BRIDGING THE GAP

Cooperation in the Mainport-Greenport Complex from an Industrial Ecology perspective

Dit onderzoeksverslag is het eindproduct van een verplicht vak binnen de Industrial Ecology master aan de TU Delft en Universiteit Leiden, de zogenaamde Project Groups. Project Groups geeft studenten de mogelijkheid om in een groep van maximaal 5 personen een casestudy uit te voeren binnen een bedrijf of overheidsinstantie.

Dit onderzoek is verricht in het kader van het Mainport-Greenport project van het Xplorelab en TransForum en richt zich voornamelijk op de massa, energie- en informatiestromen in dit gebied. Het Xplorelab is een innovatiewerkplaats van de provincie Zuid-Holland.

Het project Mainport-Greenport schets de langetermijn samenwerking tussen de Haven en Industrieel Complex Rotterdam en het glastuinbouwgebied Westland-Oostland. Naast dit onderzoeksverslag is eerder een boekwerk ter verkenning *'Zoektocht naar de agrobasis van het Mainport-Greenport complex'* geplubiceerd.

BRIDGING THE GAP

Cooperation in the Mainport-Greenport Complex from an Industrial Ecology perspective

Xplorelab
Metropolitan agriculture

June 2010

Authors:
Evert Bouman 1
Maarten Feberwee 2
Marlies Meijer-Willems 3
Jim van Ruijven 4
Katinka Wijsman 5

Delft University of Technology
Faculty of Applied Sciences
Project groups, Industrial Ecology

Supervision:
Provincie Zuid-Holland, Xplorelab
Ir. M.G.N. van Steekelenburg

Contact
1. evertbouman@gmail.com
2. maarten.feberwee@gmail.com
3. meijer.marlies@gmail.com
4. jimvanruijven@hotmail.com
5. katinka.wijsman@gmail.com

Photo: Excursion Xplorelab, 2009

Executive Summary English

The Mainport Rotterdam and the Greenport Westland-Oostland are two of the most important sectors for the Dutch economy, while also being of great influence on the international level. Both clusters are looking for innovative solutions for products and processes, to maintain their favourable economic position. Although Mainport and Greenport are both tightly connected with other sectors of the Dutch economy, the interaction between Mainport and Greenport itself can and should be intensified in terms of logistics and organization, but also in terms of exchange of resources (such as materials, heat, knowledge, etc.). This report is investigating possible interventions that can link Mainport and Greenport in order to contribute to a more sustainable way of production and logistics.

Firstly, an analysis of the mass flows, energy usage and production, and knowledge/information of both areas has been carried out. Furthermore the already existing interaction in logistics, e.g. CO2 exchange, has been analysed. A stakeholder analysis was performed, that shows indirect linkages between Mainport and Greenport, and a SWOT analysis elaborates on the strengths, weaknesses, opportunities and threats for cooperation from a social, technical and geographical perspective.

Three case studies have been investigated as examples of possible interventions. These case studies were derived from the conceptual 'F-ladder', a model for characterizing products and processes within the Mainport Greenport complex. These case studies are:

1) Development of an information network: Based on fourteen conducted interviews from stakeholders in the Mainport and Greenport, we can conclude that stakeholders are noticing several possibilities for synergy between the two areas. The stakeholders can contribute to an cooperative information network, by building bridges, sharing or developing knowledge and carry out demonstration projects.

2) Development of a heat and CO2 network: Residual heat and CO2 emissions can be (and are) exchanged between Mainport and Greenport. A grand design is presented for a heat and CO2 network that surrounds the Greenport and is fuelled by the Mainport. From an economic perspective it is favourable to develop some parts of the networks together, but coordination is needed in the development of these networks, preferably done by regional and national government(s).

3) Bio-based pharmaceuticals: the opportunity exists to produce bio-based products in the Mainport, e.g. biopharmaceuticals. The only feasible option for creating a bio-based synergy in the Mainport-Greenport complex is using biological waste streams from the Greenport as raw materials for processes in the Mainport. Growing crops for the specific production of pharmaceutical raw materials is not feasible on the short term, but can become so in the future.

Scenario analysis supports the creation of alternative images of the future development of the internal and external environment of organizations and has been used to test the three cases in the context of global warming effects and energy politics. In general it seems there are many possibilities for synergy between Mainport and Greenport.

It is concluded that Xplorelab can act as a platform that can facilitate at least one of the cases described, the development of an information network. Xplorelabs character of a think tank provides a safe environment to discuss new, innovative and out-of-the-box concepts and ideas. Due to the transdisciplinary working methodology of Xplorelab, mutual understanding and trust between stakeholders, necessary for successful implementation of projects, can be stimulated and built.

Photo: Excursion Xplorelab, 2009

Executive Summary Dutch

De Mainport Rotterdam en de Greenport Westland-Oostland zijn twee van de belangrijkste sectoren voor de Nederlandse economie, terwijl ze ook van grote invloed zijn op het internationale niveau. Beide clusters zijn op zoek naar innovatieve oplossingen voor producten en processen, om hun gunstige economische positie te handhaven. Hoewel de Mainport en de Greenport beide nauw zijn verbonden met andere sectoren van de Nederlandse economie, kan en dient, de interactie tussen Mainport en Greenport zelf te worden geïntensiveerd. Dit kan op het gebied van logistiek en organisatie, maar ook in termen van uitwisseling van middelen (zoals grondstoffen, warmte, kennis, etc.). In dit rapport is onderzocht welke mogelijke interventies die Mainport en Greenport koppelen kunnen bijdragen aan een meer duurzame manier van productie en logistiek.

Als eerste is een analyse van de massastromen, energieverbruik en productie, en de kennis / informatie van beide gebieden uitgevoerd. Verder is de reeds bestaande interactie in de logistiek, bijv. CO_2 uitwisseling, geanalyseerd. Een stakeholder analyse, die indirecte verbanden tussen Mainport en Greenport laat zien, is uitgevoerd, en een SWOT-analyse bouwt voort op de sterktes, zwaktes, kansen en bedreigingen voor samenwerking vanuit het sociale, technische en geografische perspectief.

Drie case studies zijn bestudeerd als voorbeelden van mogelijke interventies. Deze case studies zijn afgeleid van de conceptuele ‘F-ladder’, een model voor het karakteriseren van producten en processen binnen het Mainport Greenport complex. Deze case studies zijn:
1) Ontwikkeling van een informatienetwerk: Gebaseerd op veertien interviews van belanghebbenden in de Mainport en Greenport, kunnen we concluderen dat de diverse belanghebbenden mogelijkheden zien voor synergie tussen de twee gebieden. De belanghebbende partijen kunnen bijdragen aan een informatie netwerk, door het bouwen van bruggen, het delen van kennis of het ontwikkelen en uitvoeren van demonstratieprojecten.
2) Ontwikkeling van een warmte- en CO_2-netwerk: restwarmte en CO_2-uitstoot kan worden (en wordt) uitgewisseld tussen de Mainport en de Greenport. Een grand design wordt gepresenteerd voor een warmte en CO_2-netwerk die de Greenport omringen en worden gevoed door de Mainport. Vanuit het economisch perspectief is het gunstig om de netwerken samen te ontwikkelen, maar daarvoor is coördinatie nodig, bij voorkeur gedaan door de regionale en nationale overheid.
3) Biologische farmaceutische producten: de mogelijkheid bestaat om biologische producten te produceren in de Mainport, bijv. biofarmaceutica. De enige optie voor het creëren van synergie op dit gebied is met behulp van biologische afvalstromen uit de Greenport als grondstof voor processen in de Mainport. Het telen van gewassen voor de specifieke productie van farmaceutische grondstoffen is niet haalbaar op de korte termijn, maar kan dat worden in de toekomst.

Scenario-analyse is gebruikt om de drie zaken te testen in het kader van het broeikaseffect en energie politiek. In het algemeen lijkt het dat er veel mogelijkheden zijn voor synergie tussen Mainport en Greenport.
Er kan worden geconcludeerd dat Xplorelab kan fungeren als een platform dat ten minste een van de beschreven gevallen kan faciliteren, de ontwikkeling van een informatienetwerk. Xplorelabs karakter van een denktank voorziet in een veilige omgeving waarin nieuwe, innovatieve en out-of-the-box concepten en ideeën kunnen worden besproken. Als gevolg van de transdisciplinaire werkmethode van Xplorelab, kan wederzijds begrip en vertrouwen tussen de betrokkenen, noodzakelijk voor de succesvolle uitvoering van projecten, worden gestimuleerd en vergroot.

Table of contents

Photo: Sustainable development by Brundland Commision

Preface

Society has become increasingly complex on three levels: the level of society itself, of the problems facing society and of dealing with these problems (Loorbach and Raak, 2005:2). Modern industrialized societies are confronted with many persistent problems of complex and unstructured nature (because they are rooted in different societal domains, occur on different levels and involve different actors with different perspectives, norms and values) for which longterm solution strategies (i.e. sustainable strategies) need to be developed at the level of society.

Since the Brundtland Commission produced its report "Our Common Future" in 1987, sustainable development has evolved into a concept that is no longer primarily the 'property' of activists. It has become a broadly shared challenge for the social, economic and technological development of the next decades. This has made the question how to actually realize sustainable development – for example by implementing certain policies – salient.

Recent experiences in the development of sustainable practices have seen a shift from a focus on technological development alone to enlisting a variety of societal actors. Rooted in an awareness that technology not only creates economic development but simultaneously creates drawbacks (for example environmental problems), a call for technology to place itself in the service of society arose. This shift caused the emergence of a different emphasis in the questions being asked concerning sustainable innovations[1]: matters such as agenda setting, the validity of scientific knowledge[2], the involvement of a variety of actors, and the translation from sustainable development problems into technological development problems and vice versa have become important areas of debate.

The relationship between technology and society in the context of promoting sustainability practices should therefore be described as a process of co-evolution. Technology, the state, market and society, and their developments, are not separate realms but co-evolve in a process guided by a common orientation (Grin, 2006:59). This synergistic relationship acknowledges that social, political, and cultural values affect science and technological innovation, and that these in turn affect society, politics and culture (Kemp, 2000). This becomes for example evident in the focus on sustainable innovations, which is essentially a normative focus.[3]

Dealing with this aspect of co-evolution in the light of sustainable practices has lead to a change in how diverse actors deal with such developments because of an increased complexity. Over the last decades, for example, the power of central government to develop and implement policies in a top-down manner has decreased, leading to increasingly diffuse policymaking structures and processes. The current development in Western European nation states is increasingly to develop policies in interaction with a diversity of societal actions; a process often referred to with the term "governance" (Loorbach, 2010:161).

Although commitments to sustainable and environmentally friendly policy measures – in which economic, social and environmental factors are integrated – have been expressed many times on both local and regional levels since the Earth Summit in 1992, implementation of measures is sometimes lacking. Despite a firms commitment to implementation, the reality on the ground is not always in line (Gibbs et al., 2005:172) because the commitment to sustainable and environmentally friendly development measures often becomes marginal to more mainstream economic measures such as competitiveness, technology policy and workforce skills (ibid). The emergence of new modes of governance, however, creates new opportunities for dealing with the persistent societal problems by giving special attention to learning, interaction, integration and experimentation (such as Xplorelab) (Loorbach and Raak, 2005:2).

Recent years have seen the development of such a policy initiative integrating economic, social and environmental aims in a more concrete form: eco-industrial development. [4] Eco-industrial developments seek to increase business competitiveness, reduce waste and pollution, create jobs and improve working conditions all at the same time. The focus changes from merely minimizing waste from a particular process or facility to minimizing waste and pollution by the larger system as a whole (Gibbs et al., 2005:173), while paying attention to social benefits (including economical ones). The inclusion of different types of actors (government, businesses, NGOs etc.) is illustrative of the new mode of governance for sustainability in which emphasis is put on a systemic perspective in which social (economic, political, regulatory, cultural) and technological evolution are important guiding principles for implementation.

This integrative form of governance is starting point for this report. It will focus on implementation opportunities and strategies for sustainable innovations in two of the Netherlands' main industrial and agricultural production areas: the Mainport Rotterdam and the Greenport Westland-Oostland. It will do so by integrating a variety of actors and perspectives as to come with suggestions for tangible and non-tangible interventions that offer a sustainable long-term perspective for both areas, especially focusing on connecting the two with Industrial Ecology principles as a guideline.

References

Journal sources

Gibbs, David; Deutz, Pauline; Proctor, Amy (2005). "Industrial Ecology and Eco-industrial development: A Potential Paradigm for Local and Regional Development?" in Regional Studies, Vol. 39, No. 2, pp 171-183.

Grin, John (2006). "Reflexive modernisation as a governance issue" in Voß, Bauknecht and Kemp (eds.) Reflexive Governance for Sustainable Development, Edward Elgar, Cheltenham UK, pp. 57-81.

Kemp, R (2000). "Technology and environmental policy – innovation effects of past policies and suggestions for improvement", Paper for OECD Workshop on Innovation and Environment, 19 June, Paris.

Loorbach, Derk and Van Raak, Roel (2005). "Governance in Complexity: An Multi-level policy-framework based on complex systems thinking". Paper for the conference 'Lof der Verwarring', Rotterdam.

Loorbach, Derk (2010). "Transition management for sustainable development: a prescriptive, complexity-based governance framework" in Governance; An International Journal of Policy, Administration and Institutions, Vol 23, No 1, pp 161-183.

Luecke, Richard and Katz, Ralph (2003). Managing Creativity and Innovation. Boston, MA: Harvard Business School Press.

1 Innovation is generally understood as the successful introduction of a new thing or method contributing to a positive change and therefore to development. It is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes or services (Lueke and Katz, 2003).

2 The postmodern notion of the social construction and multiplicity of reality and truth has highly influenced the value attached to scientific insights. The objective and rational nature of science characterised by analysis, systematics and accuracy is for a large part exchanged for the notion of science as being socially constructed, uncertain and subjective. Doubt is casted upon scientific positivism, arguing that 'theory is always for some one, and for some purpose' (Robert Cox). Because knowledge is dependent on values and ideas which are a reflection of a specific set of social relations, it (knowledge) is also variable if social relations transform. This suggests that all knowledge – at least knowledge of the social world – is a reflection of a specific context, time and place, thereby not objective and timeless. This view has influenced the way in which scientific views are being dealt with, for example in policy circles.

3 An example of this is also the new production of science of which a field like Industrial Ecology (IE) is part. Originated in a call for a more environmentally friendly way of dealing with industry, IE is being practiced in a context of application and can be characterised as interdisciplinary or even transdisciplinary (in which existing disciplines merge into a new one) and is therefore illustrative of the way realms co-evolve in order to come to new sustainable practices.

4 The creation of eco-industrial parks has even been adopted as an official national policy in the Netherlands, (e.g. Maasvlakte 2)

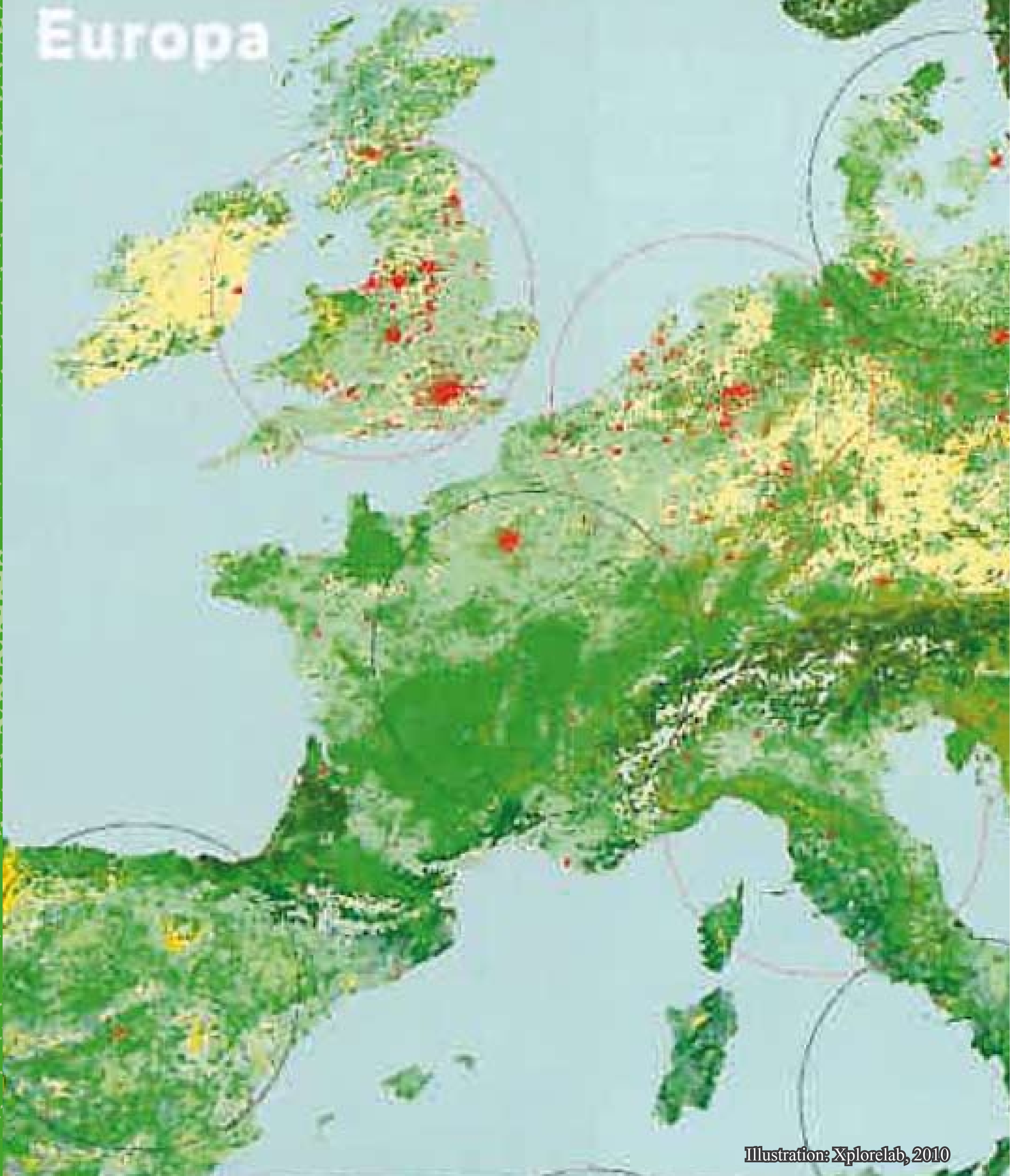

Illustration: Xplorelab, 2010

Chapter 1
Introduction

The world is undergoing a process of rapid urbanisation, which affects global agricultural and trade practices. In few social activities does the tension between globalisation and local identity and practice emerge quite poignant as in modern agriculture. Agricultural production throughout the world is becoming an element in chains and networks involving the industrial supply of raw materials, primary production and industrial processing; while at the same time agriculture remains clearly evident at local levels, including around urban areas as metropolises (Smeets, 2009:21). Under pressure of urbanization and globalization, the future for the most highly productive forms of agriculture (glass horticulture and intensive livestock farming) is being sought in much more far-reaching spatial concentrations, called agro-parks (ibid). This spatial cluster of agro-functions and related economic activities is concerned simultaneously with a reduction in environmental pollution, greater economic return and a better working and living environment for the people concerned. Production (of animals and/or plants) and processing is combined with high levels of knowledge and technology in order to close cycles of water, minerals and gases, while the use of fossil energy is minimised, particularly by the processing of various flows of waste and by-products (ibid).

In order to be able to satisfy the changing and competing demands of the urbanised population on a sustainable basis, metropolitan agriculture thus makes use of new and intelligent connections, inherent to the network society, between producers, sectors, raw materials, energy flows and waste flows, between stakeholders and their value systems. Metropolitan agriculture is characterised by intensive interactions between agriculture and the urban environment (which is the opposite of rural agriculture which is mostly just commodity agriculture), but it consists of a pallet of different forms of agriculture, with also extensive forms included. Metropolitan agriculture can be found in (Delta) metropolises, which have traditionally offered advantages of location (in areas with ample water, in lowlands and with fertile soil) offering favourable circumstances for the development of highly productive agriculture and transportation of the products. A Delta metropolis can be considered as an urban region or conurbation with a global range of influence in close proximity of the delta of a river; it is an area where global relationships – finding expression in activities related to the harbour –dominate over local ones and which impact is global (Van Susteren, 2005:7). It is both sensitive to world developments and contributes to those.

One of the super regions in which delta metropolitan agriculture is being practiced and expanded is the Rijnland area of which the Netherlands is also part. The ABC-Rijnland (Amsterdam, Brussels and Cologne) has a radius of 300 kilometres and includes The Netherlands, Belgium, Luxemburg and parts of Germany. It can be subdivided into 10 regions with a radius of 100 kilometres, which all can be diverted in 10 regions with a radius of 30 kilometres (Van Steekelenburg, 2009). One of these regions is the Mainport-Greenport region in the province Zuid-Holland. Although the whole area of this delta metropolis offers both challenges and opportunities in terms of sustainable production, this report will focus on this region. It consists of two of the main Dutch players in metropolitan agriculture which are located in close proximity of one another: the distributing Mainport Rotterdam (MP) – where the most important logistical streams to the European continent are aimed at and from where distribution to other continents takes place – and the producing Greenport Westland-Oostland – a concentrated area of knowledge intensive horticulture and agribusiness, in which primary production, processing, trade and distribution and supplying and service businesses are geared to one another (Annevelink et al, 2006:8). Both Mainport and Greenport are part of the larger region of the delta metropolis of the river Rijn.[5]

Towards a Sustainable Future: Creating Synergy between the Mainport and the Greenport

The Mainport and the Greenport are two of the most important sectors for the Dutch economy, while also being of great influence on the international level. Both clusters have a large area and are struggling with their image, under pressure of calls for sustainability. Application of innovative products and processes might be a suitable strategy for both clusters to remain competitive and innovative in the near and far future, but uncertainty about how to proceed characterises the current situation. Although Mainport and Greenport are both tightly connected with other sectors of the Dutch economy, the interaction between Mainport and Greenport itself can and should be intensified (Van Steekelenburg, 2009) and could be used as a strategy to induce competitiveness and innovation. This can happen in terms of logistics and organization, but also in terms of exchange of resources (such as materials, heat, knowledge, etc.).

In order to explore the possibilities for creating synergy between the Mainport and Greenport in the context of a more sustainable[6] delta metropolitan agriculture, Xplorelab[7], a site for innovative and transdisciplinary research and development of the Province of Zuid-Holland, started a project researching this. The objective is to develop a long-term perspective on the Mainport-Greenport (MP-GP) complex, as a foundation of delta-agriculture in Western Europe and as an example for the rest of the world. This report aims to contribute to this larger research conducted by Xplorelab, by focusing on possible interventions (both tangible and nontangible) that offer a sustainable perspective for both Mainport and Greenport. The report will elaborate upon adjustments that can be made to current practices and how implementation could be pursued. This will be done using different methodologies and will result in three case studies of possible interventions. The research question that is central in this report is therefore formulated as follows:

In a long-term development perspective for the MP-GP complex, what can be examples of interventions that link Mainport and Greenport in order to contribute to a more sustainable way of production and logistics?

In order to be able to answer this question, we will first consider the current situation of both Mainport and Greenport and look at how these can be combined in chapter 04. We will then continue in chapter 05 with sketching trends which are important for the future of the Mainport and Greenport and their connection, also by drawing up future contextual scenarios. These will be used to test if the recommendations made in the chapters elaborating on the case studies are worth pursuing considering future's uncertainty.

We will then go more into-dept by exploring three possible interventions. In chapter 06 the first case study elaborates on the importance of and possibilities for establishing an informationnetwork in order to facilitate the transition to a more sustainable cooperation between the Mainport and the Greenport. The second case study in chapter 07 presents the design and implementation of a heat and CO2-network that links the Mainport and Greenport. The final case study of chapter 08 will look at (theoretical) possibilities for biopharma in the Greenport and furthermore the support for such a transition is studied. The three case studies will then be evaluated using the scenarios developed in chapter 09.

The three case studies will then be evaluated using the scenarios developed. The report will then be finalized with a discussion – in which we will state which points are still unclear or could be interpreted or executed otherwise and what the consequences hereof would be – and a conclusion with recommendations in which our research question will be answered and which will indicate what lessons can be learned from the report.

References

Journal sources

Smeets, P.J.A.M. (2009). Expeditie agroparken: ontwerpend onderzoek naar metropolitane landbouw en duurzame ontwikkeling. Wageningen Universiteit

Van Susteren, Arjen (2005). Metropolitan World Atlas. 010 Publishers, Rotterdam

Web sources

Annevelink, E., C.M.L. Hermans, A.A. van der Maas, S.M. Pegge, M.N.A. Ruijs, S.O. Tromp, M. Favier, W. van de Geijn,

P. Bleumink and B. Roelofs (2006). Naar een gedeelde agenda voor infrastructuur en agrologistiek rondom Greenports. Wageningen University. Available at: http://library.wur.nl/way/bestanden/clc/1821629.pdf

Van Steekelenburg (2009). Aanvraag Mainport Greenport. Innovatief Praktijkproject Transforum. Available at mgn.van.steekelenburg@pzh.nl

5 The whole area is including multiple rivers and cities, but is often referred to as Rijnland, because of the importance of the German industry for the area. Here however the focus is on the Rotterdam harbour and Westland-Oostland glass horticulture which are located around the river Rijn.

6 In terms of environment, economy and social acceptance

7 Commissioned by TransForum, an innovation program aiming to offer the Dutch agricultural sector and green areas a more sustainable perspective for the future.


Photo: Google earth, 2006

Chapter 2
Current situation of the Mainport

2.1 Introduction

The Mainport Rotterdam consists of the Rotterdam harbour and the industrial complex within the harbour area. It expands along the shore of the Nieuwe Waterweg for almost 40 km. The total surface area of the harbour adds up to 10,556 ha with a total quay length of 89 km. Figure 2.1 shows an overview of the Mainport Rotterdam (Figure adapted from Port of Rotterdam, 2010).

The Mainport Rotterdam is the largest sea harbour of Europe. Its main competitors are the harbours of Antwerp and Hamburg. Together, these three harbours are good for over 60% of the market share of all harbours in the Hamburg-Le Havre range[8]. Figure 2.2 shows the main European harbours. It can be noted that most of them are grouped into the Hamburg-Le Havre range, which also overlaps with the Amsterdam-Bruxelles-Cologne delta region described in chapter 01.

The main activities of the Mainport Rotterdam are related to transport. The harbour of Rotterdam is a transit port and the transit volumes do not generate much added value. Added value is approximately 19 Euro/ton. Compared to other Dutch ports this is by far the lowest number. However, the sheer magnitude of the transit volumes is what makes Mainport Rotterdam a profitable port (de Langen, 2007:113). The industry present within the Harbour Industrial Complex (HIC) consists mainly of bulk chemical producers, a branch that works traditionally with low added value margins.

This chapter describes the current situation of the Mainport Rotterdam. The methodology that is applied focuses on

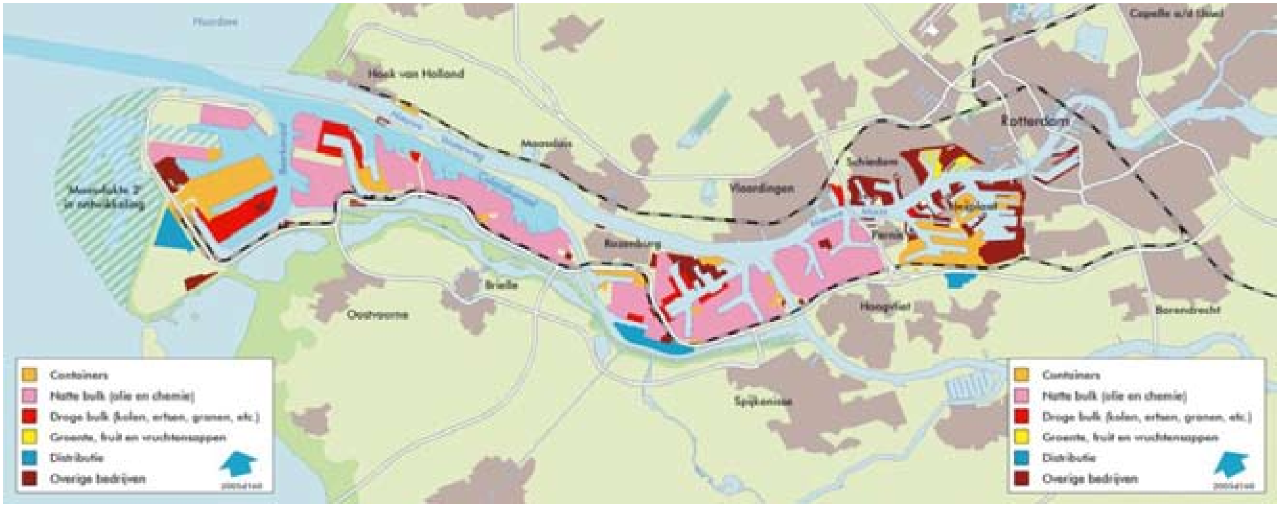

Figure 2.1: Overview of the Rotterdam Mainport

Figure 2.2: Overview of major European ports

several topics. First the mass flows through the Mainport are discussed. Second a short analysis is made on the energy production and consumption within the Mainport. Subsequently, the importance of the Mainport for the economy is described. Then we focus on governance structure of the Mainport. The chapter is concluded with the current developments in the Mainport with regard to sustainable projects.

2.2 Mass

2.2.1 Mass flows through the harbour

The Rotterdam harbour is one of the largest harbours in the World. The mass flows within the Mainport are huge. Per year, the total throughput exceeds 400 million metric ton, and adds up in 2008 to 403 million ton. Figure 2.3 shows a flow scheme of the port and the harbour industrial complex (HIC). This overview, copied from the annual report of the Port of Rotterdam 2008, is not complete. From balancing the inputs and the outputs it can be observed that the total amount of residual mass flow in the Harbour Industrial Complex is 38 million tons per year. Almost half of the mass disappears in the balance of the Port of Rotterdam. Since mass cannot disappear, one can only assume that this mass flow is somehow emitted to the environment in the form of waste or accumulates in the HIC in the form of stocks. To enhance clarity, the numbers depicted in figure 2.3 are summarized again in table 2.1 (Port of Rotterdam, 2008:124) It can be seen that the Port of Rotterdam distinguishes between imports and exports through the harbour (first 2 rows), goods that are transported directly to (and from) the hinterland (rows 3 and 4), goods that are processed in the HIC (rows 5 and 6), and goods that are sea-sea transhipped (row 7).

Activity	In (Mton)	Out (Mton)
Total imports	313	
Total exports		108
Direct transport from hinterland	89	
Direct onward transport		200
Supply from hinterland for processing in HIC	1	
Onward transport after processing in HIC		24
Sea-sea transhipment		33
Residual mass flow from HIC		38
Total	**403**	**403**

Table 2.1: Mass balance for the port and HIC

The industrial park of the Mainport Rotterdam consists of five oil refineries, 43 chemical and petrochemical companies, three industrial gas producers, six crude oil terminals, 19 independent storage facilities and distribution terminals for oil and chemical products, four terminals and four refineries for edible oils and fats. Furthermore over 1,500 km of pipelines for various gases, heat, water, and oil distribution can be found (Port of Rotterdam, 2008).

