smarteco cities

SMART-ECO CITIES IN THE NETHERLANDS: TRENDS AND CITY PROFILES 2016

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INTRODUCTION

THE SMART-ECO PROJECT

This report forms part of a series also covering China, France, Germany, and the UK, and draws on preliminary findings from a three-year (2015-2018) research project titled Smart Eco-cities for a Green economy: A Comparative Study of Europe and China. The project is being coordinated by the University of Exeter, in collaboration with an interdisciplinary team of researchers from King's College London, the Universities of Westminster, Plymouth and Cardiff (UK); TU Delft and Utrecht University (the Netherlands); the French Centre for Scientific Research (CNRS) and the University of Toulouse (France); Freiburg University (Germany); Renmin University of China, and the University of Nottingham Ningbo China. As well as funding from the Netherlands Organisation for Scientific Research (NWO), the research is supported by the national funding agencies of China, France, Germany, and the UK.

The focus of our research is on the 'smart-eco city'. The 'smart-eco city' concept captures the recent trend for future-oriented urban development schemes that display both 'green' and 'smart' ambitions. More precisely, the smart-eco city is defined as "an experimental city which functions as a potential niche where both environmental and economic reforms can be tested and introduced in areas which are both spatially proximate (the surrounding region) and in an international context (through networks of knowledge, technology and policy transfer and learning)". The idea of the 'experiment' in this definition consciously refers to recent work identifying a tendency for new urban technologies and ways of working to be trialled at a limited scale, often through cross-sectoral partnership approaches, and with the aim of learning lessons, where traditionally firmer policy commitments might have been expected (see eg: Bulkeley & Castán Broto 2013; Karvonen & van Heur 2014; Evans et al. 2016). The concept of the 'niche' is taken from the expanding field of 'socio-technical transitions' scholarship, which studies the processes through which innovations come about and are taken up in society more widely (for an introduction, see eg: Geels 2002; Kemp et al. 2007).

Each of the national reports in this series profiles a series of cities, selected on the basis that they have relatively substantial smart-eco ambitions and/or activities already taking place. This selection was made following a wider 'horizon scan' of smart and eco initiatives taking place in each country (see this report's Appendix for the method adopted in the Netherlands). The intention is not to promote the profiled cities as necessarily representing the 'best practice' examples in the field, but rather to illustrate the variety of 'actually existing' smart-eco cities in each country. The profiles provide a contextual overview of

each city's aims, relevant policies, and the key actors involved, along with short descriptions of some of the main activities or projects taking place on the ground.

THE DUTCH SMART-ECO LANDSCAPE

The research for the current report used the 'smart-' rather than the 'eco-city' concept as an entry point for mapping out the current smart-eco urban landscape in the Netherlands, for two main reasons. FIrst, the term 'eco-city' itself is only rarely used in relation to contemporary urban initiatives in the Netherlands (and therefore would have been unrevealing as a search term). Second, as is the case for the other countries covered in this series, environmental ambitions and activities are already well established within local and national policy-making (and in this sense, the presence of the 'eco' may not describe anything particularly distinctive at local level). This report therefore focuses on four cities which have relatively strong 'smart' profiles, each of which weave 'green' ideas and environmental sustainability into their smart ambitions and activities in different ways.

The findings build on a number of other recent publications which paint a picture of the varied activities and ambitions around the smart city concept. Each of these has aimed to describe the state of the art in this emerging field by identifying various 'front runner' Dutch smart cities where experiments / living labs are in evidence:

- a key report by the Ministry of Infrastructure and Environment, *Smart Cities: naar een 'smart urban delta'*, which positions the urban heartland of the Netherlands as an urban delta region and includes the examples of smart city ambitions and initiatives in Amsterdam, Delft, Assen, Eindhoven (and to a lesser extent Helmond, Almere, The Hague, Roosendaal and Groningen).[1]
- *Hoe slim kan een stad zijn?* by Pamflet 2.nl, highlighting a number of conceptual perspectives on the smart city in the Netherlands with few examples. [2] The pictures in this report suggest that Amsterdam, Rotterdam, Eindhoven, Utrecht and The Hague are key sites

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[1]   http://www.platform31.nl/uploads/media_item/media_item/36/22/Smart_Cities_krant-1422533241.pdf

[2]   https://www.internetboekhandel.nl/base/53/content/9078342153.pdf

where smart city activities are taking place.

- KPN's *De verbonden samenleving in de slimme stad* also highlights Amsterdam, Eindhoven, Rotterdam and The Hague.[3]
- Other reports, however, such as *Smart Cities NL: Verkenning naar kansen en opgaven* by Venhoeven CS, choose to focus on the ambitions and initiatives of smaller Dutch cities with a very specific smart city profile, including Delft (with a participatory design focus) and Assen (with a technological focus as a 'sensor city').[4]
- In terms of mapping out experiments, the very informative database website SmartDataCity (http://www.smartdataci ty.org/) presents a fairly comprehensive platform where municipalities and other actors can showcase their visions and projects (including a prize for the 'best' vision and project). This includes visions and examples from Amsterdam, Utrecht, Breda, Eindhoven, Rotterdam, and The Hague. At the city level, Amsterdam is the only Dutch city with a similar (even more comprehensive) platform website of such activities: Amsterdam Smart City (https://amsterdamsmartcity.com/).

