted a general ambiguousness in what comes to participation to the project. The earlier described six participants did not have a common idea on what was the project about, in what way they were engaged and to what extent.

This ambiguity is partially a consequence of lack of a clear project management. Transforum, which initiated the project and has taken the place of a project leader now, wants to project to ultimately be a project of the participants, that is the agricultural entrepreneurs [de Wolf, P. 2009]. This results in a situation where nobody really takes leadership. Transforum does not want to take this responsibility because it believes the participants need to take it. On the other hand, the participants do not know what to do (yet). Before the participants can decide up on the organization of the project, Transforum should lead the first steps and help to build a shared vision of an agropark in Noordoostpolder that is aligning the expectations of the project. Then, the commitment of participants can be asked. Hopefully this report will help in this first step.

2. Organizational infrastructure
Keeping every party walking in the same direction and steering the development when needed, requires project management. In the case of Noordoostpolder, since the number of participants is six, one assigned project manager can do the job. When the number of participants increases, a larger management structure might need to be established. The most important tasks of a project manager are to align the development of an agropark with its strategy and organize and support the information sharing. That is, the project leader should organize and direct meetings for the participants. A project manager could be one of the participating entrepreneurs or another person, e.g. citizen of Noordoostpolder, or a consultancy company. One possibility could be to have the municipality engaged and embed the project management of the agropark in the administration. This could lead to some benefits in what comes to e.g. lobbying permits. We will discuss this more in extent later in the step of creation of legitimacy.

3. Information sharing and network formation
Well organized information sharing is actually a precondition for a successful agropark, because it is crucial in what comes to all network formation. In basic, an agropark is about linkages between the entrepreneurs and in order to create these linkages a platform that enables the information exchange is needed. We propose an online central communication system that manages (1) the data materials input and out put date of all participants, (2) the logistics data of participants, including need for storage and transportation, (3) the data on utilities and machinery the participants posses, (4) the data on services the participants can provide, (5) the data on future investments and stage of the project, (6) a discussion forum for

ideas and new project developments and (7) the marketing. This website would be interactive, that is each participants has the responsibility updating it and adding all needed features to it.

4. Learning processes, knowledge development

Learning, as we see it, is one of the most important processes in the agropark development. Namely information should not just be shared, it should be created. It is not unusual that a lack of better knowledge hinders the development. This is why it is important to map the available and required knowledge. The learning can be distinguished to learning by research and learning by doing. We have noticed that the participating entrepreneurs are in general very active and innovative. The entrepreneurs do experiments within their companies and have a lot of ideas on how to develop the business. This learning by doing knowledge should be engaged equally for the benefit of the project. The available knowledge should be mapped and embedded to the online communication centre.

Also, in order to engage the promising ideas the local entrepreneurs come up with, research knowledge should easily available for the community. The learning by research is very important for an agropark since a lot of new technology is included in the design. The aquifer heat storage system and the algae farm are far from business as usual, and also the methane production and possibilities for methane use needs more Research and Development (R&D). The knowledge for this application in the specific site of Noordoostpolder should be done in collaboration with Wageningen university and Transforum with assistance of Industrial Ecology Msc. As it is crucial to map the knowledge available within the local entrepreneurs, it is equally important to do so within these R&D parties. Already within Transforum, as Pieter de Wolf noted, there are big problems with knowledge diffusion. Similar projects are happening, and a lot of relevant lessons could be learned from other projects. Knowledge mapping, for example, in form of a project archive is crucial.

5. Creation of legitimacy and meeting the expectations

As was mentioned in the beginning of this chapter, a successful implementation requires a advocacy coalition that will push the development forward. This does not only mean committed entrepreneurs but also support from the governmental bodies, R&D parties and the local community.

In order to win the trust of local entrepreneurs and get them committed to an agropark it should meet their expectations. This means that the agropark should be attractive in business terms, that is economically profitable with a low individual risk. The individual feasibility can be easily assessed with an economical analysis (as we have described in Chapter 4) and risk assessment, but this does not make a full respect to what is actually the basic benefit of an agropark. Namely, by definition in an agropark the emergent benefits are greater than the sum of individual benefits. The agropark development creates a viable area and opportunities for businesses that would not otherwise be there in Noordoostpolder. The internal and external risks, as well as the economic feasibility should be seen in light of this fact. Implementing an agropark requires a shift to systems thinking from all

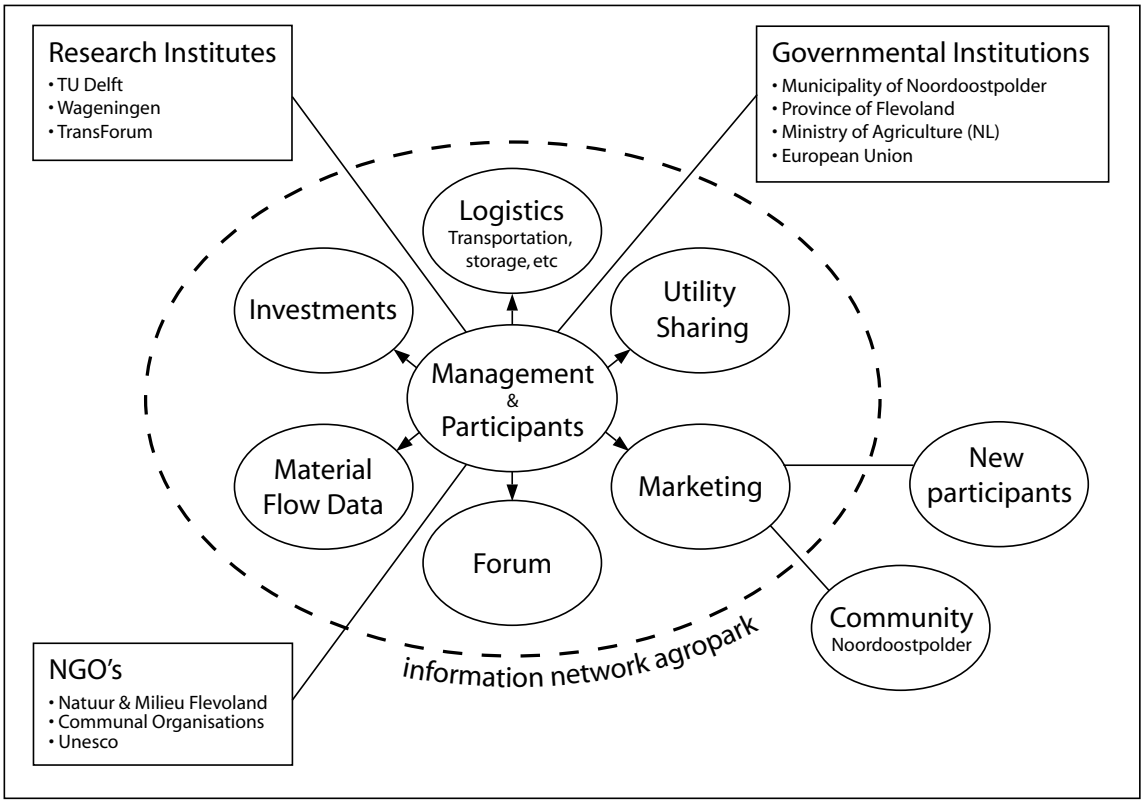
stakeholders, that is, the stakeholders should see them and their activities as a part of system and start optimizing the system not the individual benefits. Hopefully this report will play a role in learning systems thinking.

The agropark development needs the support, from the local government, community and R&D parties (such as Wageningen University). The active entrepreneurs are crucial here in lobbying the support, because the local municipality is very reluctant towards agroparks. The municipality can in the worst case finish of the whole development by not favouring the needed building permits an subsidies. The relations to the municipality should be established and maintained in an early phase of the project.

As important are the relationships towards the local community. It is clear that agropark as such adds value to the whole area of the Noordoostpolder, but as in our design the community is involved in the agropark also by tangible relationship, namely by energy users and biomass producers. To get the support of the community, and consequently good quality organic waste from the local

Figure 5.1. In this map we visualize the internal and external communication of the agropark. The information network represent the internal information exchange between the participants via the online communication center and regular meetings. This is managed by the project leader who also manages the communication with research intitutes, governmental bodies, NGO's.

Information & Communication Map of Agropark



households, a good communication of the project is a primary factor. For this, public hearings and articles in local news papers are good tools to build up a positive image and should be applied in the case of Noordoostpolder too. We see that the central communication system can play an important role in marketing, since web pages provide updated information 24 hours a day.

Besides of good relations to the communal organizations of the inhabitants of the Noordoostpolder, good relations to environmental advocates such as Natuur & Milieu Flevoland are important. This kind of communication would naturally be the task of the project leader.

