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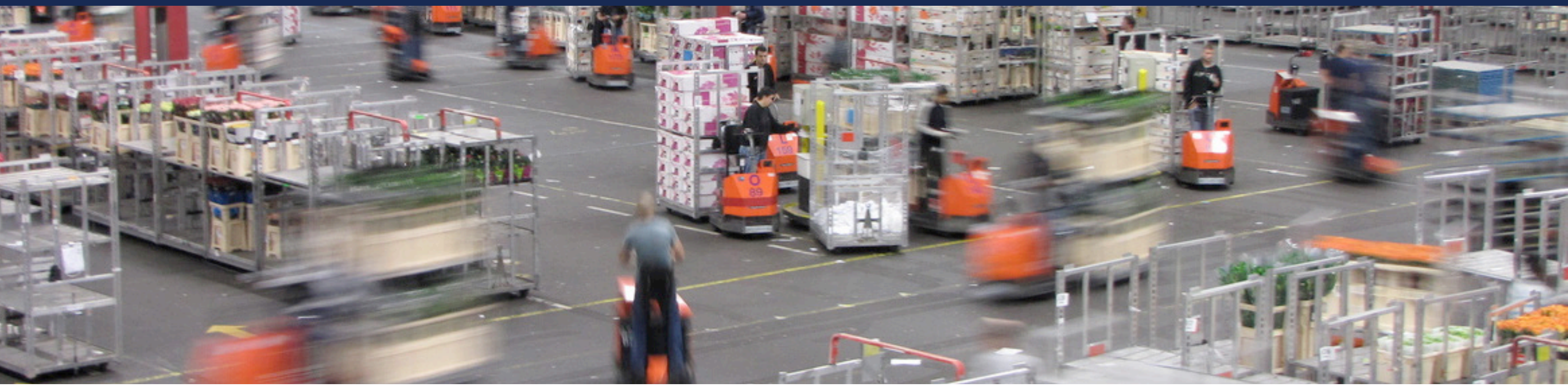

Resource Optimization in Greenport Aalsmeer

A comprehensive report prepared for:

GREENPORT Aalsmeer

December 2014

Prepared in partnership with

Fonz Dekkers

Walton Sustainability Solutions Initiatives

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Additionally, the authors wish to thank those listed below for their invaluable support and input for this project.

Rob van Aerschot, Debby de Rijk, John Nederstigt & Clement Torrre, municipality of Haarlemmermeer

Marcel van Beek, Schiphol Group

Levi Boerman & Paul Jansen, SADC

Rien Braun & Phillip Bocxe, Stallingsbedrijf Glastruinbouw Nederland (SGN)

Lennart van den Burg, Grontmij

Marcel Brans, Naktuinbouw

Eloi Burdoff & Rene Jansen, Province of North-Holland

Andrea van de Graaf, Meermaker / Tegenstroom

Wiebe van der Lagemaat, municipality of Uithoorn

Coen Meijeraan, Flora Holland

Cees Moerman, Agrimaco

Jan Mulder, Jamuflor

Bart Oostveen, de Zonnebloem / LTO noord

Andre van der Poel, municipality of Amstelveen/Aalsmeer

Ingrid Leemans & Sander van Voorn, Greenport Aalsmeer

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Executive Summary

Greenport Aalsmeer, one of six Greenports in the Netherlands, is home to the world's largest flower auction, FloraHolland, and employs over 50,000 people to work at cultivation companies, the auction, trade businesses, exporters, horticultural suppliers and flower and plant breeders.

With worldwide digitization of horticulture markets, the traditional horticulture supply chain is evolving to circumvent the intermediate physical auction house. To retain its position in the market, horticulture growers in Greenport Aalsmeer recognize the need to become competitive, and predominantly consider sustainability as a cost-reduction endeavour focusing on energy.

The goal of this project is to inventory, document and visually present resource consumption within Greenport Aalsmeer's growers (organized into 12 clusters). Additionally, Fonz Dekkers and the Arizona State University (ASU) team took this information to make recommendations for opportunities to optimize resource and energy use, improve the competitiveness of Greenport Aalsmeer, and enhance the overall sustainability of Greenport Aalsmeer.

The most promising resource optimization solutions are summarized in the table below. Green marks are the most viable and feasible options for each of the clusters. Yellow marks indicate additional options that can be complementary to, or substitutions for, the most feasible option.

Summary of Options for each Greenport Aalsmeer Cluster

Cluster	Amsterdam Heat Net	Data Park	OCAP Pipeline	Geothermal Energy	Decentralized Options
Aalsmeer	Green			Yellow	Yellow
Kudelstaart	Green		Yellow		Yellow
Amstelveen	Green			Yellow	Yellow
De Kwakel	Green		Yellow		Yellow
Nieuwe Wetering			Green	Green	Yellow
Woubrugge					Yellow
Roelofarendsveen			Green	Green	Yellow
Woerdense Verlaat					
Ter Aar					Green
Nieuwveen	Green		Yellow		Yellow
Rijsenhout		Green	Green	Yellow	Yellow
De Ronde Venen				Yellow	Yellow

Without specific energy costs for growers, using average electricity and natural gas pricing, the entire Greenport Aalsmeer organization of growers may be able to reduce their energy costs by a potential maximum of €68 million annually. This is purely an estimate based on assumptions of recurring costs, with no estimation for capital costs.

Greenport Aalsmeer needs to seek ways to distinguish themselves from other growers in the market in order to maintain and grow market share, by implementing some of these recommendations:

1. ***Strengthen the stakeholder network to successfully implement sustainable opportunities.***
2. ***Become the knowledge and innovation platform for horticulture.***
3. ***Broaden the use of sustainability assessment to optimize commodity priorities.***
4. ***Create a sustainability opportunity prioritization decision-support tool.***

1. Introduction and Background

1.1. Greenport Aalsmeer

Greenport Aalsmeer is one of six Greenports in the Netherlands. It is the world's largest trade and knowledge center for floriculture, with the flower auction FloraHolland in Aalsmeer at its core. Within the Greenport, 50,000 people work at cultivation companies, the auction, trade businesses, exporters, horticultural suppliers and flower and plant breeders. These businesses are responsible for an annual turnover of €3 billion. The agriculture sector contributes 10% of the Dutch economy and 8% of the total employment rate.

Greenport Aalsmeer organization involves collaboration among two provinces, 7 municipalities, 6 branch organizations, a financial institution and a research institute. Key stakeholders are the co-operative auctioning organization, FloraHolland, the Amsterdam Chamber of Commerce, LTO Noord Glaskracht (Dutch agriculture and horticulture advocacy organization), Naktuinbouw (Dutch General Inspection Service for horticulture), VGB (trade association), Blooming Breeders Foundation, Wellant College, Rabobank Regio Schiphol, and the municipalities of Aalsmeer, Amstelveen, Haarlemmermeer, Uithoorn, Kaag en Braassem, Nieuwkoop and the Province of North Holland (see figure 1).

Figure 1: The Seven Municipalities of Greenport Aalsmeer

Greenport Aalsmeer has a facilitating, stimulating and unifying role among its members in implementing knowledge, innovation, space, accessibility, sustainability, labour market, education, positioning and image. The sustainability goals are related to reduction of carbon emissions (by 50%), reduction of energy usage (30%), the usage of renewable energy (30%) and the reuse of waste streams (75%) by 2025. From an economic perspective, the main focus is the reduction of fossil fuel consumption and operating costs of the various businesses.

1.2. Problem Statement

The Netherlands is the World's largest and most famous producer and worldwide distributor of horticulture. In 2013, the auction FloraHolland had relations with over 6,800 flower suppliers, of which 9% were internationally based, and had a turnover of €4.35 billion. However, the horticultural world is becoming increasingly international, relying on virtual connections through information and communications technologies and complex logistics. Of the €4.35 billion turnover, nearly 18% came from imported flowers from both EU and international countries. During that same year, the value of Dutch flower exports were €5.27 billion.

Figure 2 shows the global nature of flower production (as imports to the Netherlands); and Figure 3 shows the international flower marketplace (as exports from the Netherlands).

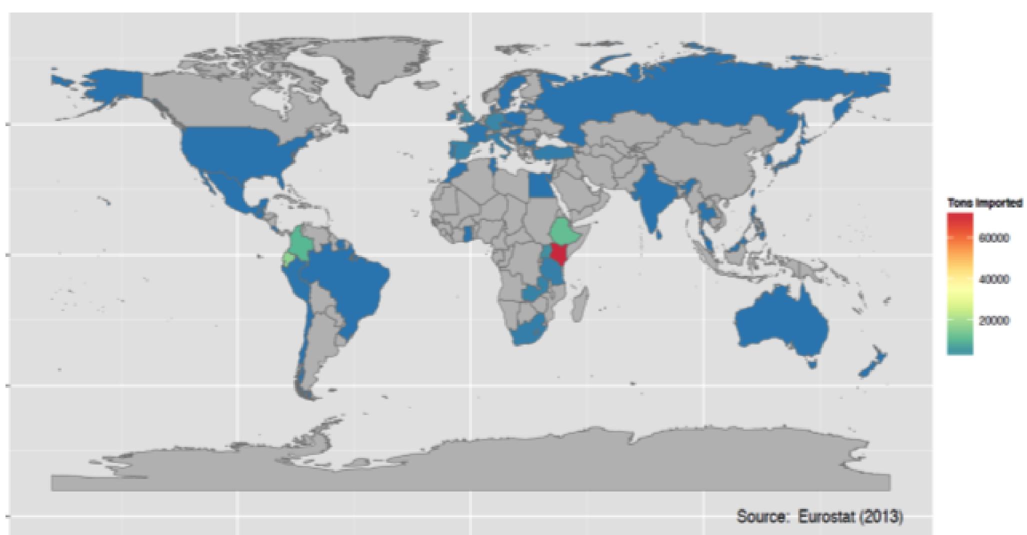

Figure 2: Worldwide Dutch Flower Imports in 2013

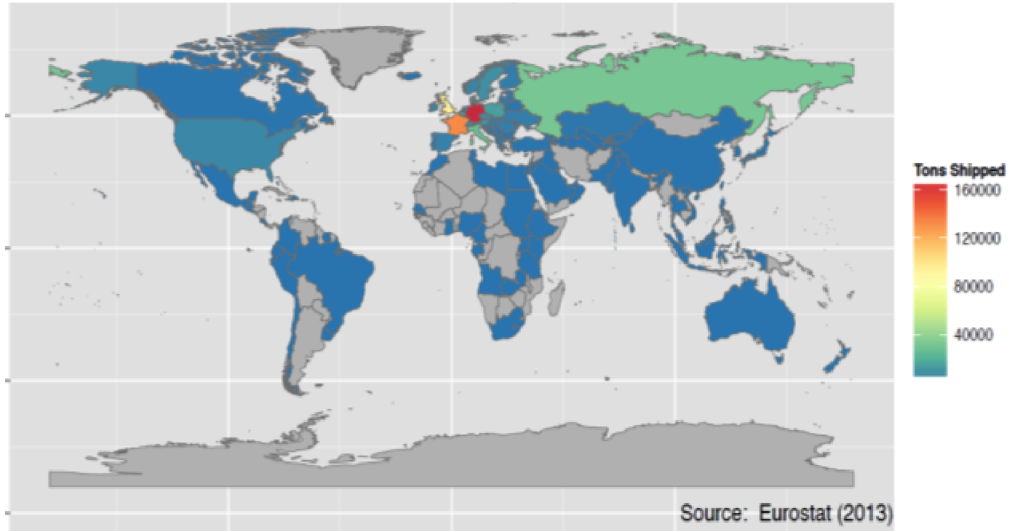

Figure 3: Worldwide Dutch Flower Exports in 2013

The costs of horticulture are based roughly on the costs for production (from seed to flower), transport to the auction, the auction itself, export to destination and the distribution to customers. The growers of flowers within Greenport Aalsmeer have a unique position with their proximity to the auction FloraHolland, so that they can compete on price by saving on the initial transportation costs. However, more and more e-commerce is occurring. The competitive landscape in the floriculture industry is shifting away from the Greenport as stakeholders migrate to utilizing the internet to grow their business. Thus, the challenge for the future of Greenport Aalsmeer is to understand how to maintain its market position as the world and the transportation system are changing through the integration of web-based tools.

In Figure 4, this problem statement is visualised.

Figure 4: Current Trading Situation (left) and Possible Future Trading (right)

For the Greenport to remain competitive, many projects have been initiated to be either competitive on price (reduce operating costs) or quality (knowledge development). In the Netherlands, energy prices, land prices and labour prices are high compared to competing countries. Additionally, while greenhouses are used in Greenport Aalsmeer to maintain year-round production and efficiency, competing countries such as Costa Rica or Kenya can grow flowers in open fields, which is cheaper.

Sustainability and innovation are therefore crucial for the future of Greenport Aalsmeer, not only from a resource efficiency standpoint, but also for the image of the floriculture sector. Greenport Aalsmeer emits more than one million metric tonnes of CO_2e per year, as much as the whole municipality of Haarlemmermeer (including Schiphol Airport) or 200,000 households. If Greenport Aalsmeer would generate all its energy via solar panels in Holland, it would need 27,180,000 square meters (approximately 10 square miles) of land to place them. The impact of making the Greenport's energy demand decline therefore has a tremendous effect on sustainability in the region.[1]

1.3. Scope of Work

Arizona State University (ASU), through its Walton Sustainability Solutions Initiatives (WSSI), together with the local firm Fonz Dekkers have quantified resource consumption through a mapping exercise, identified opportunities for resource flow optimization within Greenport Aalsmeer and then identified the opportunities for improvement. The project actively engaged the partners and stakeholders within the area via interviews, data collection and analysis activities.

The current resource flows are visualized in Figure 5. Usually there is a combined heat and power plant (CHP) active to transform natural gas to electricity, CO_2 and heat, all three needed for greenhouses to operate. The surplus of electricity is sold to the electricity grid. Although a CHP has high system efficiency, the burning of natural gas is not sustainable. Furthermore, the energy costs are about 30% of the annual operating costs for Dutch horticulture and unsecure, given the fluctuating price of natural gas. Moreover, the payback price of electricity in the grid is getting lower, further decreasing the cost efficiency of the CHP.

The main focus of this report is to show how the resource use of the greenhouses in Greenport Aalsmeer can be optimized without the use of CHP.

While research and projects have been initiated or completed by the Greenport in the recent years, an overall integrated strategy has yet to be developed. This research is a

[1] Eindrapport inventarisatie CO_2 en warmte

[2] Kengetallen 2013, FloraHolland

comprehensive analysis of resource use, which leads to identifying improvement opportunities.

This report can be used as an initiating document for a sustainability program manager at Greenport Aalsmeer. This program manager can use the data, analysis and recommendations of this report to work together with the sector and the stakeholders on implementing the sustainable measures.

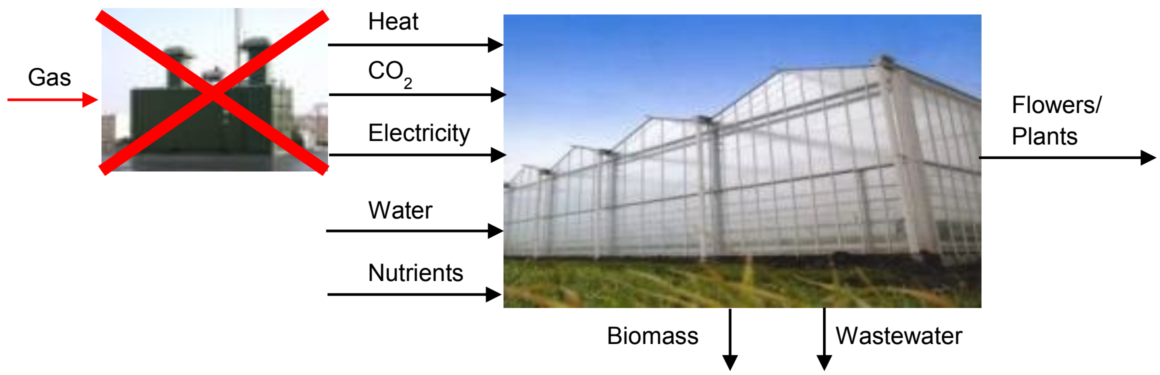

Figure 5: Simplified Resource Flow Scheme

1.4. Organization of Report

Chapter 2 will be the fundamental background of the report, the system assessment boundary, addressing the stakeholders involved, the future scenarios, and the optimization methodology. Chapter 3 will show the current resource usage and density for the greenhouse sectors in Greenport Aalsmeer. This information will be used for the optimization opportunities, presented in Chapter 4. Chapter 5 is all about the strategy for implementation, the stakeholders and next steps.

2. System Assessment

2.1. Stakeholders

Greenport Aalsmeer is a collaboration between two provinces, 7 municipalities, 6 branch organizations, a financial institution and a research institute. Key stakeholders are the co-operative auctioneering organization, FloraHolland, the Amsterdam Chamber of Commerce, LTO Noord Glaskracht (Dutch agriculture and horticulture advocacy organization), Naktuinbouw (Dutch General Inspection Service for horticulture), VGB (trade association), Blooming Breeders Foundation, Wellant College, Rabobank Regio Schiphol, and the municipalities of Aalsmeer, Amstelveen, Haarlemmermeer, Uithoorn, Kaag en Braassem, Nieuwkoop and the Province of North Holland.

One of the major stakeholders is the auction FloraHolland, an international co-operative organization comprised of growers, promotes their horticultural products. FloraHolland is positioned to have a profound impact on how flowers are grown, shipped and sold around the world. Sustainability is a key aspect to the long-term viability of the Dutch floriculture sector, given the international nature of flower production and marketing and its reliance on available natural resources, energy and labour.

FloraHolland is a co-operative sales organization of flowers, expanding a strong international trading platform with market places and sales support services.

For this project, 20 interviews were conducted with members of Greenport Aalsmeer, experts and other stakeholders of the Greenport (full list of interviewees is included in Appendix 6.1). Significant results from these stakeholder interviews are:

- **Sustainability = Energy**
  All stakeholders independently perceive sustainability as a huge opportunity for the sector to either lower costs of operations, boost the image of the sector and/or attract new businesses to the region. Interestingly, the majority of the stakeholders refer to “energy” instead of sustainability at large. Water and nutrient flows do not seem to be a problem for the sector.
- **Pragmatism and Realism**
  The past few years, sustainability has been on the agenda of the Greenport Aalsmeer, which has resulted in multiple projects, sessions, workshops and reports. There is enough information already available but, according to the stakeholders, no considerable action has been taken. Questions that did arise during the stakeholder interviews were: Who will invest? What are the risks? What is in it for me? Although there is little need for more technical information, there is a need for a pragmatic and realistic plan, including financial analyses.

Strategic investments and the risk assessments need to be prioritized and led. This report summarizes all existing data and provides a realistic framework.

- **Community Building**
  It is perceived that growers need to see each other more often to share best practises and built communities. When they convene, they usually wish to see other greenhouses, share ideas and cooperate. Some see politicians and branch organisations as decision makers who are too far away from practise and make decisions based on numbers and reports without being aware of greenhouse processes. It is furthermore expected that growers and companies who are in times of wealth should be the first to invest, rather than the growers who are struggling.

2.2. Future Scenarios

Before analysing the potentials for energy optimization, it is needed to analyse the future of the horticulture sector in the Aalsmeer region. What will the flower demand be in 2040? Will there still be a need for horticulture in the Netherlands in the future? With technologies as 3D printing and holograph pictures, why would anyone bother to have a real flower? A quick scan of the future scenarios suggests either long-term investments or quick wins in sustainability.

Figure 6: Possible Future Scenarios: Holograph Flowers (left), 3D Printer Flowers (middle) and Peer-to-peer Delivery of Flowers (right)

From stakeholder interviews it can be concluded that the demand for flowers will remain strong in the future and will not be replaced by artificial copies because of the:

- Intrinsic value of a living, natural object,
- Aesthetic and scent value, and
- Perceived enhancement of productivity and health

Despite this broad conclusion, the question is what are the trends and developments in the Netherlands? Figure 7 shows graphical representations of data from the Central

Institute of Statistics in the Netherlands (CBS) shows graphs of the number of horticulture companies and surface area of greenhouses in the seven municipalities in Greenport Aalsmeer. Although the information on the CBS database is usually outdated, the numbers show interesting trends:

- The greenhouse surface area decreases 3.6% per year on average
- Each year since 2000 on average 33 companies (7.2%) left the sector, which means that the surface area per company increases 3% due to mergers or take-overs
- In most areas (especially Aalsmeer, Amstelveen, Uithoorn and de Ronde Venen) there is a shift from flower production towards fruits and vegetables and tree nurseries.

If the trends continue, there will only be 37% of the greenhouses left in Greenport Aalsmeer area in 2040, which will then be run by a handful of large companies.

The same downfall can be seen in the annual statistics of the auction FloraHolland: Flower transactions (43,542 per day in Aalsmeer) are stable but the number of flowers sold in FloraHolland has been 6.5% lower in 2013 than in 2012. The profit of FloraHolland Aalsmeer has also declined by 4%[2].

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[2] Kengetallen 2013, FloraHolland

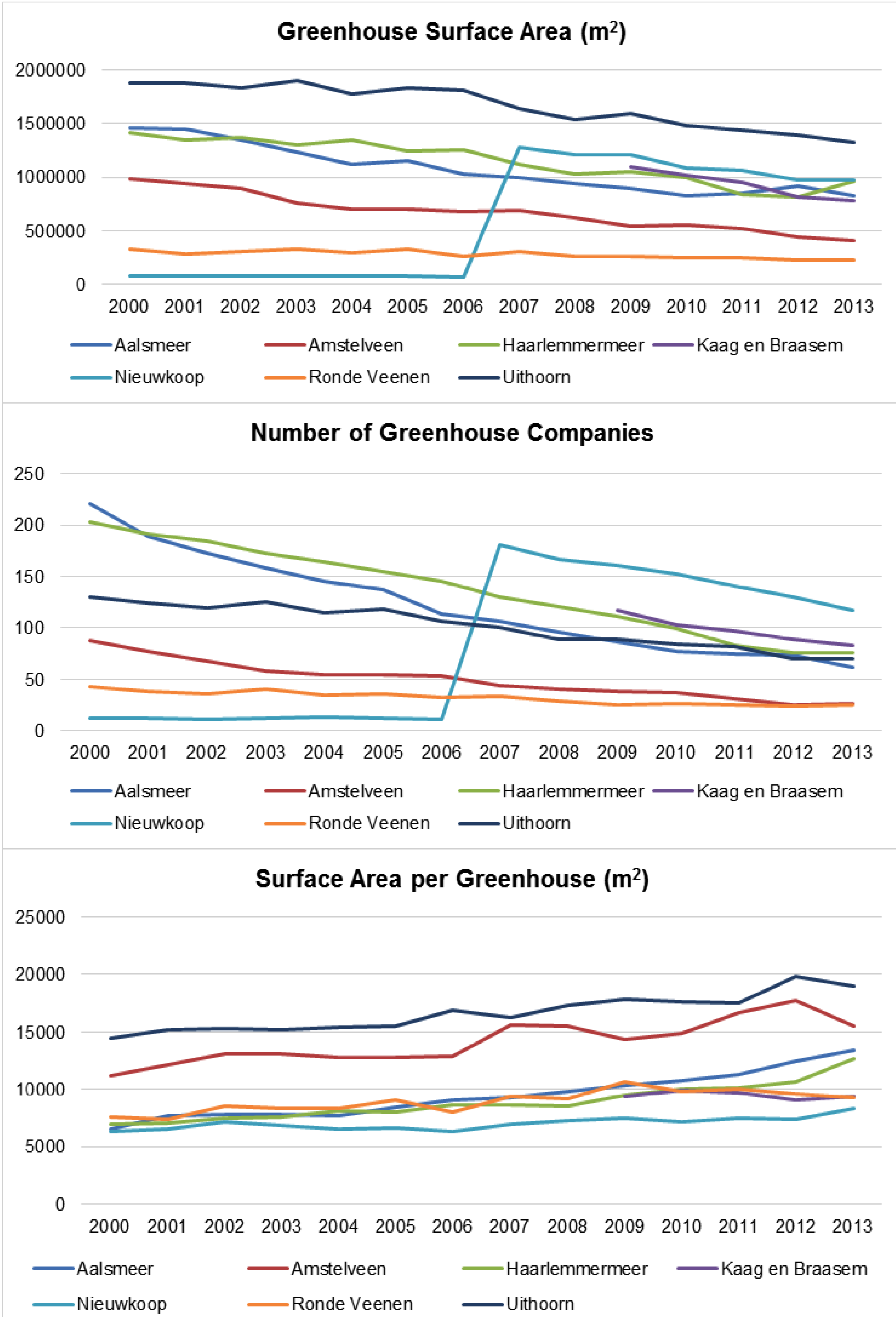

Figure 7: Greenhouse Statistics from the Netherlands Central Institute of Statistics

In conclusion, the floriculture sector in the Greenport Aalsmeer region is under pressure. Although the demand for flowers will remain, competition with growers in other countries is growing. The FloraHolland organization will still be a market leader in trading flowers, but might not be able to physically stay in Aalsmeer in the future. As can be seen in the problem statement in Chapter 1, the main reasons are e-commerce, high energy demands and costs (driven by the Dutch climate) and high labour costs.