These sources, then, display significant overlap in their coverage. Taken as a whole, however, they point more strikingly to the practical and conceptual multiplicity of the

'smart' in the Netherlands. The overall impression gained is of a rather fragmented landscape – a point made particularly clearly in Mulder's Smart cities in Nederland te versnipperd[5], which argues that coordination at the national level is required.

To make sense of this confusing picture, the present report also draws on a series of 'helicopter interviews', as well as publicly available documents related to individual activities. These five interviews were conducted with people in a position to have an overview of the smart city ambitions and initiatives in the Netherlands, representing a variety of organisations: the Ministry of Innovation and Environment, Platform 31, Digitale Steden Agenda, Vereniging Nederlandse Gemeenten, and Vicrea. Interestingly, all the interviewees were in agreement about the difficulty of gaining a comprehensive and up-to-date overview of the ambitions and especially experiments conducted in Dutch cities, because the pace of these developments is so fast ("if you start today, tomorrow your overview is already old news", as one put it).

The interviewees were nevertheless in broad agreement about the front-running cities and activities, in echo of the findings of the reports mentioned above. Without claiming to have a full overview or full information, they felt confident in being able to point to the cities with the most

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[3]   https://images.direct-email.nl/direct-email.nl/static/201501_Ebook/Whitepaper_Smart_cities_A4_interactief.pdf

[4]   http://venhoevencs.nl/wordpress/wp-content/uploads/2015/03/Extract-Dutch_Smart-Cities-

NL_VenhoevenCS_lr.pdf   For details of these cases, see: https://issuu.com/tonvenhoeven/docs/smart_cities_nl_venhoevencs

[5] http://magazine.automatiseringgids.nl/digitaleeditie/2015/8/20150925_/1_24/lowres_page.pdf

pronounced smart city ambitions and collections of relevant experiments. Independently from one another, they positioned Amsterdam as the smart city with the highest profile, with Eindhoven and Rotterdam coming equal second. Utrecht and to a lesser extent the Hague were also clearly in the picture, with Assen, Almere, Arnhem and Delft also explicitly mentioned.

By combining (1) the findings in the reports discussed above, (2) the five helicopter interviews and (3) a systematic internet search of smart city activities in all Dutch cities with a population of at least 100,000 (see Appendix for details), four Dutch front-runner smart cities were selected for inclusion in this report: Amsterdam, Eindhoven, Rotterdam and Utrecht. A brief overview profile of each is presented below, and their smart city ambitions and activities are discussed in more detail in the sections which follow. These more detailed profiles include descriptions of a small number of individual activities, which have been selected to illustrate some of the variety of the initiatives taking place in each city.

Table 1: Overview profile of the four front-runner cities

Amsterdam (MRA)	Amsterdam is clearly the leading Dutch city in terms of smart city ambitions and experiment. A highly visible coalition of municipal and corporate actors projects the image of Amsterdam as a smart city and demonstration site to world. It is also the only Dutch city with a dedicated platform that aggregates local projects and defines three areas as living labs for a wide array of smart city experimentation. This platform speaks not only for the city of Amsterdam, but for the entire Amsterdam Metropolitan region (MRA), which includes smaller nearby cities such as Almere, Haarlem and Zaanstad, which are home to a number of interesting experiments as well.
Eindhoven	The mayor of Eindhoven is a very prolific and media-savvy smart city advocate, and smart city activity forms an explicit component of the municipal budget. As the central city of the Brainport region (allegedly the 'smartest region in the world'), Eindhoven has an extremely high concentration of high-tech companies and innovative startups. As in Amsterdam, a number of areas have clearly been designated as living labs for smart city experimentation, particularly on sensor technology and lighting.
Rotterdam	Rotterdam presents itself as a smart city with a clear focus on buildings/architecture, climate adaptation, and the port. As such, there are a large number of experiments that deal with environmental sustainability in the built environment and smartness in the area of water.
Utrecht	After reviewing thousands of pages of municipal 'structuur visies' and political party coalition agreements in Dutch cities, the Smart Data City jury concluded that Utrecht was the 2015 winner of the smartest Dutch inner-city because of its comprehensive vision, cooperation between stakeholders, and approach to learning / experimentation. Utrecht also promotes itself in terms of 'healthy urban living' and hosts a wide variety of experiments on smart health and e-governance.