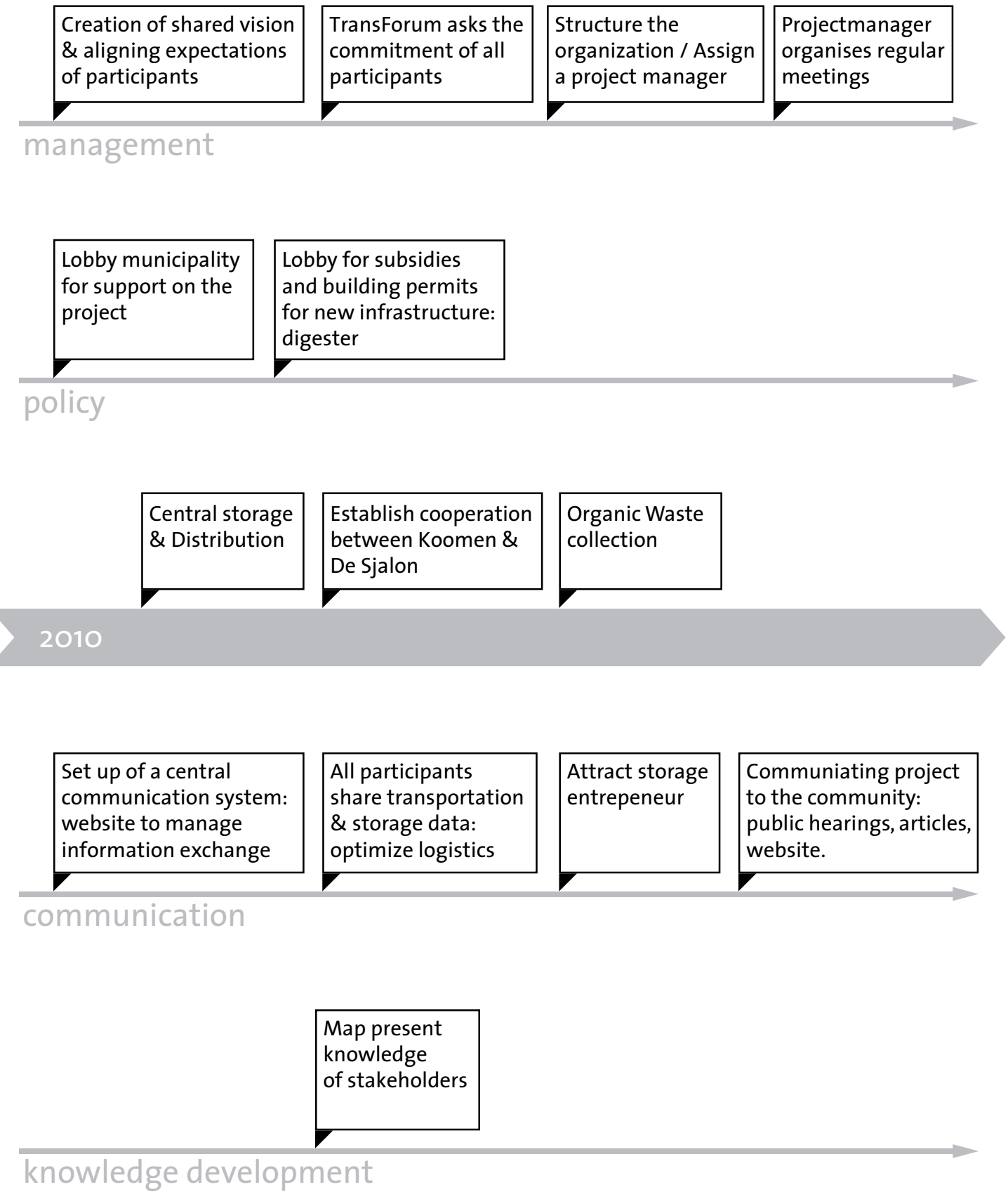
6. Resource mobilization

With resource mobilization we mean lobbying for favourable legislation, building permits and economical benefits (subsidies and tax advatages), but also attracting new participants and Research &Development.

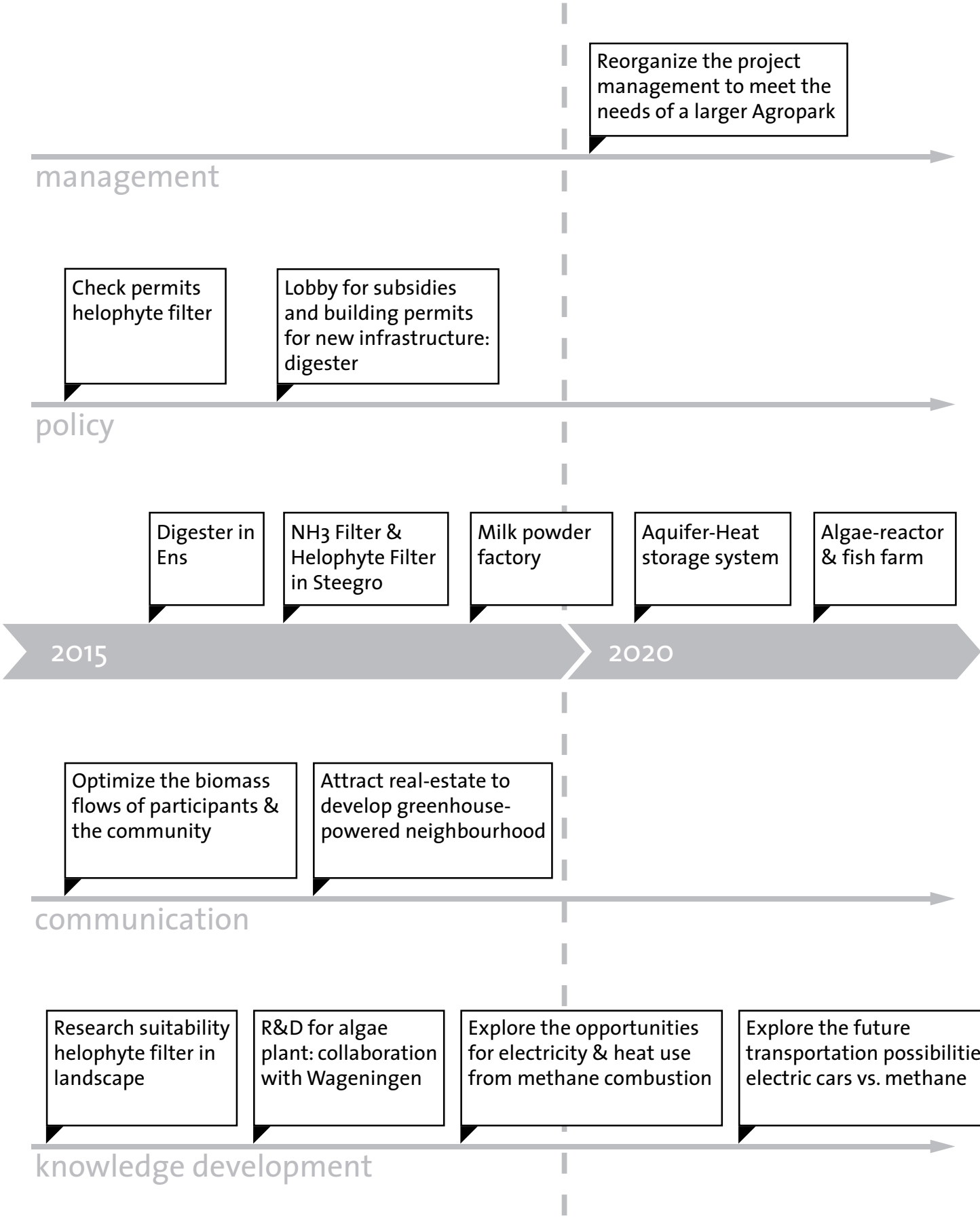
The legislative coalition ruling the municipality consists of five political parties, however CDA (Christian Democrats) (economic development, finances, spatial planning) and CU/SGP (Christian Political Parties) (transport, recreation, environment) man the crucial positions for this project. Lobbying needs to start here and it needs to start quickly. All current 24 spatial plans for Ens are being rephrased into one single plan as soon as June 25th. Proposals can still be handed in, but this fall Ens will have a definitive spatial plan (note). The CDA has campaigned for sustainability in agriculture, environmentally sound production and more innovative use of enormous European agriculture subsidies, so we advice to apply for these subsidies for the construction of the Ens digester, as well as for pipelines. We suggest that the link should be exploited between Innovatie Netwerk and the CDA dominated Ministry of Agriculture, to get the proper advice and support. Be aware however, that CDA also advocates extensification of land use. In a later phase, when recreation through heat sharing becomes a possibility, the Schokland recreation centre needs to be approached in time. CDA explicitly advocates qualitative sustainable tourism as a central focus of economic development.

New participants need to be attracted to the agropark in order for the implementation and expansion of the design of the agropark. For the central storage system, a storage entrepreneur is needed. This could be one of the actual participants but some other party too. Also in order to realize the greenhouse powered neighbourhood, real estate needs to be attracted to the area. Good platform for the marketing of the agropark is the central communication website. We note that there are lot of potential clients, agricultural and other entrepreneurs, in Noordoostpolder, and those should be equally attracted to participate the agropark in order to further develop it and achieve the ultimate goal, a sustainable C2C Noordoostpolder.

Implementation path now - 2010



Implementation path 2010-2020



VISION OF AGROPARK 2050

We see that, the design for an agropark discussed in detail in this report is just a start for a much larger transition of the agricultural area of Noordostpolder to sustainable agricultural entrepreneurship. We envision that the agropark in 2050 involves the most of the communty of Noordostpolder and the the area could call it self a Cradle-to-Cradle agricultural region. We distinguish three stages for this development.

First stage: Cooperative Community

The number of participants is small. Relationships based on exchanged benefits. No general strategy and the network is unstable. Relationship are mainly tangible (material exchange). Diversity of activities is low and high dependecy on external input. Benefits are counted in individual or on the company level. Moderate sustainability.