2.2.2 Emissions to the environment

Almost all of the chemical bulk products, produced in the Mainport, are fossil based. The biggest product from the industrial area is the styrene monomer, the building block for the plastic polystyrene, that is produced by several companies with a capacity of over 1 million metric tons per year (Port of Rotterdam, 2007:16). The chemical industry is also responsible for the large amount of mass flowing out of the Mainport system. As can be concluded from figure 2.3, there is a large amount of residual material that

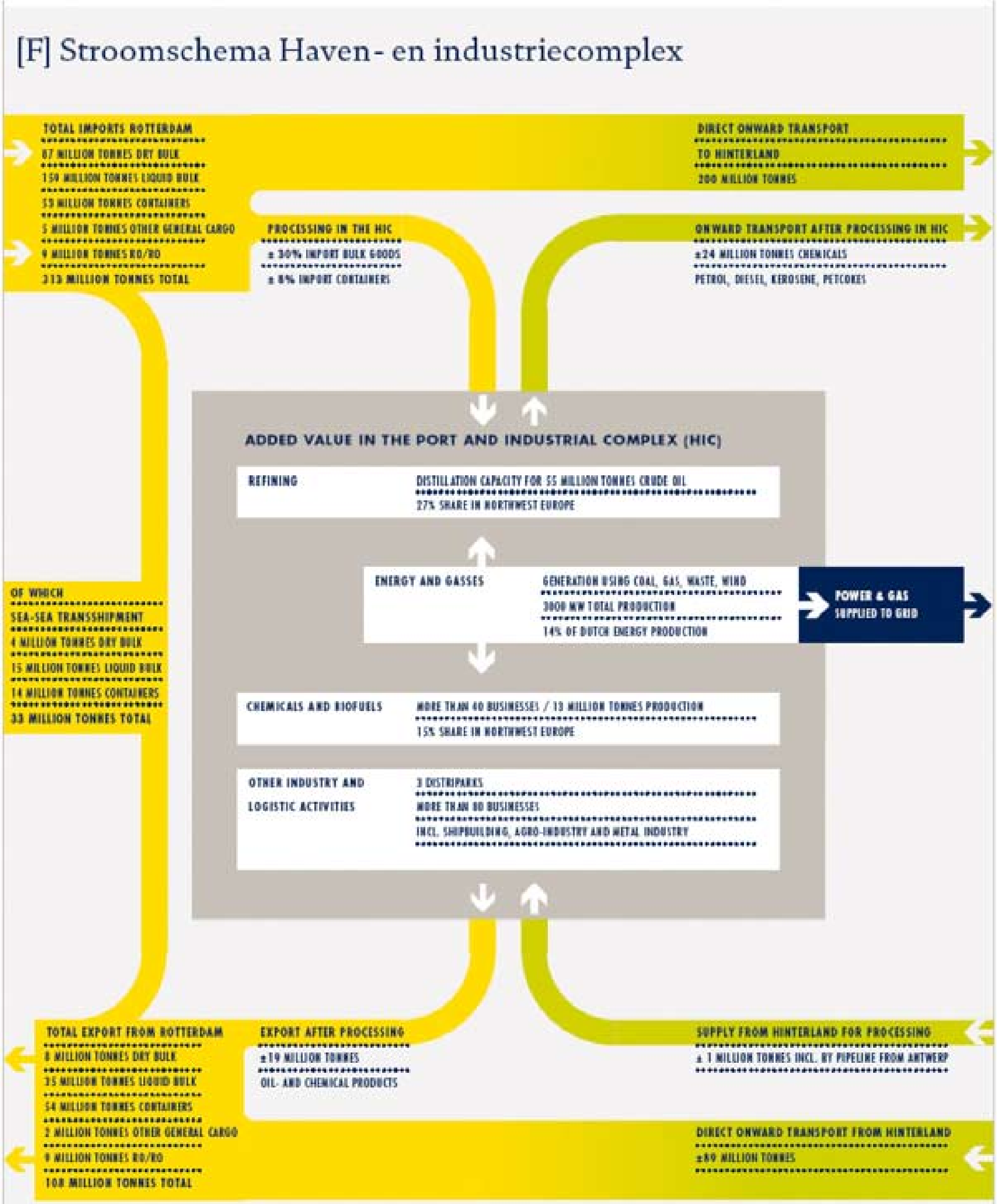

Figure 2.3: Flow scheme depicting mass flows for the port and HIC

Electricity production, utilities and crude oil refining are branches that account for more than 80% of the total emissions in the Rijnmond area (DCMR, 2009:5).

Emission	2000	2001	2002	2003	2004	2005	2006	2007
CO_2	23,683	24,419	22,741	24,774	25,603	26,008	24,988	25,232
Carbohydrates	14,886	13,565	12,576	11,888	12,753	15,982	15,511	14,694
NO_x	23,672	25,501	23,424	24,248	23,092	23,862	23,406	17,400
SO_2	35,556	34,756	31,589	30,084	33,814	33,324	33,839	31,252
Total fine particles	3,914	3,267	3,068	3,915	3,233	3,691	3,180	3,113
NH_3	227	37	41	36	40	37	72	65
Carcinogens	85	135	113	141	100	168	191	183

Table 2.2: Emission data for the Rijnmond region in the period of 2000-2007. Data for CO2 are given in kton/year, other data in ton/year (DCMR, 2009:5)

The totals for these emissions add up to over 25 Mton per year. This is within the figure of 38 Mton derived earlier. However, we would like to note that many (chemical) processes make use of resources that do not have to be transported to the Mainport, such as air and water. E.g. the combustion of coal in the E.ON power plant not only requires coal, but also air, which mainly consists of nitrogen (80%) and oxygen (20%). Through combustion, oxygen, nitrogen and coal are, amongst others, transformed in CO2, and NOx. For a CO2 holds that over 72% of the weight can be attributed to the oxygen molecules and thus 72% of CO2 comes from air. Since air is not bought, or transported to the Mainport, this weight does not show up in flow schemes such as figure 2.3. As such, data presented on material flows and emissions can differ substantially.

2.3 Energy

2.3.1 Energy production

The total energy production in the Mainport is done by several power producers. Most power plants are not owned by a single company but part of a joint venture. The present electricity production of the Mainport equals roughly 3,000 MW. This is 14% of the total Dutch production. There are several plans for building more power plants with a total extra capacity of roughly another 3,500 MW in order to cope with the rising energy demands (Melieste, 2006). In table 2.3, an overview is given of several different power plants, their capacity and CO2 emissions. This table is not complete. This is because some electricity is also produced on site.

Company	Capacity (MW)	CO_2 emission (kton/y)	CO_2 emission (kton/MW)
Rijnmond Energie	820	1568	1.9
E.ON	1040	6983	6.7
PerGen	300	580.8	1.9
Air Products	43	n.a.	-
Eurogen/Enecal	130	682	5.2
Europoort Utility Partners	25	102.5	4.1
UCML	70	n.a.	-
63 Windturbines	120	n.a.	-
AVR	100	1080	10.8
Total	**2648**	**n.a.**	-

Table 2.3 Carbon dioxide emissions per electricity producer (DCMR, 2009; Melieste, 2006)

Note that there is a large difference in CO2 emission per MW. This shows that the feedstock is extremely important. The gas fired power plant of Rijnmond Energie emits per MW electricity almost 3.5 times less than the coal fired power plant of E.ON, and even five times less than the waste incinerator AVR.

2.3.2 Energy use

Specific quantitative data on the energy use of the chemical processes operated in the HIC could not be found. It is, however, possible to make an estimate on the total use of industry. In general, it can be said that the oil refineries and chemical industry are highly energy intensive. When viewed from an energy/mass perspective; oil refineries and base chemicals are less energy intensive products than fine chemicals are. The magnitude of these processes, however, results in a very high net number. In 2002 the energy use of the Harbour Industrial Complex exceeded 477 PJ/year (1 PJ = 1015 J) and this number is expected to rise to 758 PJ/year by 2020. Interpolation results in a present energy consumption of 600 PJ (Bouma, 2004:3). In relation to the production is this approximately 16 %.

We note here that many industrial processes require cooling. The cooling water for these processes is obtained from surface water. Though we were not able to quantify this, a large amount of (low quality) heat is emitted to the surface water through cooling. This is used as a basis for the design of the heat network in Chapter 07.

2.4 Economy

In this section the economical importance of the Mainport Rotterdam is described. The Mainport Rotterdam offers a diverse supply of harbour related services; transport, logistics, wholesale and financial and ICT related services. A large part of the chemical, energy, metals and maritime industry is located within de Mainport. Together, the activities employed in the Rotterdam harbour area contribute over 11 billion Euros of added value and supply over 86,000 jobs. This is approximately 45% of the total jobs related to harbour activities in the Netherlands (Ministry of Economic Affairs, 2009:27).

The sea and airports of the Netherlands are very important for the position as a trading nation, because they contribute to international accessibility. As can also be seen from figure 2.3, the Mainport Rotterdam handles very large transit volumes. Rotterdam has a market share of 35% in the Hamburg- Le Havre range described in section 2.1. This market share is mainly due to several advantages such as a scale advantage, synergetic effects of the harbour and the harbour industrial complex and clustering advantages. The transport and logistics cluster and the petrochemical and energy cluster are contributing for 92% to the added value of the region of Rotterdam. The location of the petrochemical and energy cluster within the Mainport are an advantage, since this saves transport and storage costs. It is of national importance and accounts for more than 20% of the total Dutch chemical sector (Ministry of Economic Affairs, 2009:21-37).

2.5 Mainport governance structure

Several key players are governing the Mainport. The port of Rotterdam itself is managed by the Port of Rotterdam port authority, a former municipal department that changed to a public corporation. However, the municipality of Rotterdam remained the only shareholder (until summer 2005, from 2006 the national government has a minority share). The management (executive board) is not longer controlled by the municipality but by a supervisory board. Next to safe and efficient management of vessel and cargo flows, the Port of Rotterdam port authority also invests substantially in other activities employed in the Mainport region. The rest of the Mainport consists of several large industrial players in the petrochemical and energy sector and numerous small companies. Indirect governance is also performed by regional and national government through means of (environmental) regulation and permits (de Langen, 2007: 119-123).

The main conclusion from this section is that, other than in the Greenport where governance is highly dispersed (see Chapter 03), the Mainport is governed by several big players: the port authority, industry and municipality. This makes that implementing innovative ideas on a large scale, such as necessary for sustainable development, can be done rapidly. That is, only if these ideas are supported by the key players.

2.6 Discussion

The Mainport Rotterdam is the largest harbor in Europe. As described in this chapter, it is of major importance to the Dutch economy, but also constitutes a large environmental impact in terms of pollutant emissions. The Mainport Rotterdam has several advantages related to scale, clustering and concentration of various the activities. However, several improvements can be made in terms of enhancing market position in the container area, reducing congestion of the region and improving sustainability (or at least, reducing environmental impacts). This may be done by inviting new companies to start on the Maasvlakte 2 to fill in a niche of using a waste stream from already present companies, and in doing so decrease the environmental impact and use resources in a more efficient way. Expertise on clustering is present, so that should not be a problem. Economic benefits could be derived from this as well, by selling waste streams to other companies, but also by not having to pay for polluting emissions, like for example in the carbon dioxide emission trading scheme.

References

Journal sources

de Langen, P.W. van der Lugt, L.M. (2007) Governance structures of port authorities in the Netherlands in: Devolution, Port Governance and Port Performance, Research in Transportation Economics, Volume 17, Ch. 5 pp 109-137

Web sources

Bouma, J.W.J (2004) The Rotterdam Sustainable Energy Port and Industry Transition, IEA workshop Tokyo

DCMR (2009) Inventarisatie en vergelijking jaaremissies over de jaren 2000-2008, available via http://www.dcmr.nl/binaries/publicatie/2009/lucht/inventarisatie_en_vergelijking_jaaremissies.pdf, accessed March 19th 2010

Melieste, R. (2006) Rotterdam Energy Port, ppt presentation Port of Rotterdam, available via http://www.co2storage.org/Reports/ENERGY%20PORT%20presentatie%20english.ppt, accessed March 16th 2010

Ministry of Economic Affairs (2009) Economische visie op de langetermijnontwikkeling van Mainport Rotterdam, the Hague, publication nr. 09OI20

Port of Rotterdam (2007), Facts and figures on Rotterdam’s oil and Chemical Industry

Port of Rotterdam (2008), Jaarverslag 2008

Port of Rotterdam (2008), http://www.portofrotterdam.com/mmfiles/kerncijfers_industrie_tcm26-19701.pdf, accessed 16th March 2010

Port of Rotterdam (2010), http://www.portofrotterdam.com/nl/rotterdamse_haven/havenkaarten/branches/index.jsp,accessed 16th March 2010

8 The main harbours in the Hamburg-Le Havre Range are Antwerp (B), Hamburg (D), Le Havre (F), Amsterdam (NL), Wilhelmshaven (D), Dunkirk (B), Bremen (D), Zeebrugge (B), Zeeland Seaports (NL), Ghent (B) and Rotterdam (NL).


Photo: Google earth, 2006

Chapter 3

Current situation of the Greenport

3.1 Introduction

Greenport Westland-Oostland is one of the five Greenports in the Netherlands. The main activity in this area is focused on glasshouse horticulture and is the world's largest contiguous glasshouse horticultural cluster and thereby a site of national importance. The activities consisting out of trade, production, supply, distribution, services (export), processing of several production types (vegetables, fruit, plants and flowers) and knowledge-exchange (production/supply).

Nearly 30% of all employment in the Dutch horticultural complex is concentrated in Westland-Oostland and thereby responsible for a production of €2.3 billion. Despite declining glasshouse surface area, production rates are increasing. In the province of Zuid-Holland the area addressed to glasshouse horticulture dropped down from 6,056ha in 1995 to 5,337 ha in 2007. Figure 3.1 shows an overview of the glasshouse horticulture in the Westland-Oostland area. Greenport Westland-Oostland includes the municipalities Westland, Midden-Delfland, Pijnacker-Nootdorp, Leidschendam-Voorburg, Lansingerland, Zuidplaspolder (Zevenhuizen-Moerkapelle, Nieuwerkerk aan de IJssel) en Waddinxveen (Gemeente Westland, 2009: 43). The Greenport is restricted by urban areas, mainly Rotterdam and the Hague and designated green areas such as Midden Delfland (the green heart) and water area's like the North sea and the river Nieuwe Maas.

Figure 3.1: Glasshouse horticulture in Westland-Oostland (source: Integrale visie Greenport Westland-Oostland)

3.2 Mass

To date, no extensive input- output analysis of the Greenport has been carried out. In annual reports of Flora Holland, HBAG (Hoofdbedrijfschap Agrarische Groothandel) and FrugiVenta, the import and export numbers of vegetables and plants are published, without making distinction of destination. Buck Consultants, in their report called Florein, made rough estimations about export streams in several chains. The amount of biomass, originating from greenhouses is unknown, due to decentralized treatment (Koekebakker, 2004).

3.2.1 Logistics

The glasshouse horticulture Greenport Westland-Oostland can be roughly divided in three product types: vegetables and fruits, in lesser extent, and plants (pot- and bedding plants) and flowers. These three

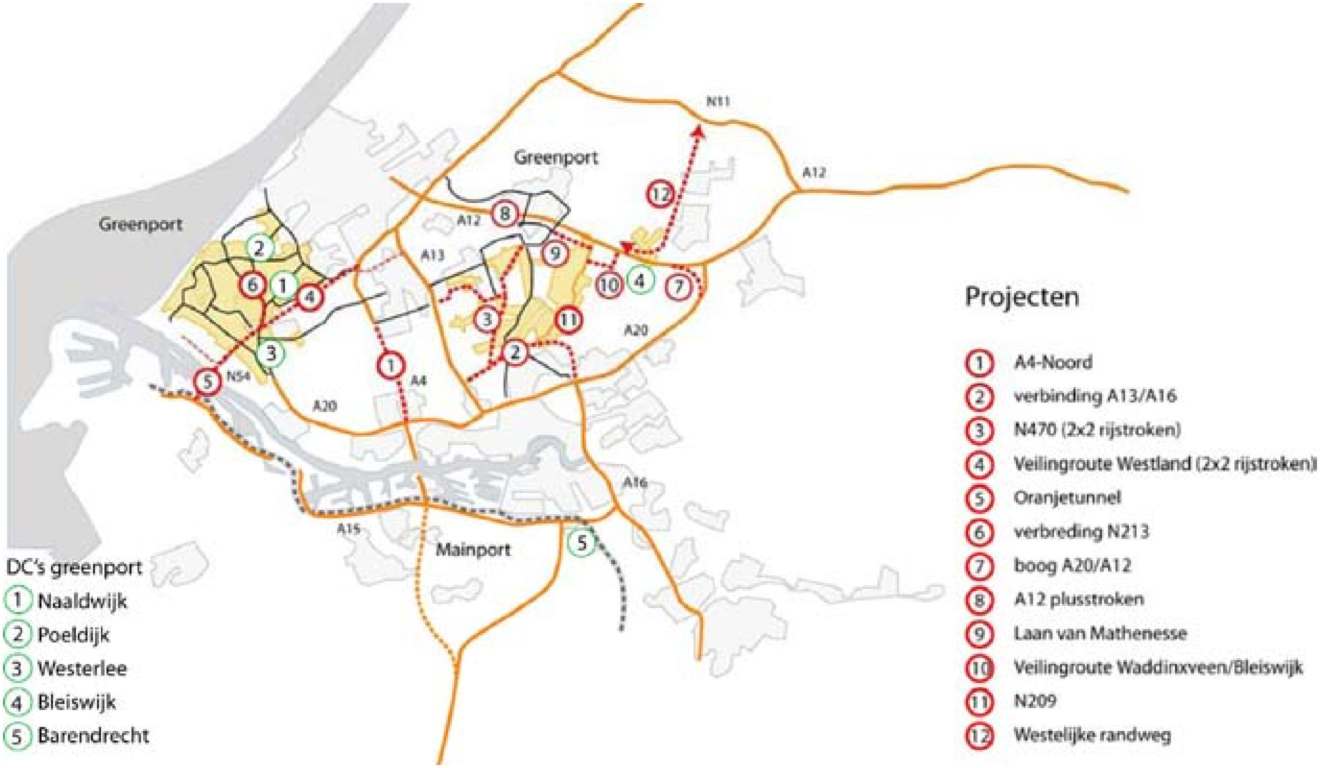

Figure 3.2: Main distribution centres and current projects of improving road infrastructure (source: Integrale visie Westland-Oostland 2020)

types of products all have their own distribution chain in a densely used area. This small available space creates problems for the infrastructure in the Greenport. Almost all transport of glasshouse product takes place by truck, on a problematic road network. In figure 3.2 an overview is given of the main distribution centres and current projects of improving road infrastructure.

The production chain of flowers starts with the production of flower bulbs. Bulbs are most of the time grown abroad and enter the Netherlands through the Mainport of Rotterdam or Schiphol. Then, the bulbs go by truck to a distribution centre close to the production sites. The bulbs are sorted and from there distributed to the flower producers by road transport. After harvest the flowers are transported by road to auction. From the auction, the flowers are transported to a distribution centre (often located next to the auction facility) where they are being send to the wholesale trade. 96% of the flowers go to the wholesale trade within Europe via road transport and 4% leaves by plane via Schiphol Airport to countries outside of the European Union (mainly US, Japan and Canada) (Van de Geijn & partners, 2006). Flowers travel to the UK by truck and ferry, or trucks using the channel tunnel. Furthermore, distribution also takes place via the Fruitport in the Rotterdam Mainport. Unfortunately it was impossible to get an exact number on how much of the Greenport's products leaves the country via the Fruitport.

The plant residual material is considered as waste and is transported by truck to a central collection centre. This gives an opportunity for future selection of specific sources of plant material for harvesting of biological compounds.

The production chain of vegetables starts in the Greenport itself. Seeds are produced for production of new vegetable plants in for example De Lier (Rijkzwaan.nl). The next step involves cultivating young vegetable plants from the seeds which takes place in, for example, Maasdijk (Beekenkamp.nl). These young plants are then transported to the horticultural entrepreneurs by road, where the plants are cultivated to adult plants and eventually their fruits can be harvested. Until a couple of years ago, the vegetables were transported to an auction, but nowadays, greenhouse entrepreneurs have formed cooperations which sell at a fixed price to wholesale companies. Transport to these companies is mostly done via road.

Several initiatives are taking place in making the transport from the Greenport to the end user more sustainable and with less trucks on the road. Three examples will be used to give an overview of different developments in this field. Fresh products are always transported on pallets, in refrigerated trucks and refrigerated area's in ships. For air transport refrigerated containers are used. Currently a new technique, Coolboxx, is used. This refrigerated container prevents several handling steps of the pallets in the Fruitport. This container can be placed on a short sea ship, river transport, train and a truck. An important advantage is that trains, ships and trucks are easily adapted for transporting a Coolboxx (Frugiventa, 2004).

Fresh Corridor is an initiative to stimulate the transport of fresh products with river boats and short sea connections to other countries, like France, Belgium, Spain, etc. Because transport of fresh products is more and more containerized, Fresh Corridor sees a large opportunity for conditioned transport by ship. Switching to this new kind of fresh product transport could partly solve the congestion problem on the Dutch highways. Every day, a lot of trucks try to find their way from the auctions to the distribution centres over a small amount of roads. When part of this can be done by ship, this would decrease the amount of trucks on the road. Goal of this project is not only making the logistics of fresh products more sustainable, but wants to do this in an economically feasible way and it tries to increase the accessibility of the markets (agrologistiek.eu).

Greenrail is an initiative to stimulate the transport of flowers and plants by train. Flowers and plants are transported with trucks to the train station, from where it can depart to a lot of European destinations, without having the trouble of road traffic congestion (Kennisalliantie.nl).

These last two initiatives can be combined with Coolboxx to get an even better result for the logistics in the Mainport and Greenport transport network. The fresh products don't have to be repacked over and over again once they are in the Coolboxx container.

3.2.2 Production

While discussing the Greenport, it is useful to make a distinction between vegetables & fruit, plants (pot- and bedding plants) and flowers. The production and major product categories are listed in the circle diagram of figure 3.3.

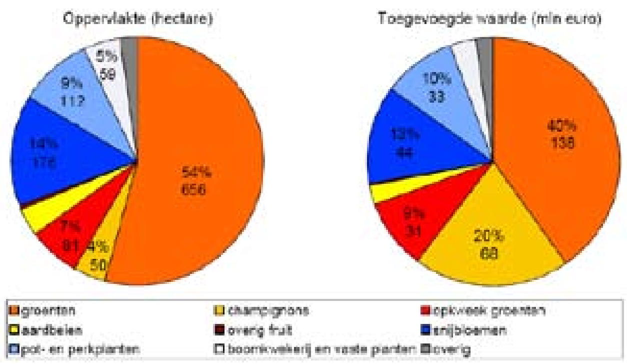

Figure 3.3: Surface and added value of major product categories (source: De kracht van het Westland)

provincie Zuid-Holland | Xplorelab

3.2.3 CO2 supply

OCAP (Organic Carbondioxide for Assimilation of Plants), is a joint venture between gas supplier Linde Gas Benelux BV and construction company Volker Wessels. It delivers pure CO2 to greenhouses in the Westland. OCAP is a partnership contracted with the Rotterdam Climate Initiative (RCI). This is an ambitious program in which the municipality of Rotterdam, Port Rotterdam, DCMR (Dienst Centraal Milieubeheer Rijnmond) - Environmental Agency Rijnmond - and Deltalinqs cooperate to mitigate climate change. The ambition: in 2025, CO2 emissions in the Mainport Rotterdam should be reduced by 50% compared to the emission level of 1990. The OCAP project seamlessly integrates the ambition of the RCI and therefore is one of the mainpillars in the initiative. Both parties, OCAP and RCI, work together to connect the horticultural industry in the region of Rotterdam to the OCAP network.

CO2 is a side product of the hydrogen production of Shell in the Botlek and would otherwise be emitted into the atmosphere. OCAP provides CO2 through an existing pipeline and a newly constructed distribution network. In this way greenhouse entrepreneurs can save up to 95 million cubic meters of natural gas per year. This exchange results into a reduction of CO2 emissions of about 170,000 tons per year. By doing so, this project is showing a unique collaboration (Limbeek, 2009).

3.2.4 Water

Water usage is playing an active role in greenhouse innovation. The water quality and availability of sweet water has to be regulated. Many greenhouses use rain water stored in large reservoirs and during dry periods, some greenhouse entrepreneurs choose to extract surface water. This water however, has a poor quality which is not desired for growing tomatoes, for instance. Other greenhouse entrepreneurs choose to extract groundwater, which faces the risk of being depleted. For this reason, the amount of rainwater available should be used in its full potential (Witberg, 2007). In the project "Waterbalans Overbuurtse Polder" commissioned by the Province of Zuid-Holland, carried out by Aqua-Terra Nova, the possibilities for a closed water system are investigated. By using this system, no surface or groundwater is needed and no discharges of salty pulp, which results into a very small waste stream (Zuidholland.nl).

3.2.5 Residuals

Water: In nurseries, usually large amounts of wastewater are produced. Currently, the wastewater is discharged directly to the surface water (ditches, etc.) in most cases. However, on October 18th 2007, the municipality Westland and the Westland Water Improvement Foundation, signed an agreement to stimulate water quality improvement. Around 300 growers in the Westland were not allowed anymore to discharge their industrial water on the surface water. The waste water is transported to an existing drainage system specifically for seepage water. The gardeners carry less brackish water through this system, so the capacity is increased for wastewater.

Biomass: the total amount of biomass as separated from the products (foliage plants etc.) is estimated 155,000 tons of biological residual material. After collection most of the biomass gets incinerated by regional companies for energy recovery. Besides that; in the Netherlands, 180 bio-fermentation plants are used by agricultural companies. In the Province of Zuid-Holland there are about three bio fermentation plants. Almost all biomass gets incinerated by waste treatment companies like Van Vliet recycling, located in Hoek van Holland (Huisman, 2009).

Emissions to environment: The emissions of nutrients, for example nitrogen and phosphorus are caused by two processes: Water Drainage: The nutrients originate from the cultivation of land (land-based farming), where excess water is removed through drainage. Excess water is not reused (recirculation), but is immediately removed.

Water Irrigation: The nutrients originate from crops grown on substrate (substrate production). These are root crops grown in a medium (e.g. Rockwool) separated from the substrate. Since 1996, the compulsory excess water is to be recirculated, thus reducing discharge systems in contrast to a situation without recirculation.

Other adverse emissions arise due to the use of Combined Heat and Power plants: CO_2, NO_x, methane, ethene, particulate dust. A favourable emission arises due to the photosynthesis process in greenhouses: oxygen (O_2) (Dueck, 2008)(Rijkswaterstaat, 2009).

3.3 Energy

3.3.1 Energy consumption

The glasshouse horticultural sector is still a major energy consumer and a producer of CO_2. The greenhouses in the Westland-Oostland area are using an estimated value 56 PJ of energy. In total the glasshouse horticulture is consuming 140 PJ.

A lot of effort is put in addressing options for decreasing energy use, introduction of alternative (renewable) energy sources and intelligent networks.

Finding appropriate networks for heat supply and streamlining them is the most important task. The combination “housing and glasshouse horticulture” is used as an example in this context. Especially in heating and lighting innovations in energy saving is expected. A number of existing energy saving techniques exist to reduce energy usage of greenhouses, for example: movable screens, flue gas condensers, heat storage and temperature integration have already achieved a high implementation rate. In addition, there are new opportunities for energy reduction in greenhouses, in particular (semi-) closed greenhouse systems. Besides that there’s a growing interest for onsite geothermal plants. Calculations by the WUR Institute, Greenhouse Technology, show that geothermal energy could be an interesting alternative. Tomato greenhouse entrepreneur R. van den Bosch, located in Bleiswijk (Oostland), is the first entrepreneur who is making use of geothermal heat. The geothermal source delivers about 150 m3 of water per hour with a constant temperature of over 60 °C (Wetzels, 2009)(Nlog.nl).

3.3.2 Energy production

Onsite energy production by using combined heat and power gas-engines is increasing the last couple of years. The explosive growth of CHP capacity in the Westland led to overproduction of electricity in 2007. The electricity supply in the Westland could grow no longer, and tended to become stuck in a permanent state of overcharge of the energy grid. Thanks to congestion management, defined as the actions taken to avoid or relieve congestion in a certain electricity grid, many problems were solved to decrease this overcharge.

Recently, several experiments have been carried out to facilitate housing projects with heat surplus originating from greenhouses. The newly constructed dwellings, in the residential area Hoogeland in Naaldwijk, can be heated by residual heat from the cooling water of the (semi-) closed greenhouse Prominent, 800m away from the dwellings. The heat delivered to 1,200 houses will correspond to approximately 400,000 m3 of natural gas equivalents per year (Energeia.nl).

Recent research by Cogen Projects and Wageningen University shows that energy from biomass originating from greenhouses is a feasible option as well. Furthermore it can meet the target for biomass energy production 2020, carried out by the Municipality Westland (Energiek 2020.nu). DHV, providing consultancy and engineering services, has investigated the potentials for biogas production by bio-fermentation plants in Zuid-Holland, showing that biogas could fulfil up to 13% of the gas demand of the total province (Mul, 2010).

3.4 Economy

Greenports are of regional and national importance. In the glasshouse horticulture in the Province of Zuid-Holland are 65,000 jobs available, of which 28,500 are direct jobs and 36,500 are indirect jobs. Internationally, this sector is of great economic importance: 80% of trade in horticultural food in the Netherlands passes through Greenport Westland-Oostland. 60% of trade in cut flowers and pot plants in the Netherlands passes through the Greenport. The product turnover is about 2.5 billion, with a significant export worldwide. Production value: €2,300 million (0.9% of the national economy) - €538 million vegetables - €1,756 million flowers, pot- and bedding plants. In 2008 There were 1,690 companies located in the Greenport (approximately 70% orientated on floriculture)(Rabobank, 2008).

3.5 Information, knowledge & organisation

3.5.1 Knowledge & education

The greenhouse cluster propagates a high level of knowledge when it comes to specific technologies and professional logistics concepts. Exchange of this knowledge with other disciplines and stakeholders is essential for competitiveness with other Greenports. Knowledge institutions such as the WUR, the Agricultural Economic Institute (LEI), the Applied Plant Research (PPO), Technical University of Delft and the life-science cluster Haaglanden Leiden are high regarded. There is plenty of innovation in progress. The government focuses on energy, water, spatial and environmental issues. Innovative applications of today and the near future include the floating greenhouse, multifunctional use of space, the application of nanotechnology for crop protection and fuel cells. The greenhouse appealing as an energy supplier (development to large scale closed greenhouses) is a relatively new feature with high incentive. A weak aspect of the Greenport is the relatively high percentage, of 30.8% of low educated people, in comparison with the average 25.7% in the province of Zuid-Holland (Rabobank, 2008).

In the Netherlands several knowledge institutions are present to support innovations in the Greenport:

- WUR, University of Wageningen: leading University on agricultural issues with a broad scope
- TU Delft
- Greenport Business School
- InHolland Hogeschool Den Haag, Agriculture
- Frugiventa
- Improvement Centre: carries out several experiments, mostly in the area of energy
- Demokas: carries out several experiment for different purposes, e.g. led lighting
- Aqua Terra Nova: knowledge about water management systems for greenhouses
- Ecofys: knowledge on several agricultural areas
- Transforum: knowledge about metropolitan agriculture
- Agro Adviesbureau: knowledge about horticulture

3.5.2 Organisational structure

The study ‘Strength of the Greenports in the Province of Zuid-Holland’ shows four levels of the greenhouse-building, which explains the basic composition of a Greenport: nursery, logistics, technology/services and vitality, visualised in figure 3.4.

Nursery in the Greenport is acknowledged by higher quality products en processes, strong technology development, scale enlargement, spatial intensification and an increasing energy production in the area. The second level, logistics, include chain management from harvest to sale. Multimodal networks (road-, water-, railroad-, areal transport) are the basis for an efficient performance of the Greenport. This level also includes the connection between Mainport and Greenport which is desirable to enhance further.

The third level, technology and services addressed to several areas: energy, lighting, climate control, information technology, water usage and sensoring.

In the fourth level 'vitality', the needs and emotions of the consumer are incentives, connected with life sciences, lifestyle and design. The activities of these companies inspire the decisions in the companies in the first three levels. The levels are supported by four columns: sustainable development, climate of innovation, employment & education, and spatial planning & infrastructure (Ruijs, 2009: 19-23).

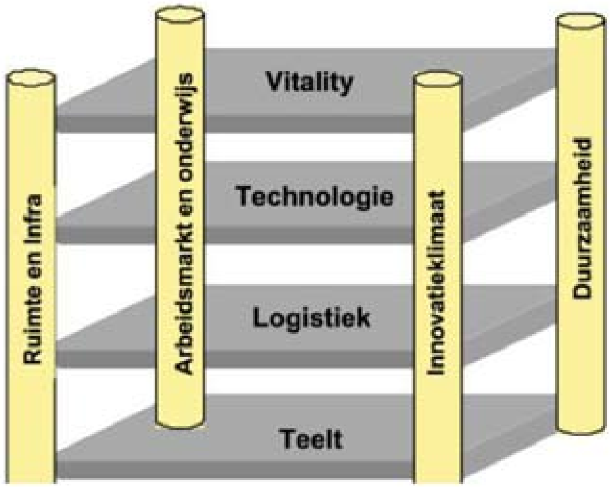

Figure 3.4: The Greenport building

3.6 Current developments

As pointed out by Vision 2020 Greenport Westland, the municipality puts the emphasis on strengthening the greenhouse cluster, an ongoing restructuring of the glass areas and improving the physical accessibility. Besides that, the living environment will be improved through a number of sustainable spatial developments: space for living, working and recreation. In the area of Westland over 10,000 houses will be developed. On the south side of Naaldwijk in the municipality of Westland, a health centre and urban area will arise the coming years, making use of the heat surplus from semi-closed greenhouses. Currently several developments and future trends are visible: increase transportation by train and vessel, innovate and enlarge added value turnover – going from 10 to 20 billion Euro- on fresh products, developments for new markets for fresh products & technology and an increase in sustainable production (lower food mileage / lower carbon footprints/ lower CO2 emissions by 48%) (Greenportsnederland.nl) (Gemeentewestland.nl).