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AMSTERDAM

Amsterdam is clearly the leading Dutch city in terms of smart city ambitions and experimentation. A highly visible coalition of municipal and corporate actors projects the image to the world of Amsterdam as a smart city, portraying it as a progressive demonstration site which also pays attention to bottom-up activity and social inclusion. Key spokespersons for Amsterdam as smart city include the city's mayor and 'chief technology officer'.[6]

Amsterdam is the only Dutch city with a dedicated smart city platform.[7] The Amsterdam Smart City platform (ASC) is a cooperative venture between the local council, economic board, citizens and a number of private sector companies. The platform was initiated in 2009 by the Amsterdam Innovation Motor (an independent organization promoting innovation, cooperation and new business – established in 2006), Amsterdam's municipal authorities, Liander (electricity grid operator) and KPN (a telecommunications and ICT provider) and now has over 100 partner organizations. Its ambitions, stated as part of its vision

statement, include the following: "...using a collective approach by bringing partners together and setting up local projects, ASC makes it possible to test new initiatives. The most effective initiatives can then be implemented on a larger scale. All the acquired knowledge and experience is shared via the ASC platform. In this way, ASC helps to accelerate climate and energy programs. The ultimate goal of all activities is to contribute positively towards achieving CO_2 emission targets, as well as aiding the economic development of the Amsterdam Metropolitan Area. In doing so, the quality of life will improve for everyone..." (Amsterdam Smart City 2013).

In the literature, Amsterdam Smart City is characterized as an 'urban innovation eco-system' that follows a 'bottom up participatory planning approach'. This reflects a peculiar institutional arrangement due to the fact that the ASC collaborative platform is at the heart of the city's smart city visions, which can be contrasted with the 'top down' approach of iconic smart cities such as Masdar and Songdo, but also to the allegedly somewhat

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[6] Amsterdam municipality has employed a so-called Chief Technology Officer (CTO) since 2014, in order to facilitate innovation and tie together various municipal strategies to (business) partners. This CTO is the key spokesperson for the smart city in Amsterdam (perhaps not surprisingly, since the name CTO echoes a function in a large hi-tech corporation, and the smart city as such is also largely a discourse put forward by corporations; in both cases the interests of these innovative corporations and city governments are tied together).

[7] see http://amsterdamsmartcity.com/about-asc?lang=nl and http://amsterdamsmartcity.com/data/file/MeteringInternational_BottomUp_GB.pdf For lessons learnt from the platform so far, see http://amsterdamsmartcity.com/data/file/ASC_SMART_STORIES_H4_lessons_learnt.pdf. And for an earlier different version of this platform, see http://amsterdamsmartcity.com/data/file/Energy%20Insights.pdf

top-down 'actually existing smart city' in Barcelona (see Zygiaris 2013; Ching 2013, Shelton et al. 2014 – though most of the sources upon which this academic literature is based are promotional documents by smart city boosters in Amsterdam itself).

The ASC platform aggregates local projects and defines three areas as 'living labs' for a wide array of smart city experimentation. These experiments are framed in terms of addressing societal challenges, including environmental sustainability. However, environmental sustainability is not always the main framing (other laudable ideals such as public participation, social inclusion and healthy lifestyles are also present). A closer look at the 90 or so experiments listed on the website reveals that around a third are also clearly couched in eco terms (mostly

experiments into energy saving and electric mobility) (Amsterdam Smart City 2016). The official 'urban living labs' from ASC are the areas of Nieuw-West (with significant focus on smart grids), Zuid-Oost (focusing on cooperation between companies and energy efficiency), and IJburg (smart living, smart working and connectivity). But there is also another 'Fab-lab' or 'experience lab' designated as smart city pilot area on Java-eiland, as well as other lively pockets of bottom up smart city activity in areas such as Buiksloterham. The ASC not only aggregates and supports these activities within the city of Amsterdam, but also for the entire Amsterdam Metropolitan region (MRA). This region includes smaller nearby cities such as Almere, Haarlem and Zaanstad – which are home to a number of interesting experiments as well.

EXAMPLES OF PROJECTS

CITY-ZEN

This project demonstrates innovations in smart grid, district heating, and green building technology, in the Nieuw-West part of Amsterdam[8] (one of the Amsterdam Smart city platform's 'urban living labs'). It aims to develop and demonstrate Zero Energy Cities with a central role for citizens, who are enrolled in the project and given more freedom of choice in how they deal

with energy. These aims resonate with Amsterdam's presentation of smart cities in terms of participation and social inclusion alongside the discourses of sustainable innovation (eg 'Innovation is at the heart of the [City-zen] project' and 'smart, sustainable and future proof', 'x tonnes of CO_2 saved') which are mobilized in the framing. The project should be seen as part of the smart city living lab in Nieuw-West, incorporating innovative and ambitious

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[8] see http://www.cityzen-smartcity.eu/objectives/ and http://www.cityzen-smartcity.eu/nl/home-nl/amsterdam/. For an overview see https://www.energiekaart.net/initiatieven/city-zen-new-urban-

energy/ and for demonstration sites see http://www.cityzen-smartcity.eu/demonstration-sites/amsterdam/).

concrete experiments. Two main goals have been formulated: reducing CO2 by installing new tech in old houses (hands-on local niche experiments); and developing a showcase on the basis of conducted experiments to serve future projects (global niche aggregate activity). Specifically, 700-900 dwellings are to be retrofitted with a CO_2 reduction target of 3,000 tonnes per year; 10,000 dwellings will be connected to a smart grid; and two heat grid projects are envisaged (sustainable heating networks cooled by water in order to reduce CO_2 emissions by 4,500 tonnes per year). This is a clear case of retrofitting an existing city, as opposed to developing a smart city from scratch on greenfield sites.