Second stage: Symbiosis

Many argicultural entrepreneurs and some other entrpreneurs in the region involved. Organized cooperation and common planning (participants jointly). The material cycles mostly closed. Sharing information on many levels. Diversity of activities is medium. Dependency on external inputs is medium. Self-Generating in some materials and energy. Benefits are collective, a win win situation between the stakeholders. In principle the collective benefit is greater than the sum of individual benefits, yet the collective benefit is local. Good sustainability.

Final stage: Cradle-to-Cradle

Whole community involved and active participation. Share and develop information jointly. All cycles closed , emerging benefits. New niches & opportunities constantly emerge. Diversity of activities is high. Self-Generating on materials energy. Dependency on external inputs: Low. Not only own benefits, but also for global benefits. Befints counted for the sytem (best for the whole community). Very sustainable & C2C.

If the design we have developed in this report is implemented as such, it means that in year 2025 Noordostpolder will have an agropark, which is not yet C2C, but sustainable with symbiotical relations among participants. It is good to remember though that as we have taken an evolutionary perpective in our design, this means that the design will evolve and the final implementation in 2025 will probably look very different than we envision. The design helps in building a shared vision and a development strategy, but as technology, legistlation, markets and the society evolves new linking opportunities will emerge and these can sometimes be very radical. Also the develoment does not stop in 2025 and where the development goes after that depends on the future scenarios (see figure 5.2). Hopefully in 2050 we will witness an C2C agropark in Noordoost polder.

Figure 5.2 shows the transition towards sustainability in the Noordoostpolder

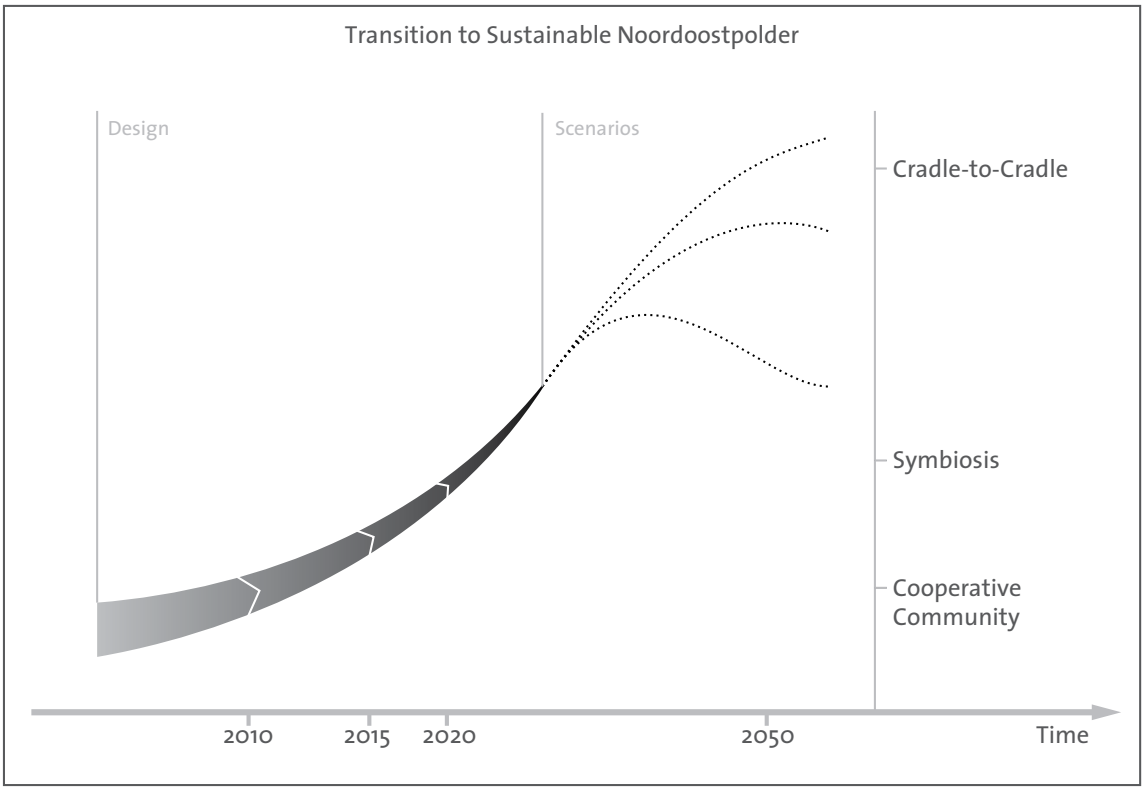


foto: Marlies Meijer-Willems

6. CONCLUSION & DISCUSSION

A feasibility analysis was performed on the exploration of an agropark in the Noordoostpolder. Our main research question was:

Is it possible to establish and exploit a Cradle-to-Cradle agropark in the Noordoostopolder?

The answer to this question is: yes.

After analyzing the current situation with stakeholder mapping and a SWOT analysis it can be concluded that there is an incentive from the side of the entrepreneurs to start an agropark. Improvement of the infrastructure makes this plan attractive for them. Another important advantage for this agropark is the availability of knowledge in the Netherlands for a lot of technologies that are needed for the agropark. The weaknesses and threats of the current situation can be used as an argument to start building the agropark. For example, the gas and the electricity supply systems are used at full capacity and this is a threat for the businesses of the farmers and greenhouse owners. This can be an incentive for improvement and whilst working on that, other connections can be made between the entrepreneurs. This also gives an opportunity for new entrepreneurs to start their business in the region. However, to be able to make a start in this project, the hesitation of the entrepreneurs for cooperation and information sharing needs to be tackled by a good management institute.

A design of a sustainable agropark was presented in four different phases, varying from short to long term. An implementation for these four phases was designed accordingly. A rough economic evaluation is given for some features of the design. Economic savings range from small amounts by sharing utilities to large savings by implementing for instance aquifer heating.

A second SWOT analysis was performed on the design. From this, it follows that a lot of strengths and opportunities exist in the designed agropark. Economical possibilities (economy of scale, reduced resource cost, etc.) create a large incentive

to start with this project, as do the subsidies in sustainable development. When physical connections are made, dependency on each other and the system can create dedication to the system, so that it can be a success. Connection of streams between the three greenhouse owners can be feasible, because of the small distance in between their companies.

This dependency on each other can also be a weakness, because of the possibility of sudden stops in production due to bankruptcy or lack of faith in the system. Some regulations on for example groundwater use for aquifers can be a problem for the system to start-up.

Implementing an agropark requires the participants to shift to systems thinking. This might be one of the biggest challenge in implementation. Namely as was seen in the SWOT -analyses on current situation the agricultural entrepreneurs appriciate individuality, whereas the fundamental principle in agropark is to seek the common benefit above/in addition to individual one. A resiliant system decreases the individual risk of interdependancy. In a robust system participants are dependant on the system and not on individual elements. In practice this means that if some of the entrepreneurs drop out the system will still remain and new connections will continue to emerge. Due to the evolutionary approach of the design, using a diverse structure of companies of the agropark, the resilience is enlarged. The agropark is not dependent on one key-actor. By developing local nods of the agropark it is also open for expansion on other places in the Noordoostpolder. Eventually, one could think of the linkage of several nods in the agropark to combine one big system as shown in the figure below.

For future research we recommend that a project leader is assigned. Further research conducted should be in the direction of further investigating the economics and risks of the design.

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4.3 GEP Benelux, data accessed in May 2009 from website www.grijswater.com

5.1 Hekkert M.P., Suurs R.A.A., Negro S.O., Kuhlmann S., Smits R.E.H.M. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological forecasting & social changeT 74 (2007) 413-432.
5.2 de Wolf, P. (2009). Interview 11.5.

APPENDICES

1. Presentation of preliminary results to commissioner, by Industrial Ecology Master Program, 03 june 2009.
2. Interview Pieter de Wolf 19/05/2009
3. Interview Cees Koomen 19/05/2009
4. Interview Henk van der Steege 19/05/2009
5. Interview Ruud van Schie 19/05/2009

1. PRESENTATION 03/06/2009

Agropark Noord Oost Polder 2009

AGROPARK

HIGH-TECH GREENHOUSE CLUSTER

HELPING GROWERS HARVEST SUCCESS

By:
Msc. Industrial Ecology
June 3rd, 2009

INDUSTRIAL ECOLOGY
INNOVATIVE BY NATURE

TU Delft Delft University of Technology

Universiteit Leiden

Contents

- Introduction
- Participants
- Agro-park - Current Situation
- Design Scenarios
- Feasibility
  - Economical analysis
  - Implementation
- Conclusion

Introduction: an agropark in Noord Oost Polder (1)

• **Goal:** To conduct a *first exploration* of possibilities to develop a C2C agropark in the Noord Oost Polder.

• **Scope of Research:**
  - Focus on streams & activities taking place on terrain of participants;
  - Study includes: network design; sustainability analysis of proposed situation; feasibility study (economic, policy, implementation)

Introduction: an agropark in Noord Oost Polder (2)

An **Agropark** is an agricultural system of relationships of **businesses** and **people** in **close proximity**. It aims to reach a more (socially, environmentally and economically) **sustainable agricultural** system, by sharing **physical flows** (materials, energy and utilities) and less **tangible flows** (information and trust). The park seeks a **collective benefit** that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only.

Introduction: an agropark in Noord Oost Polder (3)

• **Main research question:**

Is it possible to establish and exploit a Cradle 2 Cradle agropark in the Noord Oost Polder?