Most stakeholder interviewees responded to this notion with the suggestion that the Greenport Aalsmeer region should focus on high quality niche markets and branding, such as how “Gouda Cheese” or “Champagne” have become branded for high quality. Ultimately, customers around the world would start asking for flowers from Greenport Aalsmeer.

From the information above, it can be concluded that the flower industry in Holland can be stabilized in the future. However, with the strong competition of other areas such as Airport A7 in North Holland, Greenport Aalsmeer needs to claim or reclaim its position in the market. Sustainability could be the key to this success. When branded correctly, the world will ask for flowers originated from Greenport Aalsmeer because they are produced responsibly and with high quality.

2.3. Methodology

The resource optimization maps are based upon the annual usage and density of 12 floriculture clusters surrounding Greenport Aalsmeer. The clusters are based upon the structural visions of the various municipalities and the provinces as well as the geographical location. Figure 8 below shows the clusters with the various commodities that are grown within each cluster. As shown by Figure 8, the 12 greenhouse clusters in Greenport Aalsmeer produce a wide variety of floricultural and agricultural products—from tulips to fruits and vegetables as well as temperate and tropical flowers. The wide variety of commodities produced by the greenhouse clusters requires sustainability solutions to be flexible and recognize the wide variety of growing conditions within each greenhouse cluster.

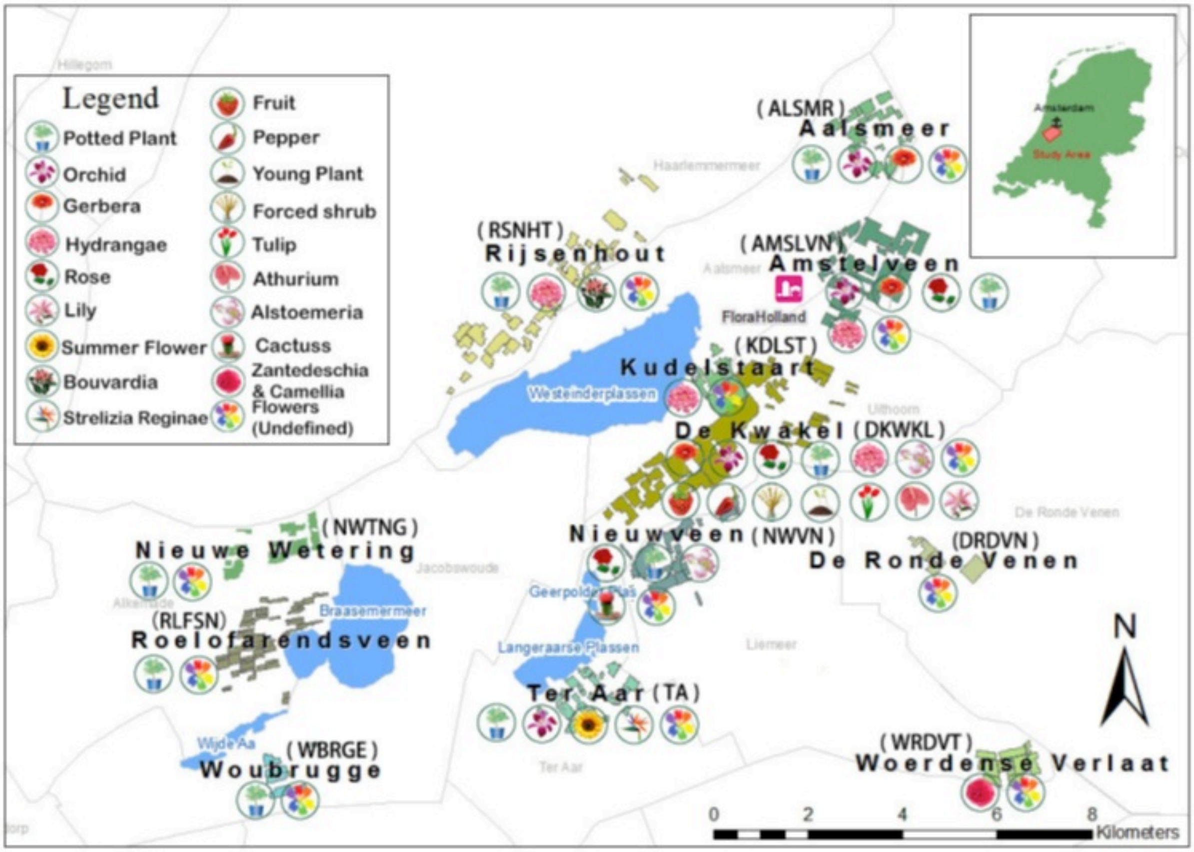

Figure 8: The 12 Greenhouse Clusters and their Commodity Production

3. Resource Demands

The maps contained in Chapter 3 show the current configuration of the 12 greenhouse clusters in the Greenport Aalsmeer floriculture system and their resource consumption. Inputs to the floriculture system include both required technical nutrients such as energy, in the form of natural gas and electricity, and plant nutrients such as carbon dioxide (CO_2), water, and fertilizers, mainly phosphorus (P) and nitrogen (N). Due to the small geographic footprint of the 12 greenhouse clusters, the transportation network is essential for getting flowers to the FloraHolland auction floors. The subsections of Chapter 3 are structured to show the current configuration with respect to resources consumed by the 12 greenhouse clusters—natural gas, electricity, CHP, energy costs, carbon dioxide, and water—and the nutrient discharges—nitrogen and phosphorus—from the greenhouses.

3.1. Natural Gas

Natural gas consumption varies widely across the greenhouse clusters, as shown in Figure 9, which also compares natural gas intensity of clusters. The De Kwakel greenhouses are the largest consumers of natural gas in the region, consuming 30,059,516 m^3 of natural gas in 2012, while the De Ronde Venen, Woerdense Verlaat, Woubrugge, and Kudelstaart greenhouses consumed around 10-times less natural gas during the same year. However, the intensity of natural gas consumption shows a different picture; the type and variety of plants grown by greenhouse clusters influence the per square meter consumption of natural gas. For example, clusters that grew a larger number of flower varietals and tropical (orchids, anthuriums, zantedeschias, and streltzia reginae) and desert plants (cactuses) had higher natural gas consumption intensities.

Natural gas combustion on-site is a major greenhouse-level contributor to global climate change. Since many of the commodities grown in Greenport Aalsmeer greenhouses are best suited for warmer temperatures, heating greenhouses in the winter creates a large demand for natural gas. The latest greenhouse gas (GHG) emissions inventory for the Netherlands reports the current CO_2 emissions factor for Dutch natural gas wells is 56.5 tonnes CO_2 per MJ of energy.[3] Results are broken down by greenhouse cluster in Table 1.

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[3] P.W.H.G. Coenen, C.W.M. van der Maas, P.J. Zijlema, E.J.M.M. Arets,K. Baas, A.C.W.M. van den Berghe, J.D. te Biesebeek, M.M. Nijkamp, E.P. van Huis, G. Geilenkirchen, C.W. Versluijs, R. te Molder, R. Dröge, J.A. Montfoort, C.J. Peek, J. Vonk. Greenhouse Gas Emissions in The Netherlands 1990-2012. National Inventory Report 2014. RIVM Report 680355016/2014.

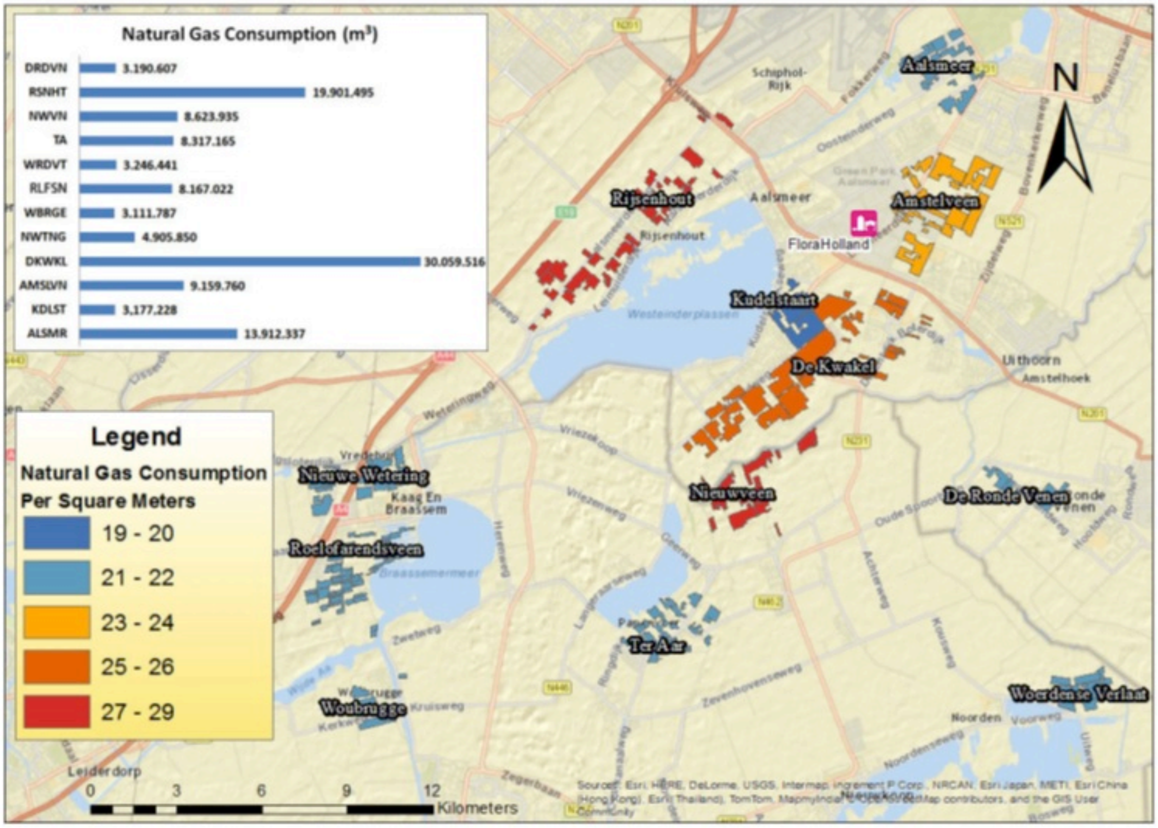

Figure 9: Natural Gas Consumption Intensity by Cluster (inset graph shows Total Annual Natural Gas Consumption)

Table 1: 2012 Carbon Dioxide Emissions from On-Site Natural Gas Combustion

Cluster	***Natural Gas Consumption (m^3)***	***CO_2 Emissions (tonnes)***
De Ronde Venen	3,910,607	8,424
Rijsenhout	19,901,495	42,873
Nieuwveen	8,623,935	18,578
Ter Aar	8,317,165	17,917
Woerdense Verlaat	3,246,441	6,994
Roelofarendsveen	8,167,022	17,594
Woubrugge	311,187	670
Nieuwe Wetering	4,905,850	10,568
De Kwakel	30,059,516	64,755
Amstelveen	9,159,760	19,732
Kudelstaart	3,177,228	6,845
Aalsmeer	13,912,337	29,971
TOTAL	***113,692,543***	***244,921***

3.2. Electricity

Consumption of electricity (Figure 10) across the clusters is dominated by the De Kwakel greenhouses. Electricity consumption in the cluster is twice as high (218,381,669 kWh) as the second biggest consumer of electricity, the Rijsenhout greenhouses (118,910,036 kWh). Similar to natural gas consumption, the De Ronde Venen, Woerdense Verlaat, Woubrugge, Kudelstaart greenhouses consumed the least amount of electricity. However, on a per square meter basis, 10 of the 12 greenhouse clusters consumed greater than 105 kWh per m^2 despite the large variation in overall consumption. The Kudelstaart and Woubrugge greenhouse clusters both consumed less than 105 kWh per m^2.

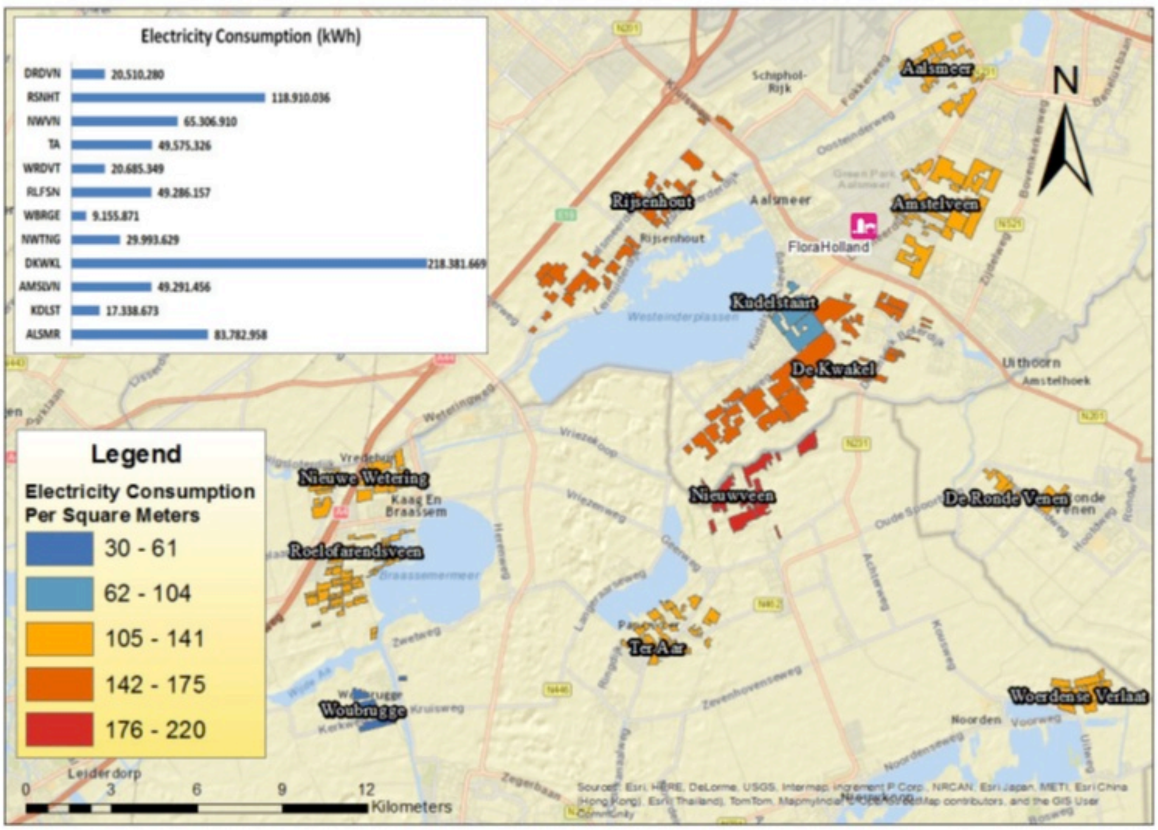

Figure 10: Electricity Consumption per square meter (inset graph shows Total Annual Electricity Consumption)

The Covenant of Mayors has calculated an emissions factor for electricity in its EU-wide Sustainable Energy Action Plan, which takes into account country-wide electricity production, exports, imports and green electricity credits. The calculated CO_2 emissions factor for electricity in the Netherlands is 0.435 tonnes CO_2 per MWh.[4] Using that emissions factor, the CO_2 emissions for the greenhouse clusters was 318,515 tonnes CO_2. Table 2 shows the results of this analysis by greenhouse cluster. A sustainable configuration of electricity consumption may include switching to alternative forms of electricity or generating electricity on-site with combined heat and power units that run on natural gas.

Table 2: Greenhouse Gas Emissions Electricity Consumption

Cluster	***Electricity Consumption (MWh)***	***CO_2 Emissions (tonnes)***
De Ronde Venen	20,510	8,922
Rijsenhout	118,910	51,726
Nieuwveen	65,307	28,409
Ter Aar	49,575	21,565
Woerdense Verlaat	20,685	8,998
Roelofarendsveen	49,286	21,439
Woubrugge	9,156	3,983
Nieuwe Wetering	29,994	13,047
De Kwakel	218,382	94,996
Amstelveen	49,291	21,442
Kudelstaart	17,339	7,542
Aalsmeer	83,783	36,446
TOTAL	***732,218***	***318,515***

3.3. Combined Heat and Power

The power used by greenhouses originates from one of two sources: the electricity grid or on-site generation from CHP generators. Figure 11 shows the distribution of power sources at each cluster. Greenhouse clusters with a higher fraction of energy coming from natural gas are more reliant on supplies of natural gas. Greenhouse clusters with a higher fraction of energy coming from electricity have a slightly more diversified energy portfolio; however, natural gas is the dominant energy source at each greenhouse cluster. Woubrugge is the most reliant (more than 75%) on natural gas. Nieuwveen and De Kwakel are least reliant on natural gas—less than 60% of the energy at these clusters is natural gas.

[4] Covenant of Mayors. Technical Annex of the SEAP Template Instructions Document: The Emissions Factors. URL: http://www.eumayors.eu/IMG/pdf/technical_annex_en.pdf.

Energy type influences the GHG emissions attributed to each greenhouse cluster. Table 3 shows the breakdown of energy sources for each cluster between electricity and natural gas, and the breakdown of energy-related GHG emissions for each cluster. Even though the majority of the greenhouse clusters utilize natural gas as their predominant energy source, the majority of energy-related GHG emissions result from electricity consumption. Therefore, greenhouse clusters that utilize more natural gas on-site as a heat source and for use in a CHP generator tend to have lower per area carbon footprint intensities. In total, 25 of the 81 greenhouse parcels studied had no electricity consumption, indicating that these greenhouses were powered entirely by CHP. However, the presence of CHP generators in a greenhouse cluster has no relation to greenhouse cluster carbon intensity (Table 4).

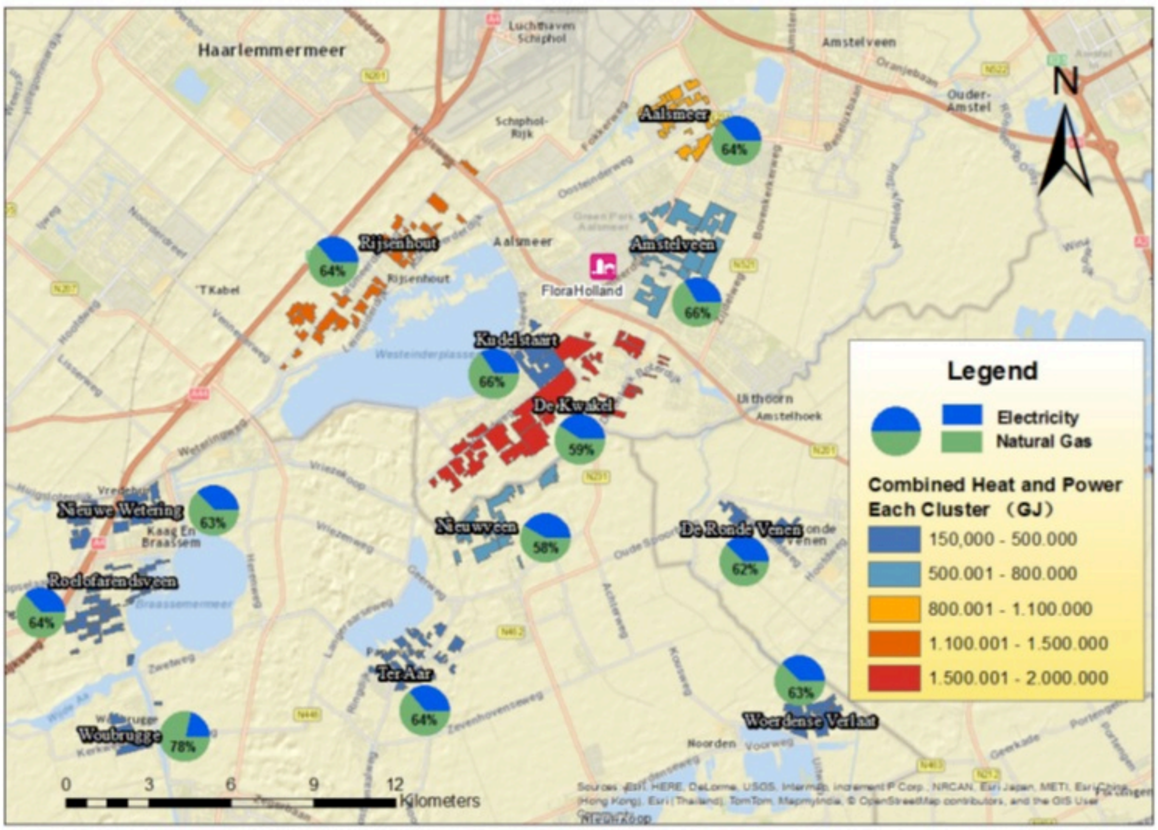

Figure 11: Distribution of Energy Sources at each Cluster

Table 3: Energy and Emissions Breakdown between Electricity and Natural Gas

Cluster	Energy From Electricity	Energy From Natural Gas	CO_2 Emissions From Electricity	CO_2 Emissions From Natural Gas	Tonnes CO_2 per m^2
De Ronde Venen	32%	68%	51%	49%	0.12
Rijsenhout	35%	65%	55%	45%	0.10
Nieuwveen	41%	59%	60%	40%	0.16
Ter Aar	35%	65%	55%	45%	0.10
Woerdense Verlaat	36%	64%	56%	44%	0.11
Roelofarendsveen	35%	65%	55%	45%	0.10
Woubrugge	73%	27%	86%	14%	0.03
Nieuwe Wetering	35%	65%	55%	45%	0.11
De Kwakel	40%	60%	59%	41%	0.13
Amstelveen	33%	67%	52%	48%	0.11
Kudelstaart	33%	67%	52%	48%	0.09
Aalsmeer	35%	65%	55%	45%	0.11

Table 4: The Carbon Intensity of the Greenhouse Clusters and the Number of Greenhouses with CHP Generators

Cluster	CO_2 tonnes per m^2	Greenhouses with CHP Generator
De Ronde Venen	0.12	0
Rijsenhout	0.10	4
Nieuwveen	0.16	2
Ter Aar	0.10	2
Woerdense Verlaat	0.11	1
Roelofarendsveen	0.10	1
Woubrugge	0.03	0
Nieuwe Wetering	0.11	1
De Kwakel	0.13	10
Amstelveen	0.11	1
Kudelstaart	0.09	1
Aalsmeer	0.11	1

3.4. Energy Costs

From the total electricity and gas usage of the greenhouse clusters, Table 5 shows the total energy costs for the growers.