This overarching project should be seen as a set of sub-projects in buildings and in the context of a wider EU project conducted in parallel in both Amsterdam and in the city of Grenoble in France. Whilst the efforts of Amsterdam here are essentially a city-level project (an Amsterdam-based lab, with Amsterdam-based actors including the municipality and Amsterdam Economic board), an interesting set of inter-scalar and transnational linkages are also evident in the form of EU funding and cooperation with Eco-Cité Grenoble. In Amsterdam, as many as 23 (mostly Dutch) partners are participating. This includes the municipality, a selection of companies and

research institutes, and citizen participation is presupposed. As is the case in such EU projects, a division is made in work package tasks, with different tasks led by the Amsterdam Economic Board, VITO, Siemens, Th!nk E, KEMA and TU Delft. The Amsterdam Smart City platform (ASC) plays a coordinating role as well. The project partners are reported to be contributing 20 million euros to the project, with a further 20 million euros also provided by the EU FP7.

The project started in March 2014 and is projected to last for 60 months. It is categorized in the EU reports as being at the 'TRL 9' (most advanced) stage of development – in other words, that it is an 'actual system proven in operational environment'. Most of the techniques and processes mentioned are in place, but their adoption has not necessarily been widespread. Implementation is also often fragmented or uneven in local settings, due to the practical reality that it has to take place "in actual urban conditions: real people living in existing buildings". Actual practices, then, typically depart from the prescriptive or idealised picture painted in the publicly available documents. In one of the interviews, a person involved with the overarching City-Zen project explained that "some expectations of some actors were not met, some projects became obsolete, or cities bailed out".

Figure 2: Screenshot from Amsterdam Smart City Platform website (Source: http://amsterdamsmartcity.com/projects/living-labs)

Figure 3: Screenshot from promotional movie on serious gaming app developed in City-zen project (Source: http://amsterdamsmartcity.com/projects/detail/id/78/slug/city-zen)

VEHICLE2GRID

Vehicle2Grid is a smart city initiative in Amsterdam which offers a solution for the surplus of energy generated from renewable sources during the day, when demand by customers is low.[9] The initiative allows for this surplus to be stored in the batteries of Electric Vehicles which function as an 'energy buffer.' The stored energy is released in the evening to meet peak demands.

The aim of the initiative is to create impact in three ways: by making it cheaper to manage peak loads, by reducing the need for fossil fuels; and through its promotion of the sharing economy. Scaling this initiative is attractive, since different profiles of household consumption and vehicle usage might complement each other and create greater overall efficiencies. Furthermore, scaling up of the project should result in more positive environmental impact and therefore city liveability.

The precursor of the project, called 'tanken op eigen dak', took place in Zaanstad, where the municipality tried to balance the supply of sustainable energy from municipal solar panels with the demand of charging electric vehicles. A visualization was added to show how much of the energy that was used by the cars was produced by Zaanstad itself. In 2013, municipal cutbacks resulted in the discharge of all employees with temporary contracts. An unintended consequence was the reduction of the department for sustainability from 13 employees to two, which resulted in the end of the project. One of the initiators of the project decided to continue the project concept in Amsterdam, and in 2013 a collaboration was formed with the companies MasterVolt, Liander and Resourcefully. A functional and technical concept was developed for a houseboat and the pilot system started running in 2014. The system has been running from 2014 until now (2016) and has generated a wealth of data about the functionality of the system such as amount of energy generated, stored, used and the decay of energy. Currently, the project initiators are trying to obtain funding from the European Commission to implement the concept on a wider scale in Amsterdam.