Directions of research:

• Looking at: different activities and their (possible) interconnectedness, locations, individual and shared interests, time scale
• Important aspects: sustainability and C2C criteria, integration of PPP, integration of IE

Introduction: Cradle 2 Cradle

• Close cycles
• Add value in 3P
• Strategic & operational
• Use existing capital
• Evolution vs Lineair

Introducing Participants: Ens' Entrepreneurs (1)

Name	Kwekerij A. Baas
Activity	Pot and Bedding plants nursery
Location	Ens
Size greenhouses	20 ha
Extra	CHP of 2.7 MW
Website	www.kwekerijabaas.nl

Introducing Participants: Ens' Entrepreneurs (2)

WOUTERS KWEKERIJ

Name	Kwekerij Wouters
Activity	Pot and Bedding plants nursery
Location	Ens
Size greenhouses	20 ha
Extra	-
Website	www.kwekerijwouters.nl

Introducing Participants: Ens' Entrepreneurs (3)

Name	Ruud van Schie BV
Activity	Tomato and Pepper nursery
Location	Ens
Size greenhouses	8 ha
Extra	Biological (EKO brand)
Website	www.greenshield.nl

Introducing Participants: Ens' Entrepreneurs (4)

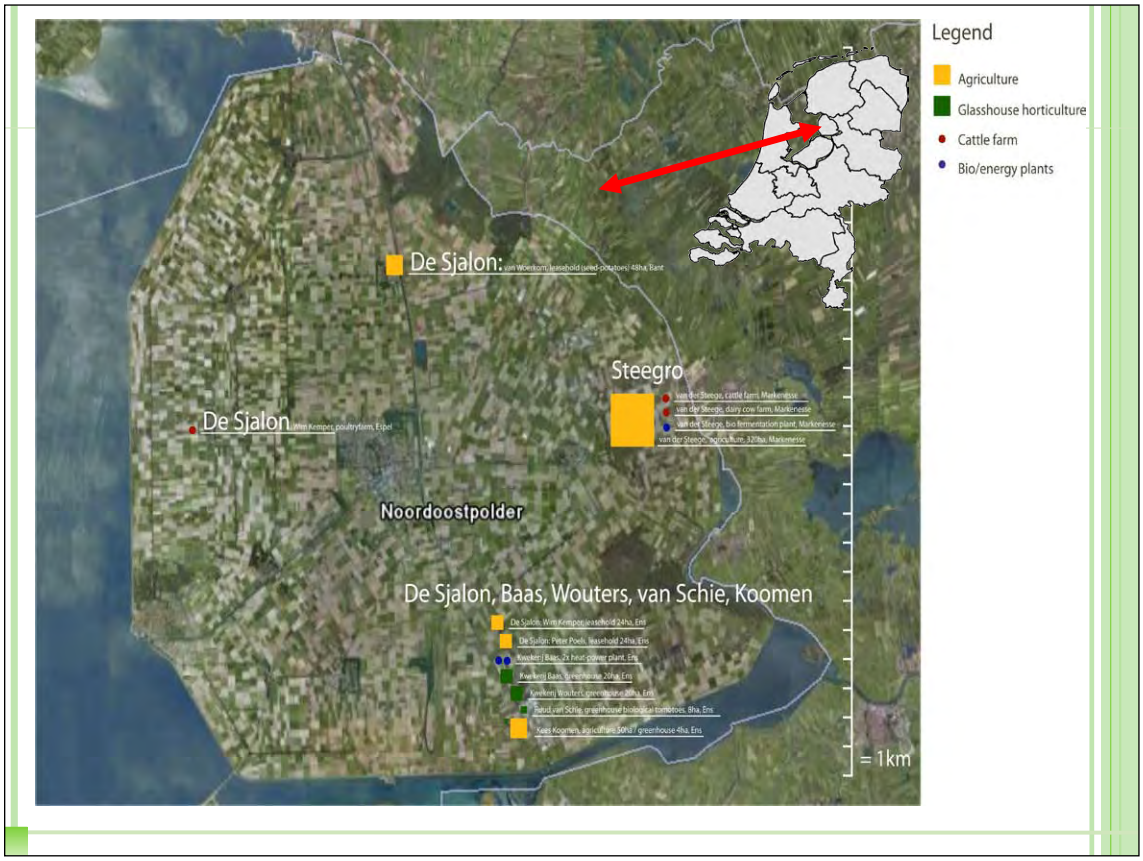
Name	Koomen Bloembollen VOF
Activity	Flowers and Bulbs grower
Location	Ens
Size lands	50 ha
Extra	-
Website	www.koomenbloembollen.nl

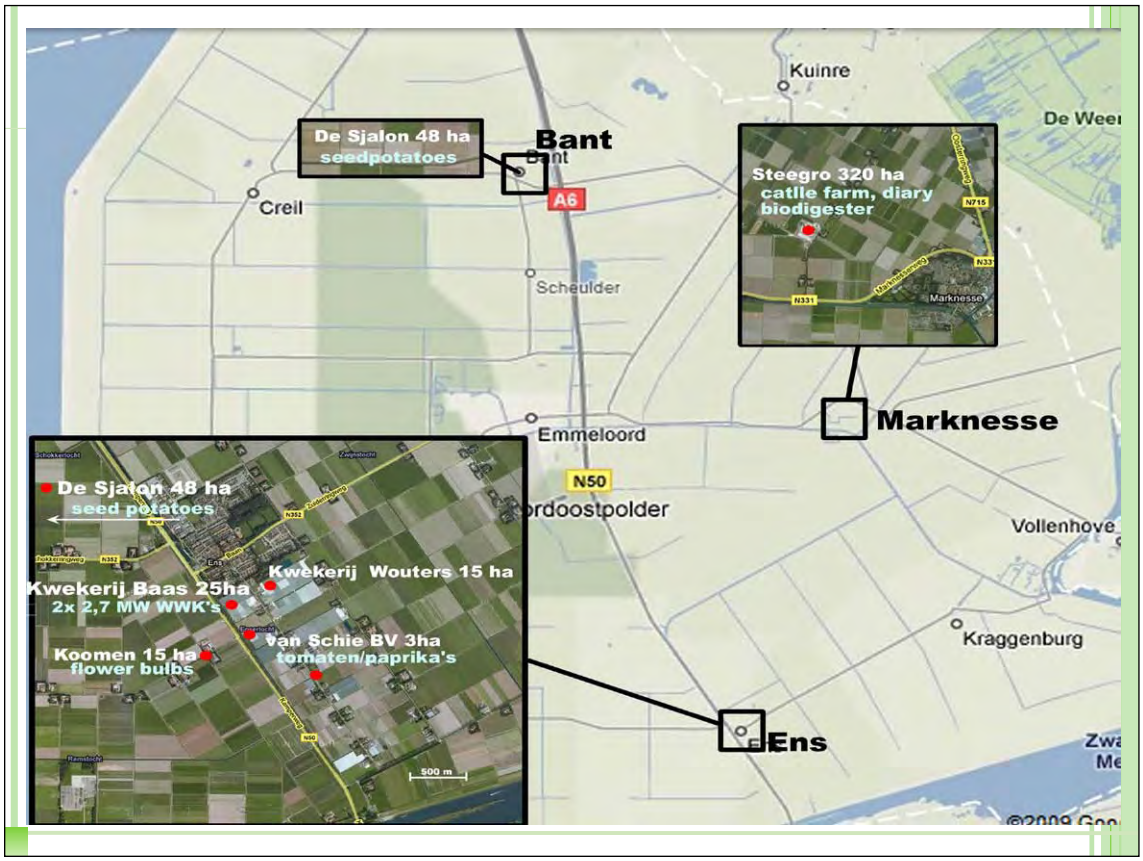
Introducing Participants: Cooperative Entrepreneurs

Name	De Sjalon
Activity	Diverse agriculture
Location	Bant, Espel and Ens
Size lands	94 ha
Extra	Treaty of cooperation, 4 entrepreneurs
Website	www.desjalon.nl

Introducing Participants: Marknesse Entrepreneur

Name	Steegro BV
Activity	Dairy Farm
Location	Marknesse
Size	400 dairy cows and 400 young cattle
Extra	Bio fermentation
Website	www.steegro.nl


Legend
Agriculture
Glasshouse horticulture
Cattle farm
Bio/energy plants
De Sjalon:
Steegro
De Sjalon
Noordoostpolder
De Sjalon, Baas, Wouters, van Schie, Koomen
= 1km


Kuinre
De Sjalon 48 ha
seedpotatoes
Bant
A6
Creil
Scheulder
Steegro 320 ha
cattle farm, diary
biodigester
N715
N331
Marknesse
Marknesse
Emmeloord
N50
Vollenhove
De Sjalon 48 ha
seed potatoes
Kwekerij Wouters 15 ha
Kwekerij Baas 25ha
2x 2,7 MW WWK's
Van Schie BV 3ha
tomaten/paprika's
Koomen 15 ha
flower bulbs
Kraggenburg
Ens
500 m

Preliminary Conclusions Research

• Main research question:
Is it possible to establish and exploit a Cradle 2 Cradle agropark in the Noord Oost Polder?