Table 5: The Costs of Electricity and Natural Gas for each Cluster

Cluster	Electricity costs/year	Natural gas costs/year	Total energy costs/year
De Ronde Venen	€ 1,743,350	€ 1,994,410	€ 3,737,760
Rijsenhout	€ 10,107,350	€ 10,149,762	€ 20,257,112
Nieuwveen	€ 5,551,095	€ 4,398,207	€ 9,949,302
Ter Aar	€ 4,213,875	€ 4,241,754	€ 8,455,629
Woerdense Verlaat	€ 1,758,225	€ 1,655,685	€ 3,413,910
Roelofarendsveen	€ 4,189,310	€ 4,165,181	€ 8,354,491
Woubrugge	€ 778,260	€ 158,705	€ 936,965
Nieuwe Wetering	€ 2,549,490	€ 2,501,984	€ 5,051,474
De Kwakel	€ 18,562,470	€ 15,330,353	€ 33,892,823
Amstelveen	€ 4,189,735	€ 4,671,478	€ 8,861,213
Kudelstaart	€ 1,473,815	€ 1,620,386	€ 3,094,201
Aalsmeer	€ 7,121,555	€ 7,095,292	€ 14,216,847
TOTAL	**€ 62,238,530**	**€ 57,983,197**	**€ 120,221,727**

The costs for energy are based on the assumption that average electricity costs 8.5 eurocents per kWh and natural gas is 16 euro per GJ (both excluding BTW, and including energy taxes) based on data from CBS. The actual price varies between growers due to type of contract, tiered pricing, total demand and energy supplier.

The Table shows that the flower growers in Greenport Aalsmeer collectively spend more than 120 million euro per year on energy. These numbers could alternatively guide quick scans on the financial feasibility of renewable energy options.

3.5. Carbon Dioxide

Carbon dioxide is necessary for photosynthesis in plants. Consumption in the greenhouse clusters studied follows similar consumption patterns as natural gas and electricity. As shown in Figure 12, the larger greenhouse clusters tend to have higher overall consumption of carbon dioxide—De Kwakel consumes the largest volume of carbon dioxide on a yearly basis, followed by Rijsenhout. However, despite the wide ranging annual consumption, carbon dioxide intensity (per square meter) each of the greenhouse clusters is fairly narrow, between 0.98 and 1.28 metric tonnes of carbon dioxide per square meter per year. The Rijsenhout cluster has the highest per square meter carbon dioxide consumption and is the only cluster to have carbon dioxide consumption intensity greater than 1 metric ton per square meter. The majority of the greenhouse clusters have carbon dioxide consumption intensities between 0.99 and 1.00 metric tonnes carbon dioxide per square meter. At 0.98 metric tonnes of carbon dioxide consumed per square meter, the Kudelstaart greenhouse cluster has the lowest carbon dioxide consumption intensity.

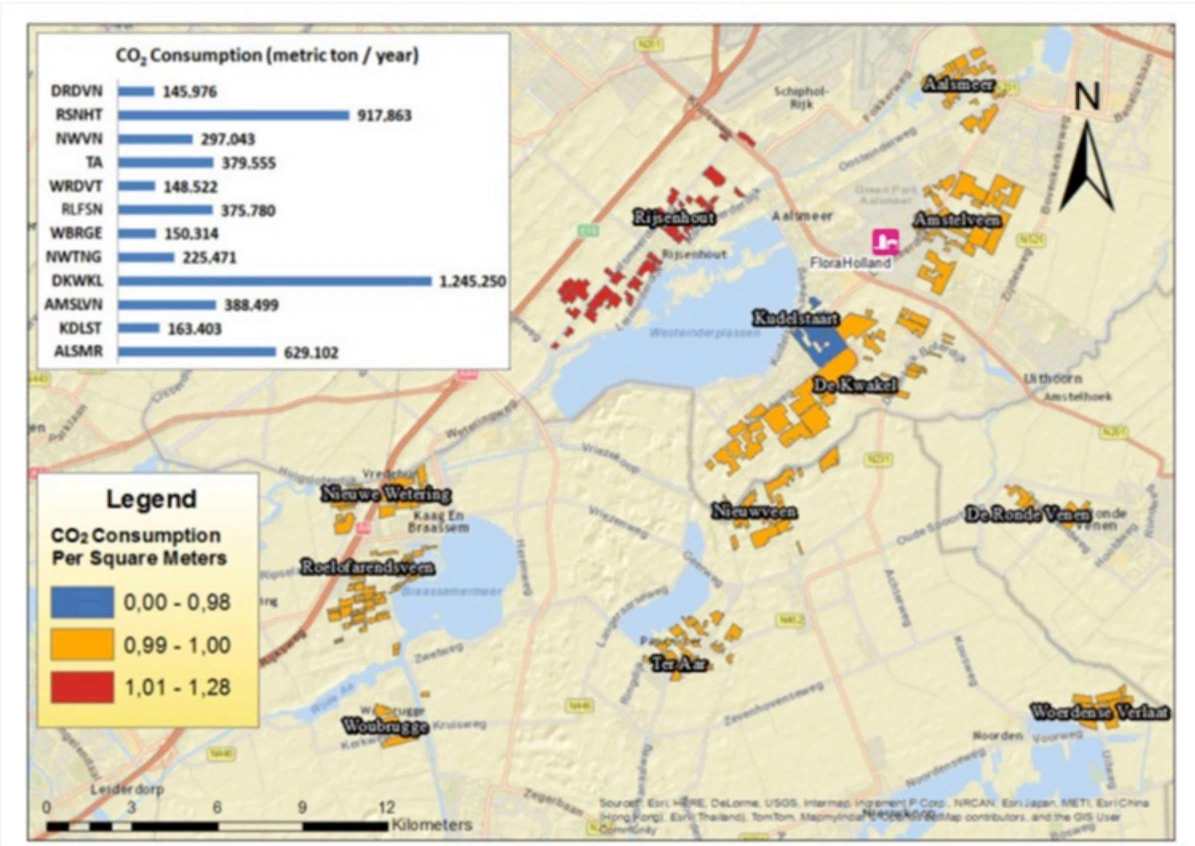

Figure 12: Carbon Dioxide Consumption per square meter (inset graph shows Total Annual Carbon Dioxide Consumption)

GHG emissions from electricity consumption and on-site natural gas combustion only show part of the greenhouse carbon dioxide balance. Greenhouses are both sources and sinks of greenhouse gases. Table 6 shows the cluster level GHG footprint with respect to electricity consumption, on-site natural gas combustion, and carbon dioxide consumption from the Organic Carbon Dioxide for Assimilation of Plants (OCAP) pipeline.

Table 6: Net Carbon Emissions from the Clusters

Cluster	CO_2 Emissions – Electricity and Natural Gas (tonnes)	CO_2 Consumption- (tonnes)	Net CO_2 Emissions (tonnes)
De Ronde Venen	17,346	145,976	(128,630)
Rijsenhout	94,598	917,863	(823,265)
Nieuwveen	46,987	297,043	(250,056)
Ter Aar	39,482	379,555	(340,073)
Woerdense Verlaat	15,992	148,522	(132,530)
Roelofarendsveen	39,033	375,780	(336,747)
Woubrugge	4,653	150,314	(145,661)
Nieuwe Wetering	23,616	225,471	(201,855)
De Kwakel	159,751	1,245,250	(1,085,499)
Amstelveen	41,174	388,499	(347.325)
Kudelstaart	14,387	163,403	(149,016)
Aalsmeer	66,416	629,102	(562,686)
TOTAL	***563,436***	***5,066,778***	***(4,503,342)***

3.6. Water

Water consumption per square meter is identical across the greenhouse clusters—0.35 m^3 water consumption per m^2. Water consumption at the cluster level becomes a function of its size; larger clusters consume more water than small clusters. Currently, captured rainwater provides sufficient water resources for the greenhouse clusters.

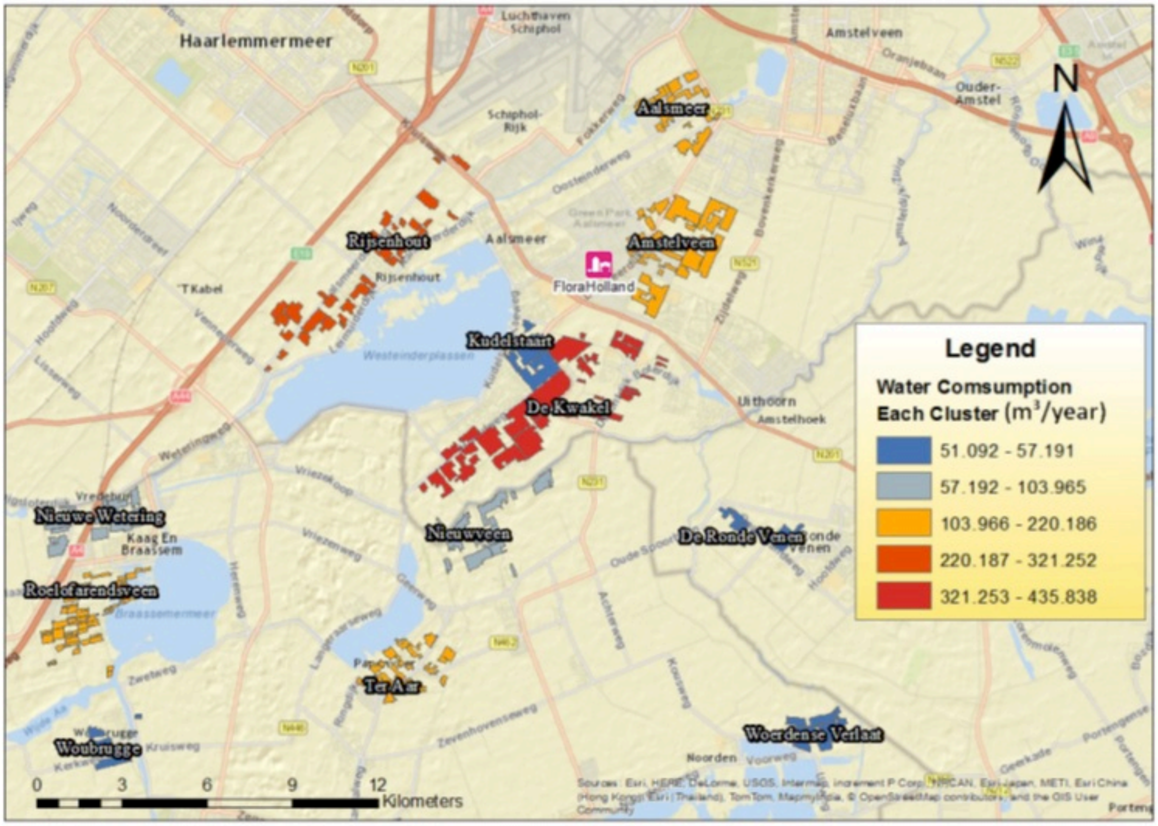

Figure 13: Water Consumption across the Clusters

3.7. Nutrient Discharge

The major nutrient discharges result from the application of nitrogen and phosphorus fertilizers. The maps below show total nitrogen and phosphorus for the study year. Data was only known about the nutrient content of effluent discharges. The effluent discharges represent potential recoverable nutrients that could be reused in greenhouse processes after treatment.

At the greenhouse cluster level, nutrient discharges are a function of the type of plant grown in the cluster. Plant-level nutrient discharges are shown in Figures 13 (for nitrogen discharge) and 14 (for phosphorus discharge) and Table 7.

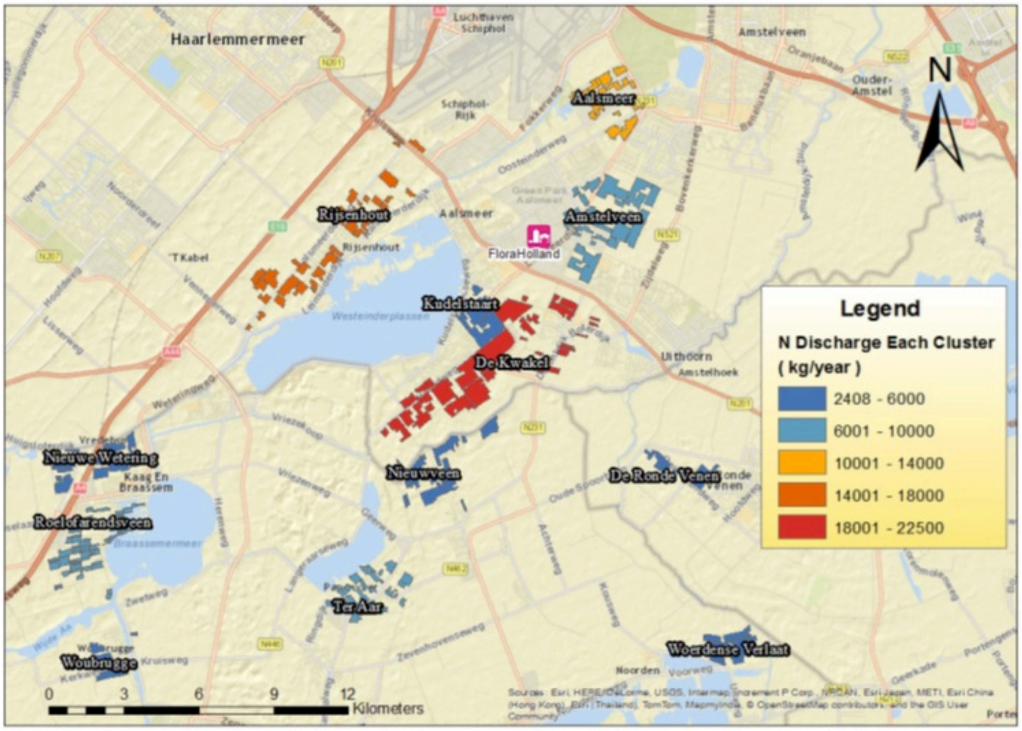

Figure 14: Nitrogen Discharge from Clusters

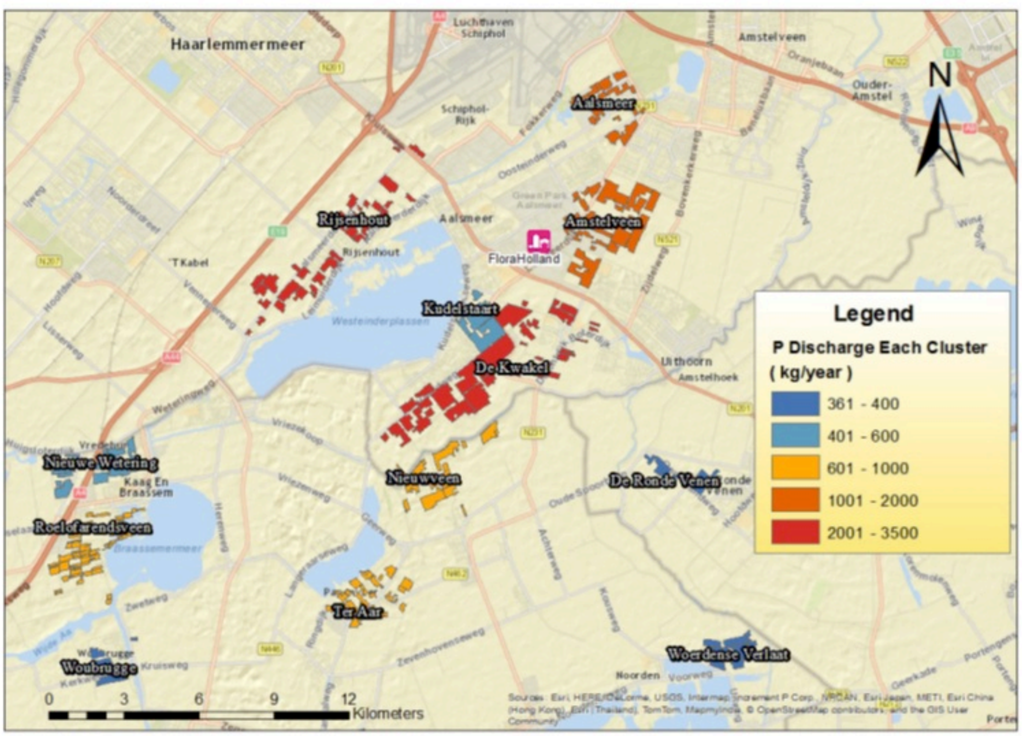

Figure 15: Phosphorus Discharge from Clusters

Table 7: Annual Nutrient Discharge by Flower Type

Flower Type	Land Use (m^2)	N Discharge Per Area (g N/y/m^2)	P Discharge Per Area (g P/y/m^2)	N Discharge Per Area (kg N/y)	P Discharge Per Area (kg P/y)
Anthurium	34,000	5.00	0.75	170	26
Astroemia	13,000	15.63	2.34	203	30
Bouvardia	21,000	15.63	2.34	328	49
Cactusses	20,000	15.63	2.34	313	47
Cutting Hydrangea	76,200	15.63	2.34	1,191	179
Flowers (Undefined)	2,912,458	17.70	2.65	51,553	7,728
Forced Shrub	5,900	15.63	2.34	92	14
Fruits/Vegetables	92,000	2.50	0.38	230	35
Gerbera	182,000	2.00	3.75	4,550	683
Hortensia	11,000	15.63	2.34	172	26
Hydrangae	40,000	15.63	2.34	625	94
Lilies	17,000	15.63	2.34	266	40
Orchids	286,000	18.80	2.81	5,377	804
Potted Plants	680,720	15.00	2.25	10,211	1,532
Potted Plants/Alstoemeria	15,000	15.00	2.25	225	34
Roses	258,000	25.00	3.75	6,450	968
Roses/Gebera/Young Plants	78,000	25.00	3.75	1,950	293
Roses/Potted Plants	80,000	15.00	2.25	1,200	180
Strelitzia Reginae	2,000	15.63	2.34	31	5
Summer Flowers	3,200	15.63	2.34	50	7
Tulips	20,000	15.63	2.34	313	47
Vegetables (Peppers)	118,000	20.00	3.00	2,360	354
Young Plants	22,000	15.63	2.34	344	52
Zantedeschia and Camellia	1,300	15.63	2.34	20	3

4. Resource Optimization

Chapter 4 maps out potential sustainable scenarios for Greenport Aalsmeer greenhouse clusters focusing on optimizing resource. Resource scenarios were developed for natural gas use, carbon dioxide consumption, nutrient discharges, and the transportation network surrounding Greenport Aalsmeer.

As shown in Figure 11, the predominant energy source for the greenhouse clusters in the study area is natural gas. Natural gas provides over half the energy demanded by the greenhouse clusters; in some cases, that fraction is over three-quarters. Given the prominent role that natural gas plays in powering the greenhouse clusters, several future scenarios of natural gas use were developed.

4.1. Future Greenhouse Area Planning

This project on resource optimization is a project of the working group ‘sustainability’ of Greenport Aalsmeer. In parallel, the project team ‘space’ of Greenport Aalsmeer has conducted a study on the future area planning of floriculture. There is a strong relation between the potential of resource optimization and the feasibility of greenhouses to be planned in a certain area. For instance, a close distance to the Amsterdam heat net or carbon pipeline can be beneficial to create critical mass, while a more remote location could force the grower to be more autonomous. Information has been exchanged from both studies in order to tune the results and recommendations.

The results of the area planning study show that there will probably be a shift in the greenhouse clusters. Some of them will probably decrease in size (Aalsmeer, Ter Aar) while others have space and opportunity to grow (Rijsenhout, Nieuwveen), as shown in Table 8.

Table 8: Projected Greenhouse Space (as predicted by Project Team "Space")

Cluster	**Current Hectares *(CBS data)***	**Future Hectares *(Project Team 'Space')***
Aalsmeer	63	35
Amstelveen	39	60
De Kwakel	125	206
De Ronde Venen	15	26
Roelofarendsveen	38	39
Kudelstaart	16	25
Nieuwe Wetering	23	44
Nieuwveen	30	51
Rijsenhout	92	70
Ter Aar	38	0
Woerdense Verlaat	15	0
Woubrugge	15	21
TOTAL	**509 ha**	**577 ha**

Woerdense Verlaat is a cluster that will most likely be remediated. Currently, there is only 1 hectare still in operation. For this study, this data is therefore outdated. Within this report, there will be no recommendations for resource optimization for Woerdense Verlaat. Ter Aar is a cluster that, according to the study of WB Ruimte, Agrimaco and Terra Incognita, will be marked as transformation area where in the future no investments for the greenhouse sector will be made.

It should be kept in mind that growth of greenhouse surface will have an impact on the overall carbon footprint of the sector. This is why the area planning project focuses on clustering, intensification and sustainability as key conditions for new areas. With this in mind, the extension of Rijsenhout seems more likely than the growth of Nieuwveen as a new sustainable greenhouse cluster.

4.2. Amsterdam District Heating Network

District heating is a potential source of heating for the greenhouse clusters that can offset natural gas consumption. However, at the moment, the Amsterdam district heating network does not extend to the region of the greenhouse clusters studied. In Figure 16, the southern extent of the Amsterdam district heating network ends just to the northeast of the Greenport Aalsmeer region. Given the close proximity of the district heating network, there is potential for extending this heating source to reach the greenhouses.

Another potential source of heat is the future data center to be built near the Rijsenhout cluster. Heat from the data center could be easily piped to the Rijsenhout cluster, but the location of the future data center prohibits from being a viable heat source for other greenhouse clusters.