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[9] I am grateful to Yvette Oomens, MSc student at the Eindhoven University of Technology, for providing information about this initiative.
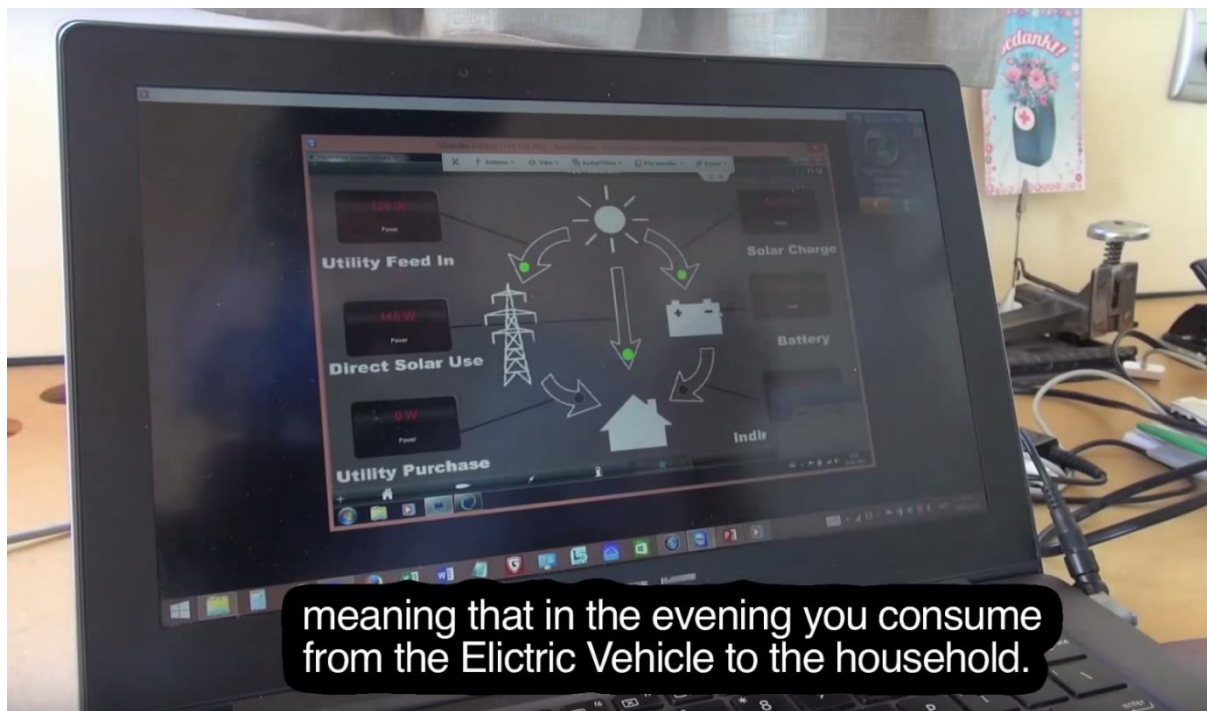
Figure 4: Screenshot from promotional movie Vehicle2grid (Source: http://www.amsterdamvehicle2grid.nl/)

AMSTERDAM ARENA INNOVATION CENTRE (AAIC)

AAIC is located in the ArenA stadium in Amsterdam.[10] It was established in 2015 as a living lab for smart city innovation to enable rapid development, testing and demonstration of smart applications and solutions with the mission to "accelerate the creation and market introduction of new unique smart city applications to improve profitability, sustainability, safety and customer experience" (Amsterdam Arena, 2016). The stadium is being renovated in advance of the European Championships in 2020, which provides the opportunity for the AAIC to transform it into a sustainable and 'sensing' building. The AAIC has several strategic partners (Huawei, Microsoft and KPN) that ensure the availability of several core facilities. The programmes that function on these facilities have their own consortia that also pay for the facilities. Data from the stadium and its surrounding neighbourhood can be used for all kinds of projects (experiments within this larger aggregate AAIC living lab / experiment). One of the key distinctive features of the project is the embeddedness of scale in the plan.

One example of the smaller scale experiments under this overall umbrella is the Mobility Portal, where the ArenA aims to enhance customer experience by getting

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[10] I am grateful to Yvette Oomens, MSc student at the Eindhoven University of Technology, for providing information about this initiative.

in touch with the customer at an early stage to provide advice on sustainable transport options, and up-to-date travel information on the road and in the ArenA area. It is connected to the 'mobility room', where social media sources are monitored to provide people with up-to-date, personal information for one of the venues in the area. This mobility portal is designed to be scaled up, with options such as creating a 'corridor' between Schiphol Airport and the

Floriade being developed. The corridor entails a connection between Schiphol Airport and the ArenA during the European Championships, such that ArenA visitors will be scanned at the airport, making the security process at the ArenA itself faster and easier, thereby also enhancing the customer experience. A similar system is planned for Schiphol and the Floriade in 2022.