To give shape to the ambitions, currently several projects are carried concerning sustainable development in the Greenport:

- Spatial economical vision Greenport Westland-Oostland
- Heat distribution supplied by greenhouses to new housing projects
- Signature en development covenant Zuidplaspolder
- Masterplan AquaReUse Overbuurtse Polder
- Rosenuresery project Schieland and Krimpenerwaard
- Waterkader Haaglanden
- Feasibility study heat distribution Hoogeland
- Sewer system Glasshouse horticulture
- Electricity production in Greenport and distribution towards the grid
- Innovative housing in Poelzone development area

3.7 Discussion

The Greenport Westland-Oostland is one of the main centres of world trade regarding plants, flowers and vegetables. Greenport is a concept based on cluster approach. It is not just about the primary process, the cultivation of flowers, trees, bulbs and vegetables. Supply companies in the area of transport and logistics, banking and insurance, energy and processing are structuring and value adding components of the whole. Along with knowledge and research institutes. Many greenhouse entrepreneurs are dealing with water and energy problems, but currently several (pilot) projects are carried to deal with those problematic issues. To conclude the strengths and weaknesses are summed up, below:

Strengths	**Weaknesses**
Low unemployment	Low educational level
Great job motivation	Limited expansion
Companies Networking	Unilateral economic structure (strong focus on horticulture)
Proximity urban market area	Congestion and outdated urban market infrastructure
Proximity urban labour market	Tightness on the labour market
Location relative to Mainport	Image greenhouse area
International connections	Fragmentation and lack of space

References

Journal sources

Dueck, T.A., van Dijk, C.J., Kempkes, F., van der Zalm, T., Emissies uit WKK installaties in de glastuinbouw, WUR, 2008

Web sources

Agrologistiek.eu, http://www.agrologistiek.eu/?id=31&grp=2, visited on 26 January 2010

Beekenkamp.nl, http://www.beekenkamp.nl/vegetables/vegetables.htm, visited on 12 February 2010

Energeia.nl, http://www.energeia.nl/dossier.php?DossierID=26&ID=39099, visited on 26 January 2010

Energiek2020.nu, http://www.energiek2020.nu/in-de-praktijk/geslotenkas-prominent/nieuws/1550, visited on 26 January 2010

Frugiventa, Coolboxx, impact voor de groenten- en fruithandel, 2004

Gemeente Westland, Duurzame greenports in de Randstad: een wereldkans, 2009

Gemeentewestland.nl, http://www.gemeentewestland.nl/Smartsite.shtml?ch=GRE&id=55498, visited on 27 March 2010

Greenportsnederland.nl, http://www.greenportsnederland.nl/Content/www.greenportsnederland.nl/Documenten/Greenports%202020%20challenges.pdf, visited on 27 March 2010

Huisman, C., (March 17th 2010), Personal communications with M.A. Feberwee

Kennisalliantie.nl, http://www.kennisalliantie.nl/index.php?id=34236, visited on 12 February 2010

Koekebakker, E., Florein: Naar een infra- en ruimtebeleid voor Greenports, Buck Consultants, 2004

Limbeek, J., OCAP, CO2 voor de tuinbouw, Factsheet, 2009

Mul, P., Kooij, van der, A., van biomassa naar biogas, kansen in Zuid-Holland, DHV, 2010

Nlog.nl, http://www.nlog.nl/resources/Geothermie/Profiel2vdBosch%5B1%5D.pdf, visited on 27 February 2010

Rabobank, De kracht van het Westland Jubileumeditie 2008, 2008

Rijkswaterstaat, Lozing nutriënten vanuit glastuinbouw, 2009

Rijkzwaan.nl, http://www.rijkzwaan.nl, visited on 12 February 2010

Ruijs, M.N.A., et al, Kracht van de greenports Zuid-Holland, 2009

Van de Geijn & partners, infra- en ruimtebeleid voor Greenports: werkdocument, 2006

Wetzels, W., et al. Kenschets van de Nederlandse glastuinbouw, ECN, 2007

Witman, Bouwstenen Glastuinbouw-bedrijvenlandschap Zuidplaspolder, 2007

Zuid-holland.nl, http://www.zuid-holland.nl/overzicht_alle_themas/thema_programma_en_projecten/glastuinbouw/content_duurzaam_en_hoogwaardig.htm, visited on 27 february 2010

Illustration

Chapter 4

Combining the Mainport and Greenport

4.1 Introduction

In order to evaluate possibilities for sustainable development, by interactions of the Mainport and Greenport, a stakeholder assessment has been done and SWOT analysis has been made. This chapter describes the outcomes of these analyses. Section 4.2 starts with the stakeholder assessment, in which key stakeholders are identified, and connections between stakeholders are described. Section 4.3 continues with the SWOT analysis for combining Mainport and Greenport.

4.2 Stakeholder assessment

When a government is willing to make changes in a densely populated region, with a lot of companies present as well, a stakeholder analysis of the region is necessary to find out the different viewpoints and connections of the stakeholders. Stakeholders include those individuals, groups and other organizations who have an interest in the actions of an organization and who have the ability to influence it (Savage, 1991). This influence can be executed in many different forms and does not have to be explicit. In the MP-GP complex, the stakeholders can be split into three main groups: Mainport stakeholders, including companies in the Mainport and their shareholders; Greenport stakeholders, including greenhouse companies in the Greenport and their suppliers; external stakeholders, including higher governments research institutions. Stakeholder analysis can be used to generate knowledge about the relevant actors so as to understand their behaviour, intention, interrelations, agendas, interests and the influence or resources they have brought -or could bring- to bear on decision-making processes (Brugha, 2000). When the analysis is done, it will be clear in what policy environment one is operating. It also helps to assess the feasibility of future policy directions and to develop strategies for managing the stakeholders.

According to Jepsen et al. (2009) there are several steps in the stakeholder analysis. The first step is to identify the stakeholders. One way of doing this is a brainstorm session (Calvert, 1995). If the boundaries of the project are clearly defined, the stakeholders will be easily defined (Reed, 2009). In this case the boundary is mainly geographical. The brainstorm session generated a list of stakeholders in both the Mainport and the Greenport, as well as external stakeholders like EU government and Universities. The next step is to characterize the stakeholders, regarding the contributions needed from them, the rewards achieved by them when joining the project and their power in relation to the project. When this information is gathered, a strategy can be developed to influence all the different stakeholders to head in the right direction to achieve the goals of the project.

4.2.1 Identification of stakeholders

For the first stage of the stakeholder analysis brainstorm session is done to make a list of all the different stakeholders. The stakeholders of various parts of the region are placed in separate lists, one for the Greenport, one for the Mainport and one for the remaining stakeholders which influence both, but are not actually situated within the region. This list is used to create a map of all the stakeholders and their relations. In order to map the relations between all the various stakeholders one can use an actor-linkage matrix. In this matrix the stakeholders are listed in rows and in columns of a table and so creating a grid (Reed, 2009). All the stakeholders (Mainport, Greenport and external) are listed in this matrix. Keywords can be used to fill in the table. A popular method for this is to determine whether the relationships between the stakeholders are of conflict, are complementary or are of cooperation. This separation can be difficult to make in real life situations, because stakeholders can have ambiguous relations. Sometimes their goals are conflicting so that their relation is one of conflict, while at other times they have the same goal, from which cooperation and competition can originate. The actors from the matrix can then be connected in the stakeholder map.

In this stakeholder map of figure 4.1 the two central stakeholder groups of this research have a central position, the Mainport and the Greenport producers. As can be seen, these stakeholders are not directly connected and although it looks like they are connected through other stakeholders, this is only marginally the case. In the next stages of the stakeholder analysis, the different stakeholders and their connections are characterized.

4.2.2 Characterization of stakeholders

In this phase of the research, the roles and the positions of the stakeholders is investigated and also their power in relation to the project. Because this project is about future development of the region, visions of the main stakeholders on the future are also included in this part of the research. The two main stakeholder groups are clearly defined, but the other groups are different companies for the both main stakeholders. The roles of the eleven different groups of stakeholders from the stakeholder map in the MP-GP complex:

- Mainport producers: the role of the Mainport producers is using raw materials to produce consumer products. Examples of these producers are companies from the chemical industry (DSM, Akzo Nobel, Nerefco, etc.), the petrochemical industry (Shell, Q8, Esso, etc.) and electricity producers (E.on, RWE, Electrabel, etc.). (Port of Rotterdam, Facts and figures, 2007)
- Greenport producers: in this report, when Greenport producers are mentioned, the owners of greenhouses

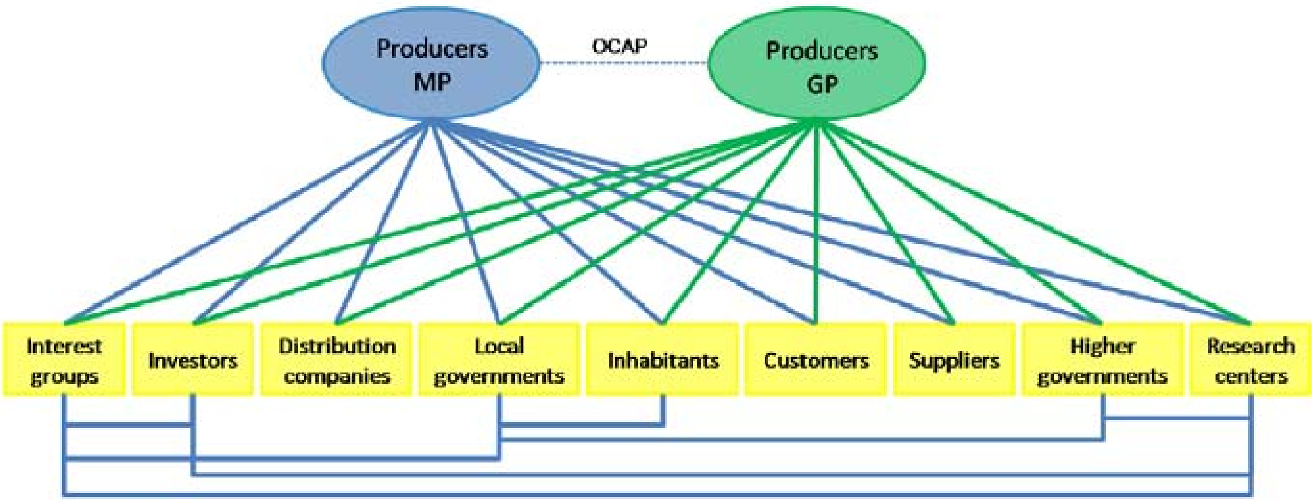

Figure 4.1: Stakeholder map of the Mainport and the Greenport

are meant. Their role in the system is the production of greenhouse products, like vegetables (peppers, tomatoes, cucumbers, courgettes, aubergines, etc.), flowers (roses, lilies, chrysanthemum, etc.) and plants (tropical plants, potted plants, etc.).

- Interest groups: these interest groups represent the sector in one or another way, or represent the external environment. For example, they are structuring the communication in the sector or stand up for the environment.

Greenport: Productschap Tuinbouw, LTO-Glaskracht, Greenport(s) Nederland, Greenport Westland-Oostland. Mainport: Havenbedrijf (Port of Rotterdam), Deltalinqs. External: Milieudefensie, Greenpeace.

- Investors: these companies are investing money for developments. Rabobank, Senter Novem and private investors.
- Distribution companies: these companies take care of all the transport to and from the producing companies. Truck transport, train transport, ship transport, plane transport, distribution locations (Flora Holland, Harbor Rotterdam).
- Local governments: they are important stakeholders, because they set the rules in which the producing companies may function. Municipalities of Westland, Lansingerland, Pijnacker-Nootdorp, Rotterdam.
- Inhabitants: they are the closest neighbours of the producing companies and they have to be taken into account during the production process. They inhabit one of the municipalities mentioned above.
- Customers: these can be individual customers or corporate clients. The production companies produce their goods for these stakeholders.
- Suppliers: suppliers of energy, resources and pre-products. They supply the resources that are necessary for production.
- Higher governments: these stakeholders set the rules for the larger context of the region. EU, Ministry of Housing, Spatial Planning and the Environment (VROM), Ministry of Finance, Ministry of Transport, Public Works and Water Management (VW) and the Province of Zuid-Holland.
- Research centres: to be able to innovate, research is needed and done by for example the TU Delft, Wageningen University and TNO.

4.2.3 Characterization of connections between stakeholders

MP producers-Interest groups: The Port of Rotterdam accommodates growth in the harbour area and is therefore cooperating with the companies in the harbour. It is managing the infrastructure in the harbour and it facilitates companies with services like traffic management, area management and social environment management (portofrotterdam.com). Deltalinqs is a cooperation of the companies in the harbour and is acting as spokesperson for the logistic and industrial companies of the Rotterdam harbour area to the outside world (deltalinqs.nl). It also facilitates communication between companies in the area to create more trust and synergy and to share information, so that companies became aware of possibilities for cooperation (Boons, 2008: 46-47).

MP producers-Investors: To be able to invest in new technologies, investors are needed to lend money to the companies. This relationship is one of cooperation, which is secured through signing a contract. Companies can also lend money from investors through selling of corporate bonds, for which the investors receive interest (beleggen-in-aandelen.com). A power relation is created through these contracts, giving investors influence on decision making of producers.

MP producers-Distribution companies: Production companies need a lot of transport to receive raw resources, to get rid of products and by-products and to get rid of waste flows. This transport can take place by truck, train, but in the harbour most of the time by ship. Some different companies are needed for all those different modes of transport. These all have different contracts with the production company to settle the payments etc.

MP producers-Local governments: This relation is ambiguous. On the one hand, local governments want to have companies in their region to ensure economic stability through the providing of jobs. On the other hand, companies need to follow a lot of rules from local governments to ensure the well-being of the environment, employees and civilians. Companies also need to follow the development plan of the local government and have environmental and legal licences for production (Uitvoeringsprogramma "Een sterke stad, een sterke haven", via obr.rotterdam.nl)

MP producers-Inhabitants: The rights of the inhabitants are secured by the local governments. The relation between the inhabitants and the producing companies can be of conflict (when companies disturb the lives of inhabitants by making a lot of noise or by odour nuisance) or of cooperation (when inhabitants find a job in the harbour or follow education via one of the harbour companies) (uitvoeringsprogramma "Een sterke stad, een sterke haven", obr.rotterdam.nl)

MP producers-Customers: A production company produces products for customers. These products can be bulk chemicals, for which there is a contract to supply a certain amount in a certain time (most of the time for other companies), or these can be consumer goods, for which there is no contract. In the harbour area, customers will in most cases be another company which needs the product as a raw resource. This relationship is one of cooperation (or even stronger, of mutual dependency), while the interaction with other producers is one of competition, while they are having the same goal but are not working together to achieve this goal.

MP producers-Suppliers: Suppliers deliver resources to the production companies. This happens on the basis of legal contracts. This relationship is based on cooperation. The suppliers can be based inside the harbour (as they supply their product or waste flows as resource for this company) or outside of the area (as they supply their product of mining or harvesting).

MP producers-Higher governments: The European Union has a lot of laws that apply for the harbour area and the companies present. These laws are mostly interpreted by the local governments and applied to the region. These laws can be about the environment (the amount of emissions the company is allowed to produce, the management system that must be applied, about safety issues, etc.) or the formation of cartels (anti-trust laws) (ec.europa.eu/anti-thrust) These environmental laws are applied in several subdivisions: waste, soil, atmosphere, water, chemicals, biodiversity and noise (ec.europa.eu/consumers-health) This relation is one of conflict. The European also provides subsidies for sustainable investments (ec.europa.eu/contracts).

MP producers-Research centres: Research centres work in cooperation with production companies when they are looking for new knowledge about the corporate processes. But the relationship can also be one of conflict when the research centres work for environmental protection groups, that have doubts by the processes of the company.

GP producers-Interest groups: Productschap Tuinbouw is an organization that unites all the levels of the greenhouse production chain (www.tuinbouw.nl). Production companies are member of this organization by paying a contribution. LTO-Glaskracht promotes the interests of the sector on all political levels (ltonoordglaskracht.nl). Also for this organization, production companies need to pay a contribution to be a member. Greenport(s) Nederland and Greenport Westland-Oostland are organizations that lobby for the sector at the national and provincial level for spatial policy and infrastructure (greenport-zh.nl). These organizations lobby for entrepreneurial organizations in the greenhouse sector. The relations between the producers and these organizations are of cooperation.

GP producers-Investors: Investors are needed to be able to invest in sustainable development. Because most Greenport production companies are relatively small compared to Mainport companies, corporate obligations are not an option. Investors in this sector are mainly mortgage companies, like banking institutions (rabobank.nl). This is a relation of cooperation.

GP producers-Distribution companies: In the Greenport sector, distribution companies are very important. This sector mainly has to do with fresh products that need to get to the customers as fast as possible. The fresh products are mainly transported by truck to the distribution location of the auction. From there on, the products can go by truck to a train station, harbour or airport, to be transported to the customers. The Flora Holland distribution centre and auctioneer also provides boxes and cars where the products are transported in (floraholland.com). This relation is based on cooperation.

GP producers-Local governments: Local governments set rules for producers to work with. A lot of these rules are meant to protect the inhabitants from some features of Greenport entrepreneurship, like too much artificial light in the nights or too much noise from machines (wikis.irion.nl). This is a relation of conflict, because the stakeholders have different goals. Local governments also make sure that the infrastructure is sufficient. This relation is based on cooperation, because the goal of a good functioning sector is for both stakeholders the same.

GP producers-Inhabitants: In the Greenport, inhabitants live close to the production companies and therefore they sometimes have some inconvenience with too much light or too much noise. The local governments protect the inhabitants by legislation. But on the other hand, a lot of inhabitants of the region depend on jobs provided by the Greenport producers (and the other way around, Greenport producers depend on inhabitants as labour force), so this relationship is also of an ambiguous nature.

GP producers-Customers: The production companies have different forms of supplying customers with their products. Vegetable producers work in large cooperations of companies that produce directly for customers based on contract prices. These products go directly to for example supermarkets. Flower and plant producers work with an auctioning system. The flowers and plants go to an auction where the products are sold to distribution companies, which sell the products again to the stores. These relations are based on competition, because the buyers want to have the products as cheap as possible, while the sellers want to have the highest price possible.

GP producers-Suppliers: Greenport producers are relying on their suppliers for raw materials to be able to produce. Fertilizer, natural gas and water, but also packaging material machines are things necessary to be able to produce. These relations are based on cooperation.

GP producers-Higher governments: Higher governments set the rules for local governments for example on environmental performance. But also subsidies are supplied by higher governments for sustainable investments (agriholland.nl). There are for example subsidies on the production of sustainable energy, environmental friendly investments and for promotion of agricultural business. This relationship is thus ambiguous, sometimes of conflict (legislation), but sometimes of cooperation (subsidies).

GP producers-Research centres: Research centres are producing knowledge for the GP producers, but mainly for the sector as a whole, steered by the interest groups. The research centres are paid by the interest groups, from the contributions of the producers. This relationship is based on cooperation, because the same goal is strived for, namely the production of new knowledge. But when the research institutes are hired by environmental protection groups, the relation can become one of conflict.

MP producers-GP producers: the only direct relationship between the Greenport and the Mainport producers at this moment is the OCAP-pipeline for the supply of CO2. This connection will be explained in more detail in one of the case studies later on in the report.

4.2.4 Changes needed in relations between the stakeholders

It is clear that the direct connections between the Mainport and the Greenport producers are limited. Only one small connection is made by means of the OCAP-pipeline. This OCAP-pipeline brings waste CO2 from Mainport production companies to production companies in the Greenport. The OCAP relation is handled in more detail in chapter 07. But if it works, it can be a good step to come to more interaction between the stakeholders and for building trust. If it does not work, trust can be far away and cooperation will not be reached. More interactions on material basis and on a transport basis are necessary to get to a combined sustainable development in a social, economical and environmental perspective. These interactions can be based on utility sharing as well as stronger bonds in the exchange of resources (energy, knowledge and materials, as further detailed in the case studies further on in the report).

4.3 SWOT analysis of the MP-GP region

4.3.1 Introduction to SWOT

In the Strengths, Weaknesses, Opportunities and Threats (SWOT) methodology, systematic thinking is used to find all factors affecting a new product, technology, management or planning. SWOT allows analysts to categorize factors into internal (strengths and weaknesses) and external (opportunities and threats) as they relate to a decision, enabling comparison of these internal and external factors. A large limitation to this methodology is the fact that the factors cannot be quantitatively measured or ranked and it is difficult to assess which factor has the greatest influence on strategic decision making (Arslan, 2008).

The more carefully the area that is to be evaluated is defined, the more productive the analysis is likely to be. By focusing on a particular issue and excluding non-relevant topics, the production of bland and meaningless generalizations can be overcome. Because of its apparent simplicity and ease of communication, SWOT analysis works very well with planning teams as well as with executives. There is no barrier and no 'experts' are needed to execute the analysis. This will result in the generation of ideas and information from a number of sources (Piercy, 1989). The outcomes of the SWOT analysis can be used for scenario building and analysis as the driving forces and the (critical) uncertainties.

4.3.2 System boundaries

The system boundaries are defined as in figure 4.2. Strengths and weaknesses are specific features from within the system boundary, so from the Mainport, the Greenport or a combined feature of the Mainport and the Greenport. Opportunities and threats are exposed on the system from the outside of the system boundary, so from outside the orange box.

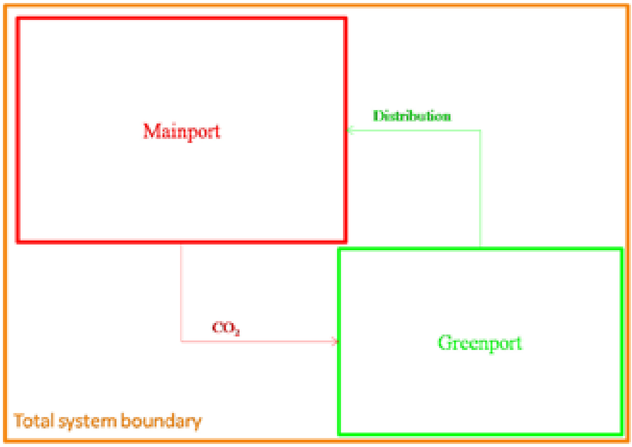

Figure 4.2: System boundaries of the SWOT analysis

4.3.3 Analysis

In the table below, the strengths and weaknesses from within the system are summarized and the opportunities and strengths from outside the system are summarized as well. Colours are used to indicate for which region the strengths, weaknesses, opportunities and threats are true. Green indicates Greenport (GP) SWOT's, red indicates Mainport (MP) SWOT's and orange indicates a combined SWOT. Many aspects unique to the Mainport or the Greenport are identified, as can be seen in table 4.1.

Context	Strength	Weakness
Social	Cooperation within the Greenport (GP) is very strong	Within the GP hesitation exists with regards to dependency on the MP
	Cooperation within the MP is strong, physical connections between companies exist (Boons, 2008)	The MP seems to have an attitude of 'more importance' towards the GP *(if THEY want to cooperate…THEY are welcome…)*
		Bad communication about reliability of CO_2 delivery during maintenance/production stop from MP side
	Both communities have a long term vision which includes close cooperation with each other	MP and GP are separated through the water (FEELS like barrier)
	Both communities are proud of their identity.	Cooperation amongst GP and MP is almost non existent
		Cultural differences exist between the MP and the GP
Geographical	Amount of labour supplied by MP	Traffic connected to labour force
	Amount of labour supplied by GP	Traffic connected to labour force, link to main road in GP having limited capacity.
	GP and MP are in close proximity to each other	MP not really open for 'short' lease time of land, GP requests at least 10 years, MP will 'only' offer 5 years
	MP and GP are separated through the water (USE as corridor?)	MP not close to urban labour market (Rotterdam→ Maasvlakte 2 is about 50km
	GP close to urban labour market (Den Haag)	Main road through GP has very limited capacity
	Open area's in MP for 'short' time use (10-15 years??) by GP companies	Intensive land use in GP so difficult to change the infrastructure
Technical	Cooperation between MP and GP through OCAP (CO2)	Adjustment or expansion of OCAP network is difficult/expensive
	GP is already capable of delivering heat and electricity to villages or other businesses	More cooperation between MP and GP needs more pipelines or other infrastructure
	Relatively small companies in GP, so more flexible to change, but not a broad view	Delivery CO_2 through OCAP is not reliable
		Building the infrastructure for synergy is expensive

	Opportunity	Threat
Social	Knowledge of creating MP-GP synergy is present in the Netherlands	NIMBY syndrome for instance: no pipelines trough residential area's
	Local, provincial and state politics are starting to support the MP-GP synergy	With aging society, increased difficulty of finding reliable workforce
Geographical	(Future) improvement of the infrastructure (including pipelines) will create possibilities of more effective transport and improve accessibility of region, businesses and communities.	Living and recreation need to be considered when developing the area
	GP and MP are not 'protected' heritage sites → easy adjustment of land-use plan	Transfer of crop production to 'cheaper' area's in the world, but this offers the opportunity to switch to higher steps in the F-ladder, like
Technical	Start up of 'Fresh Corridor' project	Choices made now can act as a break on sustainable development in the future

Table 4.1: SWOT analysis of Mainport, Greenport and combination

Furthermore many aspects, which result from the Mainport and the Greenport together, are identified. All of these aspects need to be considered when designing new systems within the MP-GP complex. It is important not only to know the strengths, but also the weaknesses; if these are overlooked, the system might become instable and collapse. The goal is to use the strengths to improve and solve the weaknesses, and manage the opportunities and threats from outside the system boundaries. All of these aspects can be used in the case studies later on in this report; the goal is to design a more connected system. A more connected system becomes more stable to fluctuations and influences from outside the system. This includes fluctuations in the local and world economy, and influences like (European) legislation.

As can be seen from table 4.1 and in more detail in chapter 6.4, both the Mainport and the Greenport have a long term vision which includes close cooperation with each other. But on a lower level, amongst part of the entrepreneurs in both areas, hesitation about dependency, a sense of superiority, and a lack of trust exist (e.g. greenhouse entrepreneurs that are connected to the OCAP network, but do not always get as much CO_2 as they want). Both parties see the need for cooperation, and therefore the need for increased connectivity between the Mainport and Greenport. This will stimulate the willingness for cooperation between the two regions. To reach this cooperation between the regions, it will be important to have an institution (governmental, NGO or a mix of both, for example KOMBi, Kenniswereld, de Overheid, Maatschappij en Bedrijfsleven) to coordinate the exploration and start-up phase of making connections and increasing cooperation. This will be developed in more detail in the information case in chapter 06.

Trust between the entrepreneurs of the two regions is vital for success. This must be built to decrease the fear of dependency which is present amongst entrepreneurs from the Greenport. One of the main sources of this fear is the unreliability of the CO_2 supply though the OCAP pipeline from the Mainport to the Greenport. With increased and timely communication, the first steps can be put in place to increase this trust. The OCAP pipeline is an established and important connection between the Mainport and the Greenport. Although the fear of dependency is only observed in the Greenport, it can be assumed also to be present in the Mainport. The CO_2 supply to the Greenport is (or might become) part of the CO_2 reduction plans of the Mainport based companies. They are (or will become) depended on the Greenport for this reduction; so mutual trust is important, although the focus of this trust will be in the Greenport towards the Mainport.

The close proximity of both the regions to each other makes the possibilities to establish physical connections more likely. Furthermore this might reduce the amount of transport movement and make heat exchange more easy. In that perspective, placing greenhouses inside the harbour area, will shorten the transport distance even more. Unused land area in the Mainport can be used to built greenhouses (or maybe even floating greenhouses can be placed on the water area), but then it must be sure that these lands are available for a time period of at least ten years, the depreciation time of greenhouses.

Technical strengths can mainly be found in the availability of knowledge in sharing waste heat or other materials. In the Greenport some projects are started that exchange heat and electricity from greenhouses to housing areas. Physical connections between different companies within the Mainport and Greenport (heat, CO_2 and knowledge on a local scale) are also present. This knowledge, on how to achieve cooperation, can be used in creating the cooperation and connections between Mainport and Greenport. Because companies in the Greenport are relatively small compared to (multinational) Mainport based companies; they will be able to respond quickly to changes in the environment. A negative side of this, is that these small companies can be overwhelmed by the multinational companies in the Mainport. As described earlier; mutual trust is vital for further development of cooperation. The OCAP connection will be studied in more detail in the heat and CO_2 network case study.

Some opportunities and threats arise from outside of the system boundary. A huge opportunity is that a lot of knowledge about creating synergy between companies and regions, is already available in the Netherlands. This means that this knowledge does not need to be developed from scratch. But it is important to get this knowledge locally available, as will be explained in more detail in chapter 06. Furthermore, there is a lot of support from local and higher governments to create synergy between the regions. A threat to this synergy can be inhabitants of nearby villages protesting against certain infrastructural interventions. For example, a CO_2 pipeline through their backyard. Other kinds of infrastructural interventions can have positive effects for inhabitants, like a better road system with less congestion. A threat for MP-GP synergy is that not everything is possible, because living and recreation are increasingly important factors in these regions. Furthermore, the Greenport is densely built and therefore infrastructural changes will be difficult.

Opportunities arise for new companies to enter business in the region, by offering new distribution options. This can be achieved by using the existing infrastructure, so investment costs can be low. Examples of this are the Fresh Corridor initiative and the Coolboxx company, as described in the current situation of the Greenport in chapter 03 of this report.

A threat coming from inside the system has to do with choices. If, for example, a heat network will be developed, some options for decentralized energy production are not feasible anymore. It is of great importance that all options are deliberated carefully to prevent undesirable situations in the future.

4.4 Configuration of the F-ladder

Biomass from agriculture serves as raw material for many products. Often the English 'Fladder' (fig. 4.3) is used to conceptually illustrate the versatile application of agro-production. Roughly, the 'F-ladder' runs from high volume (and spatial use) with relatively low added (economic) value to low volume products with high added value. One should keep in mind, the competitiveness of agricultural products with flora and fauna. The orange colours schematically refer to the amount of volume necessary and the green colours to the amount of biomass available for cascading to lower 'F'-categories'. Purple colours refer to the amount of facilities needed.

The text below gives a short description of every 'F-category':

Fuel & Fire: fuel and energy production, mostly by the application of coarse chemistry. To date, this is consisting of mainly fossil fuels, but the demand for biomass is increasing.

Fodder & Feed: feed and other bulk products. These products are used for, for instance food or meat production.

Fabricated Products (Fibre) for consumption goods; ranging from clothing to furniture.

Fresh products (Fish): fresh, long-preservable products such as vegetables and fish.

Food (Meat): traditional and modern food production, including meat processing.

Flowers & Fashion: The non-edible horticulture, e.g. flowers and plants, for (house) design and fashion.

Fun, Flavours & Fine Chemicals: diversified agriculture, with themes such as recreation, taste (spices and herbs) and contents with high added value. This also includes stimulants such as tobacco and alcohol containing drinks and drugs (pharmaceuticals).

Facilities & Value: the 'F-latter' complements the whole by 'Facilities', as a kind of residual category. Examples include the upstream manufacturing for agricultural production: breeding and seed companies, pesticides, (artificial) fertilizers, packaging, finance, IT, marketing and planning (Van Steekelenburg et al, 2009).