• Yes:
  • Easy short term cooperative gains
  • Various long term scenarios

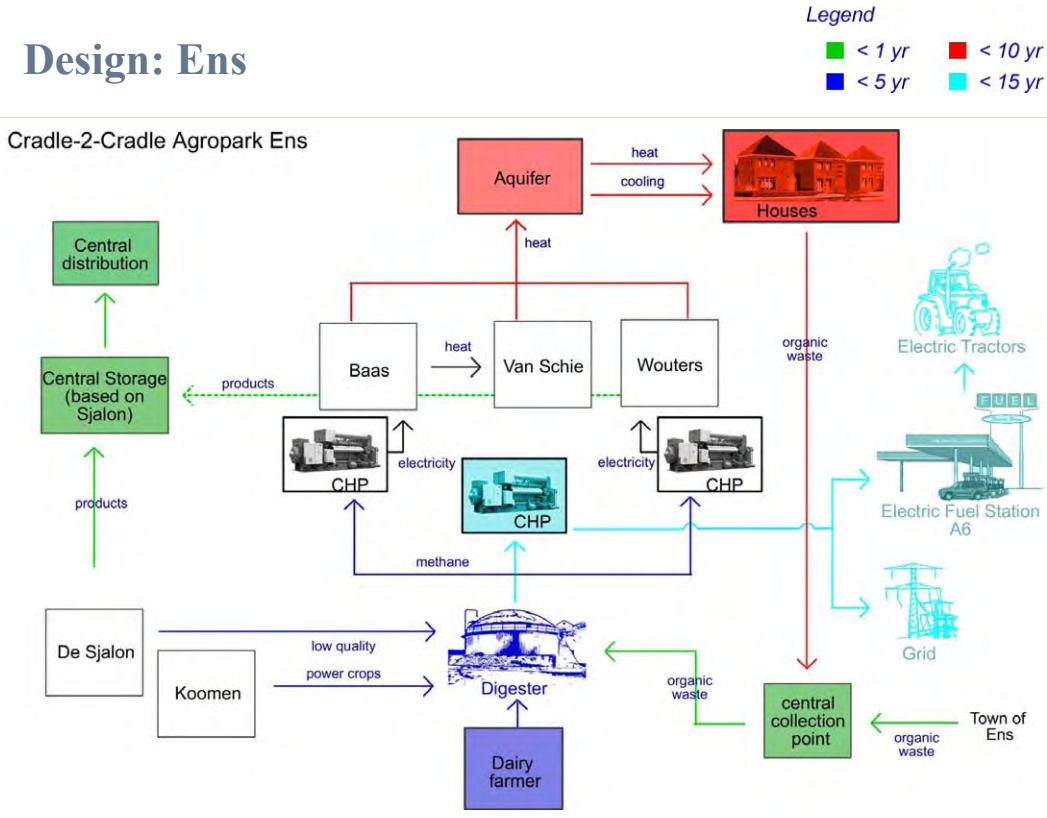
• But, focus on:
  • Cooperation and mutual trust
  • External factors (i.e. Subsidy, Government)
  • More research: (i.e. more in depth CBA)

SWOT analysis of current situation

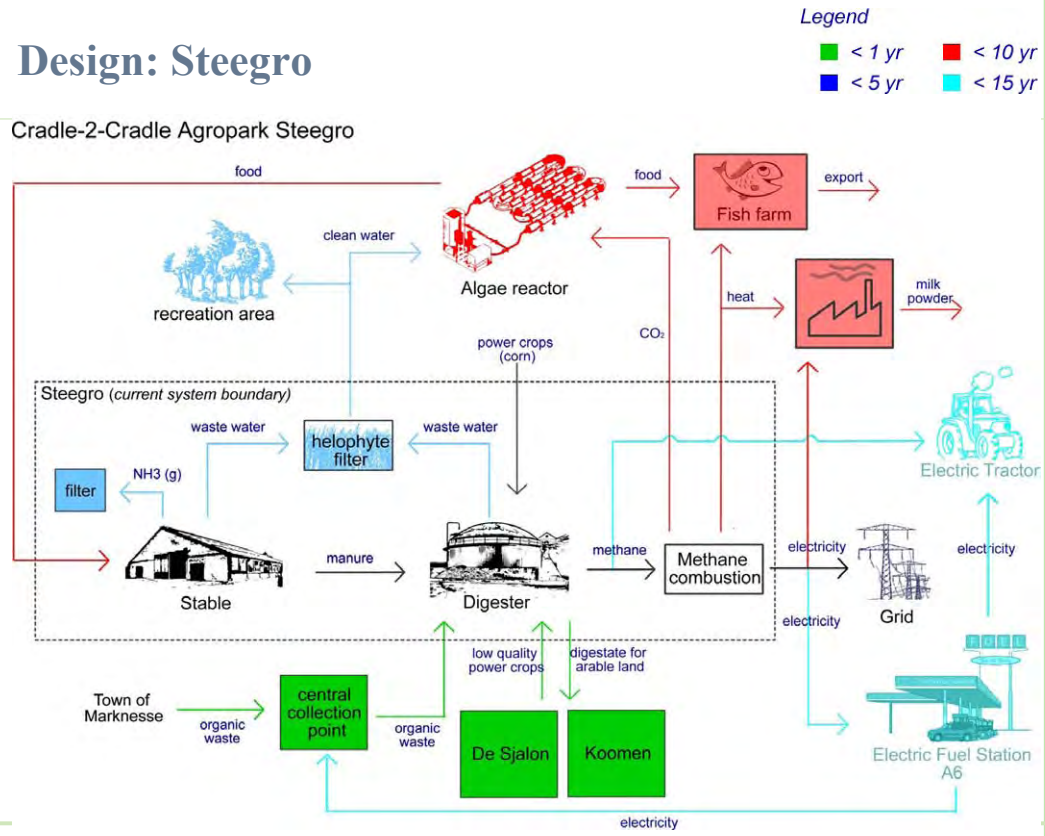
• Main Strength: Ens entrepreneurs close proximity
• Main Weakness: Mutual information sharing is lacking
• Main Opportunity: Knowledge on different techniques available in the Netherlands
Willingness of participants to innovate
• Main Threats: Local municipality is conservative towards innovation
Banks reluctant to provide credit