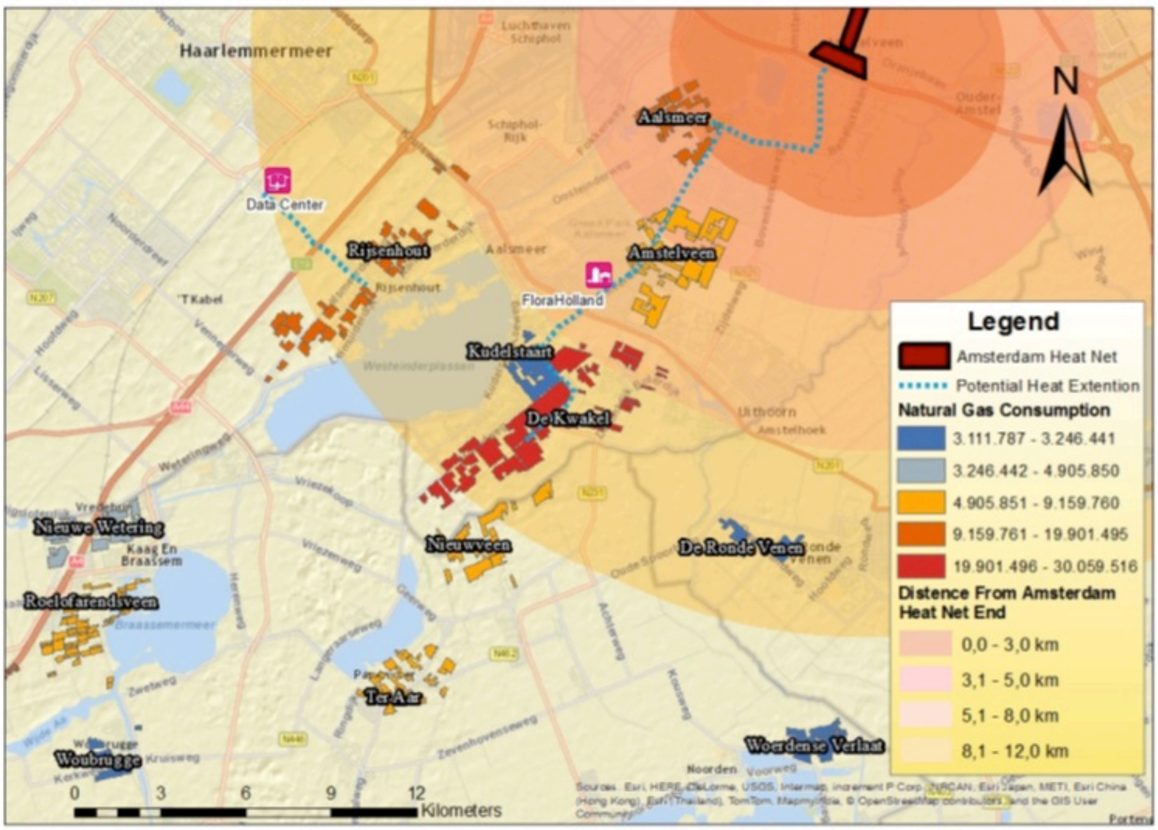

Figure 16: Proximity of the Clusters to Southern District of the Amsterdam District Heating Network (dashed lines are potential extensions)

Figure 16 shows the distance that the greenhouses are from the Amsterdam district heating network. The Aalsmeer, Amstelveen, Kudelstaart and De Kwakel greenhouse clusters are within 12 kilometres from where the district heating network ends. Figure 17 shows the data center in relation to the greenhouse clusters as well as the most probable route to extend the Amsterdam district heating network to the growing center of the greenhouse clusters between Kudelstaart and De Kwakel. Extending the southern district of the Amsterdam heat network to the south down into the De Kwakel/Kudelstaart clusters and piping heat from the proposed data center to Rijsenhout could potentially benefit other businesses and residents along these heat corridors. This approach also aligns with the national sustainable energy and greenhouse gas reductions plans.

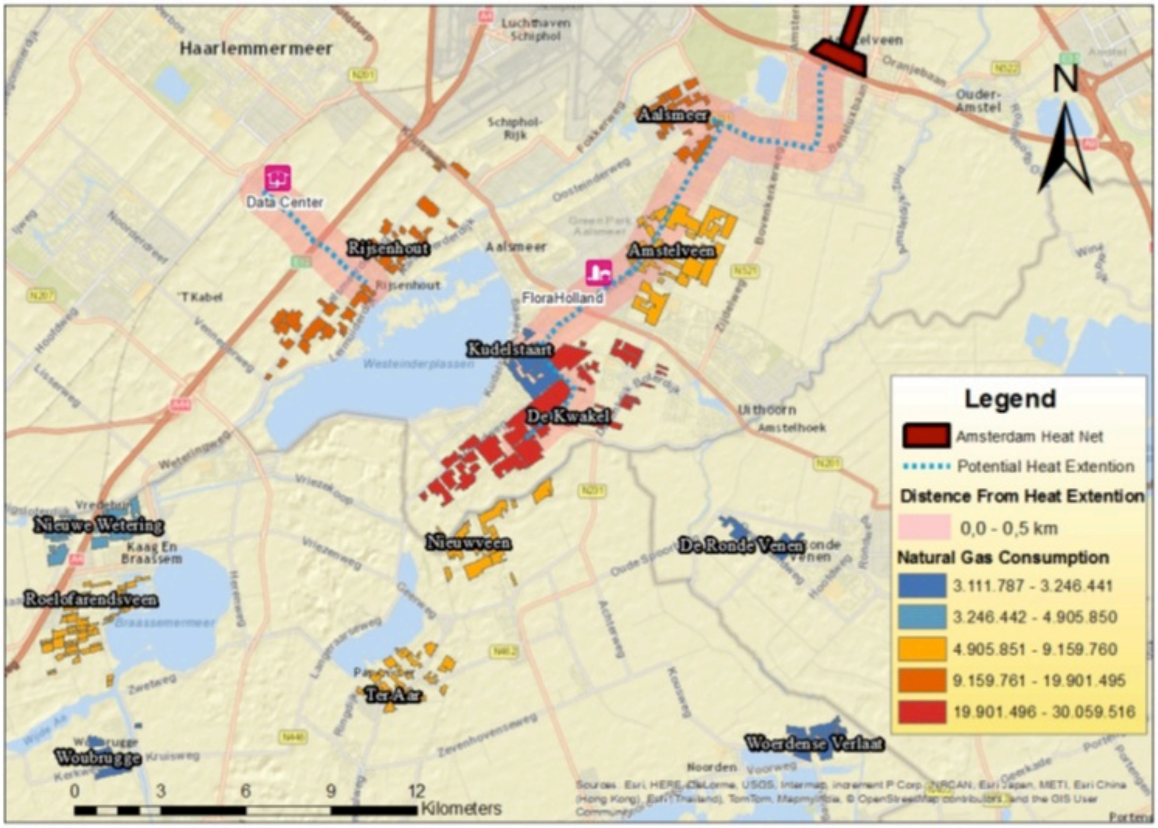

Figure 17: Potential Extended Heat Networks to the Clusters

Extending the Amsterdam district heat network and data center heat source to cover all greenhouse clusters has the potential to reduce 64,932,776 cubic meters of natural gas usage, resulting in a potential market for the heat net investors of around €33 million per year, depending on the price of natural gas.

4.3. Geothermal Energy

Geothermal energy is another potential source of heat for the greenhouse clusters. The ThermoGIS[5] application created by TNO was used to map the current technical geothermal potential in the study area. The area surrounding Greenport Aalsmeer currently has an unknown theoretical potential for energy potential due to a lack of exploration in the area.

However, the current state of knowledge on the technical potential of geothermal energy in the area shows the highest geothermal potential for greenhouse clusters in the southeast of the study area—Nieuwe Wetering, Roelofarendsveen, and Woubrugge, as shown in Figure 18.

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[5] ThermoGIS data is based on a series publications on the geothermal potential of the Netherlands:

1. D. Bonté, J.-D. van Wees & J.M. Verweij. Netherlands Journal of Geosciences — Geologie en Mijnbouw, 91–4, 491-515, 2012.
2. L. Kramers, J.-D. van Wees, M.P.D. Pluymaekers, A. Kronimus & T. Boxem. Netherlands Journal of Geosciences — Geologie en Mijnbouw, 91–4, 637-649,2012.
3. M.P.D. Pluymaekers, L. Kramers, J.-D. van Wees, A. Kronimus, S. Nelskamp, T. Boxem & D. Bonté. Netherlands Journal of Geosciences — Geologie en Mijnbouw, 91–4, 621-636, 2012.
4. J.-D. van Wees, A. Kronimus, M. van Putten, M.P.D. Pluymaekers, H. Mijnlieff, P. van Hooff, A. Obdam & L. Kramers. Netherlands Journal of Geosciences — Geologie en Mijnbouw, 91–4, 651-665, 2012.

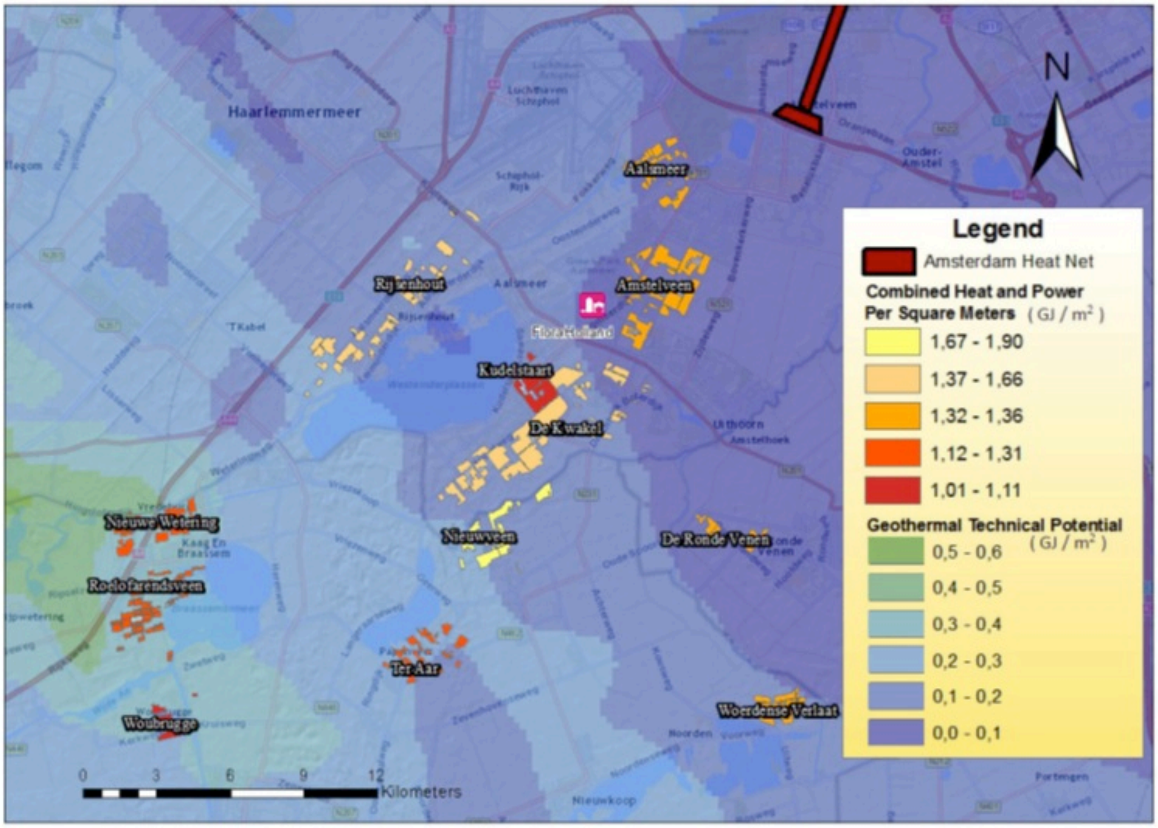

Figure 18: Technical Geothermal Potential of the Study Area as calculated by TNO

The underlying geothermal energy has the technical potential to offset 30% of their total current energy demand, for both electricity and natural gas, as summarized in Table 9. Developing geothermal energy resources for these three greenhouse clusters would reduce the annual greenhouse gas emissions in the study area by 7%.As more knowledge about the geothermal energy reserves in the study area is gained, geothermal energy may become a more viable energy option for the greenhouse clusters. Geothermal energy could be used to power CHP generators and dramatically reduce the GHG emissions that result from greenhouse management.

Table 9: Fraction of Total Energy Demand that could be offset by Geothermal Energy

Cluster	Energy Demand (GJ per m^2)	Technical Geothermal Potential (GJ per m^2)	Current Potential Offset (%)
De Ronde Venen	1.58	0.1	6%
Rijsenhout	1.33	0.1	7%
Nieuwveen	1.95	0.2	10%
Ter Aar	1.35	0.2	15%
Woerdense Verlaat	1.38	0.1	7%
Roelofarendsveen	1.34	0.4	30%
Woubrugge	1.01	0.3	30%
Nieuwe Wetering	1.35	0.4	30%
De Kwakel	1.60	0.1	6%
Amstelveen	1.40	0.1	7%
Kudelstaart	1.16	0.1	9%
Aalsmeer	1.36	0.1	7%

4.4. Carbon Pipeline

The OCAP pipeline holds the potential to be a long-term sustainable source of carbon dioxide for the clusters. Figure 19 shows the current path of the OCAP pipeline as it traverses the study area. The greenhouse clusters in the Kaag en Braassem municipality have the greatest potential to immediately access the OCAP pipeline. As the OCAP pipeline enters the Kaag en Braassem municipal area, the pipeline is adjacent to the Nieuwe Wetering and Roelofarendsveen greenhouse clusters and less than 5 km from the Woubrugge greenhouse clusters. While many of the greenhouse clusters in the study area do not have direct access to the OCAP pipeline, the planned extension to the Rijsenhout greenhouse cluster could provide the necessary carbon dioxide for this cluster also.

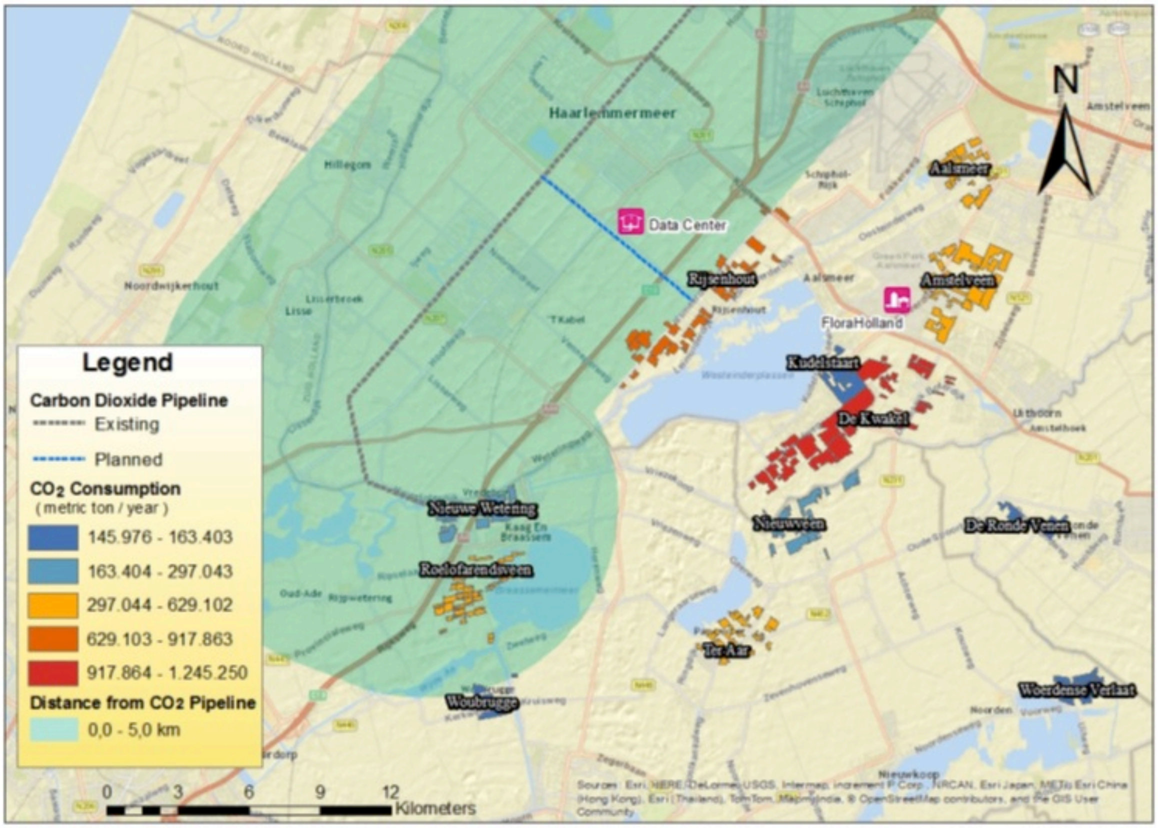

Figure 19: Distances of Clusters from the OCAP Pipeline

4.5. Water

Water for the greenhouse clusters is sourced from harvested rainwater from greenhouse roofs. On average, the greenhouse clusters consume 0.35 cubic meters of water per square meter of greenhouse space. The rainfall intensity in the region is on average 0.84 cubic meters of water per square meter. Given current levels of water consumption and rainfall, harvested rainwater should be an adequate source of water for the greenhouses into the future. Under current climate change projects, the precipitation in the study area is projected to increase slightly, so rainwater will be a continued reliable water source for all of the greenhouse clusters.[6]

[6] IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

4.6. Nutrients

Nutrient discharges from the greenhouse clusters have the potential to be reprocessed for use as fertilizers. Reprocessing effluent to harvest nutrients could provide a new source of revenue for the growers. Phosphorus has the potential to be limited globally in the future.[7] The process for manufacturing nitrogen is highly energy intensive and could be subject to price fluctuations in the future depending on the price of electricity.[8]

The economic potential of nutrient recovery was calculated for three fertilizers: diammonium phosphate (DAP), triple superphosphate (TSP), and urea. Prices for calculating economic potential were based on the latest market price of fertilizer in the European markets from IndexMundi.com. The market price used for DAP is €373.67 per ton; TSP for €318 per ton; and urea for €252.64. Since phosphorus discharges were much lower than nitrogen discharges, the economic potential of DAP recovery was calculated based on annual phosphorus discharges.

Tables 10, 11, and 12 show the economic potential of nutrient recovery based on the market prices of these major fertilizers. While phosphorus has the highest potential to become a limiting nutrient due to worldwide market dynamics and physical supply, the nitrogen recovery has the highest economic potential. Since nitrogen discharges are heavily regulated by EU Directives[9], recovering nitrogen for reuse has the additional potential benefit of reducing regulatory burden.

DAP and urea would not be precipitated from greenhouse effluent discharges, rather struvite ($MgNH_4PO{\cdot}6H_2O$) or hydroxyapatite ($Ca_5(PO_4)_3OH$) would be the mineral fertilizers precipitated from greenhouse effluent.[10] However, since there is not a reliable market price for recovered struvite or hydroxyapatite, urea and DAP were used as proxies to determine the economic potential of recovered nutrients. Further, because nitrogen-bearing struvite has a 1:1 molar ratio of nitrogen to phosphorus, phosphorous would still be the limiting constituent for nutrient recovery. Calcium, in the form of lime ($CaCO_3$), and magnesium, in the form of magnesium chloride ($MgCl_2$), would be potentially key inputs for nutrient recovery from greenhouse effluent because phosphate

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[7] Cordell, Dana, and Stuart White. "Peak phosphorus: clarifying the key issues of a vigorous debate about long-term phosphorus security." *Sustainability* 3.10 (2011): 2027-2049.
[8] Smil, Vaclav. "Global population and the nitrogen cycle." *Scientific American*277.1 (1997): 76-81.
[9] Reference to the EU Nitrates Directive of 1991, which was created to reduce nitrogen pollution in European waterways and to reduce the potential for eutrophication in freshwater and coastal estuaries.
[10] Yi, Wei-Gang, and Kwang Victor Lo. "Phosphate recovery from greenhouse wastewater." *Journal of Environmental Science and Health, Part B* 38.4 (2003): 501-509.

removal efficiency and the composition of the precipitate, whether struvite or hydroxyapatite is formed, is dependent on Ca/Mg ratios and N/P ratios.[11]

Table 10: Potential Market Value from Recovering P (based on the Market Price of DAP)

Cluster	P Discharge	100% Recovery	75% Recovery	50% Recovery	25% Recovery	10% Recovery
Aalsmeer	1,738.52	€ 2,770	€ 2,078	€ 1,385	€ 693	€ 277
Kudelstaart	421.17	€ 671	€ 503	€ 336	€ 168	€ 67
Amstelveen	1,108.60	€ 1,767	€ 1,325	€ 883	€ 442	€ 177
De Kwakel	3,353.36	€ 5,344	€ 4,008	€ 2,672	€ 1.336	€ 534
Nieuwe Wetering	593.42	€ 946	€ 709	€ 473	€ 236	€ 95
Woubrugge	361.12	€ 575	€ 432	€ 288	€ 144	€ 58
Roelofarendsveen	987.00	€ 1,573	€ 1,180	€ 786	€ 393	€ 157
Woerdense Verlaat	393.68	€ 627	€ 470	€ 314	€ 157	€ 63
Ter Aar	990.56	€ 1,578	€ 1,184	€ 789	€ 395	€ 158
Nieuwveen	674.82	€ 1,075	€ 806	€ 538	€ 269	€ 108
Rijsenhout	2,398.95	€ 3,823	€ 2,867	€ 1,911	€ 956	€ 382
De Ronde Venen	387.33	€ 617	€ 463	€ 309	€ 154	€ 62
Regional Potential	**13,408.53**	**€ 21,366**	**€ 15,562**	**€ 10,375**	**€ 5,187**	**€ 2,075**

Table 11: Potential Market Value from Recovering P (based on the Market Price of TSP)

Cluster	P Discharge	100% Recovery	75% Recovery	50% Recovery	25% Recovery	10% Recovery
Aalsmeer	1,738.52	€ 2,090	€ 1,567	€ 1,045	€ 522	€ 209
Kudelstaart	421.17	€ 506	€ 380	€ 253	€ 127	€ 51
Amstelveen	1,108.60	€ 1,333	€ 999	€ 666	€ 333	€ 133
De Kwakel	3,353.36	€ 4,031	€ 3,023	€ 2,015	€ 1,008	€ 403
Nieuwe Wetering	593.42	€ 713	€ 535	€ 357	€ 178	€ 71
Woubrugge	361.12	€ 434	€ 326	€ 217	€ 109	€ 43
Roelofarendsveen	987.00	€ 1,186	€ 890	€ 593	€ 297	€ 119
Woerdense Verlaat	393.68	€ 473	€ 355	€ 237	€ 118	€ 47
Ter Aar	990.56	€ 1,191	€ 893	€ 595	€ 298	€ 119
Nieuwveen	674.82	€ 811	€ 608	€ 406	€ 203	€ 81
Rijsenhout	2,398.95	€ 2,884	€ 2,163	€ 1,442	€ 721	€ 288
De Ronde Venen	387.33	€ 466	€ 349	€ 233	€ 116	€ 47
Regional Potential	**13,408.53**	**€ 16,117**	**€ 12,088**	**€ 8,058**	**€ 4,029**	**€ 1,612**

[11] Yi, Weigang, et al. "The effects of magnesium and ammonium additions on phosphate recovery from greenhouse wastewater." *Journal of Envirnomental Science and Health* 40.2 (2005): 363-374.