Figure 5: Inside the AAIC office - a presentation about the AAIC projects for a Chinese delegation from Huawei (Source: picture by author, 2 June 2015)

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EINDHOVEN

As the central city of the 'Brainport' region in the South of the Netherlands (allegedly the 'smartest region in the world'), Eindhoven has an extremely high concentration of high-tech companies and innovative startups. As in Amsterdam, a number of areas have been designated as living labs for smart city experimentation, particularly on sensor technology and lighting. There are a number of relevant living lab sites: Startumseind, Strijp-S and Eckard Vaartbroek; and the area between Eindhoven and Helmond for smart mobility. Two large smart city urban living lab projects have received EU funding: TRIANGULUM (Strijp-S site) and AiREAS (thoughout the city). TRIANGULUM projects are also being run in parallel in Stavanger (Norway) and Manchester (UK).[11]

Most of the experimental projects conducted in Eindhoven give centre stage to technological innovation or optimization, and involve the testing of high-tech hardware. This has been quickly translated in a number of concrete projects and hence Eindhoven can be seen as exhibiting a truly hands-on experimental approach to the smart city. The eco-element is not the main concern – it can be found in some projects (where the focus is on smart mobility, air quality, some lighting projects) but not in others (where the focus is on security, entrepreneurship other lighting projects). There are also differences between the 'eco' component of the various living labs throughout the city: the Eckard Vaartbroek lab features energy efficient renovations (more eco), while the Stijp-S area features as a 'creative smart city district' (less eco) and the Stratumseind 2.0 lab is about security and crowd management (no eco).

Given the nature of these experiments, and compared with 'tier 1' smart cities such as Barcelona and Amsterdam, the approach in Eindhoven has been characterized as limited in focus (see European Parliament ITER 2014).

EXAMPLES OF PROJECTS

STRATUMSEIND 2.0

This small but iconic experiment that has managed to capture the attention of national media – and for that reason alone some of the actors involve have declared the project a success. In this case, the experiment itself is called a living lab (other sites in Eindhoven labelled as living labs are home to multiple experiments). The

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[11] For further details of the TRIANGULUM project, please see the UK report in this series (Caprotti et al. 2016: chapter on Manchester).

'Stratumseind' is a street in the centre of Eindhoven known for its many clubs and bars, and with its own particular related problems (excessive alcohol consumption, street brawls etc). The street has been equipped with lighting devices and sensors, cameras and an actual control centre (resembling Rio de Janeiro's smart city control centre, but much smaller) in order to collect street-level activity data (movement of people, volume of sound, twitter feeds etc). The aim is to provide an integrated solution for 'Smart Crowd Management' with the ambition to make them more 'manageable', attractive and profitable for businesses, citizens, law enforcement and other stakeholders. The project is framed in terms of cutting edge technologies and applications (eg smart sensors, smart interfaces, smart lights, smart data, smart design, augmented reality, gaming) and improving the quality of the local site (to 'improve livability, safety and attractiveness').

It is an ongoing project for the local municipality (two people from the municipality are the main initiators), and is supported by local businesses and a few high-tech companies (including both multinational corporations and local startups). Initially €50,000 was paid by the municipality and the collective organization representing the local bars, but with the advent of more hi-tech companies and recent publicity, the budget is likely to have increased (this is not clear from the documents and probably subject to change).

The initial project, Startumseind 1.0, was launched in 2012 and the current Stratumseind 2.0 is its successor. The project seems to have developed organically. One evaluation report is critical of the project in that: "… one of the main concerns and structural weaknesses, almost a logical consequence of that key success factor, is the lack of embedding of the Living Lab. It would be better for an experimental setup like the Living Lab to be guaranteed at least a 2- or 3-year period for experimenting, rather than being confronted frequently with existential uncertainty. That uncertainty quite often scares potential new partners…" (Venture Spring 2015). Concerns over privacy have also been raised with regard to this experiment, in particular comparing the Stratumseind 2.0 site to a Panopticon, highlighting the risk that data will not be sufficiently anonymized, and asserting the city dweller's right not to be measured (Tegenlicht 2016).
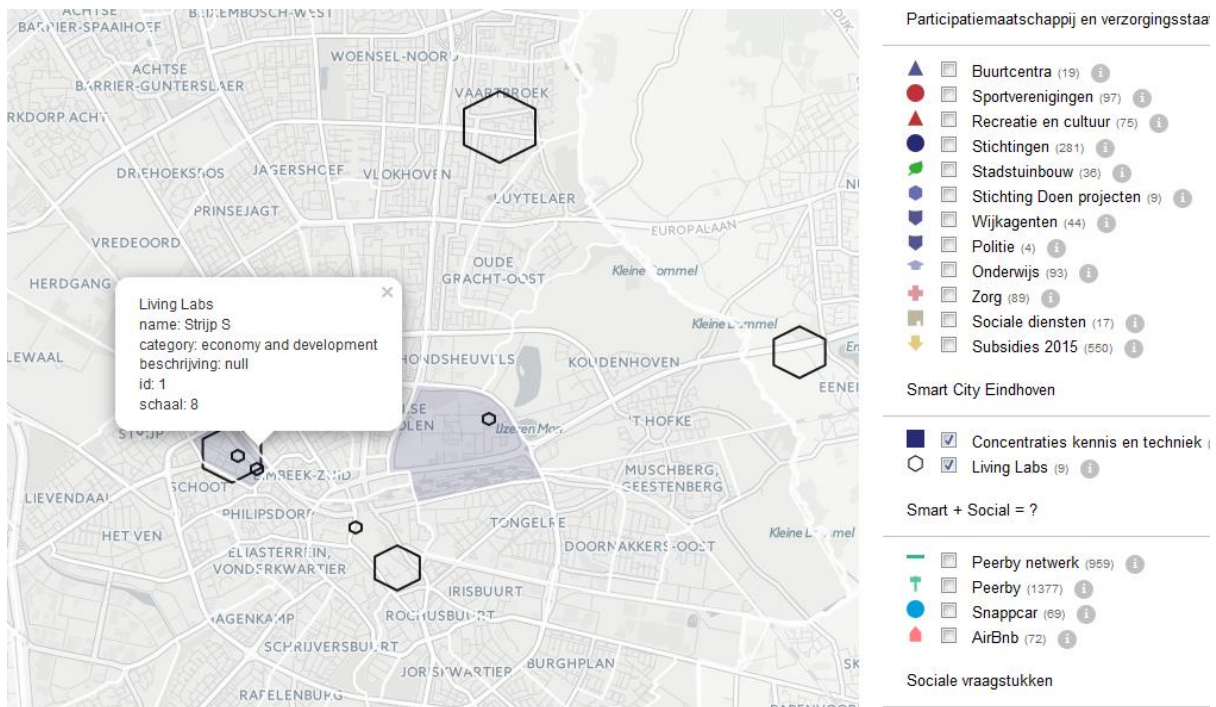
Figure 6: Locations of smart city living labs in Eindhoven