The case studies discussed in chapter 6 till 8 are derived from the 'F-ladder':

06. CREATING A MP-GP NETWORK FOR INFORMATION, refers to the category 'Facilities'

07. HEAT AND CO2 NETWORK, refers to the category 'Fuel & Fire'

08. BIOBASED PHARMACEUTICALS, refers to 'Fun, Flavours and Fine chemicals'

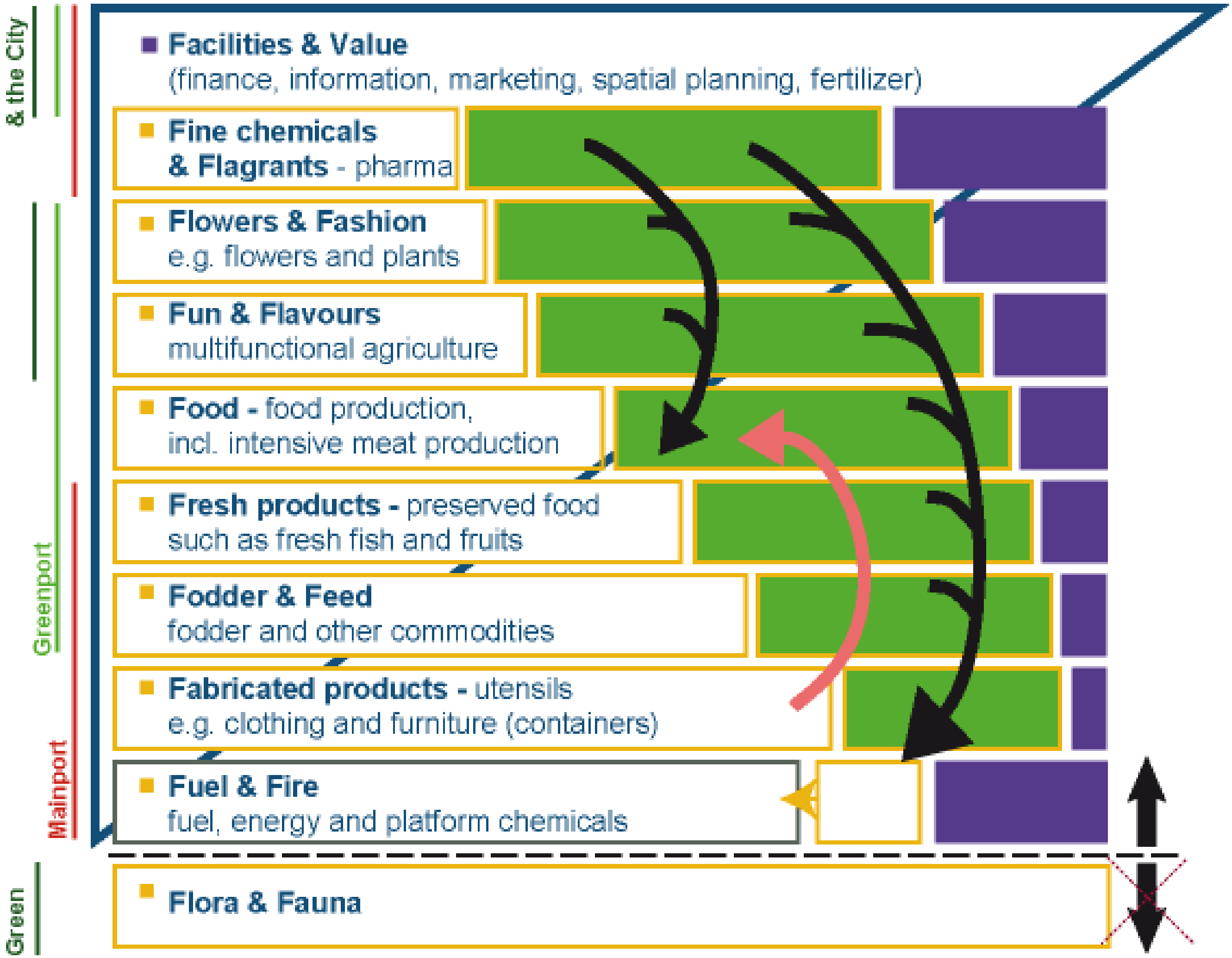

Figure 4.3: F-ladder: versatile application of agricultural products

References

Journal sources

O. Arslan, I. Deha Er, SWOT analysis for safer carriage of bulk liquid chemicals in tankers. Journal of hazardous materials, Volume 154, issues 1-3, 901-913 (2008)

F. Boons, Self-organization and sustainability: The emergence of a regional industrial ecology. Self-organization and sustainability, Vol. 10, nr 2, 41-48(2008)

R. Brugha, Z. Varvasovszky, Stakeholder analysis: a review, Health Policy and Planning, 2000 Volume 15, Issue 3, 239-246

S. Calvert, Managing stakeholders. In: J.R. Turner, editor. The commercial project manager. Maidenhead: McGraw-Hill (1995), 214-222

A.L. Jepsen, P. Eskerod, Stakeholder analysis in projects: challenges in using current guidelines in the real world, International Journal of Project Management, 2009 Volume 27, Issue 4, 335-343

N. Piercy, W. Giles, Making SWOT analysis work. Marketing intelligence & planning (1989) Volume 7, issue 5/6, page 5-7

Port of Rotterdam, Facts and figures on Rotterdam's oil and chemical industry, January 2007

M.S. Reed, A. Graves, N. Dandy, H. Posthumus, K. Hubacek, J. Morris, C. Prell, C.H. Quinn, L.C. Stringer, Who's in and why? A typology of stakeholder analysis methods for natural resource management, Journal of Environmental Management, 2009 Volume 90, Issue 5, 1933-1949

G.T. Savage, T.W. Nix, C.J. Carlton, J. Whitehead, J.D. Blair, Strategies for assessing and managing organizational stakeholders, Academy of Management Executive, 1991 Volume 5, Issue 2, 61-75

Web sources

http://www.portofrotterdam.com/nl/over_het_havenbedrijf/bedrijfsinformatie/missie_en_visie/index.jsp, accessed at 13-01-2010

http://www.deltalinqs.nl/, accessed at 12-04-2010

http://www.beleggen-in-aandelen.com/obligaties.html, accessed at 12-04-2010

http://www.obr.rotterdam.nl/Rotterdam/Openbaar/Diensten/OBR/pdf/OBR-uitvoer-haven(totaal-def).pdf, accessed at 12-04-2010

http://ec.europa.eu/competition/consumers/antitrust_nl.html, accessed at 12-04-2010

http://ec.europa.eu/policies/environment_consumers_health_nl.htm, accessed at 12-04-2010

http://ec.europa.eu/contracts_grants/index_nl.htm, accessed at 12-04-2010

http://www.ltonoordglaskracht.nl/Wie_zijn_wij.17515.0.html, accessed at 12-04-2010

http://www.greenport-zh.nl/, accessed at 12-04-2010

http://www.rabobank.nl/bedrijven/producten/financieren/met_garantstelling/, accessed at 12-04-2010

http://www.floraholland.com/NL/AANVOEREN/LOGISTIEK/Pages/Logistiek.aspx, accessed at 16-01-2010

http://wikis.irion.nl/milieuhulp/index.php/Subthema:Landbouw_en_veeteelt:_wetten_regels_en_beleid, accessed at 12-04-2010

http://www.agriholland.nl/subsidies/#tuinbouw, accessed at 12-04-2010

Chapter 5

Contextualising the Mainport-Greenport complex

5.1 Introduction

Planning with a view to prepare for the future comes with one important difficulty: the future is inherently uncertain. Uncertainty here means an absence of data or information necessary to make an informed judgement. This uncertainty is becoming more manifest in today's society due to the increasing complexity of society and systems and the greater awareness of this complexity.[9] Reducing uncertainty has therefore become a key concern for planners of all kinds. In this process, planners have to account for different types of uncertainty: risks (which can be calculated and often reduced); structural uncertainties and unknowables (which are both often irreducible).

When uncertainty is irreducible, one can distinguish four levels of possible futures. First, there is a 'clear-enough' future which is a single forecast precise enough for determining a strategy (for which traditional planning tools are available). Second, there are 'alternate' futures, in which a few discrete outcomes define the future and tools include decision analysis and game theory. Third, there is a 'range' of futures, which is a bounded range of possible outcomes, but without discrete scenarios. For this type of future, a scenario analysis tool could be useful. Finally, there is 'true ambiguity', in which there is no basis to forecast the future. These scenarios are sketched in figure 5.1.

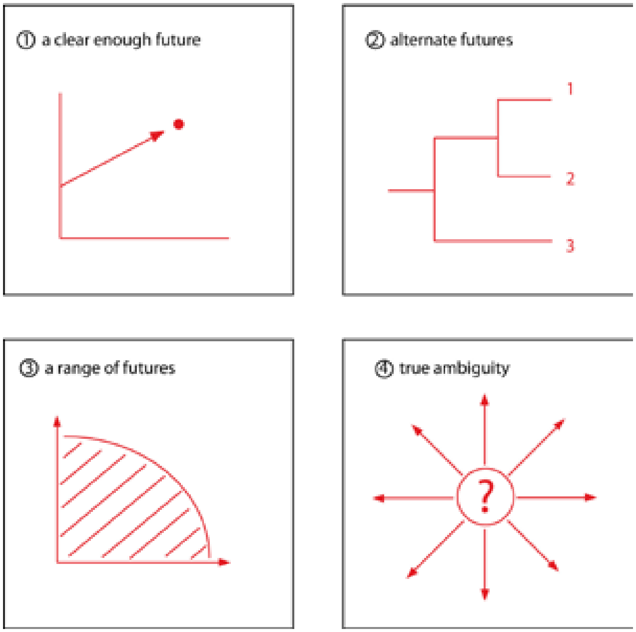

Figure 5.1: Possible future scenarios

Thus, in a situation in which a problem[10] has long-term characteristics and is of a complex nature, while resources are limited and interventions costly, and uncertainty prevails regarding the future conditions under which the suggested interventions must produce results, scenario analysis can be used. Since the 1970s, multiple-scenario analysis has been used to deal effectively with the many uncertainties that surround the future of (business) organizations. The many internal and external factors that may result in unexpected changes in the environment of the organization are dealt with in these analyses. This chapter is devoted to contextual scenario's that may influence the collaboration of the Mainport and the Greenport. After a description of the method used to develop scenarios in the next paragraph, the third paragraph will go into dept of contextual scenario's developed for the MP-GP complex.

These will be used in chapter 09 to assess the propositions made in the chapters on our case studies in terms of their usefulness in the future, keeping uncertainty in mind.

5.2 Scenario building and analysis

Scenario analysis is not used for obtaining forecasts, but supports the creation of alternative images of the future development of the internal and external environment of organizations. If this is done accurately, the scenarios will reveal and highlight crucial uncertainties, which will impact the (strategic) decisions of the organization. The analysis differs from most other approaches to forecasting in two important ways. First, it usually provides a more qualitative and contextual description of how the present can evolve into the future. Second, it tries to identify a set of possible futures which are probable but not assured.

In the analysis, a scenario is a construct that results from a combination of research (structure) and design (creativity). Providing reliable scenarios goes hand in hand with making correct and accurate assumptions. Its aims are to explore uncertainty and identify possible (or desirable) futures ahead (usually 10-15 years). When the time horizon gets longer, the contents of the scenarios progressively become vaguer. No specific time horizon is best, the best 'test' for setting the time horizon is determining how far into the future the resources (of an organization) are committed. A scenario is build around possible developments, contingencies and possible policy strategies and is usually related to a specific issue or problem. It may serve as a frame of reference, a discussion booster or a touchstone.

Scenarios exist in different forms and types: quantitative and qualitative scenarios; possible and probable scenarios; general background or specific background scenarios; and normative (desirable) or descriptive (possible) scenarios. The choice of the type of scenario to be developed depends on the aims one has for the analysis.

Developing scenarios can be done according to several methods. The first step usually involves a problem analysis in which a quite clear idea of the problem situation, its origins, its boundaries, causalities and the actors involved is made. Next is an analysis of the future, which means an exploration of possible developments, events and policy strategies that may impact upon the problem situation. It is important to distinguish between trends (which are more predictable) and uncertain developments. The third step is the development of a limited number of scenarios on the basis of the second step. In this scenario the identified driving forces should be assessed according to how influential these are with regard to the future development of the problem situation and also according to their uncertainty. After two axes are created of degree of importance and degree of uncertainty, those of both high importance and high uncertainty will be put together for the scenario axes (they have to be mutually independent factors), as can be seen in figure 5.2.

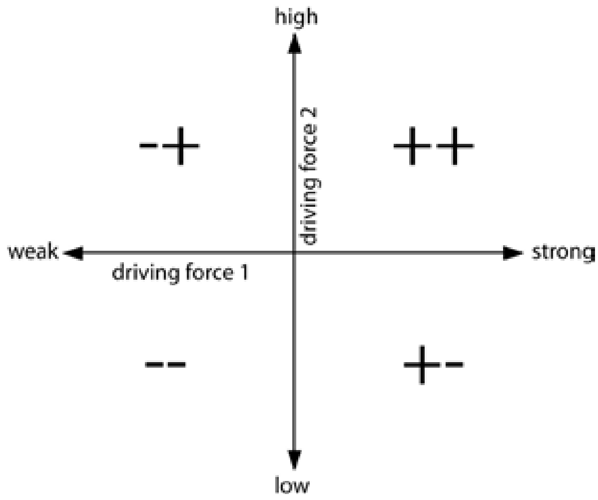

Figure 5.2: Scenarios axes

The last step then is to develop the scenarios into stories, in which one has to take care of plausibility and internal consistency; imagination and contrast, comprehensibility for the target group; and appealing scenario names. The developed scenario's can then be used to investigate its implications for stakeholders or to assess strategic options for the organization in question.

5.3 Setting the stage: contextual scenario's influencing Mainport-Greenport development

We have identified scenario analysis as an effective tool for dealing with uncertainty in such a way that it can be taken into account for strategic decision making, as it provides a contextual framework in which one operates. In the long term sustainable development perspective for the MP-GP complex, certain future trends and less-predictable events and developments can create (un)favourable conditions for the execution of the suggested interventions made in our case studies. By identifying some of these events and developments and elaborating upon the most important ones by developing four ideal types of the context in the form of different scenarios, we will be able to evaluate the recommendations made in the case studies.

Starting point for making these scenarios was a brainstorm in which a combination of literature and common-sense was used as to explore major possible developments, events and policy strategies that may impact upon the context in which a connection between Mainport and Greenport is strived for. These were then structured according to their degree of uncertainty and their degree of importance, which resulted in the scheme of figure 5.3.

As stated above, it is important to distinguish between

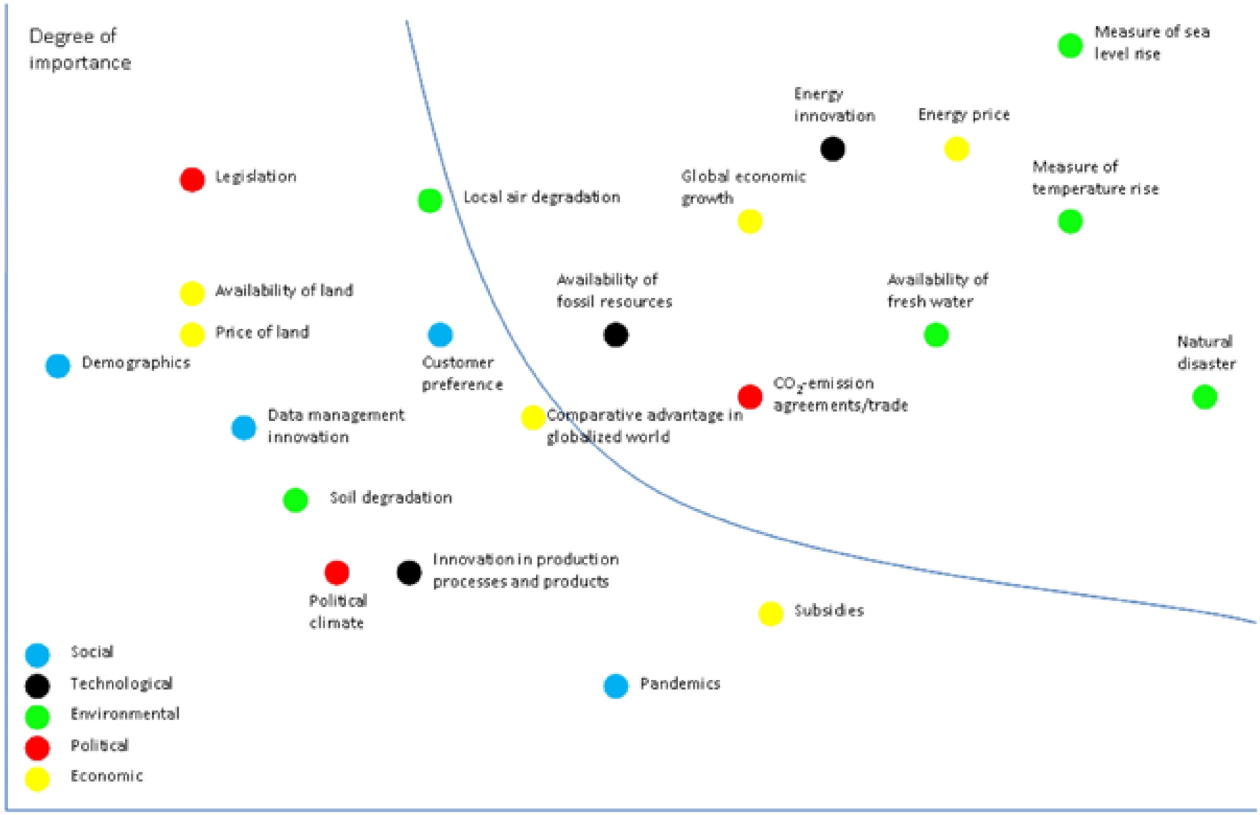

Figure 5.3: Degree of importance and uncertainty of possible events

trends (which are more predictable) and uncertain developments. Thus, the bullets that are less uncertain but of high importance are defined as trends and are not the focus of the scenarios: those focus upon the bullets that are both highly uncertain and of high importance. For the development of our scenarios we chose to combine some of these bullets into umbrella terms and identified two uncertainties to develop our scenarios with: the impact of global warming on the MP-GP area and the global energy politics.[11] Within these themes, we decided to base our axes on extremes: the impact of global warming on the MP-GP area is either huge or not present; and the global energy politics is either completely based on renewable energy or is business as usual (oil based). This results into four ideal types of scenarios with names that cover the essence of their position as shown in figure 5.4.

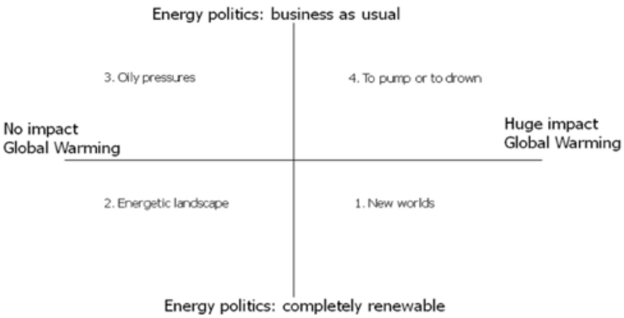

Figure 5.4: Types of scenarios with names

5.3.1 New Worlds (Huge Impact Global Warming; Energy Politics Completely Renewable)

The impact of global warming on the MP-GP area in this scenario is severe. Although the rise of the sea level will have no immediate impacts on most businesses located in the harbour area (most businesses are already located on the 'Maasvlakte' which is 7 meters above sea level) and therefore economic activity could continue, some major changes and adaptations will (have to) take place. The rising level of sea water (estimated at between 65 and 130 cm in 2100) could lead to storm surges more frequently and quickly and they can lead to dangerous situations (V&W,2010). Therefore, water barrages will have to be closed more often, which makes the Rijnmond area less accessible than it is now. Moreover, these closures could coincide with high discharge of water from the rivers – since these rivers will have to carry off melt and rain water from the inland – leading to higher water in the future than is currently the case, flooding areas outside the dikes more often and deeper. At the same time, due to climate change, the discharge of water from the rivers may decrease during the summer in comparison to current situations. This shifts the intrusion of salt from the sea along the bottom of the rivers further inland, which may amplify salination. It will therefore become more difficult to use the water for agri- and horticulture, ecology and maintaining the water level (V&W, 2010).

Since costs and reliability are largely defining in the competitiveness of the inland navigation, and both will be put under pressure due to climate change, this may lead to a decrease of cargo transported by boat over the rivers thus changing the share of cargo in the modal spit (Knowledge for Climate, 2010). This will also influence the competitiveness of the sea harbours, since transhipment of goods is largely dependent on the inland navigation. Mitigation and adaptation to changing situations caused by global warming is crucial for the future of both inland navigation and sea harbours. When global warming impacts on the MP-GP area will be huge, their effects will be defined by adaptation strategies. This may lead to either large problems and therefore decrease of business activity and revenue collection or problems will be mitigated and the large impact of global warming will not lead to a severe decline of economic activity. In any case, investments have to be made to secure the position of the Rijnmond area.

The severe impacts of global warming will also have an effect on the horticulture in the Greenport. Problems with ground water can lead to shortages and higher costs. Also, the Westland has been confronted with storm water before (1998, 2004) and global warming may cause flooding to occur more often (leading to problems such as pollution, destruction of property and crops) unless appropriate measures to protect the land are taken.

In this scenario energy politics will have shifted to a demand that is met by renewable sources as much as technologically possible. This will mean a huge change in the harbour area, since some of its prime activities are focused around fossil fuel energy. The landscape of the area will have changed as to facilitate the production of renewable energy through for example wind turbines. Also, some of the old businesses will have transformed into newer ventures, while others are still at work (since fossil fuels also function as resource for goods rather than just as source for energy), either still as fossil oil production plants or as bio-based resource plants.

The shift to renewable energy will have changed the way of production of greenhouses drastically. Since gas will no longer be used as primary source for heating, some of the greenhouses will have shifted to use geo-thermal heat, while others make use of the heat generated in the harbour area by applying a cascading system. Another option will be the use of aquifers for storage of redundant heat in the summer for use during the winter. Using energy from wind turbines and bio-fuels from bio-digesters, the energy demand of greenhouses can be almost completely be supplied through renewable sources. At the same time the Greenport area may be administered to grow products especially for the production of bio fuels. In short, a change in energy politics is likely to have huge impacts upon the production practice in the Greenport; offering huge challenges but also opportunities in terms of sustainability (lower costs, lower environmental impact etc). Furthermore, the Greenport area may have to find a different source of CO2 as the changing dynamic of the MP area might result in the departure of CO2 supplying businesses.

5.3.2 Energetic Landscape (No Impact Global Warming; Energy Politics Completely Renewable)

In this scenario, global warming has no severe impacts on the MP-GP area in terms of sea level rise or temperature change. This can either be because no major changes have occurred or because mitigation and adaptation schemes have resulted into possibilities that provide for MPGP activity to continue in line with current trends. These will depend on EU regulation, the development of technology, demographics etc. but are all fairly predictable. Productivity in horticulture will increase with about 3,5% (Lei, 2009:41) while in the harbour container transhipment will increase to 17,6 million in 2020 (three times as much as in 1995).

In this scenario energy politics will have shifted to a demand that is met by renewable sources as much as technologically possible. This will mean a huge change in the harbour area, since some of its prime activities are focused around fossil fuel energy. The landscape of the area will have changed as to facilitate the production of renewable energy through for example windmills. Also, some of the old businesses will have transformed into newer ventures, while others are still at work (since fossil fuels also function as resource for goods rather than just as source for energy), either still as fossil oil production plants or as bio-based resource plants.

The shift to renewable energy will have changed the way of production of greenhouses drastically. Since gas will no longer be used as primary source for heating, some of the greenhouses will have shifted to use geo-thermal heat, while others make use of the heat generated in the harbour area by applying a cascading system. Another option will be the use of aquifers for storage of redundant heat in the summer for use during the winter. Using energy generated in the harbour area by applying a cascading system. Another option will be the use of aquifers for storage of redundant heat in the summer for use during the winter. Using energy from wind turbines and bio-fuels from bio-digesters, the energy demand of greenhouses can be almost completely be supplied through renewable sources. At the same time the Greenport area may be administered to grow products especially for the production of bio fuels. In short, a change in energy politics is likely to have huge impacts upon the production practice in the Greenport; offering huge challenges but also opportunities in terms of sustainability (lower costs, lower environmental impact etc). Furthermore, the Greenport area may have to find a different source of CO2 as the changing dynamic of the MP area might result in the departure of CO2 supplying businesses.

5.3.3 Oily pressures (No Impact Global Warming; Energy Politics Business as Usual)

In this scenario, global warming has no severe impacts on the MP-GP area in terms of sea level rise or temperature change. This can either be because no major changes have occurred or because mitigation and adaptation schemes have resulted into possibilities that provide for MPGP activity to continue in line with current trends. These will depend on EU regulation, the development of technology, demographics etc but are all fairly predictable. Productivity in horticulture will increase with about 3.5% (Lei, 2009:41), while in the harbour container transhipment will increase to 17.6 million in 2020 (three times as much as in 1995).

Energy politics in this scenario will be ‘business as usual’, meaning that the majority of our energy demand will come from fossil fuels such as oil and gas. The price of crude oil will have increased to about USD 105 per vat in 2020 (LEI, 2009:41) to about 150-200 USD in 2030, but only after a time period with huge fluctuations of the price. This will influence the amount of goods transported to and from the harbour area as well as the composition of the bulks arriving at the harbour. Although the majority of the energy demand will come from fossil fuels, the percentage of bio fuels in the transport sector will have increased to 10%, because of legal commitments.

The increased price of fossil fuels will impact greenhouse cultivation; especially vegetable production will decrease due to competitive disadvantages of the Greenport in comparison to cheaper South European or African production. The growing of flowers will decrease as well, but to a lesser extent, because the international demand for flowers will increase while there is only a limited amount of producers worldwide (LEI, 2009). The increase of costs and decrease of production will go hand in hand with increased consumer prices, thereby still making the sector viable and even profitable. The energy costs in greenhouse cultivation are however also depending on policies concerning energy and climate. In 2013 the Dutch government will have started an emission trading system for CO2 for the sector, thereby pricing CO2 emission (about 15-20 Euros per tonne) (LEI, 2009), which can affect the production in numerous ways, even leading to worsened competitiveness (ibid).

Thus, if energy politics will be executed in a ‘business as usual’ fashion, this will lead to insecurity for both the Mainport and the Greenport sector and can worsen their competitiveness.

5.3.4 To pump or to drown (Huge Impact Global Warming; Energy Politics Business as Usual)

The impact of global warming on the MP-GP area in this scenario is severe. Although the rise of the sea level will have no immediate impacts on most businesses located in the harbour area (most businesses are already located on the ‘Maasvlakte’ which is 7 meters above sea level) and therefore economic activity could continue, some major changes and adaptations will (have to) take place. The rising level of sea water (estimated at between 65 and 130 cm in 2100) could lead to storm surges more frequently and quickly and they can lead to dangerous situations (V&W,2010). Therefore, water barrages will have to be closed more often, which makes the Rijnmond area less accessible than it is now. Moreover, these closures could coincide with high discharge of water from the rivers – since these rivers will have to carry off melt and rain water from the inland – leading to higher water in the future than is currently the case, flooding areas outside the dikes more often and deeper. At the same time, due to climate change the discharge of water from the rivers may decrease during the summer in comparison to current situations. This shifts the intrusion of salt from the sea along the bottom of the rivers further inland, which may amplify salinisation. It will therefore become more difficult to use the water for agri- and horticulture, ecology and maintaining the water level (V&W, 2010).

Since costs and reliability are largely defining in the competitiveness of the inland navigation, and both will be put under pressure due to climate change, this may lead to a decrease of cargo transported by boat over the rivers thus changing the share of cargo in the modal spit (Knowledge for Climate, 2010). This will also influence the competitiveness of the sea harbours, since transhipment of goods is largely dependent on the inland navigation. Mitigation and adaptation to changing situations caused by global warming is crucial for the future of both inland navigation and sea harbours. When global warming impacts on the MP-GP area will be huge, their effects will be defined by adaptation strategies. This may lead to either large problems and therefore decrease of business activity and revenue collection or problems will be mitigated and the large impact of global warming will not lead to a severe decline of economic activity. In any case, investments have to be made to secure the position of the Rijnmond area.

The severe impacts of global warming will also have an effect on the horticulture in the Greenport. Problems with ground water can lead to shortages and higher costs. Also, the Westland has been confronted with storm water before (1998, 2004) and global warming may cause flooding to occur more often (leading to problems such as pollution, destruction of property and crops) unless appropriate measures to protect the land are taken.

Energy politics in this scenario will be ‘business as usual’, meaning that the majority of our energy demand will come from fossil fuels such as oil and gas. The price of crude oil will have increased to about USD 105 per vat in 2020 (LEI, 2009:41) to about 150-200 USD in 2030, but only after a time period with huge fluctuations of the price. This will influence the amount of goods transported to and from the harbour area as well as the composition of the bulks arriving at the harbour. Although the majority of the energy demand will come from fossil fuels, the percentage of bio fuels in the transport sector will have increased to 10%, because of legal commitments.

The increased price of fossil fuels will impact greenhouse cultivation; especially vegetable production will decrease due to competitive disadvantages of the Greenport in comparison to cheaper South European or African production. The growing of flowers will decrease as well, but to a lesser extent, because the international demand for flowers will increase while there is only a limited amount of producers worldwide (LEI, 2009). The increase of costs and decrease of production will go hand in hand with increased consumer prices, thereby still making the sector viable and even profitable. The energy costs in greenhouse cultivation are however also depending on policies concerning energy and climate. In 2013 the Dutch government will have started an emission trading system for CO_2 for the sector, thereby pricing CO_2 emission (about 15-20 Euros per tonne)

(LEI, 2009), which can affect the production in numerous ways, even leading to worsened competitiveness (ibid). Thus, if energy politics will be executed in a 'business as usual' fashion, this will lead to insecurity for both the Mainport and the Greenport sector and can worsen their competitiveness.

References

Journal sources

Beck, Ulrich (1992). Risk Society: Towards a New Modernity. New Delhi: Sage

Giddens, Anthony (1999) Runaway World: How Globalization is Reshaping Our Lives. London : Profile.

Hobart, J. and A. Turnbull (2009). "Past the Great Unwind, Outlook and Scenarios for the Global Financial System" in Oliver Wyman Journal (26), pp 20-29.

LEI Landbouw Economisch Instituut (2009). De agrarische sector in Nederland naar 2020. Perspectieven en onzekerheden. Wageningen University Press.

Postma, T.J.B.M. and F. Liebl, F (2005). "How to improve scenario analysis as a strategic management tool" in Technological Forecasting & Social Change (72), pp 161-173.

Schnaars, S.P. (1987). "How to Develop and Use Scenarios" Long Range Planning (20), pp 105-114.

Web sources

Knowledge for Climate (2010). "De effecten van klimaatverandering op de binnenvaart via de Rotterdamse regio". Accessed February 20th 2010, available at: http://knowledgeforclimate.climateresearchnetherlands.nl/nl/25222856-Projects.html

V&W Ministerie van Verkeer en Waterstaat (2010). "Deltaprogramma".Accessed February 20th 2010, available at:http://www.verkeerenwaterstaat.nl/onderwerpen/water/deltaprogramma/deelprogrammas/rijnmond_-drechtsteden/

9 This becomes manifest in what some authors have called the “Risk Society”, which describes the manner in which modern societies organise in response to risk, including environmental risks. According to sociologist Anthony Giddens, a risk society is “a society increasingly preoccupied with the future (and also with safety), which generates the notion of risk”(Giddens, 1999:3), while sociologist Ulrich Beck defines it as a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself (Beck, 1992:21). Both authors argue that while humans have always been subjected to a level of risk (such as natural disasters) these have usually been perceived as produced by non-human forces. However, modern societies are exposed to risks that are the result of modernization itself (such as pollution, crime); thus manufactured risks. Since these are the product of human activity, it is argued that it is possible for societies to assess the level of risk that is being or will be produced.

10 The word problem can refer to problematic situations which are strived for to be improved, but may also refer to situations or propositions which are uncertain and therefore perceived to be problematic.

11 We acknowledge that these two are somewhat related to each other. However, since the causality or interdependence of the two is highly uncertain and debated upon, we assume these developments to be separated enough for the purpose of developing our future scenarios. This is especially because in terms of impact of global warming we will only look at local impact (because these impacts will differ greatly in type and scope between different areas and countries), while energy politics is always a matter of global or at least national politics and therefore not only applicable to the MP-GP area.

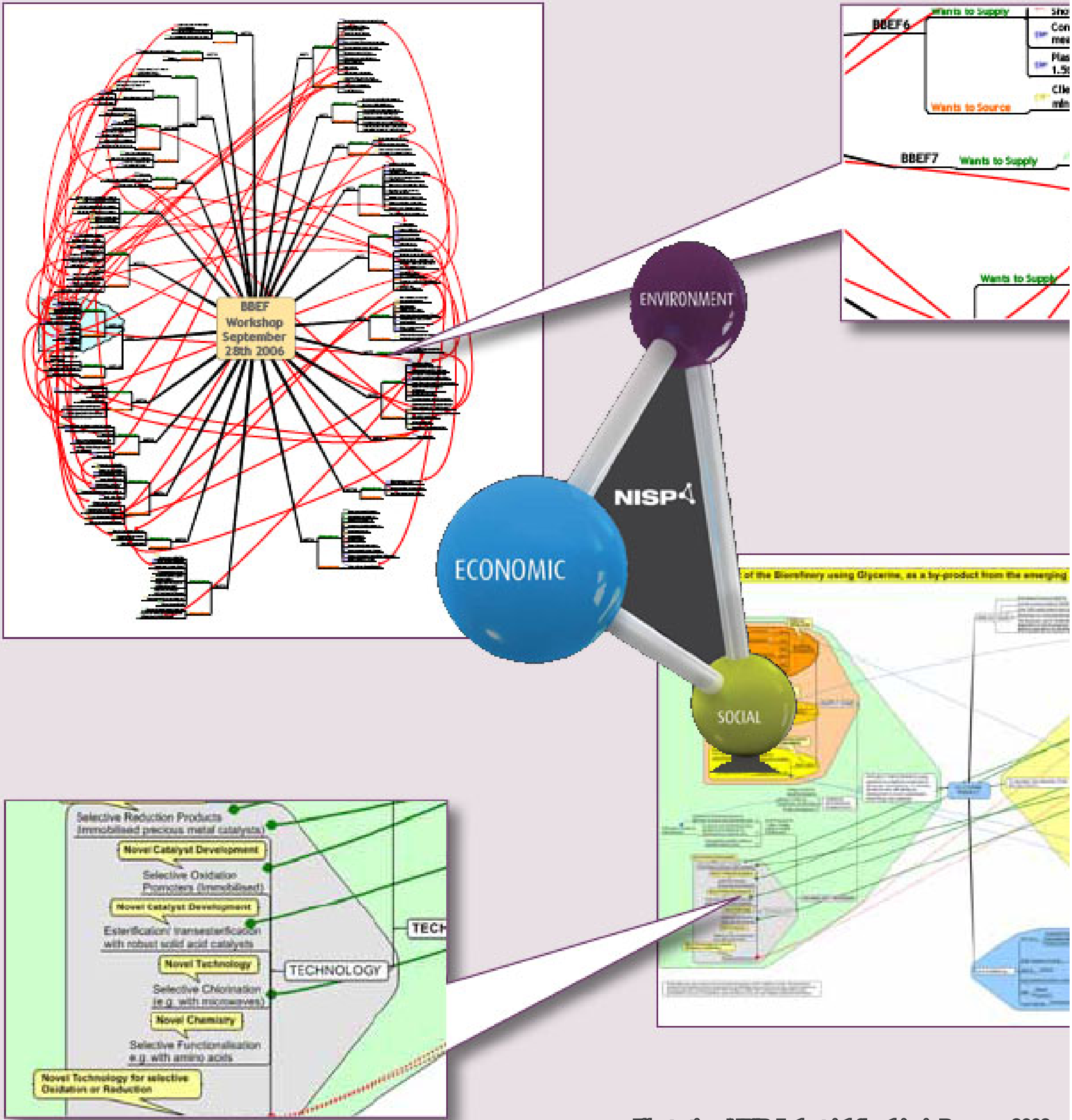

Illustration: NISP, Industrial Symbiosis Program 2009

Chapter 6

Creating a MP-GP network for information

6.1 Introduction

The positive effects of which enterprises can benefit from being located in close proximity to each other, have in past often accrued despite any planned efforts by the firms involved. However, some benefits can only be accrued by targeted joint actions in which stakeholders address challenges and opportunities by jointly agreeing on priorities, strategies and activities and implementing the same. Especially when these benefits do not only affect the enterprises involved, but have effects on the larger societal system – which is the case when industrial systems such as the Mainport and Greenport are targeted to become more sustainable – a specific governance approach is needed in order to effectively target those persistent problems that can only be dealt with on the very long term, while keeping the complexity (of society itself, of the problems facing society and the way of dealing with these problems (governance)) in mind. These persistent problems, which are thus targeted under the header of 'sustainable development', are unstructured and highly complex because they are rooted in different societal domains, occur on different levels and involve different actors with different perspectives, norms and values (Loorbach and Van Raak, 2005:2).