Table 12: Potential Market Value from Recovering N (based on the Market Price of Urea)

Cluster	N Discharge	100% Recovery	75% Recovery	50% Recovery	25% Recovery	10% Recovery
Aalsmeer	11,597	€ 6,284	€ 4,713	€ 3,142	€ 1,571	€ 628
Kudelstaart	2,810	€ 1,523	€ 1,142	€ 761	€ 381	€ 152
Amstelveen	7,405	€ 4,013	€ 3,009	€ 2,006	€ 1,003	€ 401
De Kwakel	22,363	€ 12,119	€ 9,089	€ 6,059	€ 3,030	€ 1,212
Nieuwe Wetering	3,959	€ 2,145	€ 1,609	€ 1,073	€ 536	€ 215
Woubrugge	2,408	€ 1,305	€ 979	€ 653	€ 326	€ 131
Roelofarendsveen	6,584	€ 3,568	€ 2,676	€ 1,784	€ 892	€ 357
Woerdense Verlaat	2,626	€ 1,423	€ 1,067	€ 712	€ 356	€ 142
Ter Aar	6,609	€ 3,581	€ 2,686	€ 1,791	€ 895	€ 358
Nieuwveen	4,497	€ 2,437	€ 1,828	€ 1,218	€ 609	€ 244
Rijsenhout	16,003	€ 8,672	€ 6,504	€ 4,336	€ 2,168	€ 867
De Ronde Venen	2,584	€ 1,400	€ 1,050	€ 700	€ 350	€ 140
Regional Potential	**89,444**	**€ 48,471**	**€ 35,303**	**€ 23,535**	**€ 11,768**	**€ 4,707**

4.7. Decentralized Options

These innovative, decentralized energy saving and energy producing options are available for individual greenhouses, dependant on the size (glass surface) and commodity (type of flower) of the specific grower. The options below will never be a complete or sole solution, but is an overview of the possibilities that are already used or going to be used within Greenport Aalsmeer and have the potential to be more widely used.

4.7.1. Fresnel Lenses

Fresnel lenses (shown in Figure 20) are a type of concentrated solar panels. Instead of using mirrors for concentrating the solar energy to one focal point, the light is centered to a point behind the lens. These lenses do not affect the diffused light, which means that sunlight still enters the greenhouse. Wageningen University is piloting these models in Bleiswijk to either produce electricity (by installing a photovoltaic panel behind the lens) or heat a heat-absorbing fluid to create steam for a turbine. This technology will generate 1,350 MJ/m^2 and will cost approximately €66 per GJ.[12]

[12] P.J. Sonneveld, G.L.A.M. Swinkels, B.A.J. van Tuijl, H.J.J. Janssen and T.H. Gieling Wageningen UR Greenhouse Horticulture, 2011

Figure 20: Fresnel Lenses

4.7.2. Decentralized Bio-fermentation Plant

In lieu of composting, organic waste streams can be anaerobically (no oxygen) fermented in large closed silos to generate biogas (shown in Figure 21). The process is technically applicable on different scales, varying from one greenhouse to a complete region. The feedstock can also be augmented with other sources of local biomass (organic waste and wet biomass as manure, roadside grass, etc.). De Meerlanden in Rijsenhout has a medium-large version of a fermentation plant, which provides approximately 3 million cubic meters of biogas per year. Smaller installations are available through a small local start-up company, the Waste Transformers. The cost of such a plant is approximately €18 per GJ of energy production, which can further decrease if subsidies such as SDE+ are available.

Figure 21: Decentralized Bio-fermentation Plant

4.7.3. Heat Exchange with Aquifers

The marine climate in the Netherlands is perfectly suitable for seasonal heat storage in underground aquifers, as shown in Figure 22. The Dutch outside temperature fluctuates between 21°C in summer and 1°C in winter. The storage of the excess heat in summer for the winter times can radically reduce energy demand. This seasonal storage can take place within water-bearing formations below surface. Most of the time, a closed system is used. The fluid that runs through the greenhouse and the water inside the aquifer are physically separated. Between those two systems, a heat exchanger is installed that not only exchanges energy, but also boosts the heat value. A heat exchanger does however need electricity, and so does the pumping system. Although, this is not a completely self-supporting system, there is more energy saved by not having to heat and cool the greenhouse. For a typical greenhouse, the energy saved per square meter per year is about 700 MJ (35%) energy saving with a payback time of about 6 year.[13]

[13] Dekkers, F. Sustainable Area Development in Haarlemmermeer, 2009

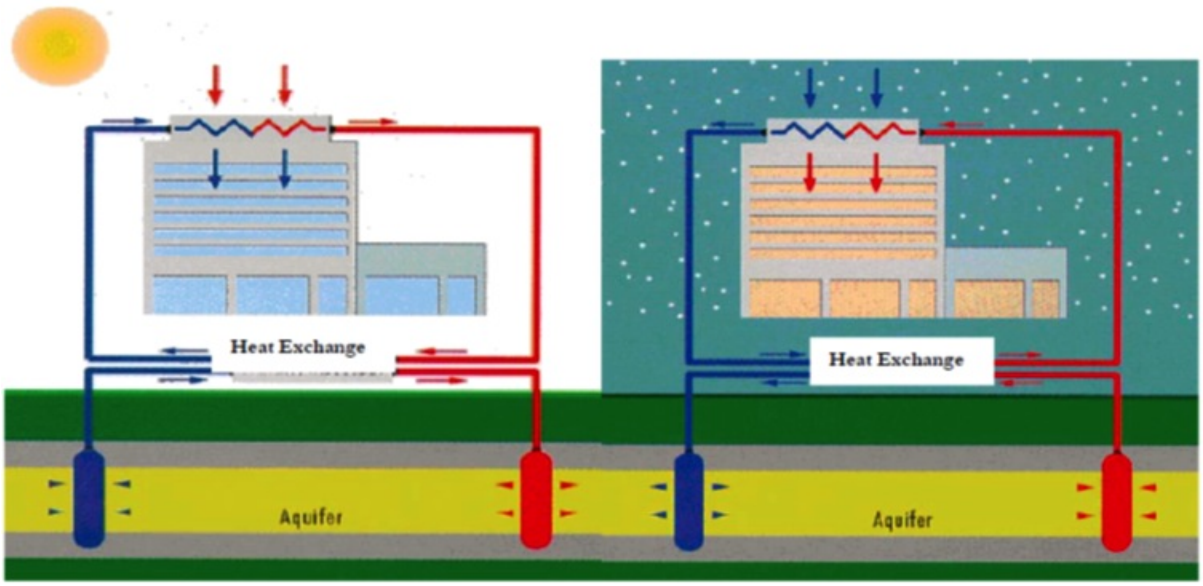

Figure 22: Heat Exchange with Aquifers

This system can also be cascaded, where surplus heat of the greenhouses is transported to nearby offices and residences. Unfortunately, in order to capture this surplus energy within greenhouses, the greenhouses themselves would have to be modified. New greenhouses should be built with a 'closed' concept, which means that the roof and the walls should only allow sunlight in, but no air – and heat – out. When doing so, the average temperature of the greenhouse would be as shown in Figure 23. The surplus energy in summer is more than the minimal required energy in winter. The surplus heat from one hectare of greenhouses that is stored in summer can be enough to supply the heat demand of 100 households[14].

[14] Kas als energiebron, *'Innovatieagenda tot en met 2012, EnergieTransitie - Creatieve Energie'*, 2009

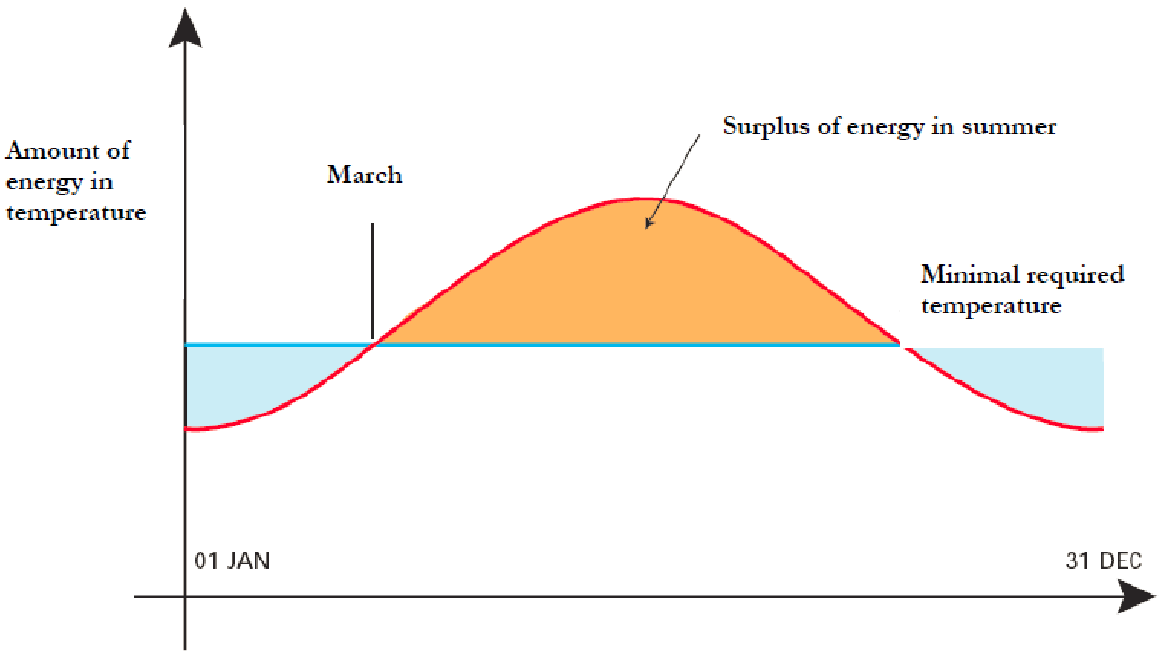

Figure 23: Surplus Energy of a Closed Greenhouse System

4.7.4. Collective Solar PV cells

Although buying solar PV cells is a feasible investment for house owners, it usually is not for greenhouse owners. Greenhouse owners pay 8.5 cents per kWh, while the average prices for households is around 23 cents per kWh. The Dutch National Government is however stimulating renewable energy generation with the Stimulating Sustainable Energy production (SDE+) subsidy for companies. With this SDE+ subsidy, the business case is easily made.

Stallingsbedrijf Glastuinbouw Nederland (SGN) has collaborated with the municipality of Haarlemmermeer to apply for this subsidy in oktober 2014 and has offered to collectively order and facilitate the process. The PV cells can be put on “closed” surfaces as storage facilities and the offices of the greenhouses. In 2015, the SDE+ subsidy will be available again. It might be interesting for other greenhouse clusters to participate in this collective apply for subsidy. For more details, contact Lennart van den Burg, Grontmij.

Although solar energy is very efficient, it will not be enough to provide the Greenport Aalsmeer enough energy. To compare, it would take 12,231 hectare of solar panels to provide enough energy for Greenport Aalsmeer.

4.7.5. Wind Energy

Another sustainable option for Greenport Aalsmeer is to collectively invest in wind energy within the greenhouse areas. The financial benefits will not directly affect each grower's energy costs since a CHP system or connection to the electric utility grid will still be required. However, the profits of a wind turbine farm could get distributed amongst the owners.

There are numerous wind turbines available on the market, suitable for each specific location. For a location with altering wind directions or with a lot of turbulence, a vertical axis wind turbine would be ideal, as used for example on rooftops. Horizontal axis wind turbines are the most common and efficient, and should be placed as high as possible in order to get a constant wind speed. The technical performance of wind turbines is highly dependent on wind velocity. When the wind velocity doubles, the maximum energy that can be generated will increase by a factor of eight. This means that in some locations a 5 meter difference of placement may change the power output by a factor of two[15]. Due to the importance of the wind speed, most wind turbines are placed high above flat surfaces. The robustness of the surface has a great influence on the wind speed, the more obstructions there are, the less velocity the wind achieves. To place wind turbines next to greenhouses is therefore less efficient than in an open (agricultural) field. Locations are recommended that are on the boundaries of the built environment and the rule of thumb for wind energy is: the bigger the better. Payback times of large wind turbines vary among factors of height, location and the proximity to the electric utility grid. Usually, payback times of on-shore wind turbines vary between 6-8 years.

Within Greenport Aalsmeer, various spatial constraints occur with respect to wind energy:

- In both the Structural Vision and the Provincial Spatial Regulation, the Province of North Holland has stated that wind energy locations within the Greenport Aalsmeer area are limited to Park 21 in Haarlemmermeer. Due to Schiphol Airport flight routes, 100 meter high wind turbines might not be allowed.
- The Province of Utrecht allows all wind turbines in the built environment but only small wind turbines (up to 20 meters) in open fields. The Province's Structural Vision limits large wind turbines to four locations near Utrecht, Nieuwegein and the Amsterdam-Rijnkanaal. Within de Ronde Venen, large scale wind energy is not allowed.
- The Province of South Holland's Structural Vision has not reserved space for wind turbines within the Greenport Aalsmeer area either.

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[15] Mertens, S, *'Wind Energy in the Built Environment; Concentrator effects on buildings'*, (Proefschrift) TU Delft 2006

In conclusion, although wind energy is one of the most efficient energy sources, it is not a viable option for the growers in Greenport Aalsmeer. The growers can invest in wind turbines elsewhere (for instance, off-shore). Due to the nature area “Groene Hart” and the proximity of Schiphol Airport, large wind turbines within Greenport Aalsmeer are either not allowed, or only allowed in limited locations by the three Provinces. Additionally, small wind turbines are not technically or financially viable.

4.7.6. Algae Production for Purification

Algae are the fastest growing species in the world. Although often viewed as weeds or a nuisance in lakes and pools, algae are very effective in purifying wastewater. From the 125,000 different types of algae, there are a few thousand discovered to be suitable for processing grey water[16]. The only feedstock that algae need is sunlight and CO_2. Therefore, most algae purification plants occur in open space, so that the CO_2 can be fixated from air, under influence of direct sunlight. The most widely used technology is that of algae raceways for optimal algae growth (Figure 24), with active wastewater mixing. With the constant pumping within the raceways, carbon dioxide can be diffused in the water more quickly, while the algae and nutrients can interact more. The algae remove nitrogen and phosphorus for growth. Additionally, algae are also capable of binding copper, lead and nickel. Some algae forms are even capable of breaking down complex organic molecules, such as pharmaceutical drugs. The main advantage is that the resulting sludge is a mixture of solid waste and algae. Algae are a valuable product, as it can be used for biofuel, proteins, methane and pharmaceuticals.

Figure 24: Algae Production

[16] Noüe, J. de la, Laliberté, G., Proulx, D., *‘Algae and waste water’* Groupe de Reserche en Recyclage Biologique et Aquiculture (GREREBA), Journal of Applied Phycology 4, 1992

The amount of organic materials within wastewater is usually measured as 5-day biochemical oxygen demand [BOD_5]. The algae raceway system uses about 0.5 kW per hour per kilogram removed BOD_5. Considering the fact that domestic wastewater has about 200 mg BOD_5 per litre, the energy requirements for grey water purification with algae is half of the energy that is required for conventional wastewater treatment.

Algae production can be a very useful alternative for growers who are in old greenhouses. Also, it can be used to purify wastewater while creating biofuels. In Rijsenhout, there is one grower (Bevelander) who is working on an algae farm.

4.7.7. Direct Current

In the Netherlands, the electricity grid uses an Alternating Current (AC) system while most appliances, such as laptops and lighting, use Direct Current (DC) to operate. Grower Vreeken in Rijsenhout uses DC as a pilot in the greenhouse and saves 25% on electricity costs. This technology is interesting for the other greenhouses to implement as soon as Dutch regulations allow a DC.

5. Conclusion and Recommendations

5.1. Conclusions

Sustainability is the key to the successful future of Greenport Aalsmeer. Although this is already known and accepted by stakeholders, actions are commonly taken on an individual basis. With the strong competition of other areas such as Airport A7 in North Holland, Greenport Aalsmeer needs to claim or reclaim its position in the market by producing high quality, sustainable products at competitive prices. Continuous innovation is needed.

The resource optimization shows that for each cluster, different collective options are available. Below are the most viable options for the different clusters. Section 5.3 proposes next steps that a Greenport Aalsmeer sustainability manager can use in 2015 to engage stakeholders, attract investors and start Greenport Aalsmeer's transformation to a sustainable future.

5.1.1. Connection to Amsterdam District Heating Network

The residual heat of Amsterdam is a great opportunity for the north-eastern clusters of Greenport Aalsmeer. The heating network currently originates from energy producers in Amsterdam (Diemen) and ends just north of highway A9. For this project, extension of the heating network to the large greenhouse clusters in Uithoorn, Kudelstaart and Nieuwveen is proposed. The infrastructure capital investment required for this distance would not likely be feasible. Therefore intermediate areas where the heat can be used are necessary, to build the viability of the business case. These "stepping stones" would be the clusters in Aalsmeer and Amstelveen (via Legmeerdijk). Within these areas there is a total of 2,055 TJ of heat demand, which is similar to the maximum capacity of the Amsterdam district heating network. An extension to the greenhouse area in Nieuwveen or De Kwakel also could be an opportunity for linkage to new heat suppliers. Other clusters are too far from the current heating network and have low heat densities to be financially viable.

5.1.2. Connection to Future Data Park in Haarlemmermeer

Schiphol Area Development Company (SADC) is planning a large-scale data park (an area for multiple data centers) in Schiphol Trade Park, about 2 miles northwest of Rijsenhout. This future data park will produce sufficient residual heat for Rijsenhout and the planned greenhouses within PrimA4a. The route of the heat piping under the A4 can be combined with the piping and wiring for electricity, wastewater and CO_2 so that infrastructural investments are minimized by bundling different flows.

5.1.3. OCAP Pipeline

Rijsenhout, Nieuwe Wetering and Roelofarendsveen are near the existing OCAP pipeline. Other areas are currently too far for a piping system to be financially feasible. In the future, an extension along the southern tip of the Westeinderplassen to Uithoorn, Nieuwveen and Kudelstaart would be an option as soon as the Amsterdam district heating network or another sustainable heat source is available. The latter is a prerequisite for the security of a steady demand.

5.1.4. Geothermal Energy

Stakeholders of Greenport Aalsmeer have previously discussed the potential for geothermal energy. However, this project shows that the regions with a high temperature in the geothermal formations (more than 70 degrees Celsius), have a low transmissivity which causes the well to be an inconsistent source of heat. Conversely, the areas of high transmissivity have a low temperature, which would mean that heat pumps would be needed to get the desired temperature. The areas between these zones become compartmentalized because of fracture lines in the surface (as with Jamuflor).

Clusters where geothermal energy has the most potential are Roelofarendsveen, Woubrugge and Nieuwe Wetering. In Aalsmeer, Amstelveen, Haarlemmermeer and de Ronde Venen, the transmissivity is the highest, which means the risk is the lowest. Due to the fact that heat from the Amsterdam district heating network and the data park are more feasible, it is suggested that only the cluster in De Ronde Venen is investigated further.

5.1.5. Decentralized Sustainability Options

In all areas, shallow aquifers are very suitable for seasonal thermal storage and exchange, while locally-available biomass present opportunities for biogas production. In particular, areas that have lesser opportunities for geothermal energy or heating networks could utilize aquifers for thermal storage and exchange, such Ter Aar and Woerdense Verlaat. Ultimately, it depends on the commodity and size of the grower which decentralized sustainability option suits their needs.

5.1.6. Water

The supply of water is no problem for the greenhouse sector at the moment. Eighty five percent of the irrigation water comes directly from rainwater and the remaining part can be supplied by using drinking water, ground water and/or other surface fresh water.

5.1.7. Nutrients

Nutrient discharges from the greenhouse clusters have the potential to be reprocessed for use as fertilizers. Reprocessing effluent to harvest nutrients could provide a new source of economic revenue for the greenhouse clusters. However, for the amount of capital required to recover the limited amounts of phosphorous and nitrogen that are currently available, results in (only) €100k per year for all of Greenport Aalsmeer and an infeasible business case. However, phosphorous prices should be monitored due to the foreseen worldwide scarcity in the near future – which could make it financially viable.

5.1.8 Summary

The most promising resource optimization solutions are summarized in Table 13 below. Green marks are the most viable and feasible options for each of the clusters. Yellow marks indicate additional options that can be complementary to, or substitutions for, the most feasible option.

Table 13: Summary of Options for each Greenport Aalsmeer Cluster

Cluster	Amsterdam Heat Net	Data Park	OCAP Pipeline	Geothermal Energy	Decentralized Options
Aalsmeer	Green			Yellow	Yellow
Kudelstaart	Green		Yellow		Yellow
Amstelveen	Green			Yellow	Yellow
De Kwakel	Green		Yellow		Yellow
Nieuwe Wetering			Green	Green	Yellow
Woubrugge					Yellow
Roelofarendsveen			Green	Green	Yellow
Woerdense Verlaat					
Ter Aar					Green
Nieuwveen	Green		Yellow		Yellow
Rijsenhout		Green	Green	Yellow	Yellow
De Ronde Venen				Green	Yellow

For this project, we do not have precise energy costs for each grower. However, using average electricity and natural gas pricing, the entire Greenport Aalsmeer organization of growers may be able to realize energy savings of a potential maximum of €68 million annually. This is purely an estimate based on assumptions of recurring costs, with no estimation for capital costs. A more accurate analysis of energy costs and potential savings by each cluster and each grower can be used to estimate the potential payback for investment considerations.

5.2. Recommendations

Despite the worldwide growing demand for flowers, production in Holland is declining. FloraHolland will likely open more locations in the world due to the increasing digitalisation which has opened the market to competition.

Greenport Aalsmeer needs to seek ways to distinguish themselves from other growers in the market in order to maintain and grow market share, by implementing some of these recommendations:

1. ***Strengthen the stakeholder network to successfully implement sustainable opportunities.***

    a. Synergy and exchange of resource streams is always cheaper and more reliable over time than being dependent on external resource flows.

    b. Greenport Aalsmeer can develop a sectorial appearance, creating a community for capitalizing on clustering, sharing of knowledge and give the heat suppliers and infrastructure companies, such as Alliander and OCAP, a secure demand over time, which will result in system efficiency improvement, and possibly cost reduction. For example, the logical areas to expand the number of growers are within Rijsenhout and De Kwakel; Rijsenhout due to its proximity to the OCAP pipeline, De Kwakel due to its high heat density.

2. ***Become the knowledge and innovation platform for horticulture.***

    a. The new PrimA4a area is a great opportunity to exhibit sustainable innovation and new concepts. The area near Rijsenhout could serve as a horticulture knowledge and innovation platform for the other regions and align with future locations such as Park 21 and Schiphol Trade Park, which are being developed as sustainable locations for leisure and logistics.

    b. Prepare for new (innovative) technologies such as algae production in wastewater, smart-grid applications and/or the use of DC electricity. These technologies are still in their infancy, but may play a very important role in the future of energy reduction and generation. Greenport Aalsmeer could become the testing ground and beneficiary of these technologies in the future.

3. ***Broaden the use of sustainability assessment to optimize commodity priorities.***

a. The interviews clearly showed that the stakeholders see sustainability as "energy", while ideally, other sustainability potential should also be addressed, for example:

   - How growers are and can contribute further to the community with economic development opportunity, education and outreach, and poverty alleviation,
   - How growers can build a broader partner network to expand support,
   - How spatial and ecological quality can be optimized,
   - How historical context of the area can be opportunistically utilized, such as with branding and market evolution,
   - How the relationship with the polder can be expressed in the spatial plan and,
   - How the location of area can be used as a showroom for passing travellers.

b. An optimization of the full sustainability potential of Greenport Aalsmeer can lead to comprehensive broader conclusions than the optimization of solely physical resources. The sustainability manager should expand the conclusions of this report to be more comprehensive by including qualitative aspects and flows (social, cultural, cognitive and environmental aesthetics).

c. This comprehensive sustainability assessment can then be used to prioritize and optimize the commodities grown within Greenport Aalsmeer.

4. ***Create a sustainability opportunity prioritization decision-support tool.*** This tool can then convert the comprehensive sustainability assessment into spatially-targeted economic potential for Greenport Aalsmeer.

5.3. Next Steps for the Sustainability Manager (Duurzaamheidsmakelaar)

From the interviews conducted in this study, it can be concluded that all stakeholders see the importance of sustainability (i.e. saving on energy bills, which is about 30% of the operating costs) as a precondition for future growth. Starting January 2015, a sustainability manager will be appointed by Greenport Aalsmeer to work with the various stakeholders on the implementation of the suggested sustainability improvements.