(Source: De staat van Eindhoven - http://destaatvaneindhoven.hetnieuweinstituut.nl/mapping)

Figure 7: The control center of Stratumseind 2.0

(Source: Philips Communications https://www.flickr.com/photos/philips_newscenter/11288344355)

WOONCONNECT

Another example of an experiment conducted mainly in Eindhoven is WoonConnect. [12] This digital library contains specified building components of over a hundred manufacturers and can also put together different components from different manufacturers. All features and information on the components can be found in the library and the library can be integrated with building applications. WoonConnect enables a user to create new houses and make adjustments to existing houses in 'real-time' through the use of dynamic 3D information-models. Thus, individuals are able to adjust a house to their wishes. Users can be individuals, building companies, project developers, architects, buyers and sellers, municipalities and housing corporations. The platform has many components, including direct feedback on the energy savings produced by a certain adaptation in the 3D information-model and the possibility to share information with other citizens.

All of this started in 2001 when the design and automation company De Twee Snoeken developed the BouwConnect library, at that time still called 'het Digitale Huis'. In 2010, the telecom company KPN joined in and helped finance the development of the library. When in 2012 it appeared that the package of BouwConnect was extensive enough to contribute not only to buildings, but many different domains (living, sustainability, health), it was decided to make BouwConnect the core technology of the platform WoonConnect. In 2013, the first prototype was finished, and in 2014 KPN stopped financing WoonConnect and became a strategic partner of the Twee Snoeken.

After this, an agreement was signed with De Twee Snoeken, KPN, and the municipality to implement WoonConnect in the neighbourhood Eckhart Vaartbroek in Eindhoven, as part of the municipal programme Eindhoven Smart Society. The project obtained €900,000 co-funding from the European Commission. Other partners joined the project, such as Eindhoven Technical University and the SPARK campus for construction innovation. So far in Eckhart Vaartbroek, 4,500 houses have been digitalised and by the end of 2016, this should have increased to 7,500 houses.

But this project did not stay limited to Eindhoven. It was scaled up (more houses) and scaled out (houses in other cities). So far, two projects have been executed in Den Bosch, 200 houses have been digitalised in Arnhem and the digitalisation of 300 houses in Rotterdam is taking place. The project was also selected by the five largest cities in the Noord Brabant province as a 'CityDeal', a UK-based idea of a collaboration agreement between cities

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[12] I am grateful to Yvette Oomens, MSc student at the Eindhoven University of Technology, for providing information about this initiative.