Design Scenarios

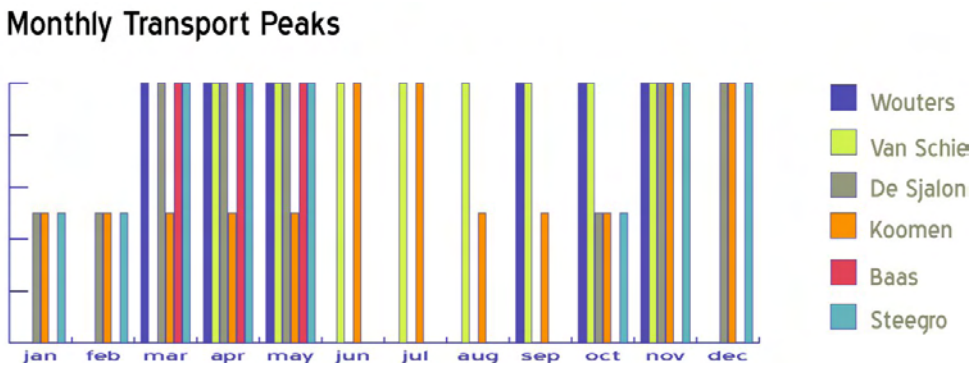
Design: Ens



Design: Steegro



Design: Transport



- Trucks Wouters unused for 6 months/year

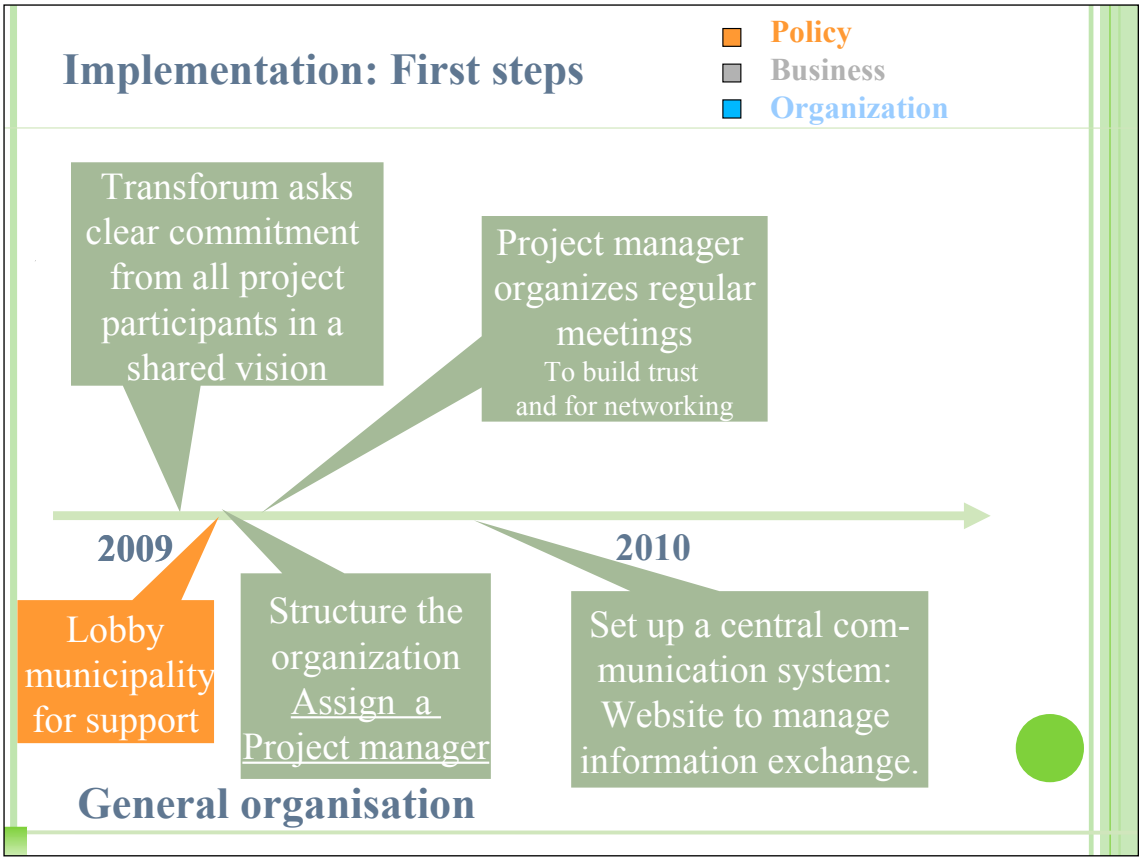
Economics

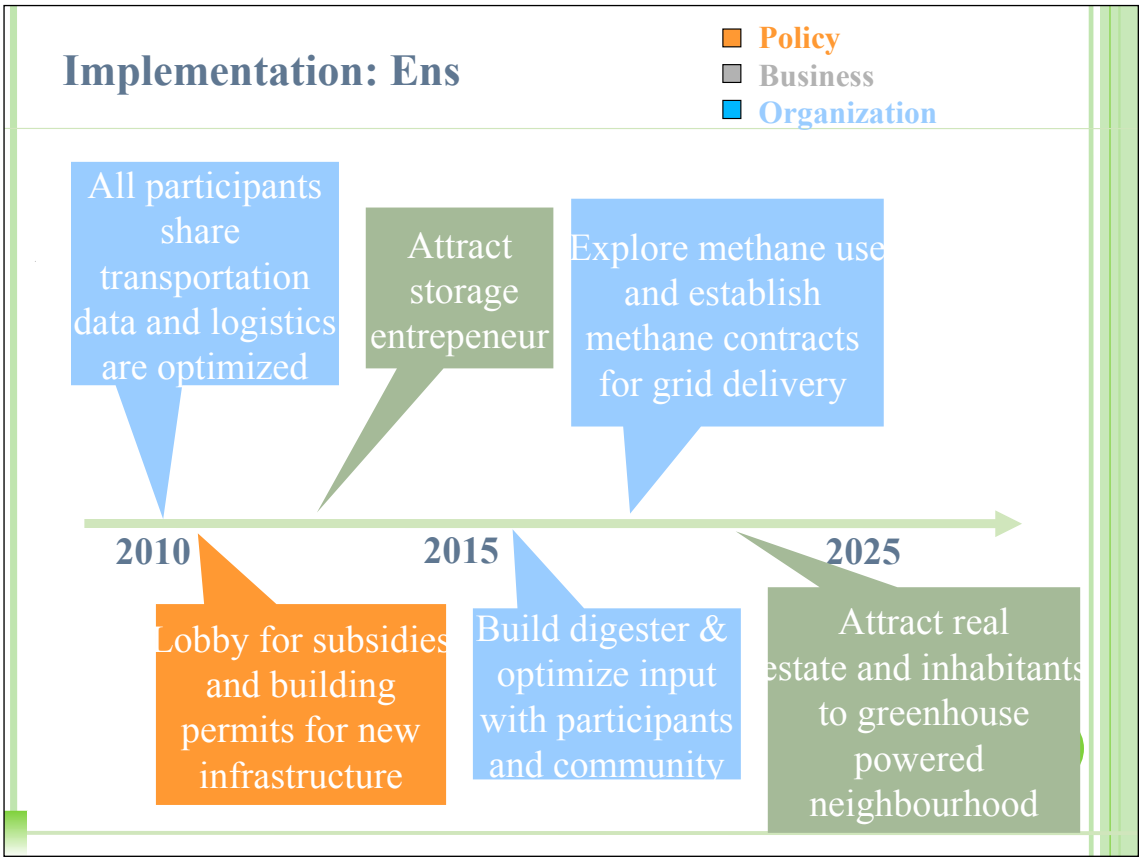
Technology	Costs/benefits[1]
Logistics	Save 30-50 Euro per transport
Other input digester Steegro	Save 67,000 Euro by replacement corn by flower bulbs (Koomen) and organic waste (municipality)
Digester	Investment 1-3 million Euro
Algae/fish farm	Investment 300,000 euro per hectare[2]
Pipelines (heat)	Costs 450 euro/meter
Greenhouse heating (aquifer)	Payback time 6-10 year

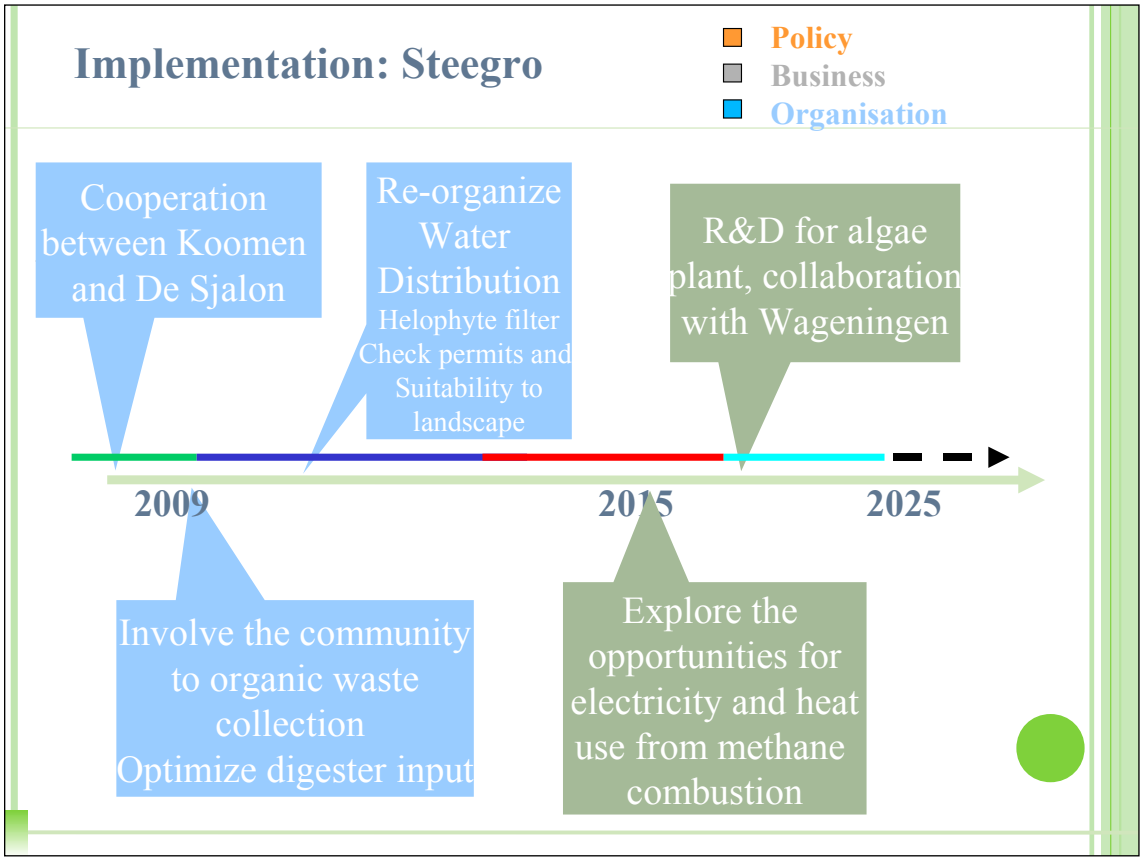
1. Sources are interviews with farmers or assumptions
2. Michael Briggs 2004 *Widescale Biodiesel Production from Algae*, University of New Hampshire