Numerous studies, workshops and sessions have been devoted to sustainability topics in recent years. Now there is a need for a pragmatic and realistic approach. Questions such as: “who is going to invest? Who covers the risks? And what is in it for me?” need to be answered in the next step. There is a need for information on connecting knowledge and creating clarity and security for the growers. With this report, the sustainability manager has enough background information to become a connector, facilitator, coordinator and stimulator. He or she will need to communicate, be informed of the existing information and should also be able to speak the “language” of the growers.

The stakeholders which need to be recruited for each of the potential improvement areas are discussed below:

1. <u>Amsterdam District Heating Network:</u> Connect the heating network coordinator of the Amsterdam Economic Board, the electricity grid operator Alliander and recruit and inform potential users in Aalsmeer and Amstelveen. Identify additional heat consumers or heat producers in the area (data centers, hospitals, swimming pools, etc.).

2. <u>Data Park in Haarlemmermeer:</u> Conduct further discussions with stakeholders such as PrimA4a, Schiphol Trade Park (SADC), municipality of Haarlemmermeer, Water board of Rijnland and the electricity grid operator Alliander.

3. <u>OCAP pipeline:</u> Primary stakeholders are OCAP, municipalities of Haarlemmermeer and Kaag en Braassem. One particular grower Looijen in Rijsenhout has already signed a contract which would be the first major investor.

4. <u>Geothermal energy:</u> Connect with specialists in the field of geothermal energy; Ger de Bruin of T&A Survey is a front runner on the technology. Start conversations with the municipality of de Ronde Venen.

5. <u>Decentralized options:</u> Investigate the current duration of the contracts for organic waste delivery to Meerlanden and analyze the feasibility of placing an extension within a remote greenhouse area. Additionally, start conversations with Waste Transformers, a start-up company at ENGINN in Haarlemmermeer who sell movable containers which transform biomass to nutrients, heat, electricity and CO_2. This could be viable for small scale applications.

6. <u>Other options:</u> Learn more about the use and viability of Fresnel Lenses, Algae Growth, (semi-closed greenhouse concepts and solar energy). The main contacts for these innovations are Andrea van der Graaf of Meermaker and Lennart from Grontmij. It is crucial that the available innovations are communicated and shared amongst the growers in the area.

With these stakeholders, the goal of the sustainability manager should be to assist and prepare business cases, collect letters of intent of potential users and draft contracts for implementation.

Summarizing, the critical initial priorities for the sustainability manager should be:

A. Create a business case for extension of the Amsterdam district heating network to Aalsmeer.
B. Combine existing plans for the data park in Schiphol Trade Park with the OCAP Pipeline extension in Rijsenhout and the newly planned PrimA4a;
C. Convene with Province of South Holland to further assess geothermal potential in Kaag en Braassem and plan for trial drilling.
D. Conduct a comprehensive and holistic sustainability assessment of Greenport Aalsmeer.
E. Develop a decision-support tool for all growers to immediately understand their potential for savings.

6. Appendix

6.1. Stakeholders Interviewed

Stakeholder interviews are chronologically listed below. This excludes the various meetings with sustainability manager Ingrid Leemans, who has been invaluable during the entire process. Also, Cees Moerman of Agrimaco and Wiebe van der Lagemaat of the municipality of Uithoorn have been consulted multiple times over the past months.

July 15th 2014 – Rene Jansen, Provincie Noord-Holland

July 18th 2014 – Coen Meijeraan, Flora Holland

July 21st 2014 – Rien Braun, Stallingsbedrijf Glastuinbouw Nederland (SGN)

July 23rd 2014 – Andre van der Poel, Municipality of Aalsmeer/Amstelveen

August 19th 2014 – Marcel Brans, Naktuinbouw

August 22nd 2014 – John Nederstigt & Bart Oostveen

September 10th 2014 – Bart Oostveen, de Zonnebloem / LTO noord

September 10th 2014 - Rob van Aerschot, Debby de Rijk, Clement Torrre, municipality of Haarlemmermeer & Phillip Bocxe, Stallingsbedrijf Glastuinbouw Nederland (SGN)

September 24th 2014 - Marcel van Beek, Schiphol Group

September 24th 2014 - Levi Boerman & Paul Jansen, SADC

November 13th 2014 - Phillip Bocxe, Stallingsbedrijf Glastuinbouw Nederland (SGN) & Lennart van den Burg, Grontmij & Andrea van de Graaf, Meermaker/Tegenstroom

November 14th 2014 - Eloi Burdoff, Province of North-Holland

6.2. Wide Format Maps

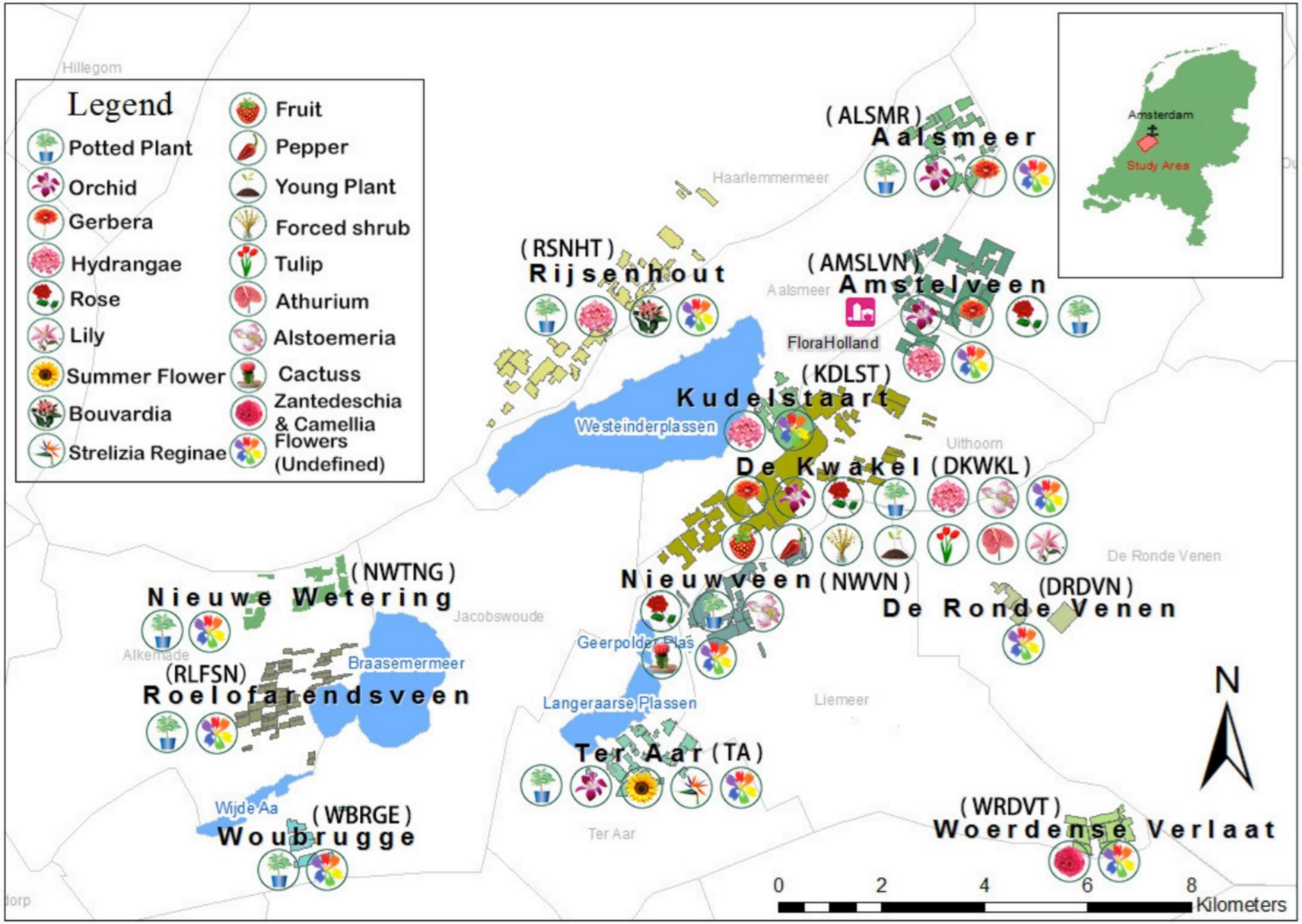


Figure 8: The 12 Greenhouse Clusters and their Commodity Production

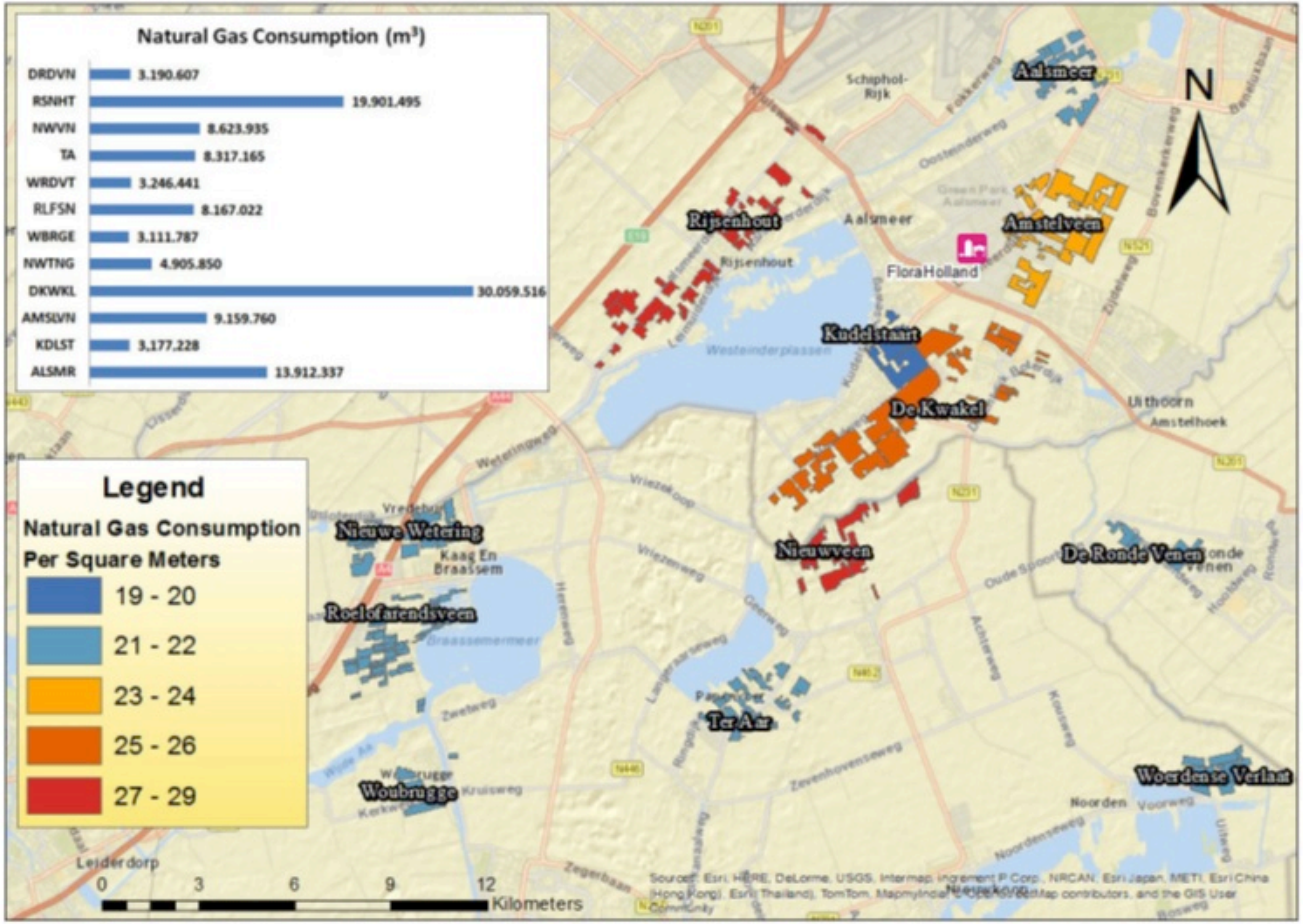


Figure 9: Natural Gas Consumption Intensity by Cluster (inset graph shows Total Annual Natural Gas Consumption)

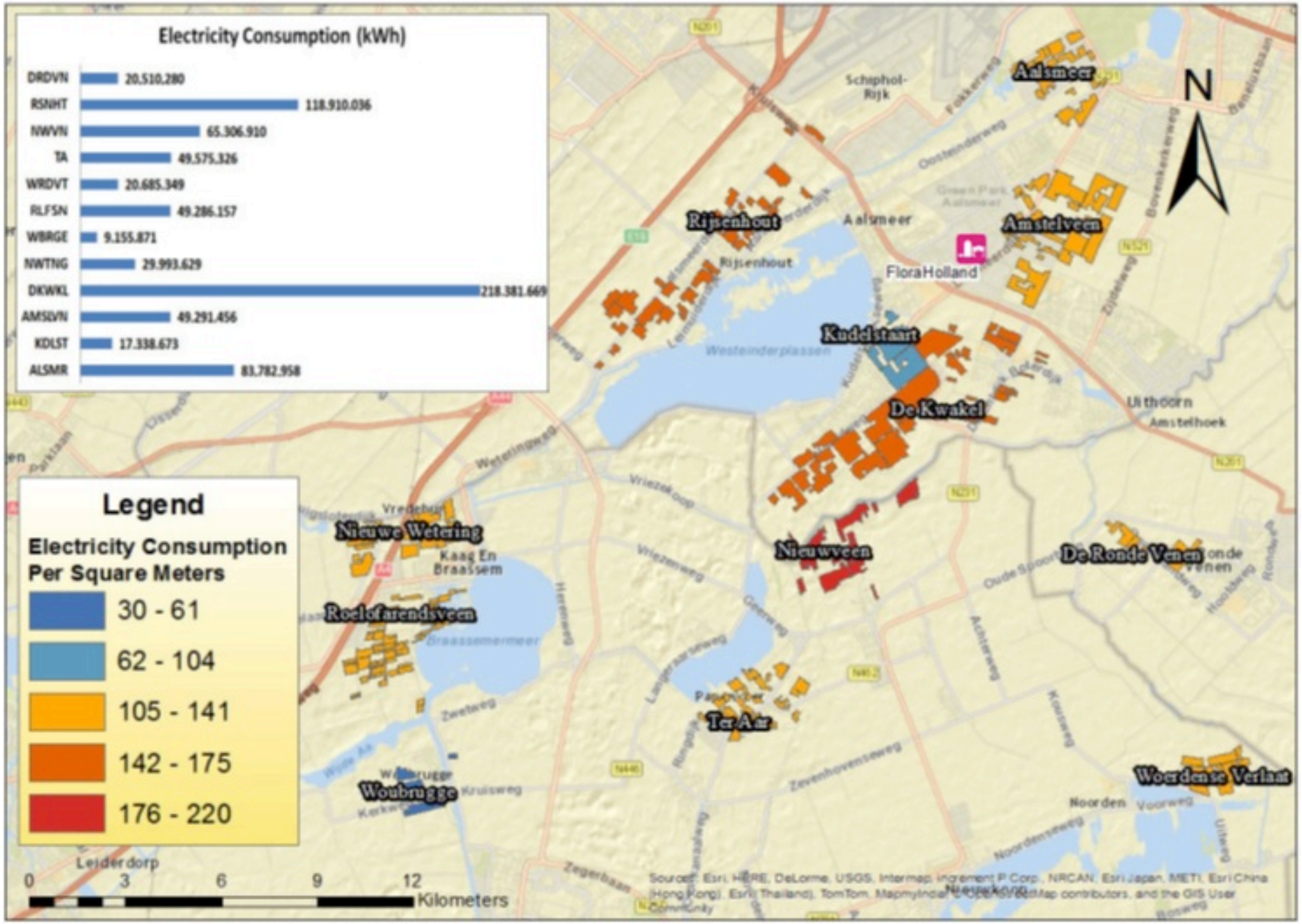


Figure 10: Electricity Consumption per square meter (inset graph shows Total Annual Electricity Consumption)

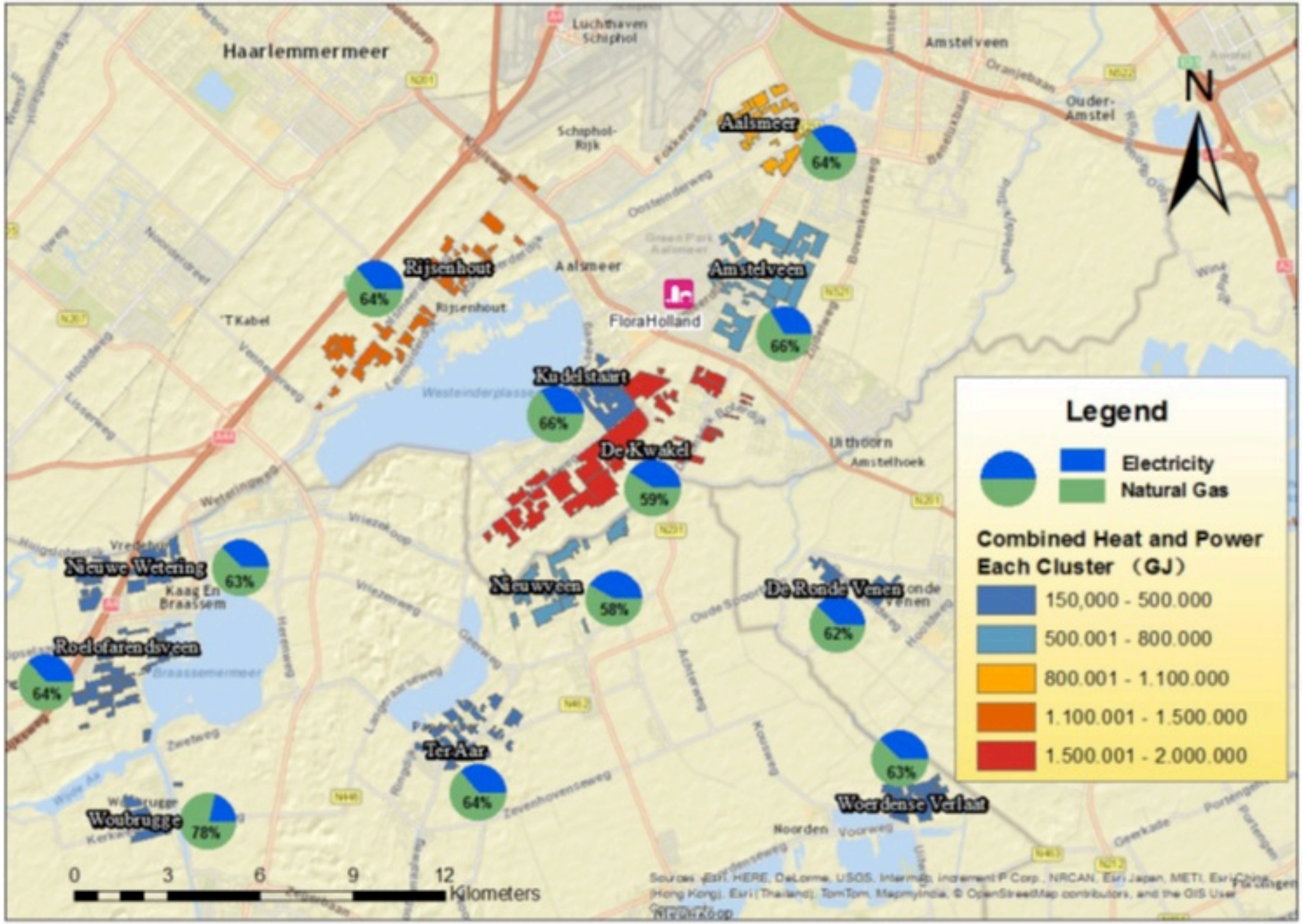


Figure 11: Distribution of Energy Sources at each Cluster

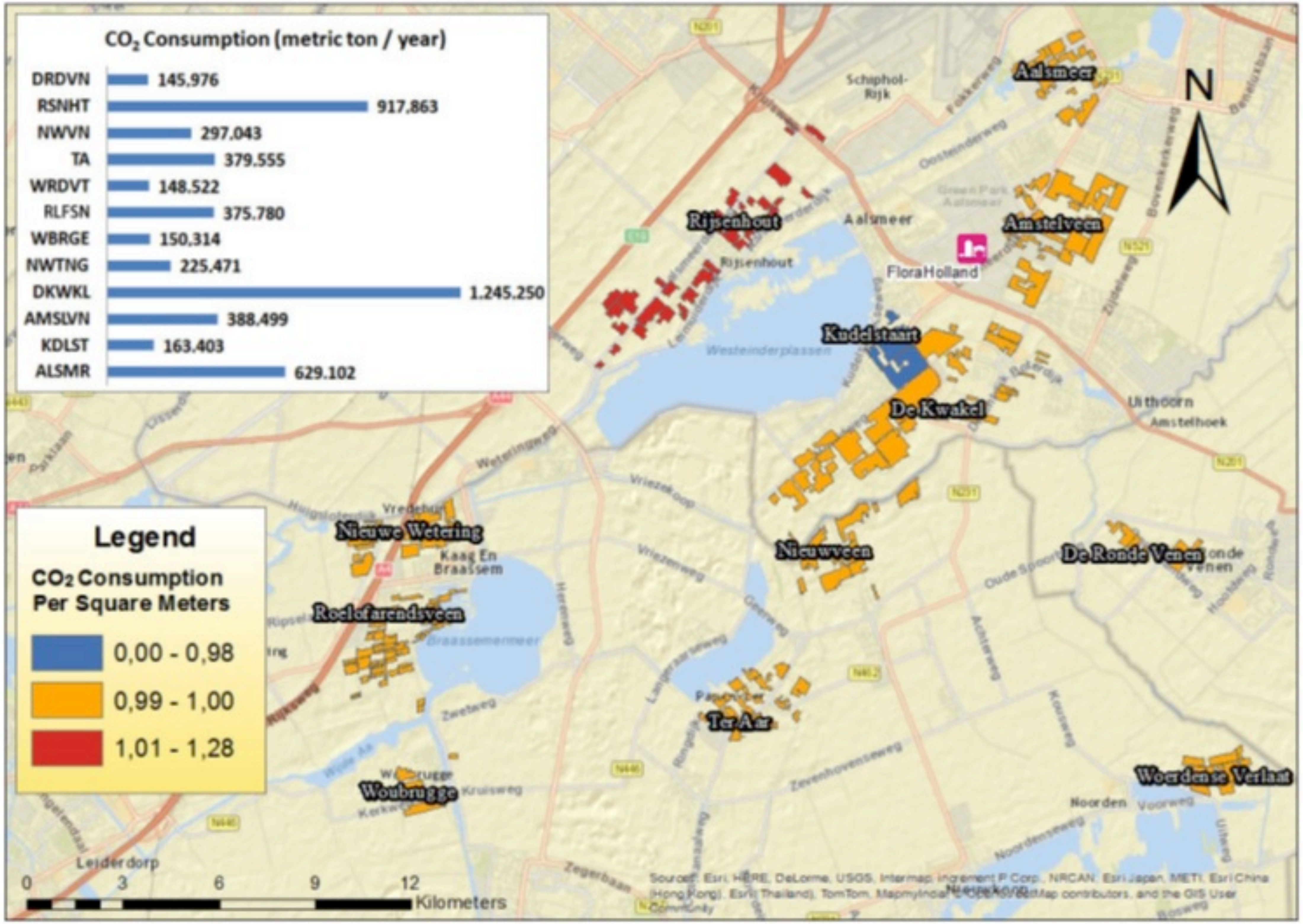


Figure 12: Carbon Dioxide Consumption per square meter (inset graph shows Total Annual Carbon Dioxide Consumption)