This increasing societal complexity is the result of trends such as internationalisation, informatisation, integration and individualisation, which have led to the emergence of the network-society (Castells, 1996) – which is a society where key social structures and activities are organized around electronically processed information networks.

These persistent problems (which are the adverse effects of modernisation) can only be dealt with through specific types of network and decision-making processes (Loorbach, 2010:161) that give special attention to learning, interaction, integration and experimentation (Loorbach and Van Raak, 2005:2), because every implemented solution will reflexively lead to changes in the societal structures, thus transforming the original problem itself (ibid).[12] Over the last decades, the power of central government to develop and implement policies in a top-down manner has decreased, leading to diffuse policymaking structures and processes in which interaction between all sorts of actors in networks often produce (temporary) societal consensus and support upon which policy decisions are based (Loorbach, 2010:161).

Combining the complexity of society, its persistent problems and the diffuse character of governance has led to the concept of "transition management"; an integrative form of governance as an approach for sustainable development. Transition management aims at the development of a portfolio of management strategies to influence different types of developments and can be considered as a form of multi-level governance whereby state and non-state actors are brought together to co-produce and coordinate policies in an iterative and evolutionary manner on different policy levels (Loorbach and Van Raak, 2005:4). Governance processes based on transition management are designed to create space for short-term innovation and develop long-term sustainability visions linked to desired societal transitions (Loorbach, 2010:163).

These processes include broad innovation networks, including business, government, science, and civil society (KOMBi, Kenniswereld de Overheid, Maatschappij en Bedrijfsleven), which create shared visions, agendas for (social) reform and influence policies. This chapter is devoted to researching what kind of innovation networks can be build for the advancement of the MP-GP area in the light of transition management towards a more sustainable way of producing and processing in the MP-GP area.

In order to do so, the next paragraph is devoted to theories on and methodologies used in processes of transition management. Starting with a section on why industry can be described as a specific type of social network, this section will continue with how such an industrial social network can be created with regard to transition management. Transition management is focused on those practices that offer innovative alternatives for the future that are more sustainable than current practices. By sharing knowledge and information through a flexible network, the transition can spread to a higher level of organisation (spill-over effect). It will also devote special attention to the practice of discourse analysis, which can pinpoint differences as well as similarities in the various perspectives of actors involved, leading to threats and opportunities in creating a shared vision.

The third paragraph will go more in-depth in creating a transition arena and network for the MPGP case. Here, we will come up with players that could collaborate in the start up of the transition; thus an initial design for a knowledge network. It is an initial design, because – as we will explain in the second paragraph – the network ought to be flexible and interactive in order to stay innovative and valuable for the MP-GP complex. A discussion of 'owning' the network and its knowledge will be included in this section.

The fourth paragraph will elaborate on how the creation of the knowledge network can be stimulated or contravened by some of the main actors in the Mainport and the Greenport. This is done by investigating the dominant discourse used by some of the most important actors in the area: the Rotterdam harbour, Greenport(s) Netherlands and government. The threats and opportunities will be investigated and strategies for dealing with those presented.

6.2 Industrial Clusters as Social Networks: theory and methodology for creating an innovation network for the MP-GP area

6.2.1 Clustering of industry as a social network

The concept of industrial clustering has been theorized in a number of different ways. One of the main approaches is the neo-institutionalist approach, which perceives the existence and development of hierarchical organizations and institutions to be a rational response to transaction-cost problems caused by bounded rationality[13] and opportunism in a pure marketcontracting economy (Gordon and McCann, 2000:519). From this perspective, the development of organizations that allow transactions to be internalized and coordinated (which can be the case in industrial clustering), means that trust (i.e. non-opportunism) becomes institutionalized within the economic system (520). However, sociologists have argued that the implicit and explicit contracts between actors within the individual organization primarily act as a substitute for trust (which is evidenced by the existence of internal incentive and penalty schemes) (ibid) rather than that trust is institutionalized within the economic system. A 'social-network model' was therefore put forward, which argues that there is more order to interfirm interactions (thus interactions between different firms) and less order to intrafirm interactions (within one firm) than economic models imply. This is because social networks of certain strong interpersonal relationships can transcend firm boundaries, especially in Castell's 'network society', with the result that many interfirm social interactions may be stronger than their intrafirm counterparts (ibid).

These interpersonal relationships depend crucially on interpersonal trust, and the informality of these relationships is viewed as being a potential strength rather than a weakness. When there are relationships among individuals who have decision-making power in a group of different firms or organisations, the existence of these trust relationships will mean that the actions of the firm will differ from the behaviour associated with either pure market-contracting or hierarchically organised relationships (ibid). Gordon and McCann (2000:520) identify three key features of this trust-based behaviour:

1) firms within the social network are willing to undertake risky cooperative and jointventures without fear of opportunism

2) firms are willing to reorganise their relationships without fear of reprisals

3) firms are willing to act as a group in support of common mutually beneficial goals.

These behavioural features imply that the social network is comprised of a set of transitive private relationships in situations where neither price signals nor monitoring are sufficient to ensure the implementation of a particular project or activity.

The strength of the relationships is described as the level of 'embeddedness' of the social network, which refers to the situation that they depend upon shared norms, institutions and sets of assumptions (they thus are not simply the outcome of economic decisions but depend on the social and political context).[14] The size of these groups, the strengths of the norms and the nature of the shared beliefs vary between different networks, which causes differences in the types of relations that are being sustained, the intensity of the interactions and the willingness to take certain kinds of risks.

The social-network model is thus independent of spatial applications (although it is possible, it is merely not a necessary condition), because social networks are essentially a form of durable social capital, created (and maintained) through a combination of social history and ongoing collective action. In this sense, their strength is inherently problematic, depending upon a prior accumulation of trust, circumstances which facilitate monitoring of others' behaviour, a source of leadership and/or a sense of common interest, as well as the expectation of significant gains (Olsen, 1965). Access to the club will therefore depend on past experience and routine interaction as well as on investments of effort in developing personal relations and trust (Gordon and McCann, 2000:520). This is expressed in the importance of 'weak ties' (Granovetter, 1973), both direct and indirect, and more pluralistic and open-ended networkbuilding strategies in which actors cultivate more extensive sets of links, particularly with betterconnected actors, which may prove to be more useful than committing to any single 'club'. The networks are thus of dynamic and expanding character.

6.2.1.1 The issue of trust

All relationships in an industrial social network depend to some extent on trust. At first instance, information is needed about the other party in relationships and alliances – which are both building blocks of networks. Eventually, the need for information may be partially substituted by a willingness to trust. Trust can be defined to mean areas of life which one can take as a given and is a fundamental factor in deciding what amount and type of information will be presented towards other parties. Trust derives from learned, usually interactive, experiences (Tomkins, 2001:168). The process of trust building itself depends upon information as well as the appropriateness of information which depends on the state of trust: relationships are built through stages of experience, trust intensity, interdependence, and information needed by each party varies according to the stage of the relationship (Tomkins, 2001:174). The building of trust is thus a dynamic process, in which the role of information in it is variable. The expectation of continuity and repeated meaning are important as well. Because of all this, trust is contextually dependent on cultural and personal variables (169). A relationship will not develop without the growth of trust. However, the willingness to continue the relationship depends upon more that the existence of trust: the relationship must deliver something of value to the parties involved. The sharing of information therefore has two goals: establishing willingness to trust and planning collaborative actions for mastery of certain events (thus cooperation towards a common goal) (174). These observations of trust are applicable in both interpersonal and interorganisational settings (185).

6.2.2 Transition management: how to create an industrial social network for sustainability

Transition management is a new governance approach for sustainable development. Transitions are processes of structural change in societal (sub-)systems and come about when the dominant structures in society (called regimes) are put under pressure by external changes in society (such as the call for sustainability) or by endogenous innovation (Loorbach, 2010:166). The management of these transitions is by definition a multi-actor process as the complexity of transitions is too high to be managed in terms of command and control by one actor (Loorbach and Van Raak, 2005:5). This is because transitions become apparent and analyzed simultaneously in multiple levels which are influencing each other: there are innovations in niches, a dominant regime and an external landscape. The level of regimes is the level of a specific socio-technical domain and refers to institutions: dominant practices, formal and informal rules and technologies that pertain in the domain, giving it stability and guiding decision-making (3). Niches are the level in which novelties are created and tested, including new technologies, new rules and regulations, new ideas and new organisational practices (ibid). The level of the landscape is the overall societal setting in which processes of change occur, consisting of social values, political cultures, the build environment and economic development and trends (ibid). These three levels are adaptive and co-evolutionary, which means that their characteristics are dynamic and the levels are mutually influential. Because of these different levels, long term thinking is crucial; the setting of short term goals should be based on long term goals and the reflection on future developments through the use of scenarios (Loorbach, 2010:167). Because the complexity of the system is at odds with the formulation of specific objectives or blueprint plans, objectives should be flexible and adjustable at the system level.

Transition management therefore builds upon the idea of advocacy coalitions and partisan mutual adjustment. Participation from, and interaction between stakeholders results in processes of negotiation, adaptation, co-production, and sometimes dispute, thereby changing or adapting the views of the actors, making them redefine their own place and role in the system and rephrasing perceived problems and imagined solutions. In order to translate all of this into practical management frameworks without losing too much of the complexity involved or becoming too prescriptive, a multi-level transition framework[15] was developed (Loorbach and Van Raak, 2005). This framework distinguishes between three types of transition management. The first is strategic management, which involves processes of vision development, strategic discussions, long-term goal formulation, collective goal and norm setting and long-term anticipation (Loorbach, 2010:168-9). It is thus focused on culture and its problem scope involves the societal system as a whole. The level of activities is the whole system and the time scale is long term (30 years) (171). The second type of transition management is tactical, which focuses on structures by looking at institutions and regimes and their transformation in the mid-term (5- 15 years) (ibid). It involves processes of agenda-building, negotiation, networking and coalition building in order to question and influence established patterns and structures, such as rules and regulations, institutions, organizations and networks, infrastructure and routines (169). The third level is that of the operational level in which processes of experimenting, project-building and implementation take place. These are concrete and short-term oriented. The combination of these three levels should in practice result in the organization of sustainable innovation and the constant transfer of knowledge (Loorbach and Van Raak, 2005:7).

The organisation of these management types and their accessory instruments are captured in a cyclical process model as a basis for implementing the transition management approach. This socalled transition management cycle (Loorbach, 2010:172) consists of four components:

1. Structure the problem in question, develop a long-term sustainability vision and establish and organize the transition arena;
2. Develop future images, a transition agenda and derive the necessary transition paths;
3. Establish and carry out transition experiments and mobilize the resulting transition networks;
4. Monitor, evaluate, and learn lessons from the transition experiments and make adjustments in the vision, agenda and coalitions.

As for the scope of this report, in the third paragraph we will elaborate on the first component, since one can only 'design' the first component because of the dynamic and iterative character of the transition cycle as a whole. In that paragraph, we will present a design of the transition arena. This is a small network of frontrunners with different backgrounds, within which various perceptions of the MP-GP problem / challenge and possible directions for solutions can be deliberately confronted with each other and subsequently integrated (Loorbach, 2010:173). To be involved, the actors have their own perception of the transition issue in question from their specific backgrounds and perspective. These people participate on a personal basis and not as a representative of their institution or based on their organizational background, this condition is in line with the transdisciplinary method of the Xplorelab. Transdisciplinary collaboration makes sense if the problems exceed the competency of an interdisciplinary team: a sum of expertise is not enough, there is a multiplication of expertise needed. Xplorelab offers a safe arena where these cross-disciplinary processes can take place. This setting allows a chemist to be an urban designer in a certain way, so certain problems can be solved and transdisciplinary knowledge is created.

There should not be too many actors (max. 10-15), and they are identified and selected based on their competences, interests, and backgrounds (ibid). These frontrunners are expected to have the ability to consider complex problems at a high level of abstraction; the ability to look beyond the limits of their own discipline and background; enjoy a certain level of authority within various networks; have the ability to establish and explain visions of sustainable development within their own networks; be willing to think and work together, and open for innovation instead of already having specific solutions in mind (173-4).

6.2.3. Discourse analysis: keep your friends close and your enemies closer

In accomplishing cooperation between MP and GP, exchange of information and knowledge is crucial, especially because knowledge is the essential source of increased productivity (Smeets, 2009:22). Both knowledge and information are however of ambiguous nature: knowledge can be latent or manifest and the owner of the knowledge can decide who (not) to share their knowledge with. This is expressed in Foucauldian understanding of the relationship between power and knowledge. Foucault conceptualises power as a feature of everyday human action embedded in social relations, which are of importance for cooperation between different actors such as firms, government and businesses. It is manifested in instruments, techniques and procedures that may be brought to bear on the actions of others. Although it is not just a weapon wielded by the ruling class (for example multinational corporations), relationships of power are rarely symmetrical and wholly democratic (Hannigan,2006:53). The exercising of power occurs through the ability to shape the process of socialisation (in which norms, customs and ideologies are inherited) rather than through naked force or physical coercion, which makes it more effective because it reduces resistance while simultaneously internalises consent. This makes power not merely repressive but also productive.

In the process of socialisation; discourses become important. A discourse is defined as ‘a specific ensemble of ideas, concepts and categorizations that is produced, reproduced and transformed into a particular set of practices and through which meaning is given to physical and social realities’ (Hajer, 1995:264). Therefore discourses are important in ‘defining the rules of the game’. A discourse is thus an ensemble of ideas and concepts that give social meaning to social and physical relationships (Fischer, 2003:90). They affect our view on all things and can not to be escaped from – it defines our ‘point of view’: social phenomena do not exist independently of our interpretation of them. Interpretations and meanings of social phenomena are crucial and can only be established and understood within discourses or traditions (Marsh and Stoker, 2002:26).

In a discourse, the world is interpreted through an interrelated set of ‘storylines’, which have a triple mission: creating meaning and validating action; mobilising action; and defining alternatives (Gelcich et al,2005:379).These storylines become deeply embedded in societal institutions, agendas and knowledge claims. The creating of these storylines can happen in a conscious manner, but also unconsciously. The storylines created can therefore be based on factual[16] or interpretational knowledge, which means that opinions (for example expressed one’s image of the other) become important aspects of knowledge.

Because of the centrality of cooperation in the MP-GP complex, it is important to decipher the discourses – which define what is considered meaningful (for example what is interpreted as problematic and what as chances) – of the main actors involved (=stakeholders). These can point out to us those issues on which actors agree and thus create opportunities for successful cooperation. Also, those issues on which actors disagree (because of clashing interpretations or values) and thus create problems for cooperation will become clear. Thus, on the same issue, there are various discourses (while one discourse may dominate, it will always be resisted by different narrations of the same issue) (Marsh and Stoker, 2002:35). Especially since the successfulness of the transition arena (in the form of a knowledge network) is dependent on its spill-over and thereby acceptance by the main stakeholders, it is useful to know the ‘language’ of these stakeholders: this indicates ways in which they might be persuaded into cooperation.

Discourse analysis (DA) is a general term for a number of approaches to analyzing written (documents) and spoken (interviews) language as a means to decipher the discourses in practice. Objects and actions acquire meaning – become ‘real’ – only when they have a place in a language (a wider web of meanings). Documents (and spoken words) do not stand on their own, but need to be situated within a theoretical frame of reference in order that its content is understood (May, 2001:191). In DA; language is viewed as a form of social practice and it focuses on the ways in which dominant ideas are reproduced by text and talk. Language shapes our view of the world rather than merely reflecting it. It is always based on the interpretations of both those who speak it and those who receive it and therefore discursive meanings, motives and actions take their meanings from the institutional-discursive contexts in which they are uttered (Fischer 2003:47). A discourse approach seeks to show that we need a much more refined understanding of the interactions that construct reality; in particular the way the empirical (practice) is embedded in the normative (viewpoints) (Fischer, 2003:viii).

Qualitative content analysis views the author as a self-conscious actor addressing an audience under particular circumstances. The task of the analyst becomes a ‘reading’ of the text in terms of its symbols (May, 2001:193). Although a clear-cut methodology through which to exercise a DA is non-existent, there are guidelines which structure the process. In our research, we have used guidelines as provided by Fischer (2003). He makes a distinction between narratives (which tie together a story through a plot and represents the ‘is’ part of the frame) and arguments (which are structured around premises designed to logically lead to conclusions; the ‘ought’ part) (181). In the DA, issues of fact and value are assessed in the broader light of historical context, affective influences, and motivational factor, recognizing the partiality of the premises in practical argumentation and their dependency on circumstance (191). The structure of an argument is typically a complex blend of factual statements, interpretations, opinion, and evaluation (ibid). The DA not only encompasses the logic of empirical falsification, it also includes the normative questions in which it operates by looking at interconnections among the empirical data, normative assumptions that structure our understandings of the social world, the interpretive judgements involved in the data-collecting process, the particular circumstances of a situational context, and the specific conclusions (ibid).

In deciphering these different layers, we have used some leading questions as provided by Gee (1999). Gee (1999:85-6) argues that one can distinguish six building tasks through which we use language to construct and/or construe situations at a given time and place in a certain way: semiotic (communicative systems, systems of knowledge and ways of knowing); world building (what is taken as real/unreal and possible/impossible); activity building (what is going on); socioculturally situated identity and relationship building (what identities and relationships are relevant to the interaction with their attitudes, values, ways of feeling etc); political building (construct the nature and relevance of social goods such as status and power); and connection building (past-present-future). All these building blocks were translated by Gee into questions (appendix B) that make apparent the specific characteristics of a certain discourse. These questions were used in understanding the dominant discourses of some of the main actors in the MP-GP area; which will be the topic of the fourth paragraph of this chapter.

6.3 Designing the Transition Arena for the MP-GP Complex

As argued above, industrial cooperation can be understood as a functioning network. Building such a network for innovative practices can be accomplished by applying principles from transition management. This paragraph is devoted to the organization of the first step of the transition management cycle by creating a transition arena. This arena consists of a number of innovative frontrunners involved in the Mainport and/or Greenport area; people who can 'think outside of the box'.

After composing a table in which we could enter data about people contacted (appendix C), the selection of interviewees could start. Twenty 'key persons', with the willingness to endeavour sustainable innovation, have been selected from both the Mainport and Greenport. These interviewees were selected using the KOMBi approach (Kenniswereld, Overheid, Maatschappij & Bedrijfsleven). This approach guaranteed a diverse list of stakeholders from knowledge and governmental organisations, society and businesses. Some of the contacts were delivered by Marco van Steekelenburgs list of participants of the Mainport-Greenport excursion held on September 18th 2009, others were taken from the Network booklet 'Greenport Westland-Oostland', published by Triagilitas. In this way we would be certain that the persons to be interviewed were in possession of innovative sustainable ambitions and some authority within or amongst organizations and colleagues. After selection of twenty key-persons (ten persons from a Mainport perspective, ten from the Greenport) and the approval of Marco van Steekelenburg we contacted all the persons by telephone. During an interview of approximately 20 minutes we asked questions listed in advance, which were based on the network table conducted. Not everyone was available to participate in the interview, so eventually 14 interviews have conducted. The results of the interviews are aligned with each other and arranged in the table in appendix E on surname in alphabetical order.

Due to our thorough desk research before conducting the interviews, we had only selected people that would fit the general profile of a network participant; we merely had to check their competencies and if the people selected were complimentary in relation to each other. As the table above shows, the participants are diverse enough (in background, competencies, ideas) to feed off each other which creates space for new and innovative ideas and practices; while also being similar enough which enables understanding and cooperation. All interviewees perceived sustainability from a different angle, mainly influenced by their backgrounds and through organisation they are employed with. The issues mentioned were mainly focused on reduction of water, material and energy consumption, change in behaviour and mindset, political and legislation barriers and the gap between governmental institutions and businesses. All the interviewees are involved in sustainable practices, not surprisingly because the persons were selected by their willingness and ambition for sustainable development. The solutions suggested for the MP-GP cooperation mainly focus on synergy; exchange of waste streams (CO2, energy, water, materials), innovation in logistics and transport (conditioned transport and inland navigation), biorefinery and knowledge sharing and development. Some of the participants mentioned the economic position of Mainport and Greenport, facing similar problems of education and employment. All interviewees seem to have a flexible mindset and are very open to sustainable innovation.

Furthermore, they have plenty of connections to other organizations, businesses and agencies which might come in handy as the process of transition evolves. All the interviewees are embedded in a large network of stakeholders and at least 10 out of 14 interviewees are already connected to each other. This facilitates the future synergy between Mainport and Greenport.

Many organisations have the ability to build bridges, share and develop knowledge and WUR, Prominent and Priva have the capacity to start up demonstration projects. Besides practical issues, organisations like Milieufederatie and Gemeente Westland are necessary to create enthusiasm, wide support and communication to outsiders. A good starting point to induce cooperation would be the formation of a platform of knowledge sharing; this makes clear what the mutual benefits are from both sides. On the longer term an overarching organisation could be established.

This list of people would, in our view, be a good start of the MP-GP transition arena. The next step in the process is to facilitate the cooperation by creating a work space (which could be partially virtual, although in the start up face actual personal contact would be preferred due to the necessity of trust building as mentioned above) and formulating an assignment (which should be broad enough for the participants to come up with fresh ideas). The goal of the network could be the development of demonstration projects and business cases in the Mainport-Greenport context, with a focus on sustainable synergetic interactions. It is important to appoint a transition manager; this person will become the spill in the network, initiating and coordinating meetings and processes. It is important that the transition manager has a broad interest and is able to communicate with a variety of actors in different settings.

One important aspect that should be considered in establishing and maintaining the network is the 'rules of the game' with respect to sharing information and knowledge. Some information or knowledge can be considered too sensitive for an organization to be shared with others. In the case of the MP-GP network however, we have searched for people that have proved to be team players and willing to cooperate before. Also, since trust among participants may grow over time, so might the willingness to share knowledge. It is therefore important that the participants themselves come up with some guidelines as to how to deal with these issues. It should be noted however that these guidelines must be somewhat flexible, because this will increase the chances of willingness to cooperate and successful outcomes of the network.

6.4 Considering other players: discourse analysis of three involved parties

In this paragraph we will investigate some of the dominant discourses used by some of the most important actors in the area as to estimate if and how the creation of the knowledge network can be stimulated or contravened by some of the main actors in the MP-GP area. For these analyses we have used documents envisioning the desired future of the actor involved.

6.4.1 Greenport(s) Nederland

In their "Excelleren! Greenport(s) Nederland Visie 2040" (fig. 6.1) the Greenport(s) Network[17] presents a vision on the horticulture sector which is developed in cooperation with the sector itself. Presented in a report with athletes running towards a finish line on the cover, the symbolism is clear: all athletes run towards the same goal, but only one can be the winner. The Dutch Greenport industry must keep up with other international competitors in order stay in the game.

Figure 6.1: Excelleren! Greenport(s) Nederland vision

The report starts by emphasising its iterative character due to the 'instability of the world'. The horticulture cluster has become such an important pier of the Dutch economy due to 'passion, talent and economy' and it is stated that these aspects will be important in the future as well. Three scenario's for the horticulture industry in the Netherlands in 2040 are presented: "potverteren" (which is something like squandered; meaning that the Netherlands will be to full for a horticulture sector that is profitable); 'consolidate'; or 'excel' (in which difficulties and opportunities are pro-actively engaged with). The title of the vision already expresses which option is favoured in the vision: the one of excellence.

The report is drawn up from five points of view: earning, strengthening, connecting, innovating, and becoming more sustainable. These are applied to the sector itself as well as to society as a whole. Stating that 'generation Y will pursue convenience, health, sustainability and authenticity', the report continues by drawing a picture of what the sector will look like in 2040. It is argued that 'consumer steered production in chains and networks is normal'; 'there will be an increase of employment opportunities as well as an increase of the availability and affordability of healthy food and a green environment''; while horticulture companies will have become 'multi-functional' combining the production of food and 'greens'(plants, flowers) with for example energy production and contributions to an attractive living environment. It is expected that the number of agro parks will increase, while transportation will shift from unimodal to multi-modal.

Knowledge, innovation and sustainability are key aspects in accomplishing the biggest challenge: the 'strengthening of the relation between the horticulture cluster and the society and consumers in terms of physicality and experience'. The vision speaks of system innovation, which is defined as 'cross-organisational innovation which hugely changes the connections between firms, organisations and individuals'. It foresees a shift from closed to open innovation as well as a shift from the development of knowledge to the implementation of knowledge. These innovations are caused by calls for sustainability, decentralisation, energy politics, health, lack of space, changes in logistics and consumer communication.

In their vision, Greenport(s) would like to see the Greenport as the international example of cluster innovation. Arguing that 'cyclical thinking is important', it states that the internalisation of costs of labour, energy and environment can be improved. The scarcity of resources, soil, energy, water and labour is viewed as an important challenge, but not so much as problematic.

6.4.2 Rotterdam Harbour

The future vision of the Rotterdam Harbour in 2020 is in fact a vision from government, although from the perspective of the harbour business, since the municipality of Rotterdam and the State are the only shareholders. The title of their vision is "Space for Quality" and some of the keywords from their vision are 'efficiency', 'industry' and 'large scale'.

Figure 6.2: Port Vision Rotterdam 2020

Their primary goal is defined as the maintenance and increase of the economic value of the harbour in terms of employment while being ‘dynamic’. This dynamic is emphasised to be important for both the harbour and the city itself, in terms of tangible arrangements (“ships, cargo and impressive technology”) and less tangible arrangements (“knowledge development, culture and liveliness”). Because of its important role for the city of Rotterdam as a whole, the municipality developed a threefold objective for the upcoming period until 2020: amplifying the international competitiveness of the harbour and industrial complex; contribute to strengthening the economical structure of the city and the region; and contribute to an improvement of the spatial quality of the environment in the region.

The elaboration of how to tackle these objectives starts with a list of threats that the harbour has to deal with: international competition; the many low educated people living in the area without ample employment opportunities; the lack of space; encumbrance from harbour activities and the risks involved in harbour activities. These threats are counterbalanced by opportunities (‘through quality’), but the fact that threats are started with before the opportunities set the tone of the vision: something needs to happen because other wise the threats will be transformed into major negative consequences for the Rotterdam region as a whole.

Nevertheless, the opportunities presented are elaborated upon as well. Due to the deep fairway and ‘excellent connections to the hinterland’ the harbour can profit from new industrial developments – especially those on the energy market – and the expansion of the industrial area which both create ‘opportunities for a new dynamic and a growing demand to specialist knowledge’. Further development of technology, creativity and regulation and a growing commitment to corporate social responsibility ‘create opportunities for a harmonious connection between the harbour and the densely populated area’, according to the vision. The vision continues by sketching six different types of quality harbours which the Rotterdam harbour can strive to be. These are: the ‘versatile harbour’; the ‘sustainable harbour’; the ‘knowledge harbour’; the ‘quick and safe harbour’; the ‘attractive harbour’; and the ‘clean harbour’. The emphasis of the types of developments necessary for the establishment of such an ideal type differ from ‘more infrastructure’ to ‘more nature areas’ to ‘clustering of businesses’. The vision states that ‘stimulating and facilitating of cooperation between companies through sharing utilities and making use of each others’ waste streams’ ought to be strived for while investing in knowledge development through facilitating cooperation between diverse actors.[18] Although the vision is thus quite elaborate, it is important to notice that the ideal types are all compartmental: rather than presenting one overall vision in which all the aspects are incorporated, it was chosen to present the ideal parts separately. This implies that combining the elements is impossible or at least too difficult to tackle in the near future (2020).

The most important dilemma for the near future is formulated as a question: ‘how can the increase of transportation streams with an increase in security and better environmental quality be combined and how can both the harbour and the city develop without hampering each other?’ Although the vision is quite open and interpretable in multiple ways, there is an emphasis on cooperation (with other harbours, with environmental organizations etc.) and transitions to sustainable practices (combined heat and power, recycling, waste to energy).

6.4.3 Westland

The municipality of Westland has developed its own vision on the development of the Greenport area in light of larger societal developments and trends. Starting by emphasising the innovative and entrepreneurial character of the horticulture industry in the area, it is argued that the major strength of the area is the mutual connectedness and dependence of functions in the horticulture sector. Quickly the connection to the Rotterdam harbour as transportation hub of importance to the sector is made, while suggesting that the combination of knowledge on horticulture in the Westland and knowledge and infrastructure on process technology and pharmaceuticals in the Mainport can lead to the creation of a whole new and innovative sector. The possibility of creating a whole new market by developing and producing energy, medicine, high quality resources and produce from agricultural sources is emphasised. Sustainable conditions for producing (water and energy use, environment and space) are a must if this market is to be developed.

The municipality of Westland claims to be ‘ambitious’ mentioning their goals to become more appealing to inhabitants, trade and industry and NGO’s in the next 15 years. They argue they should have a pioneering role in developing the ‘Greenport-thought’ even further and call upon other governmental agencies and stakeholder organizations to get involved and work together to strengthen Greenport Westland.

Emphasising multiple use of land through stacking and offering more opportunities for floating greenhouses and the so-called water cellars, the municipality shows its willingness to contribute in unconventional solutions to tackle the diverse sustainability problems. The participation of the municipality in the knowledge alliance of the province (Kennisalliantie Zuid-Holland) shows their benefit in ‘uniting practice and knowledge’. Westland has some specific qualities – they argue – that make it able to stay a world market leader in a number of segments of horticulture: a well developed knowledge network, a dense distribution system, short transport distances to the Mainport Rotterdam and Mainport Schiphol, and high ingenuity amongst its entrepreneurs. However, all these aspects need to be improved in combination with new innovative practices. The municipality stresses the importance to work together with a number of stakeholders and offer their expertise and initiative to develop a broad project group. Two things are of big importance here: cooperation between and clustering of different government levels; and an improvement of the sectors image in order to emphasise its green and environmentally friendly character.

6.4.4 Network + Existing Discourses= Success?

Although all three analysed discourses emphasise different aspects of importance to their future vision, they have commonalities too. These commonalities are focused on the need for a more sustainable way of dealing with business in the future, acknowledging the need for new forms of organization and sharing of knowledge. The development of our suggested knowledge network should not be threatened by any of these main players involved. However, much depends on the way the network will communicate and cooperate with these actors, for them not to slowly change their attitudes – and discourses – towards cooperation in the pursuit of sustainability in the MP-GP area. The network – especially the transition manager – should pay close attention to developments within the organization of these main players and consequences for the success of the establishment and ability to create new outcomes of the network.

Another important point to notice here is that it is hard to gain insight into the perceptions concerning the development of the MP-GP connection of another important group of stakeholders: citizens. Even harder is it to influence their perceptions. It is important however, because these citizens are tomorrow's voters and demonstrators when they feel unhappy with the developing situation. Smeets (2009) shows how citizen groups have blocked the development of the 'Deltapark' in the Rotterdam Harbour. This Deltapark was a theoretical design of an agropark which provided for the regional clustering of production and processing of animal proteins, glass horticulture, waste separation, and animal feed production, which were integrated with the chemical industry in the port. A feasibility study on the basis of the design worked out positively and pointed to substantial social benefits (Smeets, 2009:27).

Nevertheless, the municipality of Rotterdam has prohibited agricultural practices in the harbour area, partially under pressure of citizen and social organizations. Being labelled as a 'pig apartment building' ("varkensflat") by one of these organizations, other negative reactions and concerns accumulated: there was aversion to the image of a 'warehouse' for animals; it would be administratively complex; there were concerns for danger of a disaster concerning viruses etc. Although these concerns might have been legitimate, the arguments in favour of building the Deltapark were overshadowed. The spatial component ("ruimtewinst"), minimalisation of the risk of contagious diseases (thus food security), the becoming unnecessary of animal transportation; the advantage of closed ecosystems for the environment; and its improvement in comparison to current agricultural practices all were pushed aside due to this one catchword that instigates some kind of horror picture in peoples' minds: the "Varkensflat".

This example shows that however sustainable a suggested solution might be, it will not be implemented if it is not communicated well to citizens and social organizations. Thus, although the discourses of some of the big players are compatible with the idea of creating a MP-GP connection, special attention has to be given to inform and convince society of the necessity and advantages of creating such a complex. The proposed network should therefore not only communicate with government and businesses, but also with citizens. Some of the people in the suggested network have already mentioned their communicative skills (and some have connections to important societal organizations) and should employ these to create support and prevent a new 'deltaplan-disaster' from happening.