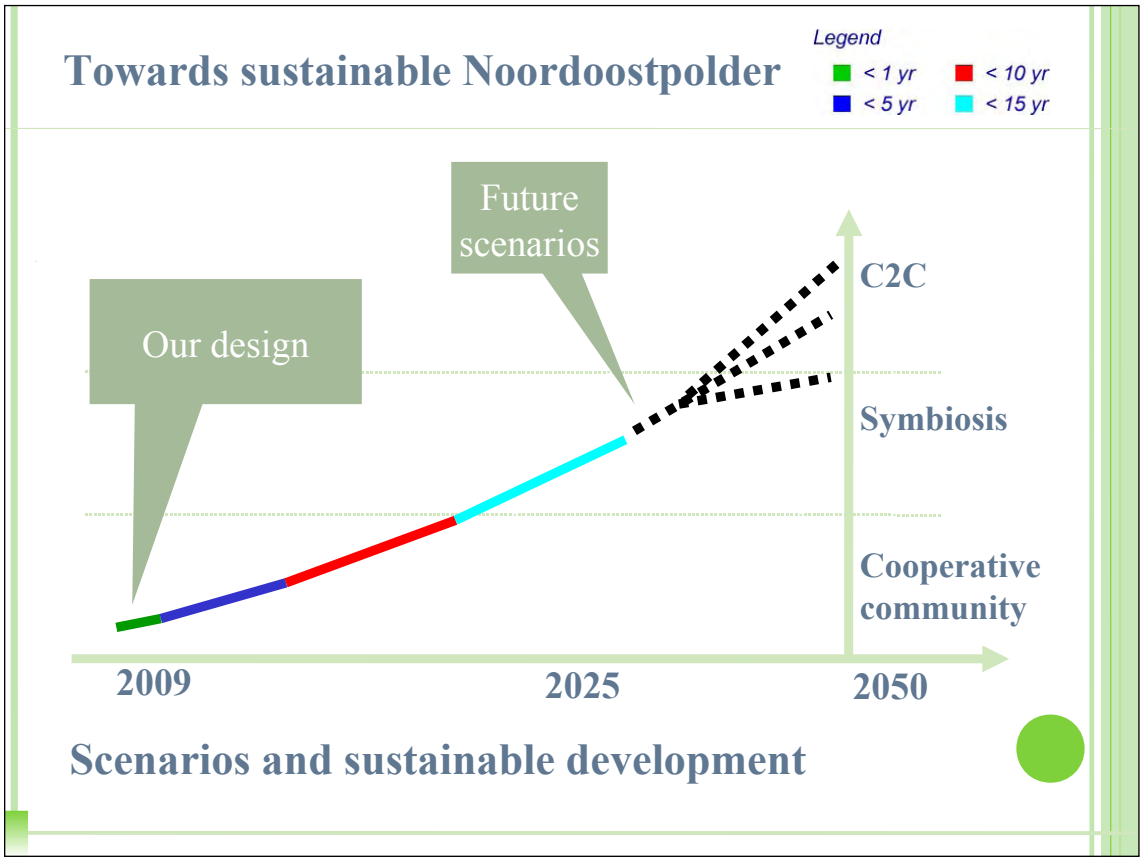
SWOT analysis of design

- Main Strength: Incremental and realistic approach builds trust for progress
- Main Weakness: High investment costs for some parts of design, uncertainty on some numbers
- Main Opportunity: Flexibility of design makes integration of new companies possible
- Main Threat: Lack of political, technological & financial support


Implementation: First steps
Policy
Business
Organization
Transforum asks clear commitment from all project participants in a shared vision
Project manager organizes regular meetings
To build trust and for networking
2009
2010
Lobby municipality for support
Structure the organization
Assign a Project manager
Set up a central communication system: Website to manage information exchange.
General organisation


Implementation: Ens
Policy
Business
Organization
All participants share transportation data and logistics are optimized
Attract storage entrepeneur
Explore methane use and establish methane contracts for grid delivery
2010
2015
2025
Lobby for subsidies and building permits for new infrastructure
Build digester & optimize input with participants and community
Attract real estate and inhabitants to greenhouse powered neighbourhood


Implementation: Steegro
Policy
Business
Organisation
Cooperation between Koomen and De Sjalon
Re-organize Water Distribution
Helophyte filter
Check permits and Suitability to landscape
R&D for algae plant, collaboration with Wageningen
2009
2015
2025
Involve the community to organic waste collection
Optimize digester input
Explore the opportunities for electricity and heat use from methane combustion


Towards sustainable Noordoostpolder
Legend
< 1 yr
< 10 yr
< 5 yr
< 15 yr
Future scenarios
Our design
C2C
Symbiosis
Cooperative community
2009
2025
2050
Scenarios and sustainable development

Conclusion

Main research question:

Is it possible to establish and exploit a Cradle 2 Cradle agropark in the Noord Oost Polder?

Yes:

Short term benefits to be gained from cooperation
Various scenarios possible for the future

But, for being successful in reaching C2C status, focus on:

Cooperation and mutual trust: (financial) dedication of participants
External factors (i.e. Subsidy, Government)
More research: (i.e. more in depth CBA)

Questions

Appendix I - Calculations and Assumptions

• 1. Transport

Saved costs = price transport van Schie (current situation) - costs transport Wouters (future scenario) = 400 - 350 = 50 euro

2. Digester

Saved costs = saved input feed from GFT Ens (a) + saved input feed bulbs Koomen (b). (expressed in mais equivalent, multiplied by 6/35 euro per liter of mais equivalent). (A) is denoted where assumption is made.

(a) Ens: 3100 citizens = 1000 households (A) x 100 kg GFT/household/year = 100.000 kg = 100 m^3 mais equivalent (A)

➠ 100 E3 dm^3 x 6/35 euro/dm^3 m = 17.000 saved costs

Appendix II - Calculations and Assumptions

2. Koomen: 300 m^3 waste bulbs (interview) = 300 m^3 mais equivalent (A)

➠ 300 E3 dm^3 * 6/35 euro/dm^3 = 50.000 euro

Total saved: 17.000 + 50.000 = 67.000 euros

Distribution of saved costs:

Steegro: 17.000 + (50.0000 - x), where x is price paid to Koomen for Bulbs

Koomen: x, where x is price reseived for bulbs

2. Interview Pieter de Wolf 19/05/2009

Interview in Wageningen UN

Organic farming

Government has subsidized a lot the past decade but only now has its market grown in the NL and abroad. Some of the organic products are now doing good, but not all! For example there is a demand for organic dairy products, e.g. Milk but not all plants are growing feasible when they are organic.

Opportunities in Agropark

On top of the connecting material and energy flows, sharing facilities, infrastructure and services is an opportunity for farmers. These are transportation, logistics, storage, agro-security, machinery, distribution etc. For some farmers this could bring important savings. The amount of savings depends on the type of farm. There is also problem combining the functions for example storage and transportation, because the divers type of products. The storage and transportation temperatures varies and the required fastness also.

There have been thoughts about a distribution center for Noordoostpolder among the farmers. Noordoostpolder has a lot of production and big companies. For example the big flower nurseries are situated in NP but the distribution center still in Lisse and flowers are imported there. A distribution center wouldn't be only logistically beneficial. It would also bring the buyers, the costumers there.

-Maybe there could be a possibility for a trade union in NP or a brand for the region.

-Use the biofermentation plant from van de Steege for organizing the organic matter in the region.

Existing problems

There are materials available in NP and thus possibilities for connecting the farmers, but this should be organized. For example Steegro needs a lot of input in their digester, but they have trouble feeding it. Big question: How to organize organic matter? For example Ruud van Schie can't be in the same system with the rest of the farmers because of the organic production.

There is also problem with soil quality in the area. The organic matter content is too low and after a heavy rain the fields dry slowly and stay wet.

Water quality is okey. Surface water can be used for spraying the crops. The problem can arise when there is a heavy rainfall. The water accumulates to the area. Yet this is not the problem of the farmers but of the region, and possible water storage capacities should be designed in regional level.

-How do you deal with upscaling? This is not wanted by the municipality, but needed for the farmers.

-Farmers would like to expand the group of participants, TransForum likes this size for the group.

Concerns of the farmers

Farmers:"How does the government want to invest in this?"

Farmers are not trusting the government, especially the municipality. So far there has been always unpredictable problems with it. In addition policy of the municipality does not initiate the development (very reactive, when you come with a plan they will look at it, but they won't initiate changes).
One of the reasons Ruud van Schie became interested in the project was the idea of subsidies. They can get an innovation subsidy from LNV of senternovem. However, this has turned out difficult from previous projects (first project the sjalon participated with from Transforum). When you write a subsidy request, the government will either accept or turn it down. When they accept it, the request goes to an independent organization which you around allowed to contact with. Most of the times, your request gets turned down in this step. Next to this, if it gets accepted the government wants public publications about your company. This can be unwanted by the farmers, because of competitive advantage.

Keep in mind in the design
The landscape is important. The industrialized arable land and huge stables are not welcome, and face a lot of resistance. The scaling up is a necessary development but big farms should be fitting the landscape.
Building in Ens is most likely to bring problems with the municipality. They want to keep it untouched. Real expertise within the municipality is not available.

Farmers ready for...
Some of the farmers are willing to combine dwelling in the agricultural activities.

A little bit more about the participating entrepreneurs
General remark: greenhouse entrepreneurs at Noordoostpolder are very individualistic, they don't want to share a lot.

De Sjalon: Its second project with transforum. Arnold van Woken, very creative
Inno Meyer: President of committee revitalisering tuinbouw Ens (revitalizing greenhouse Ens); lots of contacts, lobby-ing. His aim is to do something good for Ens
Ruud van Schie & Henk van de Steege: Very creative, Henk only joined the project a couple of weeks ago. He likes the idea of algae on his field, Pieter de Wolf thinks this is not feasible because of the location of that field next to a protected environmental area.
Baas & Wouters: more conservative, down to earth. Wouters only wanted to join if Baas and van Schie also joined.

Infrastrucural changes
Some infrastructure is going to be improved. N50 & higher bridge.

Timeplan TransForum & agro-park
They started with the idea last summer, Rien spoke to some farmers.
January first meeting,
April second meeting
May third meeting. (funding from participating entrepreneurs, 5000 cash & 5000

labor)
Start in June.
After this year they know what they need to develop.
2015; the system is kind of linked to each other.

About the project
Amount of the farmers is good because a bigger group could be hard to organize. On the other hand the farmers feel a too good working load. Farmers are the owners of the project, but they need coordination and expertise. The researcher and TransForum are looking far to the future, but farmers want to know where to start.
A challenge for the project is how to combine the ideas of Ruud van Schie and others, the ideas should be quick scanned.

Cradle to cradle
Nice ambition but it's impossible to get a quality mark for that because of the nature of Cradle to cradle.

Innovations and experiments in Wageningen
Combined dairy and edible farming. Challenge in this is the different culture of different farmers. Dairy farmers don't care about soil quality etc.
Combining logistics with flower bulbs. Flowers are harvested in different times in a year.
Cooling of buildings combined with the cooling storages, energy neutral system.