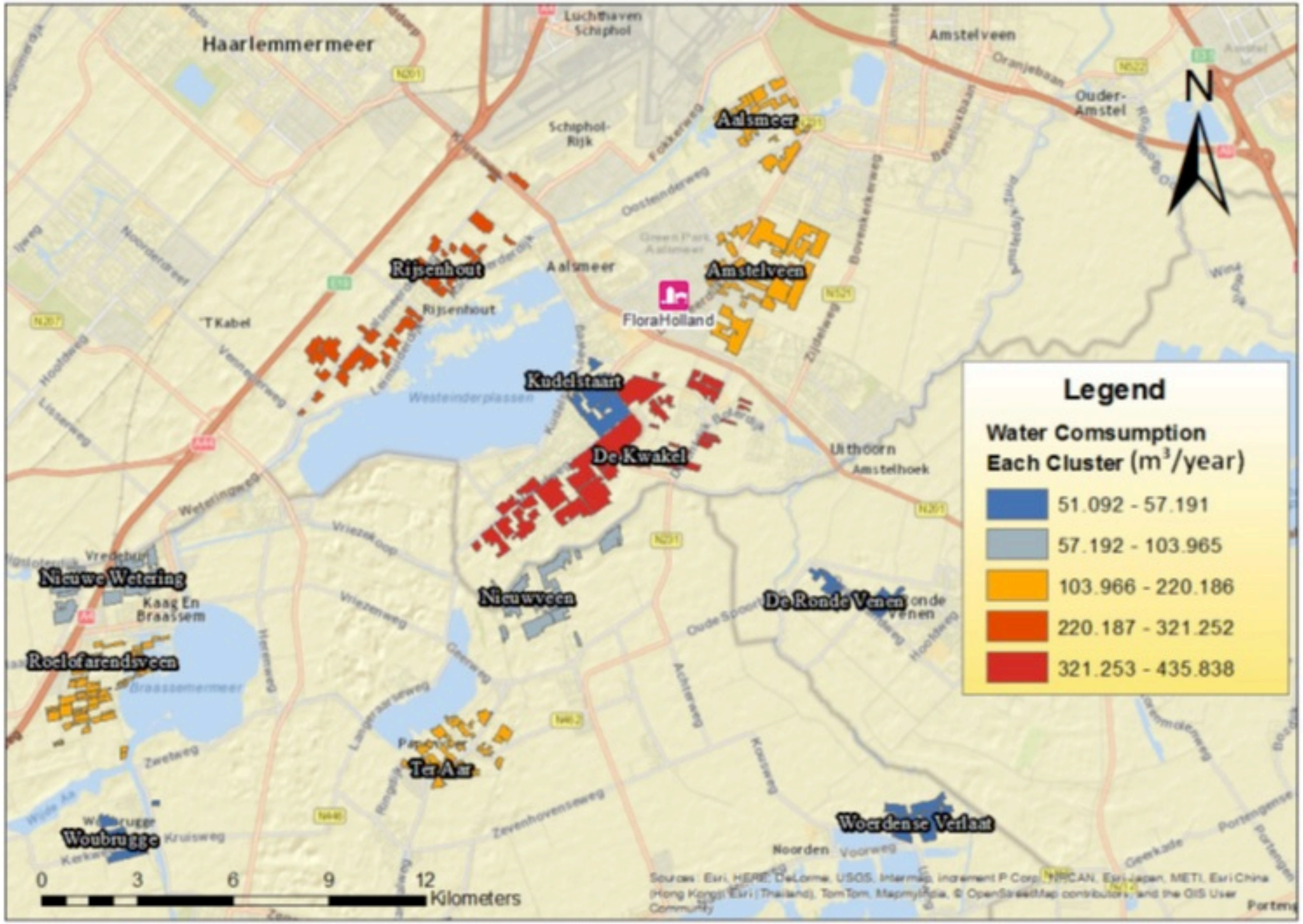


Figure 13: Water Consumption across the Clusters

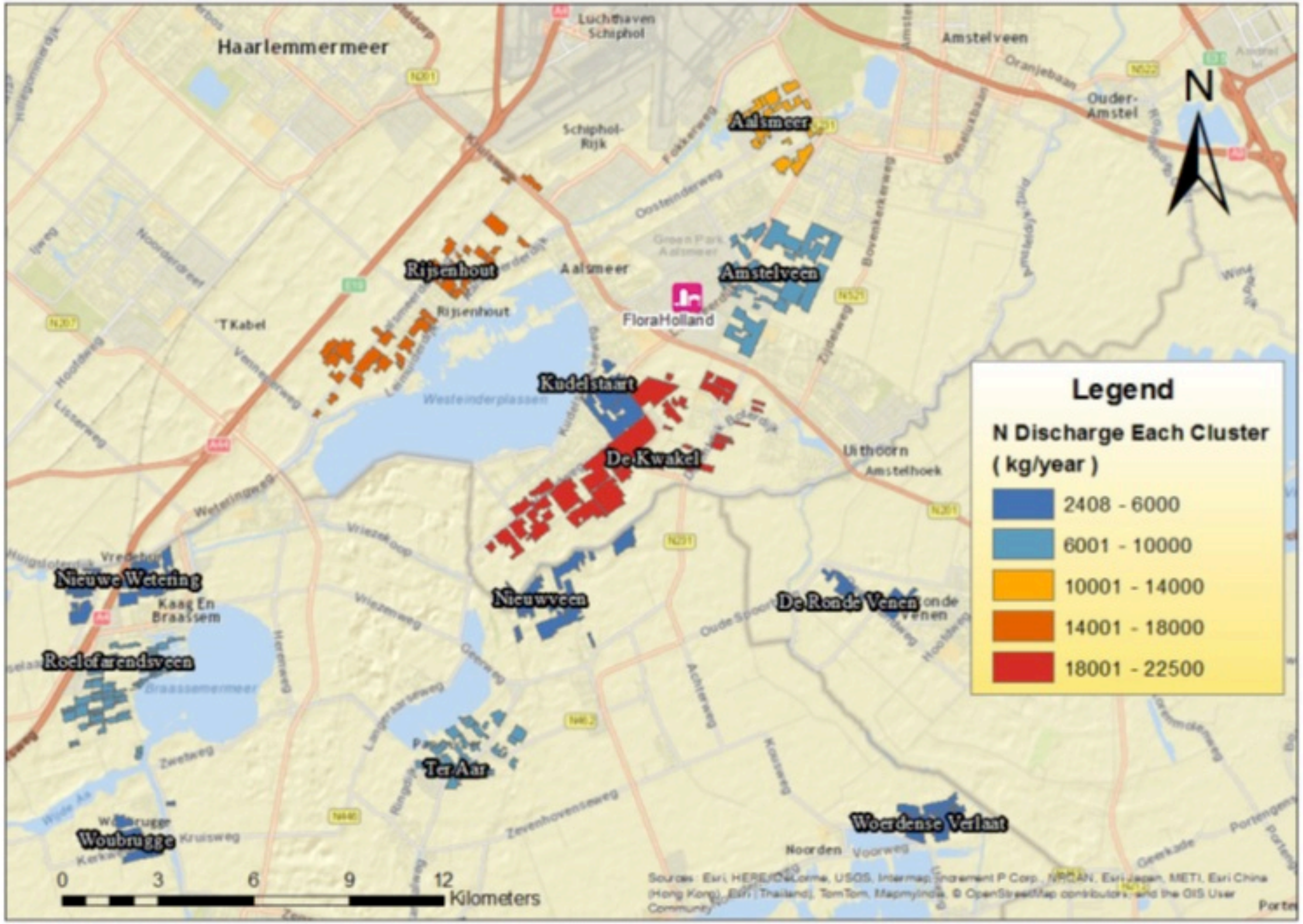


Figure 14: Nitrogen Discharge from Clusters

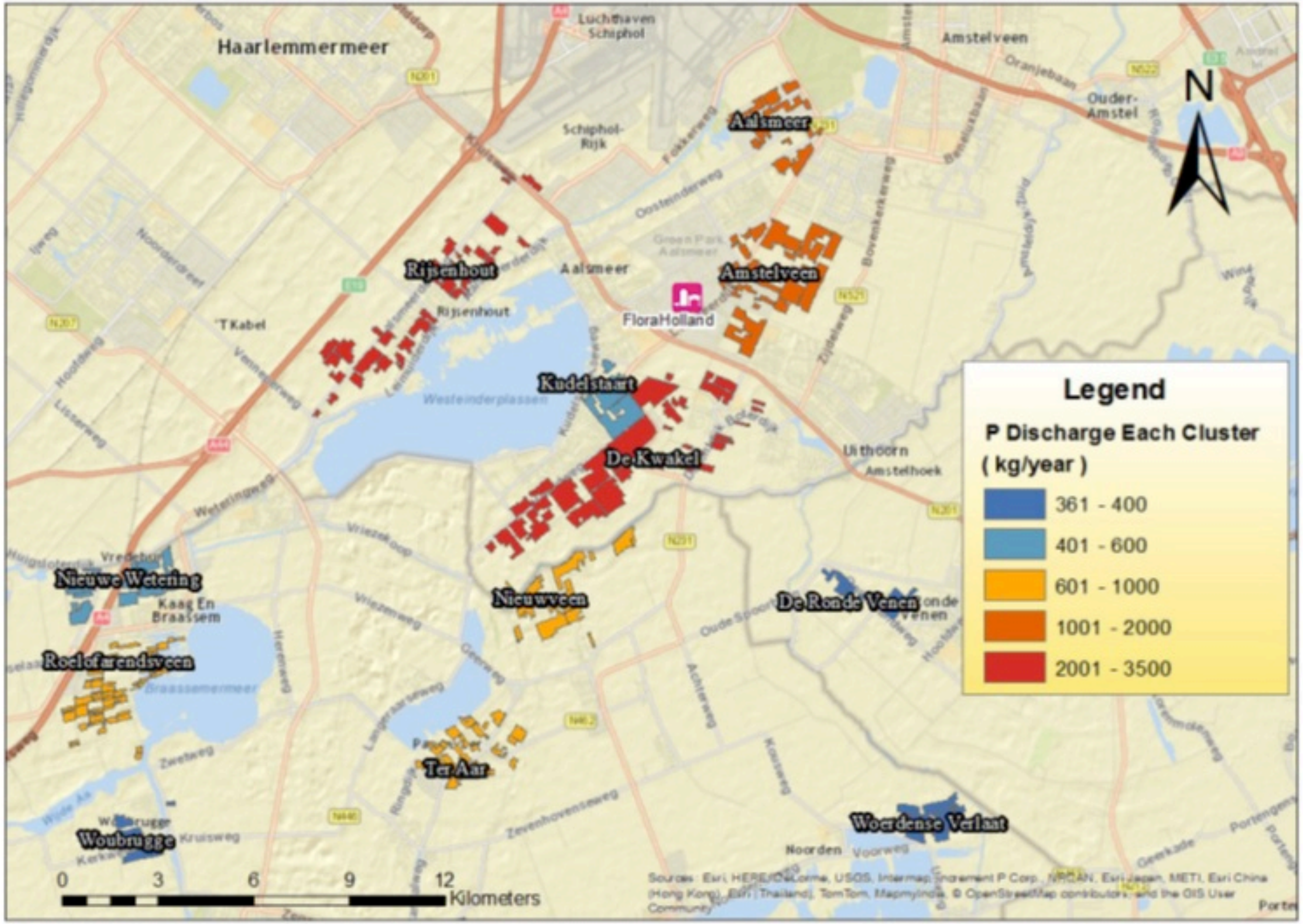


Figure 15: Phosphorus Discharge from Clusters

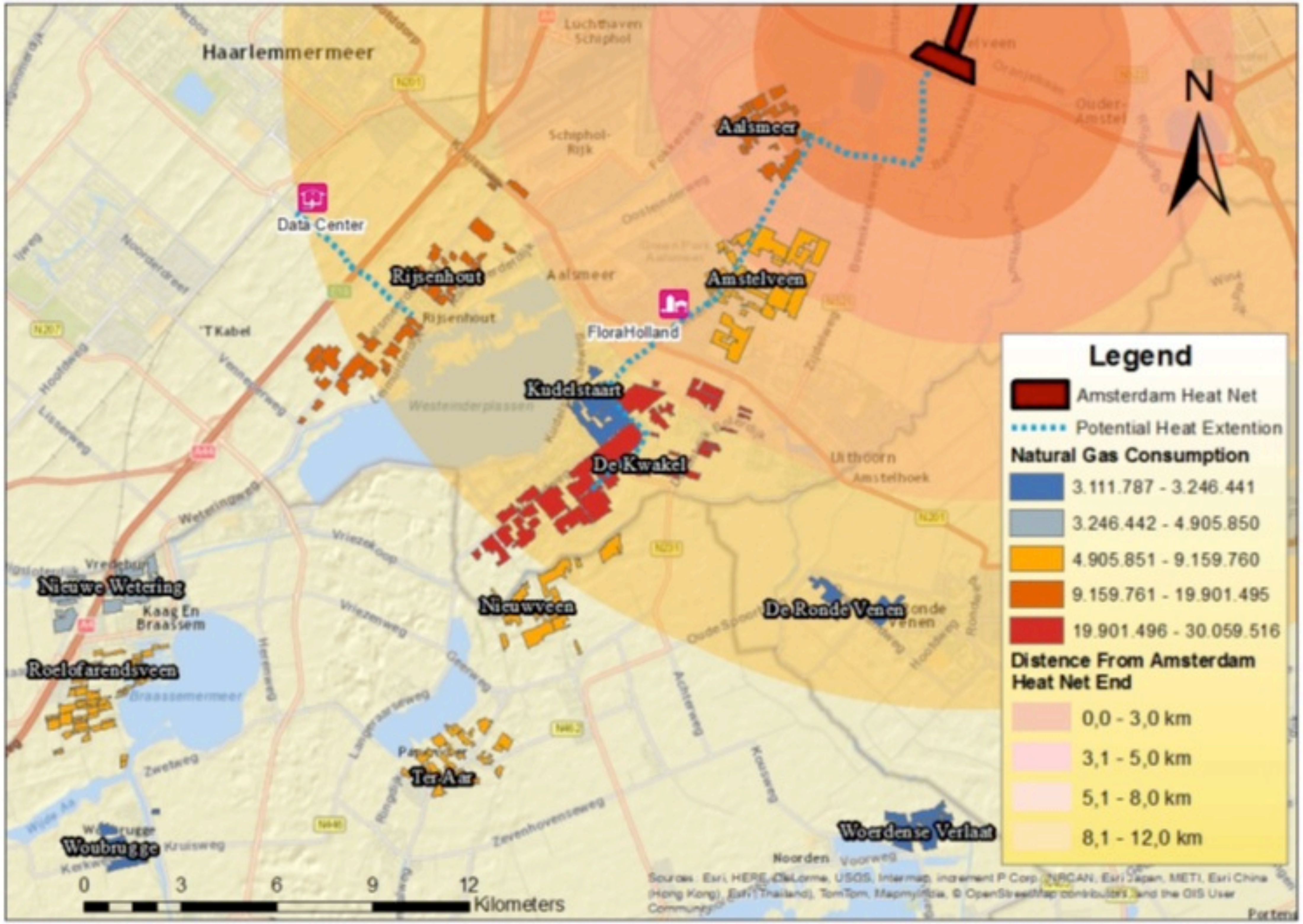


Figure 16: Proximity of the Clusters to Southern District of the Amsterdam District Heating Network (dashed lines are potential extensions)