6.5 Concluding remarks

Cooperation is a key factor in innovative projects. Especially when long-term goals as to promote sustainability are pursued, the inclusion of multiple actors from different perspectives may provide fruitful new insights. Establishing a flexible knowledge network with people from different organizations involved will help to establish a transition in the MP-GP complex towards more integrative practices. The network should focus on gathering and sharing evidence based knowledge as well as shared value development, using social, environmental and economic perspectives. A transition is a long-term process and results may not be noticeable initially. However, starting up the process by implementing a network is a necessary first step. This chapter has provided a list of people that could be approached as to be the first members of this flexible transition network. An information network could become the basis for the implementation of NISP (National Industrial Symbiosis Programme). NISP is an innovative business opportunity programme, that could offer the framework for exchanging residuals (e.g. bio-waste, industrial waste) in the MP-GP complex. NISP is a successful English program that could be introduced in the Netherlands (www.nisp.org.uk).

NATIONAL INDUSTRIAL SYMBIOSIS PROGRAMME

References

Journal sources

Castells, Manuel (1996). The information age: economy, society and Culture. Vol 1: The rise of the network society. Blackwell Publishers, Cambridge MA.

Fischer, Frank (2003). Reframing Public Policy. Discursive Politics and Deliberative Practices. Oxford University Press.

Gee, James Paul (1999). An introduction to Discourse Analysis. Theory and Method. Routledge, New York.

Gelcich,S., Edward-Jones, G., Kaiser, M.J. and Watson, E. (2005) “Using discourses for policy evaluation: the case of marine property rights in Chile” in Society and Natural Resources, 18:377-391.

Gordon, Ian and Philip McCann (2000). “Industrial Clusters: Complexes, Agglomeration and/or Social Networks?” in Urban Studies Vol 37, No 3, pp 513-532.

Granovetter, M. (1973). “The strength of weak ties” in American Journal of Sociology, 78, pp. 1360-1380.

Greenports Nederland (2008). Excelleren! Visie 2040. Drukkerij Weemen.

Hajer, Maarten (1995). The politics of Environmental Discourse. Ecological Modernization and the Policy Process. Clarendon Press, Oxford.

Hannigan, John (2006). Environmental Sociology. Routledge, New York.

Loorbach, Derk and Van Raak, Roel (2005). “Governance in Complexity: A Multi-level policy-framework based on complex systems thinking”. Paper for the conference ‘Lof der Verwarring’, Rotterdam.

Loorbach, Derk (2010). “Transition management for sustainable development: a prescriptive, complexity-based governance framework” in Governance; An International Journal of Policy, Administration and Institutions, Vol 23, No 1, pp 161-183.

Marsh, David and Stoker, Gary (2002). Theory and Methods in Political Science. Palgrave, Macmillan.

May, Tim (2001). Social Research. Issues, methods and process. Open University Press, Maidenhead.

Olsen, M. (1965). The Logic of Collective Action: Public Goods and the Theory of Groups. Cambridge, MA: Harvard University Press

Smeets, P.J.A.M. (2009). Expeditie agroparken: ontwerpend onderzoek naar metropolitane landbouw en duurzame ontwikkeling. Wageningen Universiteit.

Tomkins, Cyril (2001). “Interdependencies, trust and information in relationships, alliances and networks” in Accounting, Organizations and Society 26, pp 161-191.

Web sources

Gemeente Rotterdam (2004). Havenplan 2020. Ruimte voor kwaliteit. Accessed January 17th 2010, available at http://www.havenplan2020.nl/

Gemeente Westland (2005). Visie Greenport Westland 2020. Accessed February 20th 2010, available at http://www.gemeentewestland.nl/BIS/

Gemeenteraad/2005/26-04-05/079%20Eindversie%20Greenportvisie%2029%20maart%202005%20incl.%20kaarten%20low%20res.pdf

NISP www.nisp.org.uk, accessed April 23th

12 If a strategy for dealing with a persistent problem in a sustainable way is static rather than dynamic, this can create problems in itself. The iterative character which is expressed in learning and experimentation prevents the actors from becoming short-sighted and leaves room for the changing character of the problems involved and of the interpretations of and values attached to these.

13 Bounded rationality means that actors act in a rational way but that their rationale is limited due to the fact that knowledge is always limited and that action can therefore only be bounded rational instead of fully rational.

14 This means that the discourses adhered to by the different actors must me similar or at least compatible in those aspects that are crucial for cooperation.

15 Appendix A shows the whole Multi-level transition framework including specified goals, activities, instruments and competencies for each of the levels of management.

16 However, facts do not 'speak for themselves': social facts are always theory laden and thus rest on interpretations (Fischer, 2003:13)

17 This network is a cooperation between various businesses and government which work from an interest strategy for a healthy and sustainable greenhouse sector which contribute firmly to the Dutch economy and society.

18 In fact, the report states that research and initiatives in the area of industrial ecology should be stimulated

Photo: Excursion to OCAP Site, Botlek 2009

Chapter 7

Heat and CO_2 network

7.1 Introduction

This chapter evaluates the costs, environmental impacts and benefits of the implementation of a heat and CO2 network for the Mainport and Greenport. As was presented in the first part of this report, both Mainport and Greenport have a large CO2-emission. In the case of the Greenport, CO2 is a by-product of greenhouse heating as well as a resource for enhanced plant growth.

In order to avoid CO2 emissions and heat loss, a heat and CO2 network from the Mainport is proposed to transport excess heat and CO2, that are waste streams in the Mainport, towards the Greenport. This process, of using waste streams for new purposes, is known as cascading. At present, CO2 is already being distributed towards the Greenport by means of the OCAP pipeline. Also, several local heat networks have been developed.

In the first section, a brief description is given on the methodology used for this case study. The current status of heat and CO2 network is described in section 7.3. Next, several options of implementing heat and CO2 technologies within greenhouses will be discussed. Then, in section 7.5, a grand design is presented for the (further) development of heat and CO2 network. In section 7.6 the environmental impacts concerning the development of the networks in the grand design is discussed. Then, economy is shortly evaluated in section 7.7. The implementation of the design is described in section 7.8. Furthermore, implementation for a time frame of 30 years is described. Finally, conclusions and recommendations are given in the last section 7.9.

7.2 Methodology

This case study is performed by a desk study on existing literature. Furthermore, an explorative meeting was organized between Xplorelab, Grontmij, and OCAP in order to assess possibilities for future cooperation on the development of heat and CO2- networks. A life cycle perspective is adopted in order to assess the environmental impact of the development of networks.

7.3 Current situation

Several heat networks are already in place. Furthermore, the OCAP pipeline provides greenhouse entrepreneurs with CO2 from the Shell hydrogen production facility in the Mainport. OCAP stands for Organic Carbondioxide for the Assimilation of Plants. The OCAP pipeline supplies currently about 30% of the Greenport with CO2. The carbon dioxide originates from the hydrogen production facility of Shell in the Botlek and is transported through a former crude oil pipeline, the NPM (Nederlandse Pijpleiding Maatschappij) pipeline. Figure 7.1 depicts the pipeline as well as the connected greenhouse areas by OCAP. It also shows the remaining areas with a connection potential (OCAP, 2009).

There are examples of local heat networks already in place. At a tomato nursery of 7.2 ha in Bleiswijk, geothermal heat is used to heat the greenhouses. Water of 65oC is pumped from a depth of 1750 m and fed to a heat exchanger. The water will be pumped back at a temperature of 30oC (vd Bosch, 2009:2).

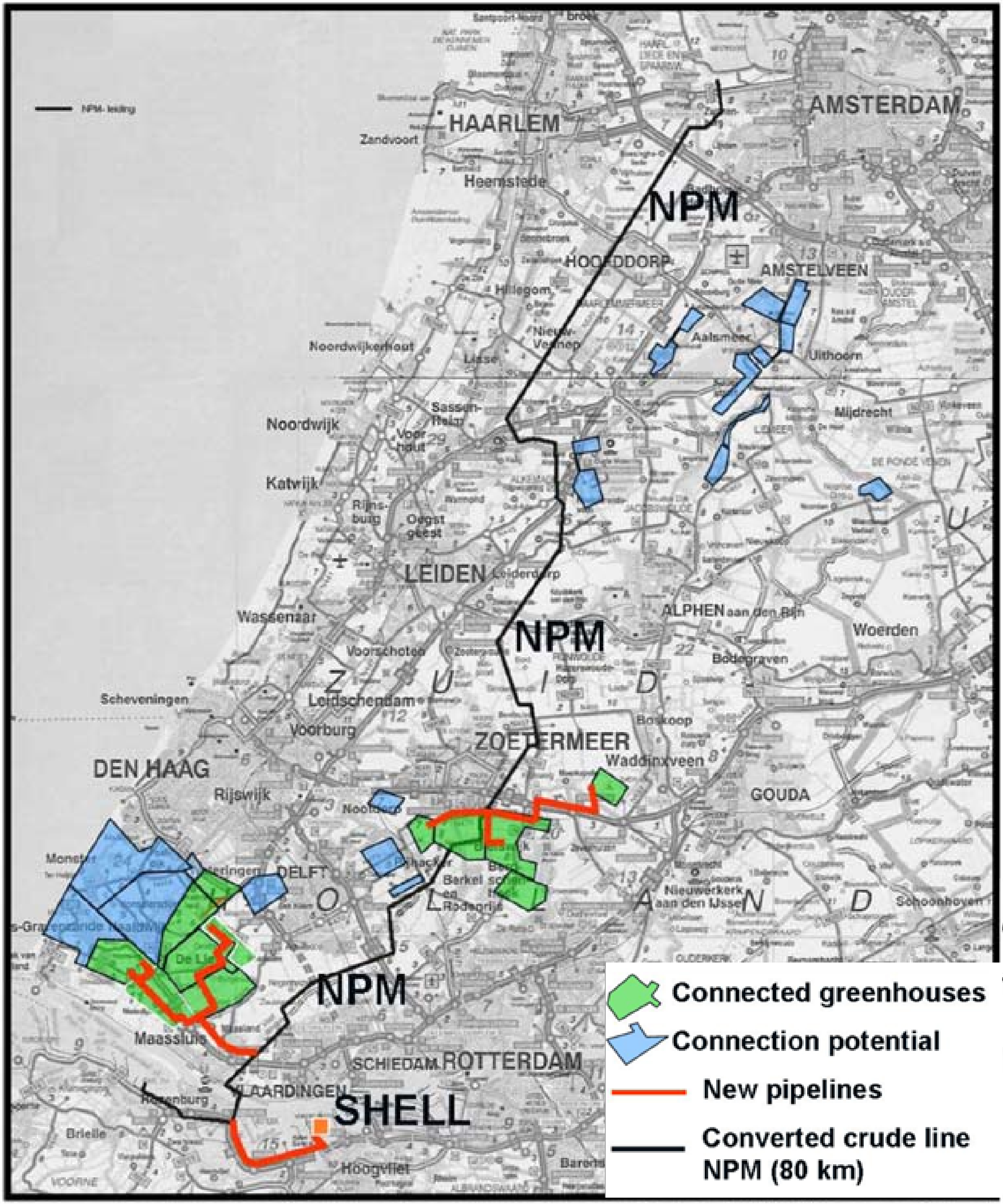

Figure 7.1: OCAP pipeline with connected greenhouse areas (Melieste, 2006)

to apply 85°C geothermal heat to connect to the heat network (Multi Energie Concept – Vierpolders, 2009). The main conclusion that can be drawn with regard to the current situation is that different companies are already developing heat-networks and a CO_2- network (OCAP) independently.

7.4 Greenhouse technologies

In this section, two greenhouse technologies are described to sketch sort of a framework in which the greenhouse designs will fit. The open greenhouse system and the closed greenhouse system.

7.4.1 Open greenhouse system

In an open greenhouse system the windows are opened when the inside temperature gets too high to cool the greenhouse. But, when opening the windows a lot of CO_2 is lost to the atmosphere. This CO_2 is crucial in the operation of the greenhouse, especially in summer when the plants have a lot of sunlight and heat, for the growth of the plants. When sunlight is abundant, plants need a lot of CO_2 to grow. The source of this CO_2 is the burning of natural gas. During summer, the greenhouse needs a supply of CO_2, but the produced heat of burning natural gas cannot be used in the greenhouse, and is therefore emitted to the atmosphere. In winter times, when the temperature in the greenhouse gets too low, natural gas is burned to produce heat.

In the current situation, natural gas is burned in a combined heat and power plant (CHP). In this way, heat, electricity and CO_2 are produced simultaneously. But, the problem of a mismatch between heat and CO_2 exists, even with this new technology. It can even be the case that the CHP plant is in operation when neither heat, nor CO_2 are necessary. This is because the electricity is sold to the grid, which is profitable for the greenhouse entrepreneurs. The same holds, however, for power plants.

Some disadvantages of the open greenhouse system:
- Heat and CO_2 are lost when the windows are opened in favor of the inside climate; in this way natural gas is used very inefficiently. Less than 10% of the CO_2 is absorbed by the plants within the open greenhouse.
- Biological pesticides (like bumblebees and lady bugs) can flee when the windows are opened.
- Crop diseases can infiltrate the greenhouse through the open windows.

To neutralize these disadvantages, a new greenhouse principle is designed, the closed greenhouse system, which is described in the following section.

7.4.2 Closed greenhouse system: the greenhouse without natural gas

A recent innovation within the Greenport is the closed greenhouse principle. This greenhouse is completely closed from the surroundings. The windows are closed all year round and because of this, the temperature, humidity and CO_2-concentration can be controlled carefully. Some key points of the closed greenhouse are (Amoremio Orchids, 2010):
- Inside climate and energy system, which enables a better control of humidity, temperature and CO_2-concentration; this enables higher production, lower energy and pesticide use
- Closed greenhouse starts to operate as a solar collector in which heat is stored in summer and cold is stored in winter
- Closed windows reduce water demand, as condensed water is recycled
- Especially suitable for crops that need a stable climate and profit from higher CO_2-concentrations
- In closed greenhouse more than 50% of the fed CO_2 is taken up by the plants (Heuvelink, 2009), while in open greenhouses this number is lower than 10% due to open windows
- 50% of evaporated water from the plants can be

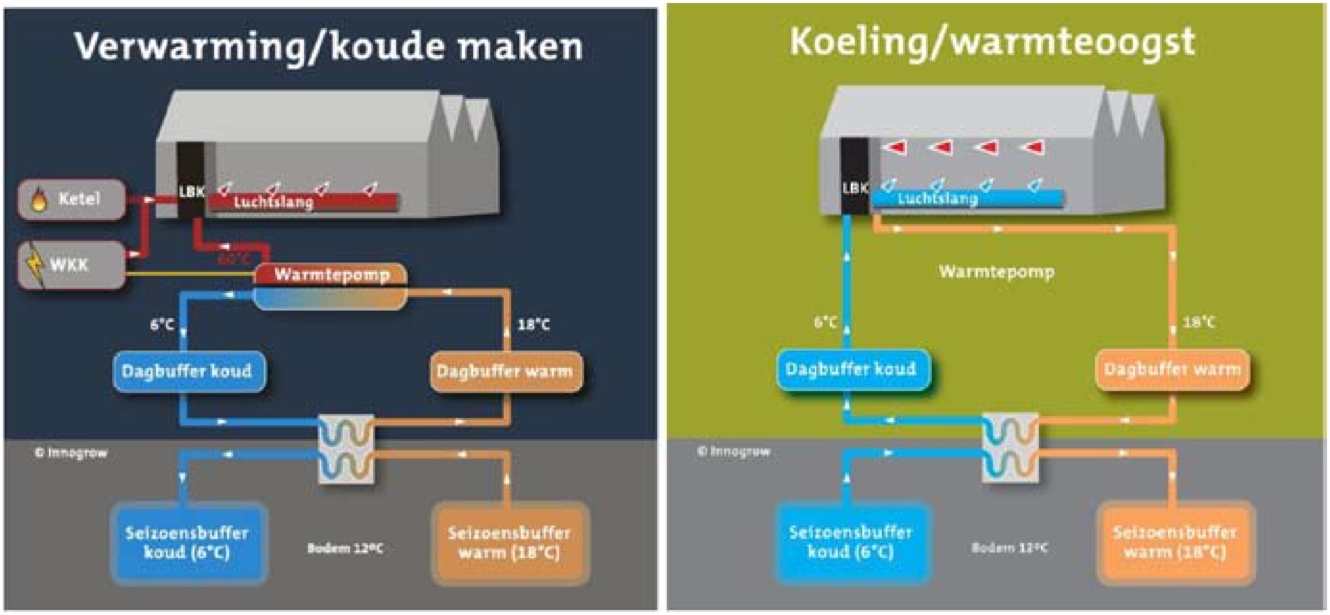

Figure 7.2: Closed greenhouse principle with heat and cold storage (summer and winter)

used again through a recycle In Figure 7.2 (Innogrow, 2010) below the principle of the closed greenhouse is depicted for the summer and winter season.

Since the greenhouse is closed from the outside environment, it needs mechanisms for heating and cooling, electricity, CO2 and other nutrients. In a normal greenhouse, heat is being transported through the windows into the greenhouse, thereby preventing too high temperatures. If the closed greenhouse needs cooling, excess heat is stored in an underground aquifer by means of a heat exchanger. There are two underground wells close to each other, one for cold storage and one for heat storage. In summer, cold water from the cold well is used to cool the greenhouse and capture the heat with a heat pump to store in the hot well. In winter, when there is a need for heat in the greenhouse, this process is operated in the other direction. The heat pump gets hot water from the hot well and uses that heat to get the cold air out of the greenhouse. The now cold water is stored in the cold well for use in the next summer. Depending on the amount of sunlight in summer and the temperature in winter, enough heat can be stored in this way to be completely independent of natural gas. However, if there is not enough heat stored, a back-up system for the production of heat is still necessary. Currently, the closed greenhouses that are already in production, use combined heat and power to generate heat, power and CO2 for use in the greenhouse. To be completely independent of natural gas, it will be better to find other sources than CHP for electricity and CO2 (Innogrow, 2010).

7.4.3 Greenhouse type used in design of heat network

Both greenhouse technologies have the option to be connected to the Mainport for the supply of heat and carbon dioxide. The disadvantage of the closed system is that cooling capacity is needed during summer when heat is supplied from an external source. Furthermore, a suitable aquifer is needed in the vicinity of the greenhouse. For both technologies it holds that greenhouse entrepreneurs earn money in selling excess electricity, that is produced by the CHP units, to the grid. Reducing the use of , or even removing, CHPs results in a decline in income. We therefore propose the use of semi-open greenhouses, a greenhouse principle in between the two principles described above where CHPs are still used, in our design of the heat network. In effect, this has the same result as combining closed and open system together. This combination is used at the greenhouses of Prominent in Naaldwijk, where 3.4 ha is semi closed greenhouse and 5.9 ha is open greenhouse. Heat is stored underground from the semi closed greenhouse, which can be used to heat houses, but also to heat the open greenhouse (www.prominent-tomatoes.nl).

7.5 Grand design

In this section a grand design for a heat and CO2 network is presented. The choice made for this design was based upon the interview with OCAP and Grontmij, which indicated that the independent design of heat and CO2 network is the most viable option in terms of economics and implementation. This is because the implementation of the CO2 network is ahead of the implementation of the heat network. The OCAP pipeline network presently supplies 30% of the Greenport with CO2, whereas a region wide heat network does not exist. Furthermore, OCAP, plans to extend its CO2 sources soon by starting up the cooperation with the new bio-ethanol production facility of Abengoa in Europoort Rotterdam.

The development of a heat network can be done in two ways: top-down and bottom-up. The first option comprises the construction of a central backbone, a main grid, to which greenhouses and residential areas can be connected. The second option comprises the development of several local networks, which can then be connected to a main grid. In this case, we take the bottom-up approach. Though geographically concentrated, the Greenport Westland-Oostland consists of many different independent entrepreneurs. Trying to implement a top-down design requires coordination and cooperation between a multitude of stakeholders; entrepreneurs, municipalities, the province etc. Not only is this very complicated and expensive, a network designed top-down is less resilient and vulnerable to unexpected events. Several parts of the network must be able to operate independently in order to cope with the for instance technical or institutional break downs. If, for instance, Zoetermeer decides to step out of the project for some reason, this should not harm the other regions.

It is therefore, that we propose the bottom-up approach. As depicted in figure 7.3 local nodes can be developed within the municipalities of The Hague, Westland, Delft and Zoetermeer. These nodes are indicated with the green and black circles and triangles in Figure 7.3 and can be operated independently on geothermal heat and excess heat of the CHP units of the greenhouse entrepreneurs (potential heat suppliers are shown in purple circles). The straight line indicates the heat network already present and the dotted line a conceptual that connects all the local nodes. This figure is only exemplary, in fact many different heat networks are already being developed, as was also described in section 7.3.

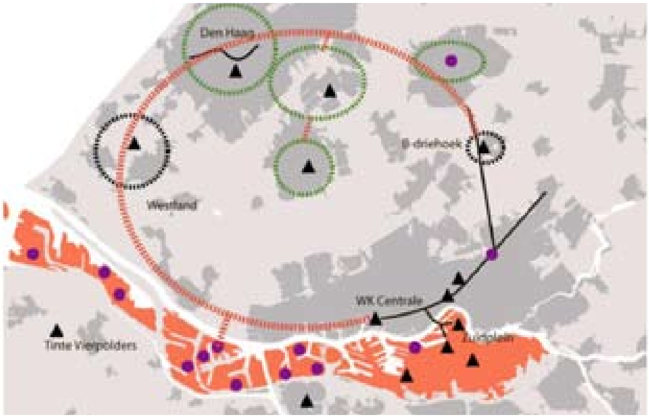

Figure 7.3: Local nodes in developing a heat network

Meanwhile, preparation can be made for a main grid that connects all these nodes together. When connected, the heat from the Mainport can replace CHP units in order to decrease gas use and avoid CO2 emissions. Growers can obtain CO2, necessary to enhance, via the OCAP pipeline.

Figure 7.4 shows a more detailed design for the main grid of the heat network. The green line indicates the heat network already present. The orange dotted line shows the proposed supply line, the main backbone of the harbour. Excess heat from industry can be used here to supply other processes and eventually the Greenport. Part of the connections in this line already exist. The red line shows the main backbone of the heat network grid. An essential part of this design is that the part of the pipeline is aligned with the A4 between Delft and Vlaardingen, which is to be constructed in the upcoming years. The trace for the pipeline is then already opened up for construction of the road, so that it is easy and cheap to place a pipeline while building this road. This part is indicated with the number 1 in figure 7.4. Furthermore, in order to reduce impacts on the residential areas and surrounding nature, the grid follows the roads, such as the A20 between Vlaardingen and Westerlee, the A12 between The Hague and Zoetermeer and the railway between Zoetermeer and Rotterdam.

At the left of figure 7.4, the number 2 indicates the E.ON power plant in the Maasvlakte. This is a location with a lot of excess heat. Especially when a new crossing of the Nieuwe Waterweg made for a possible new CO2 line a building a heat network crossing at the same time is efficient. Another possibility is to align the connection with the current NPM gas pipeline, which lies next to Vlaardingen. This point is indicated with number 3.

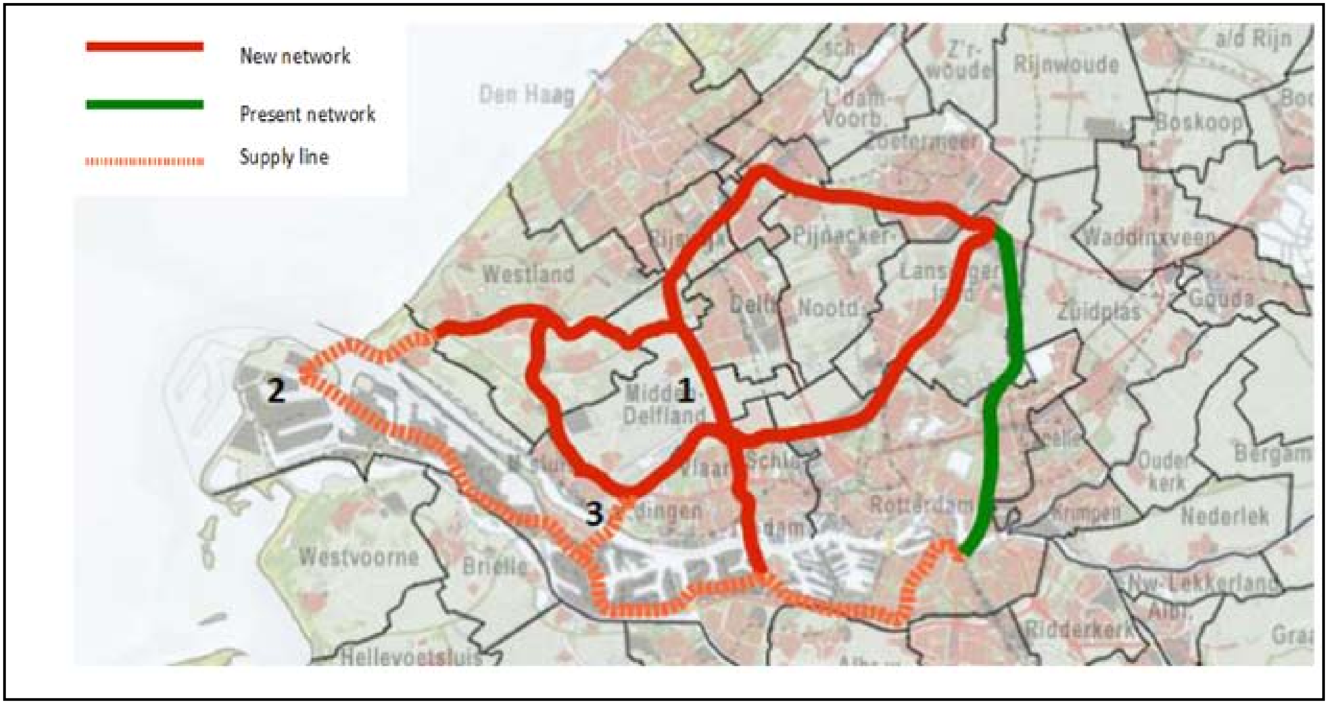

Figure 7.4: Detailed design of a regional heat network (Picture adapted from Wikipedia, 2010)

7.6 Environmental impacts

This section deals with the environmental impact related to the implementation of a pipeline suited for the transportation of heat. We will focus on the emitted carbon dioxide, related to the production and implementation of the main grid of pipelines for distributing heat and CO2, as a measure of environmental impact. Most data presented here are obtained and adapted from scientific literature. It is beyond the scope of this report to perform a full Life Cycle Assessment on this design. The results obtained are therefore of explorative nature and provide for instance insight in orders of magnitude.

In the case of the heat network, three main factors are considered. These are:
- Environmental impact during the construction phase
- Environmental impact during operation
- Environmental benefits by avoiding CO2-emission of CHP units of greenhouses.

In order for the design to have a smaller environmental impact, it is clear that the avoidance of CO2-emissions should exceed the net emissions during construction and operational phase.

Research indicates that the environmental impact of the construction a main grid of a 200 meter pipeline, composed of steel, high density polyethylene and poly-urethane foam (for insulation), for district heating is approximately 90 tons CO2-equivalent (Oliver-Sola, 2009:1920). Consequently, the environmental impact of the construction of a pipeline will be 450 tons CO2-eq/km.

Others report, however, that the CO2-emission related to the construction of a kilometre of pipeline is approximately 9 tons CO2-eq/km (Pootakham, 2010:418). This pipeline is, however, twice as small in diameter, composed of only HDPE and insulator and is fit to transport oil. Nevertheless, the conclusion can be drawn that the presence of steel is vital for the CO2-emission. In the above used research, almost 12 tons of steel was used per km op pipeline. Taking into account that the production of steel from virgin materials emits 5.3 tons CO2 / ton steel (Johnson, 2008:181), it is not surprising that steel production alone contributes more than 60 tons CO2 to the total emission of construction of a pipeline. For application to the heat pipeline, we consider the numbers published by Oliver-Sola more relevant.

OCAP currently supplies 1,300 ha of greenhouses with carbon dioxide, thereby saving 170 kton CO2 emission per year (OCAP, 2009). This leaves a market with a theoretical maximum of approximately 3,000 ha for carbon dioxide delivery (the total greenhouse area of the Greenport is approximately 4,300 ha). The actual market will depend on the amount and type of crops greenhouses produce. In general, pot and plant nurseries use less CO2 than nurseries that grow vegetables. Nevertheless, the reduction potential is in the order of magnitude of hundreds of kilotons.Compared to the environmental impact of construction of the heat network of 450 ton/km, this is several orders of magnitude higher. Even when the grid is several hundred km long, the CO2 emitted during construction will be saved within one operating year.

Also, the energy needed to pump the heated water through the heat network is not a limiting factor. The pump energy should be in the order of 5 MW, in order to handle large volumes of water needed to supply the Greenport with sufficient energy (Claverton, 2010). We assume this energy is supplied by electricity. Taking a CO2-emission for electricity of 6.7 kton/(MW.year), as was computed for a coal fired power plant in chapter 02, the CO2 emission for pumping lies around 33.5 kton/year. Also, the compression of the CO2 is not a limiting factor. The OCAP pipelines run at 20 bar. (OCAP, 2009). In industry, this is a moderate pressure. Compressors, that can handle the large throughputs required for this, have an energy use of 900-1,900 kW, depending on final pressure and total throughput (Cameron, 2006). For OCAP, this energy is supplied by electricity. Again, by using a CO_2 emission of 6.7 kton/(MW.year) the CO_2 emission of compression lies between 6-13 kton. This is still some orders of magnitude lower than total reduction, which was estimated above to be several hundreds of kilotons. We can conclude that even the reduction of the current CO_2 network is sufficient to balance extra CO_2 emissions by building a heat network and extending the OCAP pipeline. Thus, implementation of these networks will have a positive effect on greenhouse gas reduction.

7.7 Economics

In this section, an estimate is made for the costs of the development of the heat network. Literature reports figures between 0.6 and 2.1 million $/km of pipeline (Kalinci, 2008:742; Essandoh-Yeddu, 2009:1610). These costs are mainly related to the pipeline diameter needed for sufficient capacity. The bigger the diameter, the bigger the costs. These numbers are however for relative small pipelines in the United Stated and Turkey. An estimate for Dutch application ranges from 2-3 million €/km. A crossing of the Nieuwe Waterweg, number 2 in figure 7.4, would cost approximately €14 million (Bosma, 2005:1-2). For a main grid of approximately 60 km as presented in figure 7.4 including the cross of the Nieuwe Waterweg, but excluding the backbone (orange dotted line) in the harbour itself, total costs add up to €164 million. This figure excludes the costs of the branches.

7.8 Implementation

In this section, the implementation of the design is described, taking into account the current status and developments regarding CO_2 and heat distribution. The design can be divided into three phases:

- Development of local heat network nodes
- Connecting heat network nodes
- Independent CO_2-network development parallel to phases described above

7.8.1 Development of local heat network nodes

In the development of the local heat networks, a first step is made by some local governments, for example in the municipality of Den Haag, Delft and Rotterdam, as could be seen in figure 7.3. The municipalities have knowledge on the local situation, so that the best route can be chosen. It would be wise though to have some contact between the municipalities, Mainport and Greenport, to ensure that local decisions do not coincide with the larger goal of creating a regional heat network. Furthermore, expert advice from a soil specialist is necessary to determine if the soil is suitable for these pipelines. Peat soil has the ability to subside; which most likely, is not desirable when transporting large quantities of CO_2.

7.8.2 Connecting heat network nodes

In this phase of the implementation of a regional heat network, it is important to have a champion stakeholder, either from government, the main suppliers of heat (Mainport and Greenport) or an independent company, to steer the coupling of the local nodes to each other and to main suppliers. Money for this should come from stakeholders that profit most from the development, in this case being Mainport and Greenport companies and the local and regional governments. At this moment in the development it has to be assured that supply of heat is trustworthy, so the inhabitants of the municipalities do not even notice that something changed. The Dutch government (that stimulates innovation to become a knowledge producing country) should use it’s subsidy programme to stimulate this innovation in more efficient use of energy.

7.8.3 Independent CO_2-network development

For the Greenport it is important to have enough CO_2 to be able to continue business, because when a heat network is present, there will be less need for burning fossil fuels. For the implementation of the heat network there will be a lot of inconvenience for traffic, so it would be nice if the CO2-network could be developed at the same time. Already, extending the CO2 network from OCAP is planned with the connection of the Abengoa plant in Europoort Rotterdam as a new CO2 source. The CO2-network only needs to be present in the Greenport, because citizens do not have a need for carbon dioxide. The development of the CO2-network should be done in cooperation with the Greenport municipalities and the Mainport.

7.9 Conclusion, discussion and recommendations

The development of an integrated heat and CO2 network is perceived to be impossible by various actors. It is therefore, that in this chapter, the developments of a heat and CO2 network are treated separately. However, this does not mean that there can be at least some coordination and cooperation. A good example is the new supply of CO2 from the Maasvlakte/Europoort Rotterdam. The shortest route to the Westland is to cross the Nieuwe Waterweg. Combining the construction of such a crossing with the construction of a heat line from the E.ON power plant would be economically beneficial. Furthermore, especially in residential areas, the construction of both lines at the same time would decrease the impacts for the inhabitants. We believe there lies a role for the regional government to monitor these developments and coordinate as such, not only to reduce economic costs, but also as a way of mitigating risks. Though CO2 is not a very dangerous substance, local high concentrations (for instance in the case of a pipeline burst due to construction work) can cause respiratory problems and can even lead to suffocation. CO2 is about 1.5 times denser than air and is therefore not carried away by the wind easily.