3. Interview Cees Koomen 19/05/2009

If someone ask you for a license to build, you should give him a pie and flowers for his wife. When they ask you to come back in 6 months because they don't have time, that makes me sad.

What would you mainly want to achieve with the agro park initiative?
On the area of energy. Retrieving heat that others pollute to the air, for my own heating purposes.

Do you have own waste streams?
Our bolls waste could be put in a biodigester.

Which resources form the main costs for your company?
Our costs are divided in three parts:
estate
labour
energy, about 30%. If we can save 10 to 15% there, than that is substantial to our overall cost position.

Do you use rain water?
No, only surface water. 100 m^3 an hour. For three weeks a year. From a cost perspective not interesting; its free.
From an environmental perspective though, I truly believe a third world war would be about wate; the Netherlands is a relatively dry country: low precipitation and dependent on water from rivers (i.e. the Rine), controlled by other countries.

Do you think working together will benefit in this case?
I don't think working together on water would fight this effectively. We are too small as an area. With this size of the cluster, we will never be able to start shared utilities or knowledge centres. Especially compared with the Westland, we are too small.

What kind of fertilizer do you use?
Chemical fertilizer.

Are you interested in biological farming?
But there is no market for this. The product you deliver is qualitatively bad, while it should be sold for a premium price (as your costs for producing are higher).

Cradle to cradle as a certificate?
That's something I envision, for the natural products. the consumer is willing to pay a premium for this.
And in the end, money counts. Its too bad, but that's how it works.

For what do you use heat?
I use a greenhouse, and heat, for drying the bolls. After harvesting the bolls, they have to be dried within 24 hours.
That costs a lot of electricity and gas. This means we use a lot of energy in a relatively small amount of time. In june/july and October/November. In june/july you could be lucky with nice weather where you will need less heat. In October/November you need a lot of energy however.

Any final remarks?
You can make plans as you wish, but the current size of the horticultural area is not large enough to be attractive for a park. We need more and larger companies to be able to achieve results as an sustainable agropark. However, the whole Noordoostpolder area is protected; they want to preserve it for future generations in its current state. This is contrary to developing the area and giving people space.

In your opinion this is the main bottleneck?
Yes, the cooperation of governmental departments. But that's something that's characteristic for the whole Netherlands. It in the rules, legislation and bureaucracy. So the area has to become larger, if you want to achieve anything.
And if anyone ever starts about a trading centre; that's something you shouldn't do. You can never compete to trading centres such as Aalsmeer, and there is no use in trying. You have producers, but you don't have buyers; we are too small. And we're just 100km away from Aalsmeer, so there is no use in starting an own centre because you think 100 km is too far. Besides, 99% of our current buyers are from abroad. This has dropped drastically. Not necessarily because of the credit crunch, but the valuta crisis; i.e. the pound has dropped dramatically. On top of this, I expect the consequences of the credit crunch still to come.

4. INTERVIEW HENK VAN DER STEEGE 19/05/2009

What do you expect of an Agropark?
'There is a lot to develop in this region, not only for the companies itself, but also in working together. There is a large potential in working together, because the margins in this business are small. By working together in a group, some material and energy streams can be use more efficient, so the costs of entrepreneurship go down.'

What opportunities do you see?
'There is a lot of ground that is not good enough for use in agriculture. If we bundle all these pieces of land, we can for example grow algae on it. A lot of streams from different companies can be shared. I can for example use energy rich waste streams for digestion in my digester. And I can share the heat produced in that digester (1000MWh of electricity/year) with greenhouse growers or with houses. A lot of knowledge about agriculture is available in the region and we should be able to use this. The question is how to integrate all these things, but there is definitely a huge potential for growth.'

Are you willing to join financially in collective transport of waste and manure?
'Only if this is financially attractive for my company.'

Is the commercial value of an Agropark of some interest to you?
'Yes, it is definitely important, because money can be made from it. The problem is that it is not clear yet if the region is strong enough for this. Positive thing is that a lot of goodwill will be formed when we start this project.'

You are also active in real estate; do you see possibilities there for the Agropark?
'10.000 new houses are being built in this region the coming years. Because I have a lot of extra heat from my digester, I would like to share this heat with those houses. In this way, the real estate is of importance for the Agropark.'

Can you tell us something about your company?
'At this moment we have 400 dairy cows and 400 pieces of small cattle. The manure from these cows is being used in the fermenter to produce methane. This manure is 30-40% of the intake of the fermenter. The rest of the input comes from energy crops like maize and unions and furthermore glycerine and chicken manure. This is anaerobic digested in plug flow in 40-50 days and produces a gas mixture (55% methane, 35% CO_2, 1% O_2 and 5% N_2). This mixture is burned in a turbine, to produce electricity with an efficiency of 40-42%. 1000 MWh of electricity is produced this year. At each moment, 14kW of heat is produced, but nothing is done with it yet. An installation to catch the heat is there, but not in use. Use of the methane and NH_3 produced by the cows in the stables is not significant for now. But if you guys find out it is feasible, maybe it's an opportunity. Another product from the fermenter is digestate. This can be used to give structure to arable land, or when dried it can be used instead of straw inside the stables. It is free of wheat seeds. Drying of the

digestate is a possible option for us with the heat, when it cannot be shared with other companies. Maybe even building my own milk factory is an option, because the electricity and the heat I already have. 85% of the electricity I produce goes back to the grid.

I have my own water source at the farm. I have 3000 m^3 of dirty waste water every year coming from my property. To clean this up, I may install a helophyte filter.

The highest win for me of the Agropark would be better use of my waste heat and a better cooperation with the other farmers.'

5. INTERVIEW RUUD VAN SCHIE 19/05/2009

'One must share (divide) to multiply. As long as one visions at multiplying.'
'I always dreams about ritually burning my gas measurement tool.'

Is it a possibility to use biodegradable rope?
We tried, but they degraded too quickly; while they still had to hold the plants up. So before harvesting. Right now, because the nylon rope still has to be filtered out, only 10% is left over. That's then being burned.

What do you expect from other companies within the agropark?
I expect a complex situation, intensive cooperation. From this point of view I am skeptical. And everywhere where there are couplings between companies, there is dispute. In 80% there is trouble.
So on one hand I am skeptical on how to achieve this with current volatile energy prices and economical instability.
But on the other hand, we have to stay positive. If there are possibilities, there are possibilities.

How do you look at exploiting new activities such as fishery?
Manure from fishes is great for farmers; it is for them also outside their regulatory maxiumum of fertilizer to us. I looked at that fish before and we are close to Urk. But then again, the closed community of Urk shut me out. Outside this area, to set up an own fishery infrastructure, I am always open to new ideas. As an agricultural sector we are set to face challenges; we have to innovate or we will drown. If we don't act urselves, the market will determine it for us. We have overproduction and prices are sometimes lower than cost price. We have to grab the economical crisis as an opportunity for sustainable practices. but honestly, all sustainable practices are only commercially viable beucase of subsidy programs.

How do you think about a Cradle to Cradle brand? Is this attractive for you, in a the long term?
Right now biological farming and these kind of premiums, are under pressure. With the economical crisis, consumers become critical. Within the Netherlands this has always been a small market because of the price sensitivity. For reference; our export to London has dropped from 70 pallets to 2 pallets. So the extra worth is something you cannot depend on, it could turn out to be a nice side-effect, but we cannot count on it.

What do you do with waste water?
We have dreinage-system. Most water evaporates. Apart from this, I have very little water waste.

Do you use rainwater?
Yes, combined with surface water in summer. We don't use service water. I haven't seen anything about water shortage in the Noordoostpolder.

Do you cool the greenhouse sometimes?
Mechanical cooling is too expensive. We cool by air humidity. By putting fine water particles in the greenhouse, it evaporates, for this process heat is needed, so this is extracted from the greenhouse. And this water vapour is let out of the greenhouse.

Do you see possibilities to use excess heat?
In 'Energiek 2020' there are a lot of possibilities presented. We have put a lot of effort in investigating this, but it turned out to be very expensives. Without subsidy this is not commercially viable for us.

How do you look at shared utilities for water purification and biomass handling? If you invest in this, within what period would you demand to have returns? How long term are you willing to invest, in general?
Most will say 4 to 5 years. We are pressured by shorter term economical demands, which shortens the returns on investments we require. Innovate is the only way to survive, though the current economical crisis puts pressure on this.

Are these investments paid from own reserves, or investors you already have?
Banks are not very willing to lend money. It is very hard to say right now. With current economical crisis, things have become really difficult. I think right now a lot of companies will put this idea of an agro park on hold, until the economy recovers. This does not take away the fact that sustainable practices are the future for us, once the economy recovers we will run into new oil/energy shortage again. But for now, we have to take it slowly.

When would an agropark we succesfull for you? What kind of goals do you set? And what costs would you wish to decrease the most?
when cooperation is realized. Outside our own area we know very little of eachother. If we know and understand more of eachother, that would be great
we hope for 'kruisbestuiving' (synergy), where new opportunities appear. That everyone has an open attitude
energy costs, without a doubt. I always dreams about burning my gas measurement ritually.

Who started the initiative?
The provence of Flevoland. We are pulled into this. As you see, I am skeptical, but not that I don't like the idea, but I am realistic.

How do you think other participants are willing to disclose information?
This builds on reciprocity and trust. This is something we have to wait and see. You have to start sharing and wait and see what comes back.