Figure 17: Potential Extended Heat Networks to the Clusters

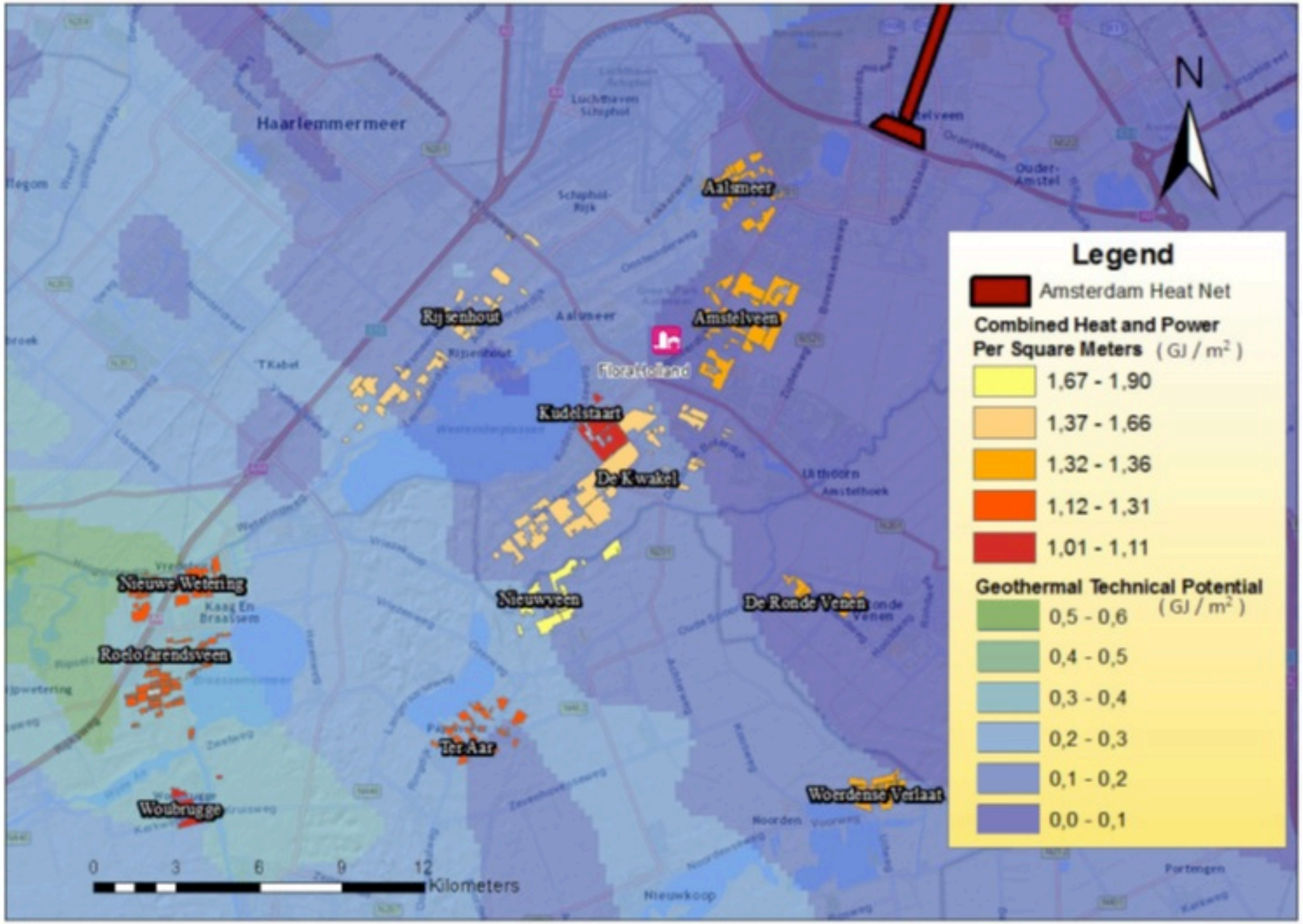


Figure 18: Technical Geothermal Potential of the Study Area as calculated by TNO

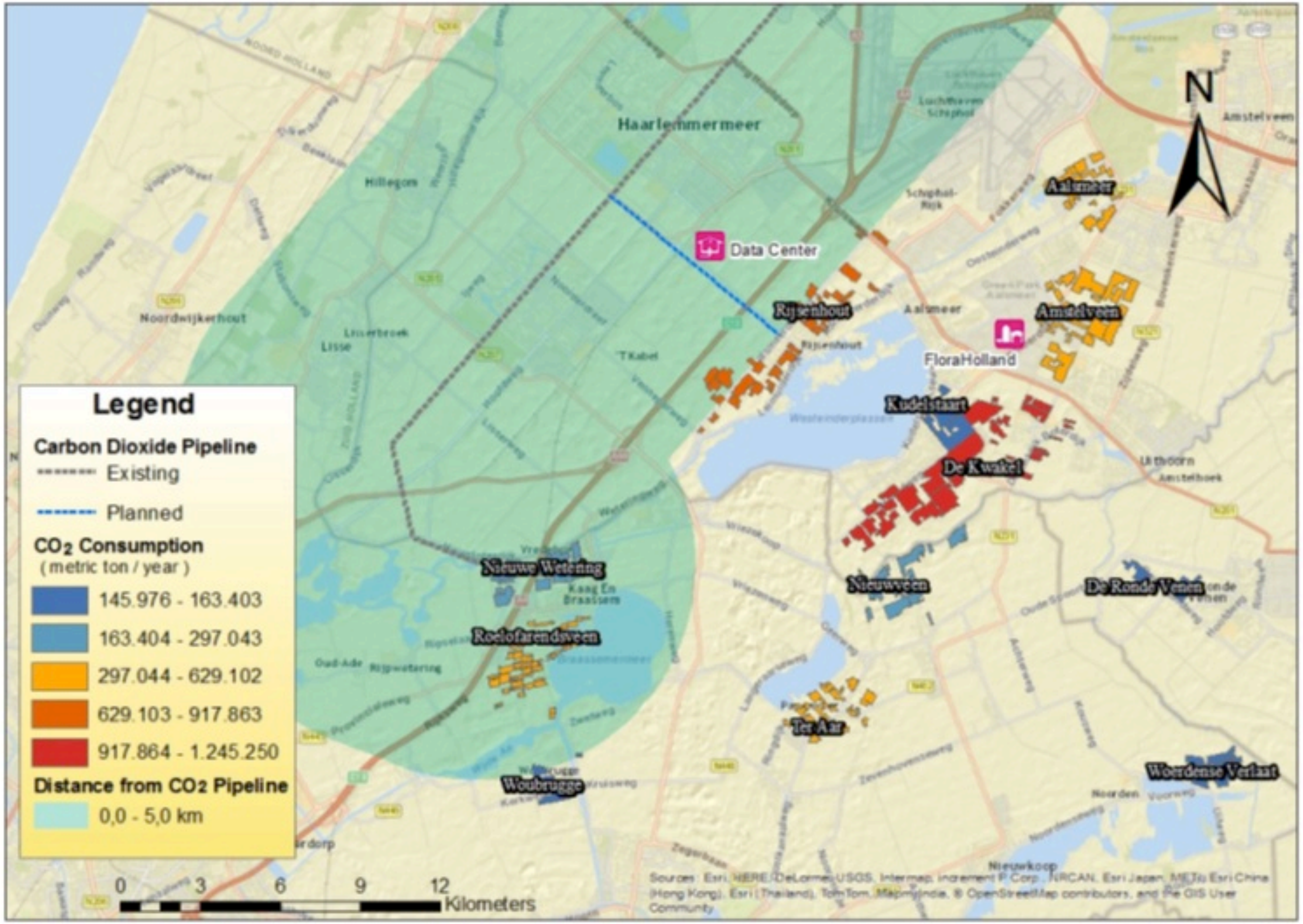
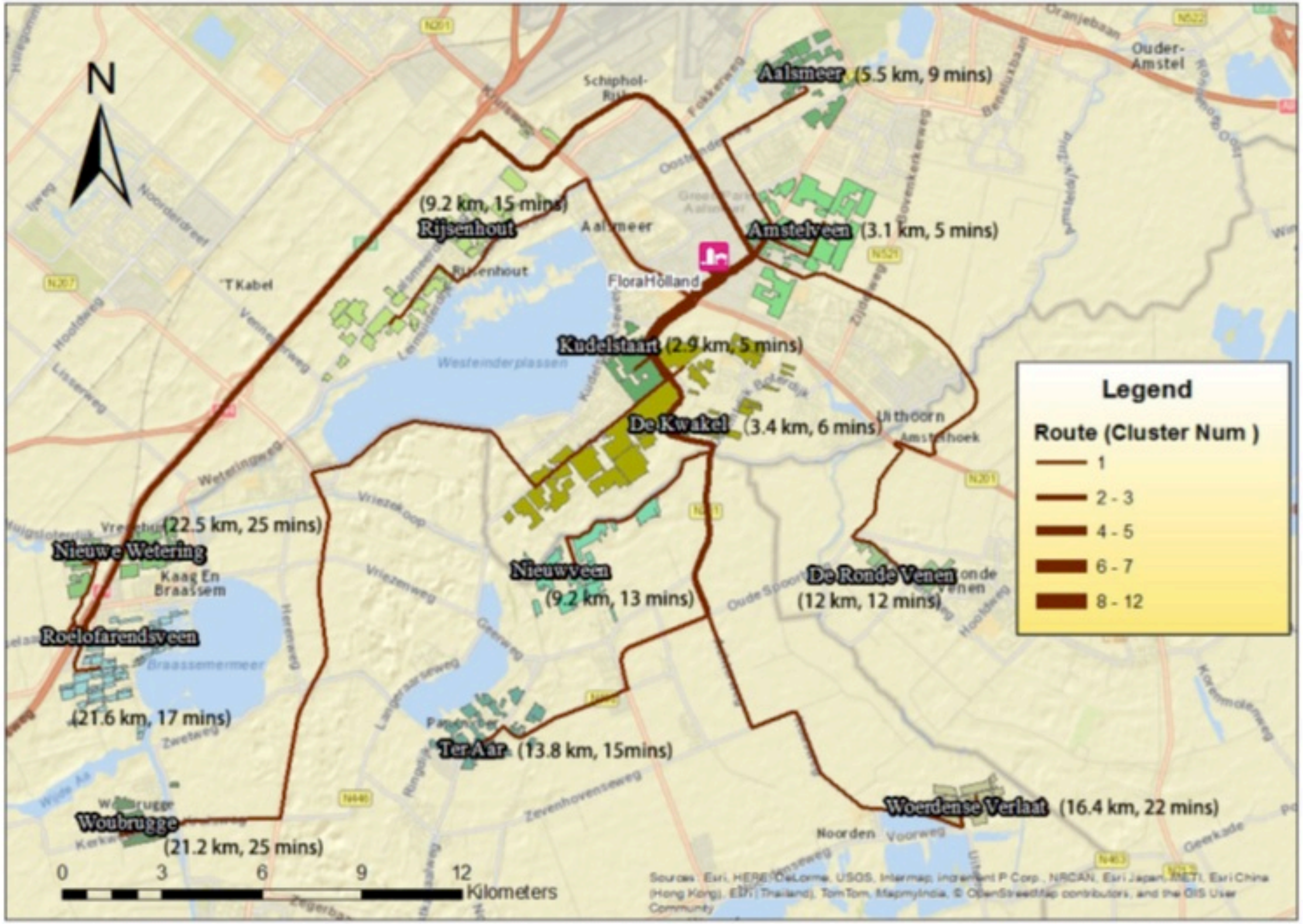


Figure 19: Distances of Clusters from the OCAP Pipeline



Transportation Routes used by Greenport Aalsmeer Growers (thicker lines indicate higher use roads)

6.3. Presentation

The presentation given to Greenport Aalsmeer stakeholders is included below as 4 slides per page.

Optimalisatie energiestromen

Greenport Aalsmeer

ARIZONA STATE UNIVERSITY

Fonz Dekkers

Stuurgroep Greenport Aalsmeer
19 november 2014

2 Rob and Melani Walton Sustainability Solutions Initiatives

Inhoud

- Introductie
- Huidige stand van zaken
- Duurzaamheidsprogramma
- Conclusies en aanbevelingen
- Vervolgstap: Duurzaamheidsmakelaar

3 Rob and Melani Walton Sustainability Solutions Initiatives

Introductie

Team Arizona State University

Richard Rushforth

ASU Resource Mapping & System Analysis PhD student

Rajesh Buch

ASU Sustainability Scientist

Qinyi (Clara) Qian

ASU Master student in CIS and GIS

4 Rob and Melani Walton Sustainability Solutions Initiatives

Ambities voor 2025

- 50% CO_2 reductie;
- In nieuwe tuinbouwgebieden klimaatneutraal en 75% hergebruik water;
- 30% energiebesparing;
- Gebruik duurzame energie 30%;
- Hergebruik 75% reststoffen en afval;
- Nul emissie gewasbeschermingsmiddelen.

"Water is niet het grootste vraagstuk, focus op warmte en CO_2"

5

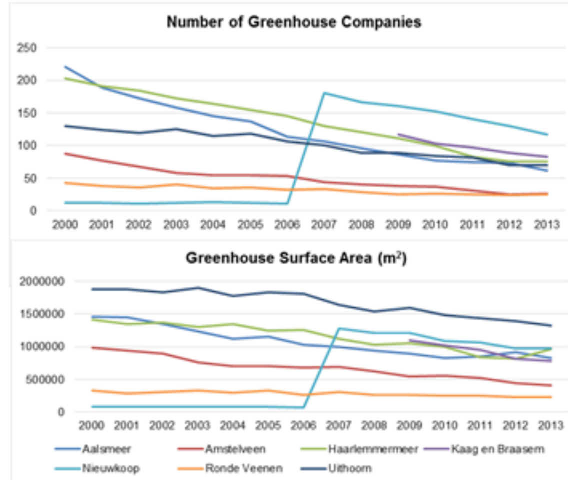
ASU Rob and Melani Walton Sustainability Solutions Initiatives

"De vraag naar bloemen zal blijven bestaan"

6

ASU Rob and Melani Walton Sustainability Solutions Initiatives

Opgave



7

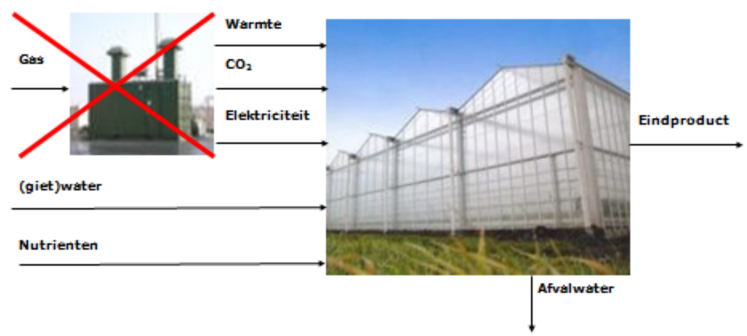
ASU Rob and Melani Walton Sustainability Solutions Initiatives

"Greenport Aalsmeer moet een duurzaam merk worden, dat herkend wordt in de wereld als duurzaam geproduceerde bloemen"

8

ASU Rob and Melani Walton Sustainability Solutions Initiatives

Analyse

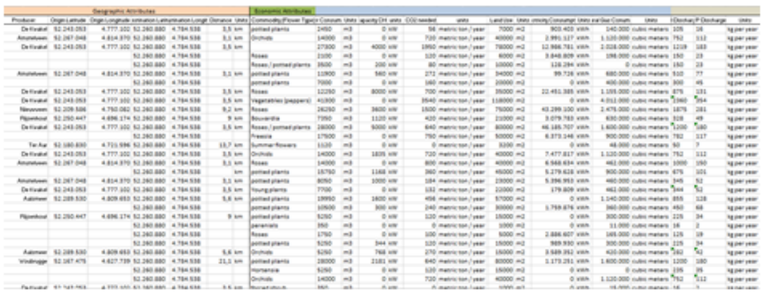


9

Rob and Melani Walton Sustainability Solutions Initiatives

Werkwijze

- 21 interviews met stakeholders
- Data verzameling van de verbruiksgegevens op clusterniveau



10

Rob and Melani Walton Sustainability Solutions Initiatives

Waar praten we over?

Bruto 4.500 kton CO_2 uitstoot voor Greenport Aalsmeer

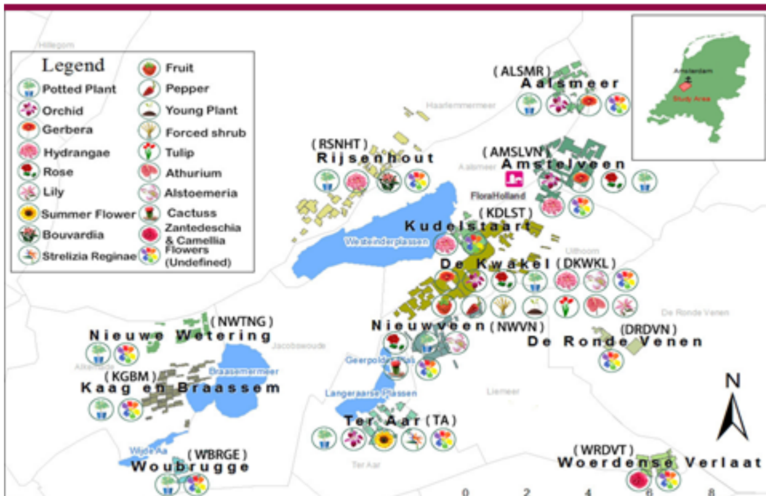
- **900.000 huishoudens**
- **12.231 hectare zonnepanelen**

Netto 563 kton CO_2 uitstoot voor Greenport Aalsmeer

"30% van mijn exploitatie gaat naar energiekosten"

11

Rob and Melani Walton Sustainability Solutions Initiatives



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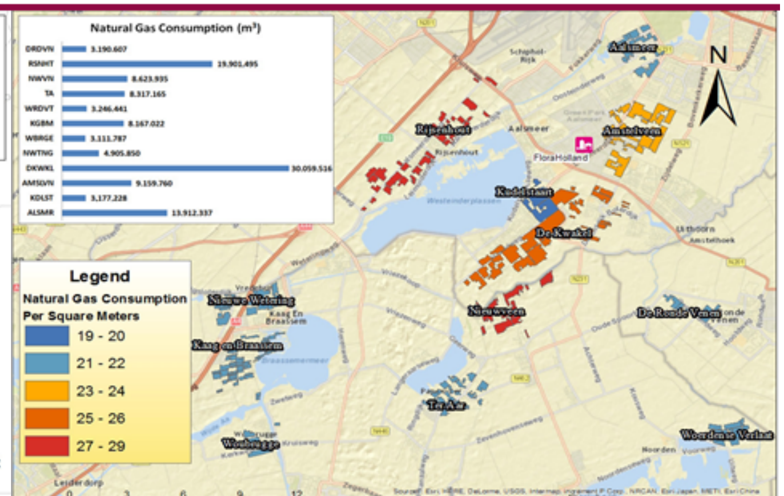
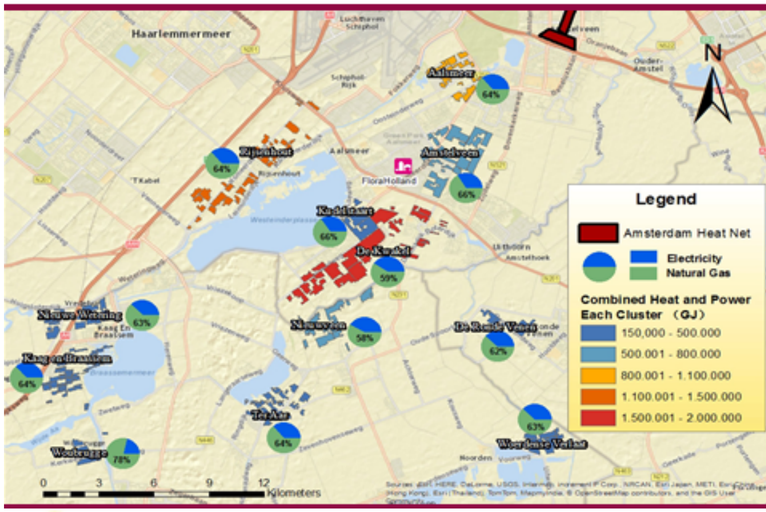
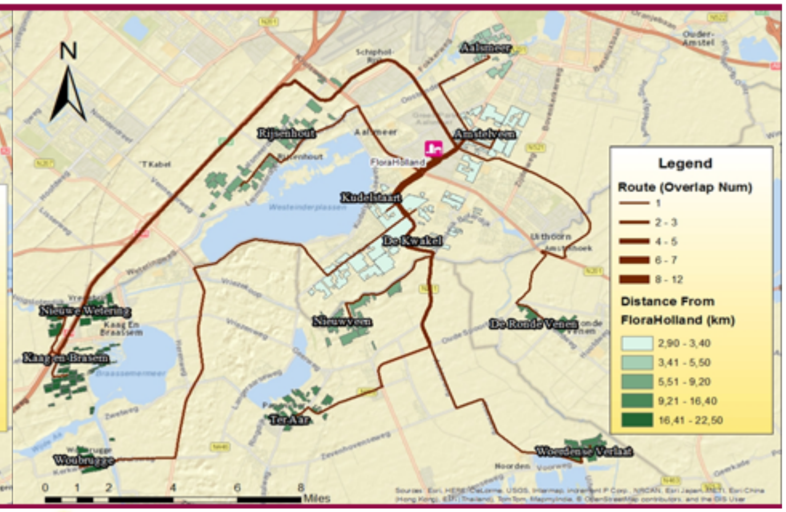
Rob and Melani Walton Sustainability Solutions Initiatives



13 Rob and Melani Walton Sustainability Solutions Initiatives



14 Rob and Melani Walton Sustainability Solutions Initiatives



15 Rob and Melani Walton Sustainability Solutions Initiatives

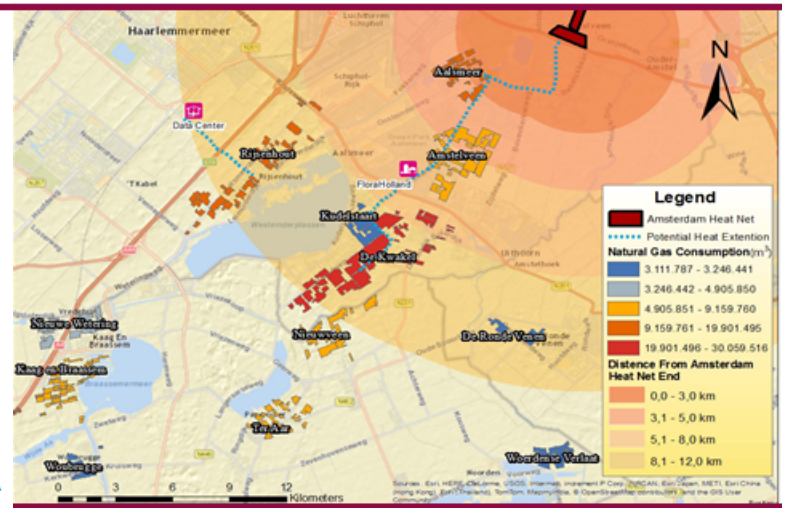
Warmtenet

- Mogelijkheden aansluiting glastuinbouwgebied aan warmtenet Amsterdam
- Amstelveen is nu gekoppeld aan NUON centrale in Diemen met mogelijkheid voor verbinding naar Glastuinbouw Aalsmeer
- Totaal 2 PJ beschikbaar per jaar

"Er is meer dan voldoende warmte aanbod in Amsterdam"

Bron: Eindrapport Warmteprogramma MRA

16 Rob and Melani Walton Sustainability Solutions Initiatives



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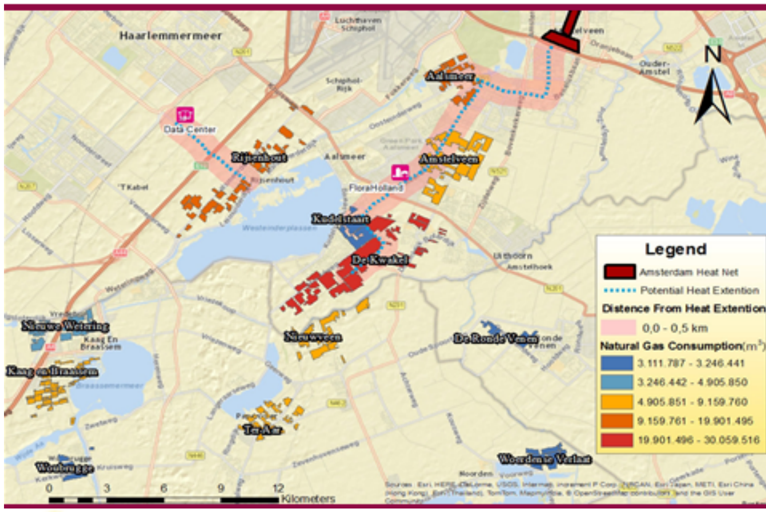
ASU Rob and Melani Walton Sustainability Solutions Initiatives



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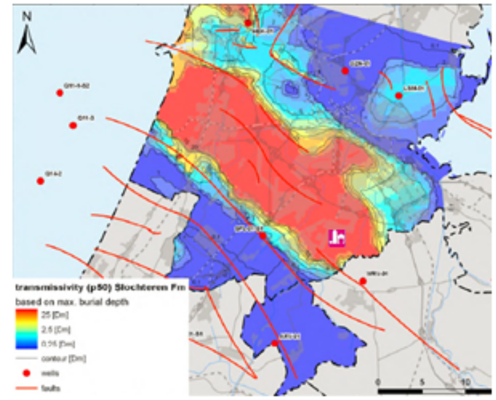
ASU Rob and Melani Walton Sustainability Solutions Initiatives

Geothermie

- Heel veel discussie rondom potentie aardwarmte
- Vergunningen zijn verleend in de regio
- Potentie = temperatuur + transmissiviteit



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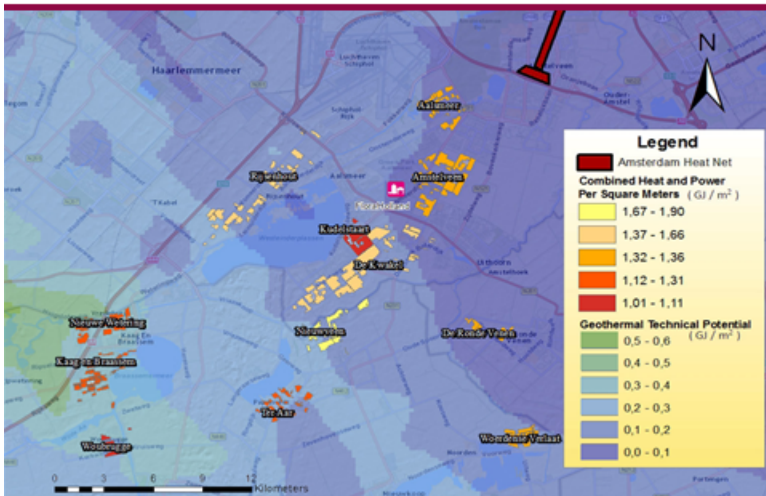
ASU Rob and Melani Walton Sustainability Solutions Initiatives



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CO_2 leiding

- Shell in Pernis kan PrimaA4a voorzien van zuivere CO_2
- In de toekomst ook verdere aansluiting Greenport mogelijk met afvang CO_2 door AEB
- 24.000 ton CO_2 per jaar

Bron: OCAP

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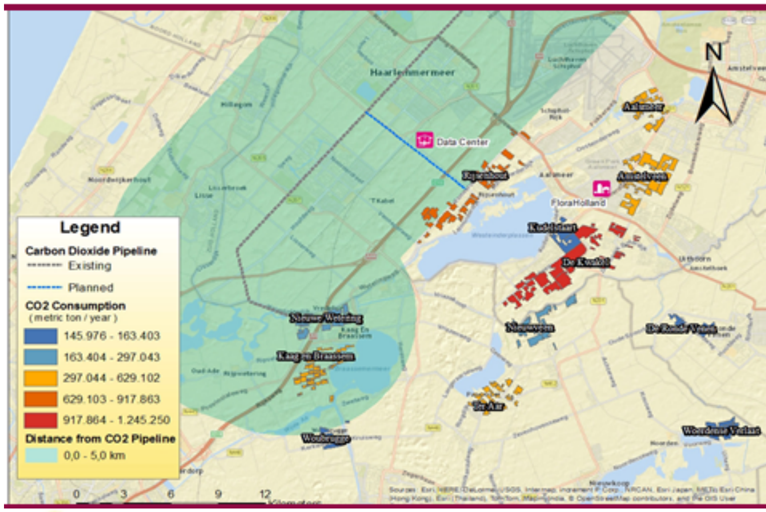
Rob and Melani Walton Sustainability Solutions Initiatives



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Biomassa

- De Kwakel (0,2 MW)
- De Meerlanden (3 miljoen m3 groengas/jaar)
- Potentie: 200 TJ/jaar
- Waarde hiërarchie?

Bron: www.b-i-o.nl

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Belangrijkste conclusies

- De vraag naar bloemen blijft bestaan en zal wereldwijd groeien
- Marktpositie voor sierteeltsector Greenport Aalsmeer kan floreren als het zich kan blijven onderscheiden op kwaliteit en duurzaamheid.
- Elk cluster heeft duurzaamheidspotenties, de een is alleen potentierijker dan de ander
- Clustering en intensivering is noodzakelijk voor succes
- Water- en nutriëntenstromen zijn vooralsnog geen aandachtspunten
- Continue innovatie naar hogere kwaliteit en duurzaamheid is nodig.

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Rob and Melani Walton Sustainability Solutions Initiatives

Aanbevelingen

- Benader duurzaamheid integraal, niet alleen projecten en ideeën
- Duurzaamheid is breder dan energie
- Er is behoefte aan een pragmatische aanpak
- Duurzaamheidsmakelaar als verbinder, coördinator en stimulator
- Zet in op de gemeenschap

"Kom uit de kas, repareer het dak in de zomer"

Duurzaamheidsmakelaar

Cluster	Amsterdam Heat Net	Data Park	OCAP Pipeline	Geothermal Energy	Decentralized Options
Aalsmeer	✓			✓	✓
Kudelstaart	✓		✓		✓
Amstelveen	✓			✓	✓
De Kwakel	✓		✓		✓
Nieuwe Wetering			✓	✓	✓
Woubrugge				✓	✓
Kaag en Brasem			✓	✓	✓
Woerdense Verlaat					
Ter Aar					✓
Nieuwveen	✓		✓		✓
Rijsenhout		✓	✓	✓	✓

"Greenport Aalsmeer kan meer sturend worden"

Vragen?

"Duurzame Greenports in de Randstad is een wereldkans"

Fonz Dekkers
19 november 2014