Though the topic of this case is the development of a heat and CO2 network in order to use energy more efficient and decrease greenhouse gases, one could ask whether or not this is the best solution. Development especially for the development of a brand new heat network large infrastructural investments need to be made. Implementation of such a network leads to what is called a technological lock-in. Once it is there, it has to be used in order to justify the costs. A network as such is, however, inflexible. It is therefore possible to think in terms of other solutions, that do not involve pipelines at all. One can think of the use of bio-digesters that are fuelled by greenhouse waste in order to produce biogas for the CHP units already in place. This has, however, its limitations. The total amount of biogas that can be produced from biomass in the province Zuid-Holland is estimated as 270 million m3. This is approximately 15% of the total gas use of the agricultural sector. However, biomass from outside Zuid-Holland could be added in order to increase production (DHV, 2009). If well designed, this system is more flexible to either changes in operation of greenhouses, such as shifting the type of production. Furthermore, this heat network does not include the application of geothermal heat, that is being developed in the Greenport. The potential for geothermal heat is large in the Greenport. Figure 7.5 shows that energy levels for the Greenport are between 100-500 MJ/m2 (Bosma, 2008).

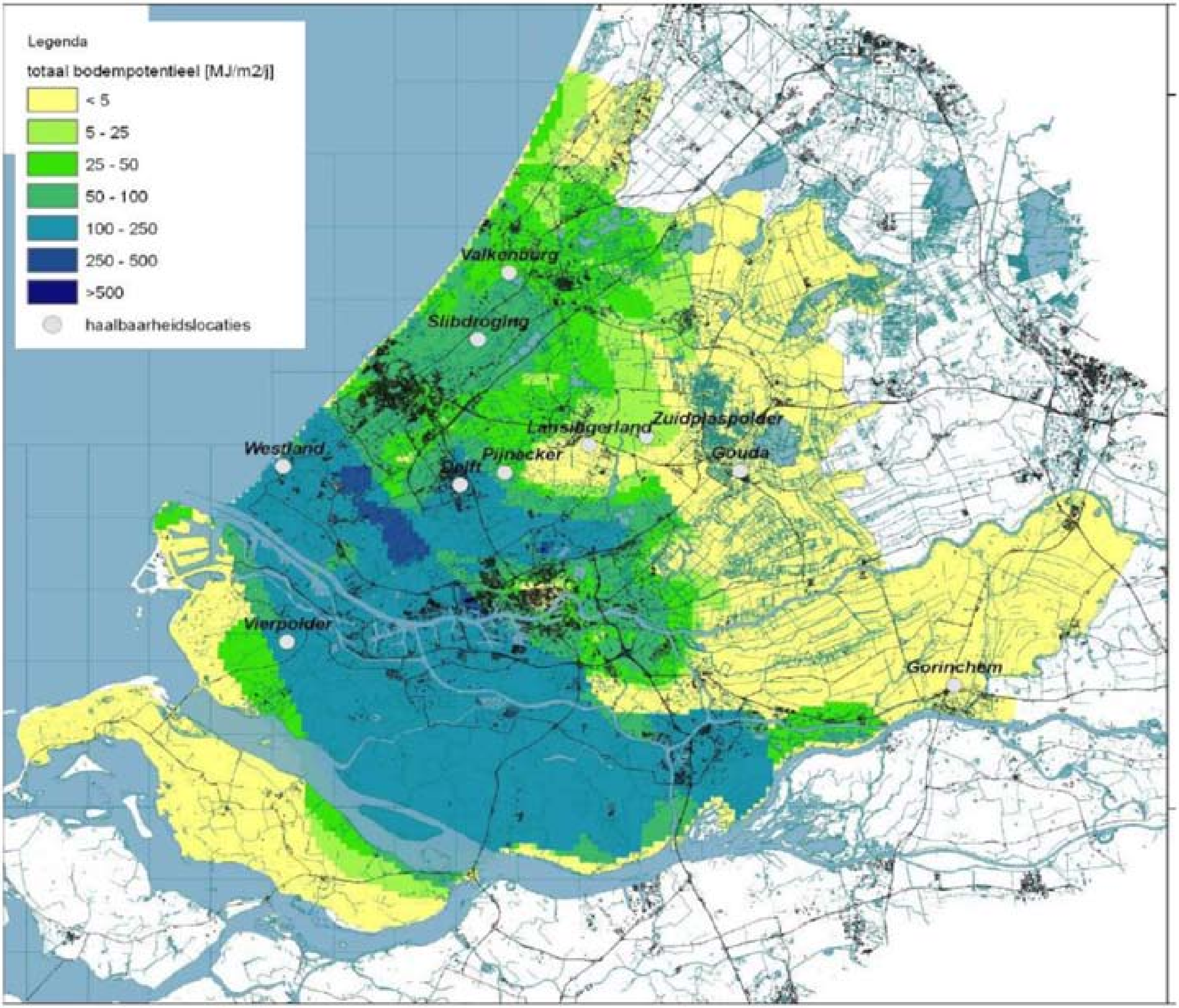

Figure 7.5: Geothermal potential of the MP-GP region (source: Bosma, 2008)

References

Journal sources

Essandoh-Yeddu, J., Gülen, G. (2009) Economic modelling of carbon dioxide integrated pipeline network for enhanced oil recovery and geologic sequestration in the Texas Gulf coast region, Energy Procedia 1 pp 1603-1610

Johnson, J. et al. (2008) The energy benefit of stainless steel recycling, Energy Policy 36 pp. 181-192

Kalinci, Y. et al. (2008) Determination of optimum pipe diameter along with energetic and exergetic evaluation of geothermal district heating systems: modelling and applications, Energy and Buildings 40 pp 742-755

Oliver-Sola, J. et al. (2009) Environmental impacts of the infrastructure for district heating in urban neighbourhoods, Energy Policy 37 pp. 4711-4719

Pootakham, T. Kumar, A. (2010) A comparison of pipeline versus truck transport of bio-oil, Bioresource technology 101 pp. 414-421

Web sources

Amoremio Orchids (2010) http://www.amoremio-orchids.eu/milieu.php, last visited March 21st 2010.

Bosma, A. (2005) Gespreksnotitie technisch eindperspectief warmtebedrijf, Province Zuid-Holland, February 09th 2005

Bosma, A. (2008) Duurzame Warmte Zuid-Holland, Province Zuid-Holland, presentation Afvalconferentie vd Bosch (2009) http://www.nlog.nl/resources/Geothermie/Profiel2vdBosch%5B1%5D.pdf, accessed March 21st 2010

Cameron (2006) http://www.c-a-m.com/content/products/product_detail.cfm?pid=3066&bunit=CC, last visited March 21st 2010

Claverton (2010) http://www.claverton-energy.com/pipe-headloss-power-calculator-calculate-how-much-energy-topump-seawater-to-the-middle-of-the-sahara-or-gobi-desert-for-desalination-in-the-seawater-greenhouse-answernot-a-lot.html last visited March 21st 2010

DHV (2009) van Biomassa naar Biogas, kansen in Zuid-Holland, DHV advies en ingenieursbureau., ppt-presentation, obtained via province Zuid-Holland

Heuvelink, E., Marcelis, L. (2009) CO2, temperatuur en energiebesparing, presentation available via: http://www.hortimax.nl/uploads/editor/file/Groeibijeenkomsten/WES_CO2-temperatuurenergiezuinigtelen_12feb2009.pdf, last accessed March 21st 2010

Innogrow (2010) www.innogrow.nl, last visited March 21st 2010

Melieste R. (2006) Rotterdam Energy Port, powerpoint presentation, available via: http://www.co2storage.org/Reports/ENERGY%20PORT%20presentatie%20english.ppt, last visited February 13th 2010

Multi Energie Concept – Vierpolders, Haalbaarheidsonderzoek naar milieu- en kosteneffectiviteit van een energieweb met geothermie en hoge temperatuursopslag in Vierpolders, Fase 2b, Juni 2009

OCAP (2009) http://www.ocap.nl/Factsheet_UK.pdf, last visited February 13th 2010

Prominent-tomatoes, http://www.prominent-tomatoes.nl/index.asp?taalID=2&onderdeelID=17, last visited April 21st 2010

Wikipedia (2010) http://nl.wikipedia.org/wiki/Bestand:2010-NL-P08-Zuid-Holland-positiekaart-gemnamen.jpg, accessed March 10th 2010

Photo: Processing of biobased pharmaceuticals

Chapter 8

Bio-based pharmaceuticals

8.1 Introduction of the case-study

In this case study the (theoretical) possibilities regarding production of bio-based pharmaceuticals in the Greenport will be studied. The 'traditional' pharmaceutical industry is struggling to safeguard their future in a sustainable way. The old ways of searching for the next blockbuster to put on the market, seem to have passed. No other industry invests as much in research and development of new medicines as the pharmaceutical industry. Even with an ever increasing budget for research and development, the number of new registered medicines each year is rapidly declining (Munos, 2009: 959). New production methods of pharmaceuticals are in development; many of the large pharmaceutical companies are now pursuing 'biotechnological' medicines (Extra, 2009: 22). In this case-study, production of 'biotechnological' medicines through the use of plants, will be studied. This new method of production might bring great opportunities for the Greenport, because of the extensive production capacity knowledge regarding horticulture which is currently present. Subsequent steps of processing, packaging etc., might be facilitated in the nearby Mainport, thereby creating a competitive advantage through reducing transportation costs. In paragraph 8.2 production of bulk and fine chemicals via biorefinery is described; the Mainport, with all its infrastructure, is highly suitable for these processes.

This case-study was performed by literature (desktop) research and an open questionnaire to 18 Dutch Life Science companies of which five were returned.

8.2 Medicines from Biological Origin

Plants and their products have been used for centuries to prevent and cure diseases. From 60,000 BC to the 19th century, plants were humans' main source of drugs. The first evidence of plants used to fight fever has been found in the Neanderthal society. The first known text on medicinal plants dates back 4,500 years to the Chinese dynasties (Liénard, 2007: 115). These and many more examples show the strong relation humans have with medicinal plants, whether or not scientifically proven.

More than a quarter of all the registered medicines used in the world today contain ingredients derived from plants (Raskin et al, 2002: 522). Over 100 of such active compounds are regularly prescribed for chronic use. More than 250 drugs are considered as basic and essential by the World Health Organization, of those 250 drugs, 11% are exclusively of plant origin and a significant number are synthetic drugs obtained from natural precursors. Furthermore it is estimated that 60% of anti-tumour and anti-infectious drugs already on the market or under clinical trial are of natural origin. The vast majority of these cannot yet be synthesized economically and are still obtained from wild or cultivated plants (Rates, 2001: 603). Even with these impressive numbers, the total percentage of fossil based medicines is estimated to be more than 90% (Koops, 2010).

The potential use of higher plants as a source of new drugs is still poorly explored. Of the estimated 250,000 - 500,000 plant species in the world, only a small percentage has been investigated phytochemically and even a smaller percentage has been properly studied for their pharmacological properties. It is estimated only 5,000 species have been studied for medical use in more detail (Rates, 2001: 603). Phytochemicals are naturally occurring compounds in plants which are assumed to have a beneficial health effect. The chance of a successful hit is one in 10,000 for synthetic compounds, while the rate for natural products is as low as one in 30,000 or 40,000 (Onaga, 2001: 263).

8.2.1 Therapeutic Proteins

However, it is only recently that biotechnology has been used to generate plants that produce specific therapeutic proteins; products that are traditionally synthesized using recombinant microbes or transformed mammalian cells (Ma et al, 2005: 580). The types of compounds which are of most interest for a bio-based pharmaceutical industry are therapeutic proteins, antibodies and vaccines (Horn et al, 2004: 711).

Therapeutic proteins can be used as intermediates in the synthesis of pharmaceuticals or as the active product itself. The list of such products is long and growing continuously. It includes products as thrombin and collagen (active products) and trypsin and aprotinin (intermediates) (ibid). Only proteins with high value will be considered as candidates for this kind of production. Natural antibodies are used by the immune system to identify and neutralize foreign objects such as toxins, bacteria and viruses. A vaccine is usually a small amount of dead or inactivated organisms or an agent that resembles the organism. The immune system is provoked by the presence of the agent (vaccine) to produce antibodies and thereby improve immunity against specific diseases.

Most of these therapeutic proteins are polypeptides; complicated molecules based on long chains of amino-acids. These products are difficult to produce via traditional organic chemistry, only a few companies in the world are equipped to produce peptides commercially in this manner (Picherau et al, 2006). Mainstream commercial protein production is mostly based on microbial fermentation and mammalian cell lines, but these systems have disadvantages in terms of cost, scalability and safety (Fisher et al, 2004: 152). This is why research into alternative production methods is a growing field.

The first of these plant-derived pharmaceutical proteins are now approaching the commercial phase, which requires large scale production. The most commonly used recombinant sources for the production of these proteins are transgenic corn, tobacco, rice and potato plants (Basaran et al, 2008: 153 and Spök, 2006: 74). In theory all plant species are possible carriers of plantderived pharmaceutical proteins, tomato plants are also one of the species under investigation (Warzecha et al 2003: 755). A different term for using recombinant sources to produce of biological active compounds is molecular farming.

8.2.2 Edible Vaccines

A future view is that vaccines can be produced as edible vaccines; if produced in consumable plants like tomatoes. Tomatoes are consumable without cooking; this prevents denaturation of the proteins. Tomatoes naturally have relatively low fruit protein content; a recombinant tomato plant with increased protein content would be preferred. Increased fruit protein content means a high expression of the gene carrying the protein information, thus resulting in a higher yield of the proteins (Horn et al, 2004: 711).

8.2.3 Production

One of the most important driving factors has been yield improvement, as product yield has a significant impact on economic feasibility. Several strategies to improve the recombinant protein yield in plants are described in literature (Liénard, 2007: 115). Attention is now shifting from basic research towards commercial exploitation and molecular farming is reaching the stage at which it could challenge established production technologies that use bacteria or yeast (EMBO, 2005: 593). There is little doubt that transgenic plants offer an unparalleled potential for scalability. Growing plants in fields provides opportunities for virtually unlimited production and even if growing sites are strictly isolated to avoid mixing or cross-pollination with other crops, there are still many areas in the world where large-scale production could take place. Even under containment, it would be possible to grow a large number of pharmaceutical plants; immense greenhouse facilities are already used routinely by the horticultural and food industries.

8.2.4 Hepatitis B Vaccine

It has been estimated that 100 hectares of greenhouse space would be sufficient to grow enough transgenic potato plants to meet South East Asia's annual demand for the hepatitis B virus vaccine. This level of large scale production is not necessary for all pharmaceutical proteins, but there will be many cases in which large quantities are required. Currently the recombinant hepatitis B vaccine is produced in genetically modified yeast; this cannot be made in sufficient quantities and at a low enough cost to meet the demands of developing countries. The scalability of production in transgenic plants could offer one of the few practical solutions to overcome these commercial and moral dilemmas (EMBO, 2005: 593).

It is expected for plants to have the highest economic benefit for the production of proteins with regards to transgenic animals, bacteria and fungi, which are currently used (ibid).

8.3 Advantages and Risks

In literature several advantages and risks regarding the use of plants for the production of pharmaceutical products are described.

The advantages of using plants include (Horn et al, 2004: 711):

- Significantly lower production costs than production with transgenic animals, fermentation or bioreactors.
- The infrastructure and expertise already exist for planting, harvesting and processing of plant material.
- Plants contain no known human pathogens (such as prions, virions etc.) that could contaminate the final product. - Higher plants usually synthesize the proteins with the correct folding. This prevents some chemical processing steps to re-introduce the correct folding of the proteins. Besides this, higher plants usually have other biologically activating features already in place.
- Plant cells can direct proteins to stability increasing environments (storage in the roots of plants where there is more temperature control and no UV radiation).

Several risks and hazards are involved when using genetically modified plants to produce biologically active proteins (Spök, 2006: 74).

- The genetically modified crops must be dealt with in same manner as the biologically active compounds would be handled. The same hazard, the potential to do harm, applies to the crops, maybe at a lower level as the proteins are still stored in (or bound to) the plant. This hazard is definitely more probable for workers processing or handling the crops. Several protective and preventative measures can be implemented to reduce this risk. However, most of the molecular confinement mechanisms are not 100% leakfree and therefore not ready for commercial production.
- The genetic modification has an increased likelihood of unintended negative health and environmental effect. It is likely that these plants include several modifications, maybe for pest control or for unambiguous visual identification to prevent unintended use (e.g. consumption). Discussion is still ongoing on the potential for the formation -and increased levels of- new and so-far unknown endogenous toxins, allergens or antinutrients and their associated

risk for human, animal and environmental health.

With a continuous growth in knowledge coming from the research field, it is likely that these hazards will be investigated more thoroughly and regulated by the authorities.

This will be the same authorities that regulate the quality aspect of production of medicinal product. The European Agency for the Evaluation of medicinal Products (EMEA) and the US Food and Drug Administration (FDA) have already issued draft documents regarding pharmaceuticals produced in genetically modified crops (EMEA, 2006 and FDA, 2002).

8.4 Good Manufacturing Practice

Good Manufacturing Practice (GMP) is a component of quality assurance that ensures that a pharmaceutical product is manufactured to a quality appropriate for its intended use on a consistent basis (Ma et al, 2005: 580).

The concept of pharmaceutical GMP was originally developed for drugs manufactured by chemical synthesis and later adapted for biopharmaceuticals produced by cell culture and fermentation technologies in closed, precisely monitored and controlled systems. In the case of terrestrial plants, natural variations and inconsistencies in growth, soil and weather conditions limits the ability to establish an equivalent level of control. Some of these limitations can be addressed by growing plants in glasshouses or other types of contained environments.

A seed bank would provide the most logical solution regarding guidelines for what, how much and how long seeds can be stored. These are issues that need to be covered and addressed by FDA, EMAE and equivalent authorities before plant derived pharmaceuticals can become a mainstream technology. GMP must also be applied to downstream processing stages of pharmaceutical production. Harvesting, extraction, isolation and purification are steps that are involved when producing plant derived proteins. It can be assumed that these downstream processing steps will have identical standards to other biopharmaceutical production systems.

8.5 Galantamine

One of the best known, and successful examples is the anti-Alzheimer's medicine Galantamine; originally found in the bulbs of snowdrops in the Caucasian Alps and in Bulgaria as a remedy against old age. In the 1950s, a Bulgarian pharmacologist noticed the use of the common snowdrop by locals by rubbing it on their foreheads to ease nerve pain (Heinrich et al, 2004: 147). Nowadays it is know that it can be isolated from many more species, especially from certain daffodil species. Currently daffodils are now grown in large quantities in the UK for the production of galantamine (www.alzheim.org). As galantamine is a complicated compound, production via traditional synthesis has long been difficult. In the last decades much progress has been made and in 1999 a chemical synthesis for large scale (commercial) production of galantamine was reported (Küenburg et al, 1999:425). Research is progressing quickly on this topic, as more species for harvest are identified and harvesting techniques are improved constantly (Turner, 2003: 784 and Turner, 2004: 10). Galantamine was introduced in the market by Johnson and Johnson in 2002 and registered under the name Reminyl and later under the name Razandyne; at that moment it was synthetically produced (Butler, 2004: 2141). Currently; only an extended release formulation is protected by patent (FDA News Drug Daily Bulletin; 2006); galantamine itself is no longer under patent. New companies can file for approval for production and marketing of galantamine (Daily International Pharma alert; 2007).

8.5.1 Dutch Developments

In the Netherlands more than 10,000 species of plants and fungi can be found in the wild (Nederlands Soortenregister); the amount of cultivated plants is much smaller. In the current situation in the Greenport Westland-Oostland 155.000 tons of biological residual material is discarded as waste (Huisman, 2010). For instance when the tomato plants have reached the end of their fruit bearing time, the plants are discarded and are sent to a waste disposal facility. This material can potentially be the source of a new block buster drug and might have enormous added value for the tomato growers.

Several initiatives (Spijker, 2009 and www.hollandbiodiversity.com) are in the making, or have already started to investigate this large and potentially rich array of cultivated plants. Unfortunately these initiatives have contradicting views of the future.
- Holland Biodiversity has created a (growing) library of plant extracts to be used by the chemical, pharmaceutical, cosmetic, agro and nutrition industry. According to the website of Holland Biodiversity; it functions as an intermediate and coordinator between producers and purchasers (www.hollandbiodiversity.com).

Figure 8.1: Overview of Life Science related companies in the Netherlands [www.lifescienceshealth.com]

- In 2010 the program “Inhoudsstoffen” by the Province of Zuid-Holland will start (Spijker, 2009), but they consider searching for the next block buster drug is like searching for a needle in a haystack. The financial risks involved for starting this research are considered too high and their focus will be on bioplastic, cosmetics or insecticides. The search for new medicines might be considered in the future; finding a commercial purpose for biological residual waste will give the project the necessary legitimacy it needs.

8.6 Dutch Life Science Industry

According to www.lifescienceshealth.com; the website of Life Sciences & Health[19] over 250 companies in the Netherland are related to the Life Science Industry and more than 500 are registered in the database. Much information regarding subsidies, news, partnerships, and events, can be found here. It is unclear how effective this website is in connecting different industries; it is mainly focused on businesses within the Life Science Industry. It gives a good overview of the location of Life Science related companies; clusters can be observed around the cities with Life Science related University research[20]. Figure 8.1, depicted below, gives an overview of the cities in the Randstad area of the Netherlands. Some examples of such companies are; Plant Research International in Wageningen[21], Biocult B.V. in Leiden[22], and Pickcell B.V. in Amsterdam[23].

8.6.1 Questionnaire

Before any project regarding bio-based pharmaceuticals can take off in the Netherlands, support from the Dutch life science industry is essential. In a limited questionnaire study, 18 Dutch companies, associated with vaccine production or other protein related activities have been approached. Five companies returned the questionnaire, their responses are treated with confidentiality; the questionnaire is added as appendix D.

The opinions of the companies range from very progressive to very conservative; some see enormous potential for the Greenport in their field of work, others do not see it. Their responses are classified under two groups; the conservative and the progressive group. The conservative group expected that problems with purification, long development times and registration of new medicines from plant origin would be too big to overcome. While the other group did not see more problems with medicines from plants over the traditional produced medicines. One company, from the progressive group, identified the strict legislation on growing genetically modified crops in Europe as the main issue why plant produced vaccines has not yet developed. Furthermore, the proven method of producing vaccines from viruses and bacteria is a very efficient alternative. Most companies acknowledge the prospects of producing vaccines with plants and expect no real problems. Genetically modified bacteria, fungi and algae are already used on large scale for medicine production. Prevention of spread of the genetically modified crop is considered very important.

Other more commonly accepted applications, like biofuels, bioplastics and cosmetics, are seen as more viable in the near future. One comment was made regarding maintaining a proper balance between food and fuel. The opinions regarding the acceptance of medicines from (genetically modified) crops by the public were very diverse. Most expected a low acceptance to start with; if no other options are possible then acceptance would grow. One expected no problems as long as the medicines are safe[24].

The University of Wageningen was mentioned several times to initiate or function as a platform or coordinator between research and industry. One critical comment was made about stereotyping and urged a ‘very unDutch’ collaboration between universities and commercial companies. This would “prevent slow academic subsidy projects”.

8.7 Biobased Chemicals

A realistic alternative, or maybe an intermediary step, is the production of fine chemicals – which can be considered as the building blocks for medicines – from plants. Fine chemicals are derived from bulk chemicals, which are nowadays mostly produced from petrochemicals. It is estimated that in 2020 all bio-based chemicals – including solvents and polymers – have a market share of 10% [Dornburg et al, 2008: 2261]. Methods for the production of bulk chemicals from plants are already existent; the production of bio-ethanol is probably the best known example. Van den Broek [2009] described the different processes of how plants can be used for the production of medicines or their intermediates. A distinction is made between 'traditional' chemical technology and 'new' bio-technology. The processes depicted in figure 8.2 are based on the report of van den Broek [2009]. The thickness of the arrows indicates the expected volumes. This method is based on the cascading principle; plants can be grown (cultivated) for molecular farming, or for their crops, and can then be processed in the bio-refinery for production of chemicals. Van den Broek considers algae in the same category as plants; no literature was found for the direct production of medicines – molecular farming – by algae. It can be assumed they will be used for the production of bulk and fine chemicals via biorefinery 25.

This method of production of chemicals assumes no changes, or minor changes, in the current practices of research and development (R&D) of pharmaceutical companies; medicines are synthetically produced, only the origin of the chemicals and solvents changes from fossil to plants. It is safe to assume that the pharmaceutical industry will change (part of) their R&D, and with that, their methods of production in the (nearby) future, but the need for chemicals will never disappear.

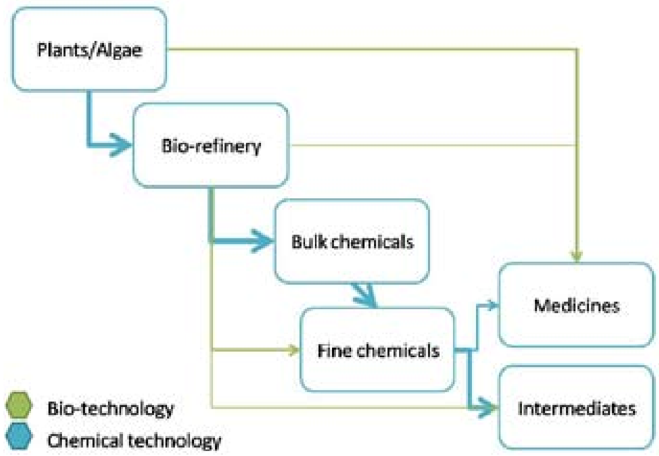

Figure 8.2: Processes needed for medicines from plants

8.8 Future Prospects

One of the risks of focusing on bioplastics or other low value goods is the necessity of large quantities for profitability. Bioplastics for instance, have potential for numerous applications and will require bulk production. The high value of Dutch soil limits the economic viability of these kinds of voluminous activities drastically. This is especially a problem in a densely populated area as the MP-GP region. If the production of these kinds of products is developed as an additional activity, it could make biological residual waste profitable. The waste becomes a raw material and can be sold to a bioplastics company. DSM Delft (DSM, 2009) is already examining the possibilities of bio-plastics from agricultural waste. Furthermore a newly founded Dutch consortium of universities, research institutions and industry has started a program that focuses on the development of new bio-based production concepts (www.b-basic.nl).

The future prospects for molecular farming in the Netherlands are also not clear; the same issue of large volumes applies in this case as well. Serving the high end of the market, pharmaceuticals, increases the economic viability of such a project. But molecular farming is not an additional activity; this implies a radical change in business, production methods and a reduction of crop production in the Netherlands.

Within the Netherlands a lot of knowledge about cultivating plants in greenhouses is present. This knowledge can be a basis for development of expertise on molecular farming. For certain types of medicine, however, large quantities are not needed, but an incentive for greenhouse entrepreneurs to switch to more ‘experimental’ crops is lacking. One can think of a company integrating both greenhouse ownership and medicine production. As earlier described, however, finding an economically feasible medicine and process is like searching for a needle in a haystack.

In other areas, besides the pharmaceutical area, other developments can be observed. Some greenhouse entrepreneurs are growing seedlings, specifically aimed for the food industry. These seedlings contain, for example, high concentrations of anti-oxidants and are sold to the high end of the food market (Steekelenburg van, 2010).

As shown in paragraph 8.7 most Life Science related businesses are located near Universities; the knowledge regarding Life Sciences – from molecular farming to production of bio-based chemicals (bulk and raw) – is growing rapidly in the Netherlands. This will ensure the future of this industry, but also creates opportunities for new businesses.

Some opportunities, and maybe even synergy, can be found between this case-study and the information network case-study described in chapter 6. A future development could be a network where knowledge can be shared about cultivating plants in greenhouses with the Dutch Life Science Industry. In this manner giant steps can be made into a bio-based pharmaceutical future.

8.9 Suggested Actions

It is important to investigate thoroughly the future visions regarding a bio-based pharmaceuticals within the ‘traditional’ pharmaceutical industry, the ‘new’ Life Science businesses, and the Universities. All options – including molecular farming and bio-based chemicals – need to be investigated. Regarding the outcome of this investigation further action can be defined. This action may include funding research towards molecular farming or production of chemicals from (residual) plant material, and bringing together the greenhouse entrepreneurs and the chemical industry. A platform – or network – can be envisioned to share knowledge and create new ideas. It is extremely important to include new and innovative businesses, like spinoffs from Universities, to prevent dominance by the ‘traditional’ pharmaceutical industry.

The greenhouse entrepreneurs need to be considered as well; they are considered as the future suppliers of the pharmaceutical and chemical industry. Their willingness to change their business strategy is vital for the success of a bio-based pharmaceutical industry in the MP-GP region. The greatest change of success is likely a joint development like a research institute or an educational centre; a combination of spinoffs from Universities with the expertise of the horticultural industry. This could be the basis for future cooperation on commercial scale, but first it will speed up the research and development of bio-based pharmaceuticals.

The greenhouse entrepreneurs who are already cultivating the seedlings (Van Steekelenburg, 2010) may provide a good starting point to increase support for a changed business strategy. It can be expected that the gap between the food and pharmaceutical industry will only decrease in the (near) future, as developments in the bio-based pharmaceutical industry will continue.

References

Journal sources

Basaran, P., Rodríguez-Cerezo, E. (2008) “Plant molecular farming: opportunities and challenges” in Critical Reviews in Biotechnology, 28: 153-172

Broek van den, B., Bos, H. (December 2009) “Biobased Economy en de Farmaceutische Industrie” from WUR Food and Biobased Research, report no. 1096

Butler, M.S., (2004) “The Role of Natural Product Chemistry in Drug Discovery” in Journal of Natural Products, 67: 2141-2153

Dornburg, V., Hermann, B.G., Patel, M.K. (2008) “Scenario Projections for Future Market Potentials of Biobased Bulk Chemicals” in Environmental Science & Technology, 42: 2261-2267

European Medicines Agency (EMEA), EMEA guideline on the quality of biological active substances produced by stable transgene expression in higher plants, Doc. Ref. EMEA/CHMP/BWP/48316/2006

European Molecular Biology Organization (EMBO), (2005) “Molecular farming for new drugs and vaccines” The European Union Framework 6 Pharma-Planta Consortium 6: 593-599

Extra (December 2009) “Big Pharma in problemen: patenten gaan aflopen en de ‘pipeline’ droogt op – Afscheid van de blockbusters” in Arts & Auto 75: 22-31

Fisher, R., Stoger, E., Schillberg, S., Christou, P., Twymand, R.M., (2004) “Plant-based production of biopharmaceuticals” in Current Opinion in Plant Biology 7: 152-158

Food and Drugs Administration US (FDA), (2002) Guidance for Industry, Drugs, Biologics, and Medical Devices Derived from Bioengineered Plants for Use in Humans and Animals, Draft Guidance, Issued September 2002

Heinrich, M., Teoh, H.L., (2004) “Galantamine from snowdrop- the development of a modern drug against Alheimer's disease from local Caucasian knowledge" in Journal of Ethnopharmacology 92: 147-162

Horn, M.E., Woodard, S.L., Howard, J.A. (2004) "Plant molecular farming: systems and products" in Plant Cell Reports 22: 711-720

Küenburg, B., Czollner, L., Fröhlich, J., Jordis U., (1999) "Development of a Pilot Scale Process for the anti-Alzheimer Drug (-)-Galanthamine Using Large Scale Phenolic Oxidative Coupling and Crystallisation-Induced Chiral Conversion" in Organic Process Research & Development 3: 425-431

Liénard, D., Sourouille, C., Gomord, V., Faye, L., (2007) "Pharming and transgenic plants" in Biotechnology annual review 13: 115-147

Ma, J.K. Chikwamba, R., Sparrow, P., Fisher, R., Mahoney, R., Twyman ,R.M. (2005) "Plant derived pharmaceuticals - the road forward" in TRENDS in Plant Science 10: 580-585

Munos, B. (2009) "Lessons from 60 years of pharmaceutical innovation" in Nature Reviews – Drug Discovery 8: 959-968

Onaga, L., (2001) "Cashing in on nature's pharmacy" in European Molecular Biology Organization (EMBO) reports 2:263-265

Raskin, I., Ribnicky, D.M., Komarnytsky, S., Ilic, N., Poulev, A., Borisjuk, N., Brinker, A., Moreno D.A., Ripoll, C., Yakoby,

N., O'Neal, J.M., Cornwell, T., Pastor, I., Fridlender, B. (2002) "Plants and human health in the twenty-first century" in TRENDS in Biotechnology, 20: 522-531

Rates, S.M.K., (2001) "Plants as source of drugs" in Toxicon 39: 603-613

Spök, A. (2006) "Molecular farming on the rise – GMO regulators still walking a tightrope" in TRENDS in Biotechnology 25: 74-82

Turner, K., (2003) "A Review of U.S. Patents in the Field of Organic Process Development Published between April to July 2003" in Organic Process Research & Development 7: 784-793

Turner, K., (2004) "A Review of U.S. Patents in the Field of Organic Process Development Published between August and October 2003", Organic Process Research & Development 8: 10-17

Warzecha, H., Mason. H.S. (2003) "Benefits and risks of antibody and vaccine production in transgenic plants" in Journal of Plant Physiology 755-764

Web sources

Daily International Pharma alert (August 30th 2007), vol. 4, No. 171; website accessed February 11th 2010 (www.fdanews.com/newsletter/article?articleId=97848&issueId=10657)

DSM - Strategische visie DSM in Delft: dat werkt! (Oktober 2009), www.dsm.com, visited on December 12th 2009

FDA News Drug Daily Bulletin (July 18th 2006), vol. 2 no. 391; website accessed February 11th 2010 (www.fdanews.com/newsletter/article?articleId=88421&issueId=9413)

Holland Biodiversity, www.hollandbiodiverisity.com, visited on December 12th 2009

Nederlands soortenregister; www.nederlandsesoorten.nl, visited on December 12th 2009

Pichereau, C., Allary, C., (January 2006) "Therapeutic Peptides under the Spotlight" in Bionest EBR, (http://www.bionest.com/publications/TherapeuticPeptides.pdf) visited on November 15th 2009

www.alzeim.org; website accessed February 7th 2010

www.b-basic.nl; website accessed February 7th 2010

www.lifescienceshealth.com; website accessed March 13th 2010

Personal contact

Spijker, H., Provincie Zuid-Holland, (November 24th 2009) Personal communications with M.E.A. Meijer-Willems and J.P.M. van Ruijven

Van Steekelenburg, M.G.N., Provincie Zuid-Holland, (April 14th 2010) Personal communication with J.P.M. van Ruijven

Koops, A., (March 26th 2010), Wageningen University, Personal communications with M.A. Feberwee

Huisman, C., (March 17th 2010), Personal communications with M.A. Feberwee

19 Life Sciences & Health is a combined initiative for and by all parties active in the health-related life sciences in the Netherlands. It is driven by the sector and empowered by the Ministry of Economic Affairs.

20 Most obvious are the cities Amsterdam, Utrecht, Groningen, Nijmegen, Leiden, Delft and Wageningen.

21 Plant Research International specializes in strategic and applied research for agriculture and horticulture, and for rural and environmental development. (Spinoff University of Wageningen; www.pri.wur.nl)

22 Biocult B.V. provides contract manufacturing services for monoclonal antibodies. (www.biocult.com)

23 Pickcell B.V. offers original equipment manufacturing (OEM) products and antibody-developing services. They also offer research services in plant genetics and reproduction, crop physiology, agrosystems, soil fertility, and the optimization of plant health. (www.pickcell-b2b.com)

24 Although the discussion regarding genetically modified organisms - including plants - does not have high priority in the political arena, many people and organizations are strongly opposed to this development.

25 Future developments may change and algae might become a direct source of medicines.

Chapter 9

Contextualising the cases

9.1 Introduction

This chapter combines the scenarios developed in chapter 05 with the case studies in the former chapters in order to place these in a practical context. In the following sections, the three cases are described per scenario.

9.2 New Worlds

9.2.1 Information network

Because the network to be created is suggested to be of flexible nature, it should in theory be applicable to any of the scenario's drawn up above. This is because the composition and the short-term goals of the network may be adapted to changing conditions and (societal) demand. However, there are different threats and opportunities for the network case within each of the scenario's. Within the 'new worlds' scenario, opportunities may occur due to the huge shift in focus towards renewable technologies and the need for practices dealing with the changing conditions. Apart from new practices that must be developed and tested in which the network could play a crucial role (such as the shift in the Harbour from oil refinery to bio-refinery; the probability that energy efficiency will be high on the agenda inducing the establishment of energy cascading and closed energy loops which need development and testing; or the design of multifunctional use of space in the Greenport) this means that more people might be interested in joining the network (thus expanding and creating more knowledge) and more money might be invested in the practices of the network due to its practical applicability.

However, although these changes in context may provide the network with new and growing functions, it might also be a threat to it, because its participants might have their priorities elsewhere (namely in their respective companies trying to cope with the changing context). To prevent this from happening, the network must invest in its existence by inducing commitment of the participants and by communicating its importance to all stakeholders in the area.

9.2.2 Heat and CO2 network

This scenario is beneficial for the case of the heat and CO2 network, because of the huge shift in focus towards renewable technologies. Due to the nature of the processes operated in the Mainport, heat cascading will still be an option and stimulated due to the large effects of global warming. A shift to renewable energy supply from biomass will still result in CO2 emissions that can be captured and fed to greenhouses in the Greenport. However, the amount of renewable technologies can create competition to these (heat and CO2) sources. Furthermore, if energy is produced via other ways, CO2 production will drop and a competition for CO2 can occur. If due to global warming effects the harbor area is closed more often, the security of supply will decrease. This causes a worsening of the attractiveness of the region to new and established businesses and this means that supply of heat and CO2 to the Greenport will be put under pressure.

9.2.3 Bio-based pharma

The totally renewable energy production can only be the result of increased knowledge and investment in sustainable (renewable) techniques and processes.

Security of energy supply may have been the initial reason for such research and investments, but the spill over effect to other industries will provide the basis for a radical change. This creates an ideal environment for the production of pharmaceuticals – or chemicals for that matter – originating from biomass. As described in the heat and CO2 network case, the reduced security of supply of CO2 will put Greenport production under serious pressure. This will have an effect on the production of dedicated plants for pharmaceuticals or the production of biomass for chemicals.

The high impact of global warming will likely result in a lack of fresh water in the summer; this implies some radical changes for horticultural farming. A shift to sustainable farming with a strict water management is necessary. Besides that, some sort of water storage is necessary; the excess (rain) water of winter will be needed during dry spells in summer. Furthermore the risks of flooding due to the rising sea level will have to be mitigated through water barrages or dikes; flooding could cause severe destruction in the Greenport. It can be expected that after such massive destruction the greenhouses will not be rebuilt if no changes to the water management are made.

9.3 Energetic landscape

9.3.1 Information network

If the 'energetic landscape' scenario would play out, this could be beneficial to the information network. Because climate change is not impacting upon the area, the participants are not 'distracted' from their role within the network. However, the urgency of their existence might therefore become challenged because the lack of a common threat might lead to an understanding that misses the necessity of cooperation. This can be counteracted by staying open to new ideas for the use of the network as well as by good communication or even promotion of the network. Furthermore, because the shift to completely renewable energy sources is still occurring in this scenario, the network may play an important role in developing, testing and expanding new technologies and practices. These could include conditioned transport (Coolboxx); improvement of logistics and transport (by offering possibilities of multimodal transport); biorefinery; and material and energy efficiency.

9.3.2 Heat and CO2 network

As in the New Worlds scenario, the huge shift in focus towards renewable technologies will be beneficial for the case of a heat and CO2 network. Due to the nature of the processes operated in the MP, heat cascading will still be an option and stimulated due to the large effects of global warming. A shift to renewable energy supply from biomass will still result in CO2 emissions that can be captured and fed to greenhouses in the Greenport. However, the amount of renewable technologies can create competition to these (heat and CO2) sources. Furthermore, if energy is produced via other ways, CO2 production will drop and a competition for CO2 can occur.

9.3.3 Bio-based Pharma

This scenario is almost identical to the previous one, except less problems with flooding and water shortage can be expected. The totally renewable energy production can only be the result of increased knowledge and investment in sustainable (renewable) techniques and processes.
Security of energy supply may have been the initial reason for such research and investments, but the spill over effect to other industries will provide the basis for a radical change. This creates an ideal environment for the production of pharmaceuticals – or chemicals for that matter – originating from biomass. As described in the heat and CO2 network case, the reduced security of supply of CO2 will put Greenport production under serious pressure. This will have an effect on the production of dedicated plants for pharmaceuticals or the production of biomass for chemicals.

9.4 Oily pressure

9.4.1 Information network

Again, this scenario offers opportunities and threats to the existence of the network to be developed. Because the energy politics will be business as usual, there will be less opportunity for the network to come up and test new cases with new energy sources, at least initially. However, sustainability is more than a difference in energy politics alone, so the network could still contribute to the establishment of a sustainable connection of the MP-GP area. The focus could shift more to logistics and innovations in which both Mainport and Greenport parties may gain in the short term. It could for example include the development of new products such as biopharmaceuticals. However, even in a 'business as usual' scenario, oil prices will eventually increase, and the development of knowledge through small pilot projects concerning renewable energy sources might become an extra focus of the network after all.

9.4.2 Heat and CO2 network

This scenario is not beneficial for the creation of a heat and CO2 network. The conservative energy policy combined with the absence of global warming effects takes away the incentive for development of the heat and CO2 network. A small incentive can be created by the implementation of the carbon trading scheme for the MP-GP sector. By replacing CO2 from the combined heat and power plants in the Greenport with CO2 from the Mainport, results in lower costs for emission rights. Costs will be higher in this scenario than in the scenarios containing complete renewable energy politics.

9.4.3 Bio-based Pharma

The expected high price of oil may be an incentive to shift to biomass sources for chemicals and pharmaceuticals, but the high oil prices will increase the cost of heating the greenhouses enormously, and in turn increase the cost of bio-based chemicals and/or pharmaceuticals. These are very unfavorable circumstances for the development of a bio-based pharmaceutical (or chemical) industry. Some opportunities can be found here as well; with increasing costs of heating, the need for 'cheap' heat is pressing and reducing expenses is part of human nature. This financial incentive might be enough encouragement for the Greenport and the Mainport for realizing a heat network; reduced costs on the one hand and increased profits – by selling heat – on the other.

The absence of global warming effect does have positive sides for the Greenport; less problems with flooding and water shortage can be expected. Furthermore, the continued production of energy from fossil sources will ensure the delivery of CO2 to the Greenport.

9.5 To pump or to drown

9.5.1 Information network

This scenario will again provide the network with opportunities to develop new sustainability practices and knowledge. Although the emphasis will not be on renewable energy sources and practices at first, other sustainability issues may be addressed through the network instead. Especially since this scenario anticipates huge impacts of global warming, the network may function as important axis in the MP-GP area, developing and coordinating new knowledge and practices on how to cope with these impacts. However, the network participants (and financiers) should be committed to the network in order for it to stay innovative and contribute to the area. If its members and financiers decide to invest (time/knowledge/money) elsewhere (for example in their own organizations), the network is bound to be abrogated. However, this may be prevented by good practices and flexibility before, since the accumulation of trust and longer existence of the network as an organization may contribute to legitimise its existence.

9.5.2 Heat and CO2 network

A large impact of global warming results in an incentive for the implementation of a heat and CO2 network. This is, however, hold back by the business as usual energy policy, though a carbon trading scheme can have positive effects on the development of the network, as was described in section 9.4.2. Costs will be higher in this scenario than in the scenarios containing complete renewable energy politics.

9.5.3 Bio-based pharma

This is the least favorable scenario for the development of a bio-based pharmaceutical or chemical industry in the MP-GP complex. It is identical to the 'oily pressures' scenario but it includes the high impacts of global warming. The expected high price of oil may be an incentive to shift to biomass sources for chemicals and pharmaceuticals, but the high oil prices will increase the cost of heating the greenhouses enormously, and in turn increase the cost of biobased chemicals and/or pharmaceuticals. These are very unfavorable circumstances for the development of a bio-based pharmaceutical (or chemical) industry. Some opportunities can be found here as well; with increasing costs of heating, the need for 'cheap' heat is pressing and reducing expenses is part of human nature. This financial incentive might be enough encouragement for the Greenport and the Mainport for realizing a heat network; reducing costs on the one hand and increased profits – by selling heat – on the other.

The high impact of global warming will likely result in a lack of fresh water in the summer; this implies some radical changes for horticultural farming. A shift to sustainable farming with a strict water management is necessary. Besides that, some sort of water storage is necessary; the excess (rain) water of winter will be needed during dry spells in summer. Furthermore the risks of flooding due to the rising sea level will have to be mitigate through water barrages or dikes; flooding could cause severe destruction in the Greenport. It can be expected that after such massive destruction the greenhouses will not be rebuilt if no changes to the water management are made.

Conclusions and recommendations

Conclusions

Rapid urbanization makes agricultural production part of international chains and networks of production, while at the same time it remains clearly present at local levels. This makes the clustering of agricultural production in agroparks evident for economic and logistic reasons. Metropolitan agriculture needs to make use of intelligent connections between producers, sectors, raw materials, energy flows and waste flows, because of limited accessibility of these goods and limited space. Delta metropolises, as the Mainport-Greenport region is, offer advantages for metropolitan agriculture, like fertile soil and good possibilities for transportation of products. This delta metropolitan region in the province of Zuid-Holland include an agricultural cluster (Westland-Oostland) and an harbour area with an industrial complex (Rotterdam). These two important sectors of the Dutch economy need to tackle sustainability issues at the same time as trying to stay competitive. To be able to do so, these two sector have to create more interaction, which induces competitiveness and innovation.

What can be examples of interventions that link the Mainport and the Greenport in order to contribute to a more sustainable way of production and logistics? According to the case studies performed in this report, these interventions are:

- Creation of a knowledge and innovation network. According to the interviews in chapter 06, a lot of stakeholders are open minded towards sustainable innovation and some of these stakeholders are able to build bridges between the Mainport and the Greenport from already existing connections to other stakeholders. Starting a platform of knowledge sharing to induce cooperation and mutual knowledge development could show what are the mutual benefits. The platform can initiate contacts between stakeholders, for example by organising meetings to discuss increasing re-use, or sharing utilities.
- Development of a heat and CO2 network. According to some stakeholders, the combined development of these two networks is impossible, but from an economic perspective it is good to develop some parts of the networks together, like crossing the Nieuwe Waterweg. Coordination is needed in the development of these networks, preferably done by regional and local government(s).
- Development of bio-based raw materials production. The only feasible option for creating a bio-based synergy in the MP-GP complex is using biological waste streams from the Greenport as raw materials for processes in the Mainport. Growing crops for the specific production of pharmaceutical raw materials is not feasible on the short term, but can become so in the future.
- Development of diverse transport opportunities. Main activities of the harbour area are related to transport, so it would be a good start to create an interaction with the Greenport at this point. Options for more interactions between the Mainport and the Greenport in this niche are the use of Fresh Corridor (river and short sea connections), Coolboxx (container system that connects truck, train, airplane and ship transport) and Greenrail (train transport), all explained in more detail in chapter 02.
- The information network will be beneficial to the connection of the Mainport and

Greenport area in all scenario's, all be it in different ways. The network therefore provides a good practice for establishing connections between the two areas and should therefore be established. The difference in scenario's however does emphasise the need for the network to be flexible, both in terms of its participants as in terms of its focus.

- For the heat and CO2 network development, the scenario's with completely renewable energy politics will be most feasible, but also under energy politics business as usual with a carbon trading scheme, this case study will be likely to happen although costs are much higher.
- In the scenario's with energy politics business as usual, the bio-based pharmaceutical production in the Greenport as resources for the chemical and pharmaceutical industry in the Mainport will not be feasible. In the other two scenario's with energy politics completely renewable, this case study will be completely feasible.

Recommendations

From the conclusions of the last paragraph, some recommendations can be abstracted:

- For creation of a knowledge and innovation network, governmental (province and municipalities) and independent (Milieufederatie) organisations are needed to create enthusiasm, wide support and communication to outsiders, but also to facilitate the contacts between stakeholders. On the longer term, in cooperation with all stakeholders, an overarching organisation should be established, with board members possibly from the list presented in chapter 06, to develop demonstration projects and business cases in the MP-GP context, but also to initiate idea generation sessions for new developments. For instance in the field of agro-industrial symbiosis. Xplorelab is a platform that can easily facilitate such meetings. The character of a think tank provides a safe environment to discuss new, innovative and out-of-the-box concepts and ideas. Due to the transdisciplinary working methodology of Xplorelab, mutual understanding and trust between stakeholders, necessary for successful implementation of projects, can be stimulated and built.
- Coordination of the development of heat and CO2 networks should be done by regional and national government.
- Stimulate the use of agricultural waste streams as raw materials and stimulate research on molecular farming (production of specific plants for pharmaceutical resources). Greenhouse entrepreneurs are important stakeholders in this respect, since they need to be willing to switch production to crops for pharmaceutical resources.
- Stimulate forms of transport that decrease congestion in both Mainport and Greenport and are more sustainable at the same time.

Appendix A. Multi-level transition Framework

Taken from Loorbach and Van Raak, 2005

Level	Goals	Activities	Instruments	Competencies
Strategic	Integration	System/Problem structuring	Integrated systems analysis	Systems thinking
	Direction	Envisioning	Transition arena, networks	Creativity, guts
	Attuning	Exchange of perspectives, coordination, interaction	Transition arena, transition coalitions	Communication skills, network competencies
Tactical	Agenda-building	Exchange of goals, negotiations	Transition agenda	Thinking in terms of co-production, negotiation skills
	Networking	Coalition building	Transition paths innovation networks	Communication and consensus building
Operational	Innovation	Experimenting	Transition experiments testing grounds	Learning and communication
	Development	Implementation	Project portfolios	Project management

Appendix B. Leading questions to conduct a discourse analysis

These questions to ask about building tasks are taken from Gee (1999:93):

Semiotic building
1) what sign systems are relevant (and irrelevant) in the situation? How are they made relevant (and irrelevant) and in what ways?
2) What systems of knowledge and ways of knowing are relevant (and irrelevant) in the situation? How are they made relevant (and irrelevant) and in what ways?
3) What social languages are relevant (and irrelevant) in the situation? How are they made relevant (and irrelevant) and in what ways?

World building
4) what are the situated meanings of some of the words and phrases that seem important in the situation?
5) What situated meanings and values seem to be attached to places, times, bodies, objects, artefacts, and institutions relevant in this situation?
6) What cultural models and networks of models seem to be at play in connecting and integrating these situated meanings to each other?
7) What institutions and/or discourses are being (re) produced in this situation and how are they being stabilized or transformed in the act?

Activity building
8) what is the larger or main activity (or set of activities) going on in the situation?
9) What sub-activities compose of this activity (or these activities)?
10) What actions (down to the level of things like “requests for reasons”) compose of these sub-activities and activities?
Socio-culturally-situated identity and relationship building
11) what relationships and identities (roles, positions), with their concomitant personal, social, and cultural knowledge and beliefs (cognition), feelings (affect), and values, seem to be relevant to the situation?
12) How are these relationships and identities stabilized or transformed in the situation?
13) In terms of identities, activities, and relationships, what discourses are relevant (and irrelevant) in the situation? How are they made relevant (and irrelevant) and in what ways?

Political building
14) what social goods (e.g. status, power, aspects of gender, race, and class, or more narrowly defined social networks and identities) are relevant (and irrelevant) in this situation? How are they made relevant (and irrelevant), and in what ways?
15) How are these social goods connected to the cultural models and discourses operative in the situation?

Connection building
16) what sort of connections – looking backward and/or forward – are made within and across utterances and large stretches of the interaction?
17) What sorts of connections are made to previous or future interactions, to other people, ideas, texts, things, institutions, and discourses outside the current situation?
18) How do connections of both the sort in 16 and 17 help (together with situated meanings and cultural models) to constitute “coherence”- and what sort of “coherence”- in the situation?

Appendix C. Empty discourse interview table

	1	2	3
Name of person			
Name of organization			
Background			
Perception of sustainability problem			
Solution suggested			
Innovative practices			
Ability to consider complex problems at a high level of abstraction			
Ability to look beyond the limits of their own discipline and background			
Enjoy a certain level of authority within various networks			
Ability to establish and explain visions of sustainable development within their own networks			
Willingness to think together			
Open for innovation instead of already having specific solutions in mind			
Knows which other people from this list			
Connections with other important stakeholders			
Can contribute to the network by/through			

Appendix D: Bio-based pharma interview

Beste meneer/mevrouw,

Mijn naam is Marlies Meijer-Willems en ik ben een deeltijd student aan de TU Delft, ik volg de masteropleiding Industrial Ecology. De opleiding zorgt ervoor dat wij zowel technisch, als milieukundig als sociaal economisch worden opgeleid en dat wij dus uit verschillende invalshoeken problemen bekijken. Een van de belangrijkste onderdelen van de opleiding is dat er met een 'systeemblik' naar een probleem wordt gekeken, dit houdt eigenlijk in, niet inzoomen maar uitzoomen op een probleem en kijken waar de kansen liggen. Het voornaamste is dat processen (binnen bedrijven of regio's) duurzamer worden. Voor een tweedejaars project, wat ik met vier andere studenten doe, onderzoeken wij de kansen die tussen de Mainport Rotterdam en de greenport Westland-Oostland mogelijk zijn. Dit een onderwerp dat wij voor de provincie Zuid-Holland aan het uitwerken zijn. Het onderwerp wat ik ga belichten is biopharma, dit is een heel breed onderwerp, maar zou een hoge toegevoegde waarde kunnen hebben voor het Westland. Om zo eerlijk mogelijk het onderwerp te beschrijven ben ik op zoek naar de mening van bedrijven die op de een of andere manier te maken hebben met farmacie en biotechnologie. Mijn onderzoek is voornamelijk gericht op bedrijven die biologisch actieve eiwitten produceren/ontwikkelen. Daarbij ben ik van de beschrijving van uw bedrijf uitgegaan die ik via het BioPartner Network Life Sciences Sector Report 2005 heb gevonden. Onder aan deze email staan een aantal vragen, zou u willen meewerken aan deze enquête? Uw antwoorden zullen worden verwerkt in een openbaar rapport, maar als u er prijs op stelt zal ik uw antwoorden anoniem verwerken. Alvast bedankt voor uw medewerking, als er nog vragen zijn kunt u gerust contact opnemen.

Vriendelijke groeten, kind regards,
Marlies Meijer-Willems

Als er vragen zijn die niet op de activiteiten binnen uw bedrijf van toepassing zijn, kunt u deze uiteraard overslaan.

1. Zou u kort kunnen beschrijven wat uw bedrijf voor activiteiten heeft?
2. Op welke wijze worden de enzymen/vaccins/antilichamen o.i.d. die uw bedrijf produceert/ontwikkeld op dit moment vervaardigd?
3. Zou productie uit planten een alternatief kunnen zijn, eventueel op lange termijn?
4. Heeft u dit al eens overwogen, zo ja, wat waren uw beweegredenen om wel of niet hiermee door te gaan?
5. Als u dit nog niet heeft overwogen, bent u geïnteresseerd om u te verdiepen in het onderwerp?
6. Ziet u toekomst voor de Nederlandse (tuinders) sector in het produceren van (grond)stoffen voor enzymen/vaccins/antilichamen voor de (bio)pharmaceutische industrie?
7. Wat zijn de problemen die u verwacht bij enzymen/vaccins/antilichamen voor de (bio)pharmaceutische industrie?
8. Verwacht u dat genetisch gemodificeerde planten een toekomst hebben bij het produceren van enzymen/vaccins/antilichamen?
9. Wat verwacht u van de publieke acceptatie van het vervaardigen van enzymen/vaccins/antilichamen op deze wijze?
10. Ziet u andere/betere mogelijkheden voor de toepassing van bio-grondstoffen? (bijvoorbeeld in energieproductie, cosmetica, plastics)
11. Wie zou bio-based pharma moeten initiëren. Is er behoefte aan een voortrekker, coördinator, kennisinstituut?\
12. Heeft u opmerkingen, aanvullingen of commentaar?

Appendix E. Filled in network table

	Name of person	Name of organization	MP/GP	Background	Perception of sustainability problem	Solution suggested	Innovative practices	ability to consider complex problems at a high level of abstraction	ability to look beyond the limits of their own discipline and background	enjoy a certain level of authority within various networks	ability to establish and explain visions of sustainable development within their own networks	willingness to think together	open for innovation instead of already having specific solutions in mind	Future perspective: long / medium/ short term	Knows which other people from this list	Connections with other important stakeholders	Can contribute to the network by/through ...
1	M. Borsje (m)	DSM	MP	Competence leader energy	Too large eco-footprint; use of chemicals; lack of energy efficiency. Sustainability understood in line with Brundtland definition	Reuse of waste streams (reuse of potassium containing substances); Biorefinery; Water recycling; Fermentation	Use of bio-based raw materials; Shift from chemical to enzymatic processes	yes	yes	yes	yes	yes	yes/ no	Medium term		Municipality of Rotterdam	Knowledge development through demonstration projects (co-siting)
2	G. Bovense (m)	PvdA Lansigerland	GP	Chairman	Development of policies are not sensitive enough towards sustainability problems	Logistics improvement, knowledge development and employment opportunities	Sustainable contracting; facilitating geothermal heat development; bike lanes for longer distances; MP-GP connection development	yes	yes	Yes / no	Yes / no	yes	yes	Medium term		Municipality of Rotterdam, LTO Noord, governmental organisa-tions; Greenery	Building bridges; stimulate people
3	J.W. Donkers (m)	WUR	GP	Business developer/ scientist	Sustainability problem is a psychological problem: mindshift and attitude change is needed	Knowledge infrastructure MP connecting to GP: including horticulture, trade and logistics (cooling technology and multimodal transport); Biorefinery	Pilot projects in which businesses get introduced with new (more sustainable) technologies	yes	yes	yes	yes	yes	yes	Both short and long term	4, 13	Municipalities; Deltalinqs; InHolland; harbour company	Knowledge sharing and development (demonstration projects); people (development teams)

	Name of person	Name of organization	MP/GP	Background	Perception of sustainability problem	Solution suggested	Innovative practices	ability to consider complex problems at a high level of abstraction	ability to look beyond the limits of their own discipline and background	enjoy a certain level of authority within various networks	ability to establish and explain visions of sustainable development within their own networks	willingness to think together	open for innovation instead of already having specific solutions in mind	Future perspective: long / medium/ short term	Knows which other people from this list	Connections with other important stakeholders	Can contribute to the network by/through ...
4	M. Dotsch (f)	KMR (Kennis Infrastructuur Mainport Rotterdam)	MP	Project secretary	Depletion of water and energy sources	Education and knowledge sharing amongst businesses; flexible legislation and subsidizing	Electronics development for energy management; researching improvement of transport modality	yes	Yes	Yes/ no	Yes/ no	yes	yes	Long term	3	Schools and universities (Erasmus, STC, ROC, Albeda), Harbour company, Deltalinqs, OBR, Metal Union	Knowledge development and circulation, building bridges, interaction schools and companies
5	C. Jordan (m)	Delta linqs	MP	Technical manager	Demographics; pressure on resources. Need to consume less. Need for closure of the gap between government and business	Use of waste heat; Biorefinery	Use of waste heat; Biorefinery	yes	yes	yes	yes	yes	yes	Short to medium term	14	Government departments Harbour company; Greenhouse entrepreneurs	Knowledge development and sharing (through thinktanks)
6	H.K. Maters (m)	Avag (platform suppliers greenhouse sector)	GP	Chairman	Using less fossil fuels; lack of knowledge how to become sustainable	Use of waste streams (CO2); using inland navigation as a way of transportation; biopharma development	Energy systems; heat and cold storage; CO2 exchange; C2C solutions; less resources; biological production method	yes	yes	yes	yes	yes	yes	Short term		Other Greenports; OCAP;Flower&Food Innovation; govern-mental organisa-tions; Frugiventa	Knowledge sharing and social skills (building bridges)

Twenty ‘key persons’, with the willingness to endeavour sustainable innovation, have been selected from both the Mainport and Greenport. These interviewees were selected using the KOMBi approach (Kenniswereld, Overheid, Maatschappij & Bedrijfsleven). This approach guaranteed a diverse list of stakeholders from knowledge and governmental organisations, society and businesses. Some of the contacts were delivered by Marco van Steekelenburgs list of participants of the Mainport-Greenport excursion held on September 18th 2009, others were taken from the Network booklet ‘Greenport Westland-Oostland’, published by Triagilitas. Eventually 14 interviews have been conducted.

	Name of person	Name of organization	MP/GP	Background	Perception of sustainability problem	Solution suggested	Innovative practices	ability to consider complex problems at a high level of abstraction	ability to look beyond the limits of their own discipline and background	enjoy a certain level of authority within various networks	ability to establish and explain visions of sustainable development within their own networks	willingness to think together	open for innovation instead of already having specific solutions in mind	Future perspective: long / medium/ short term	Knows which other people from this list	Connections with other important stakeholders	Can contribute to the network by/through ...
7	M. van Noord (m)	Promin-ent	GP	Greenhouse Entrepre-neur	Only problem is that there is lack of cooperation between parties	Using waste streams; using transportation over water rather than road	Using less energy while maintaining production levels; heat exchange to houses; use of wind energy	yes	yes	yes	yes	yes	yes	Short / medium term	8	OCAP: Syntens: PT; Greenhouse entrepreneurs	Sharing knowledge (Demonstration projects)
8	M. Prins (f)	Priva	GP	Director	Legislation and interests of vested parties is blocking sustainable development	Vertical chains; exchange of energy and water; sustainable production methods	Hardware platform (development of robots); international education centers	yes	yes	yes	yes	yes	yes	Short and long term	7	Harbour company, Rijkzwaan, Universities, Governmental department, GP Nederland	Knowledge development and demonstration projects
9	T. Stevense (m)	Tebodin	MP	Architect / C2C Consultant	Lack of changing attitudes and habits; a whole transition is needed rather than looking at parts of the problems	MP/GP: relocate horticulture into harbour area; exchange waste streams; transport over water	Research in symbiosis between horticulture and industry	yes	yes	yes	yes	yes	yes	Long term		Petrochemical entrepreneurs; Flora Holland	Building Bridges; Sharing and developing knowledge
10	F. van Tielrooij (m)	Plaform Agro logistics	GP	Chairman	Dutch are pretending to be sustainable, but they are not! Thus: behavioural change is needed	Cooled transport; physical connections; intermodal transport	Smart and sustainable transport; CO2 and energy exchange; facilitating and stimulating cooperation	no	yes	yes	yes	yes	yes	Short term		FrugiVenta, Flora Holland, WUR, entrepreneurs, Harbour company, Unilever, municipality of Rotterdam	Building bridges between government and businesses; foreseeing problems

	Name of person	Name of organization	MP/GP	Background	Perception of sustainability problem	Solution suggested	Innovative practices	ability to consider complex problems at a high level of abstraction	ability to look beyond the limits of their own discipline and background	enjoy a certain level of authority within various networks	ability to establish and explain visions of sustainable development within their own networks	willingness to think together	open for innovation instead of already having specific solutions in mind	Future perspective: long / medium/ short term	Knows which other people from this list	Connections with other important stakeholders	Can contribute to the network by/through ...
11	N. Tillie (m)	Municipality Rotterdam	MP	Consultant energy and planning	Problems in energy, water, material and food supply	OCAP, use of waste streams; transport and logistics	Research in cooperation with TU Delft (energy and urbanism)	yes	yes	yes	yes	yes	yes	Medium / long term		Deltalinqs, Habour company	Development of concepts; building bridges; executing role
12	E. Verkoelen (f)	Milieufederatie	MP GP	Consultant	Umbrella concept; people now focus too much on one aspect rather than all sustainability aspects	Cooperation is necessary and adjustment and change must be made by all parties. Government should be building bridges between involved parties.	Developing new concepts with less use of fossil fuels	yes	yes	yes	yes	yes	yes	Short and long term	13	LTO Noord; Entrepreneurs; Deltalinqs; Harbour company	Building bridges; communication to outsiders
13	M. Vintges (f)	Municipality of Westland	GP	Strategic consultant	Contamination is a larger problem than CO2. Sustainability problem is a problem of the mindset of societies	Synergy; use of waste streams; new production methods and products	Supporting GP cluster with sustainable innovations; pilot projects (water storage)	yes	yes	Yes / no	yes	yes	yes	Short to medium term	3, 12	LTO Noord; Greenports NL; trade association, harbour company, municipality of Rotterdam, Syntens	Building bridges; creating support and enthousiasm
14	J. van der Zande (m)	Formerly: Harbour company	MP	consultant	There is lack of energy efficiency and CO2 emissions in economical perspective	Synergy; use of waste streams; new production methods and products	Bioport Rotterdam development; research in utilization of high value bio-based materials	yes	yes	yes	yes	yes	yes	Medium term	5	Harbour company; Cleantech platform; Scheepvaartskring; FrugiVenta ; Priva	Building bridges; contacting outside relations; knowledge sharing

Colofon

Dit onderzoeksverslag is een uitgave van Xplorelab, provincie Zuid-Holland, in samenwerking met TU Delft (Industrial Ecology)

Samenstelling:
Maarten Feberwee, TU Delft

Tekst:
Evert Bouman, TU Delft
Maarten Feberwee, TU Delft
Katinka Wijsman, TU Delft
Marlies Meijer- Willems, TU Delft
Jim van Ruijven, TU Delft

Met dank aan:
Marco van Steekelenburg, Xplorelab
Gijsbert Korevaar, TU Delft
Carolien Huisman, PZH
Hans Spijker, PZH
Andries Koops, WUR
Martin Borsje, DSM
Gerard Bovense, PvdA Lansingerland
Jan Willem Donkers, WUR
Mary Dotsch, KMR
Chris Jordan, Deltalinqs
Harm Maters, AVAG
Marco van Noord, Prominent
Meiny Prins, Priva
Willem Stevense, Tebodin
Frans van Tielrooij, Platform Agrologistiek
Nico Tillie, Gemeente Rotterdam
Ellen Verkoelen, Milieufederatie
Marga Vintges, Gemeente Westland
Jan van der Zande, Havenbedrijf Rotterdam

Den Haag, 2010