and the national government aiming to strengthen growth, innovation and liveability in Dutch cities. The aim of these five cities now is to digitalise 100,000 houses in the Noord Brabant province (Brabantstad 2015). The number of houses digitalised as part of the CityDeal would be even bigger, but the deal has not yet been formally closed.
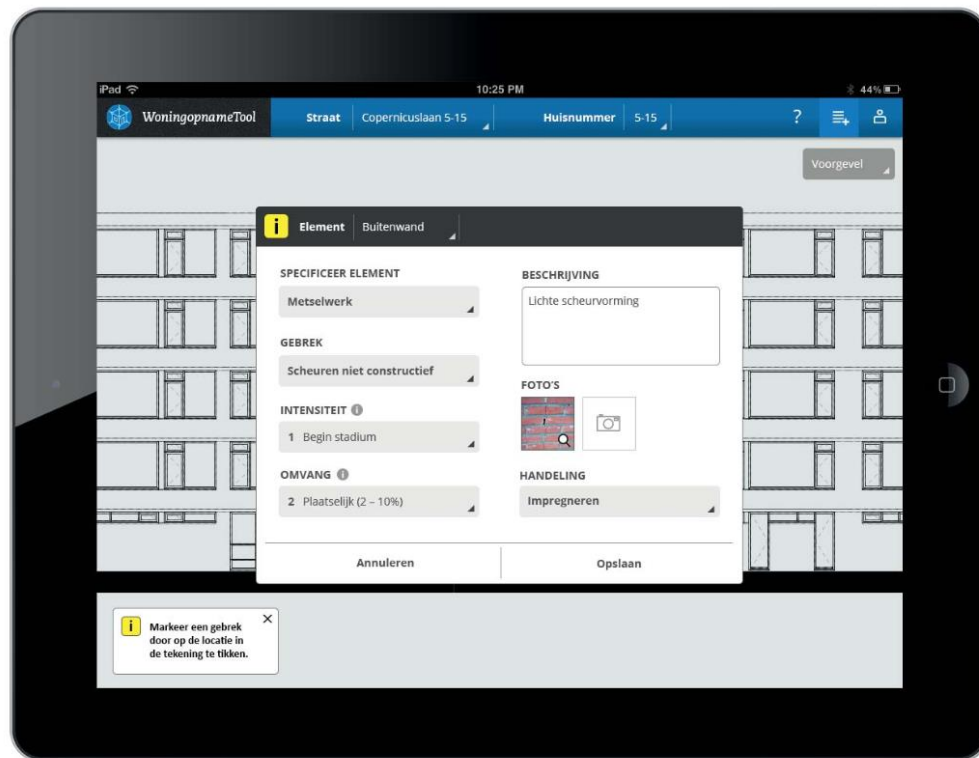
Figure 8:

Cataloguing houses in the digital Woonconnect library
(Source: http://www.woonconnect.nl/Files/pdf/woonconnect.pdf)

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ROTTERDAM

Rotterdam presents itself as a smart city with a clear focus on buildings and architecture, climate adaptation, and the port. As such, there are a large number of experiments that deal with environmental sustainability in the built environment and smartness in the area of water. This pronounced eco-component in the Rotterdam projects is expressed in its overall framing in terms of CO_2 emission reduction and climate change adaption, especially in terms of dealing with water in a sustainable way.

EXAMPLES OF PROJECTS

BENTHEM SQUARE

Benthem Square is an innovative 'water square', created in order to protect the city from sewage overload and other water damage in case of heavy rainfall, but it also has other public functions. As an effort of urban regeneration and place-making in a previously drab location, it embodies a playful attitude towards both water and infrastructure, being clearly visible and at surface level, rather than hidden away under the ground. It features an integrated system with multi-tiered gutters that drain water from the rooftops towards three basins on the square, where it is buffered instead of released directly to the sewage system. The smartness resides in the design and in the use of sensors in combination with a rainfall prediction system (the rain radar). Positioned as the first full-scale version in the world, The Benthem Square is lauded as a global 'best practice' of sorts (it had a precursor in the smaller Bellamy water square in another part of Rotterdam). In this global context, the project is not only framed by the 'smart' but also in terms of 'resilience', with the idea that it will potentially help the city recover from climate change-related shocks such as flooding.

The Benthem water square design was completed in 2011-2012, and after construction it has been in use since 2013 (though the rain radar addition only since 2015). It was funded by the Rotterdam municipality funded and designed by local architect firms, with costs estimated at €5 million.

In terms of scalar dynamics, the Benthem square features as a 'local solution' that is supported by more city-wide smart solutions such as a rain radar detector system. Interestingly, this water square is a 'spatial' innovation in itself applied to public space and to water, but has also become a springboard for 'non-spatial' technological innovations such as the rain radar. In addition to Bellamy water square, its precursor mentioned above, Benthem square's perceived success means that a further water square will be created at a new location (Staringen water square). Furthermore, actors such as Dutch Embassies and 'Holland Branding' as well as

international networks such as '100 Resilient Cities' and local actors including 'De Urbanisten' are promoting the Benthem water square as a global best practice initiative by producing promotional material, and organizing site visit tours for foreign groups.

It should be mentioned that part of the initial idea for urban regeneration came from citizens/local residents, who also participated in the design process. Some stakeholders involved describe this type of meaningful cooperation as something relatively new to Rotterdam. According to them, this is the key success factor in the project, whereas the lack involvement of – and friction with – local citizens was the reason that its precursor, Bellamy water square, failed to inspire enthusiasm in the same way.

Figure 9: Benthem water square (source: Rotterdam Architecture Prize
http://www.rotterdamarchitectuurprijs.nl/jaar/2014/upload_longlist/benthemstraat_13_3032_aa_rotte.html)

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UTRECHT

In 2015, Smart Data City (a consortium of corporations and networking organizations) organized a competition offering a prize for the smartest inner city in the Netherlands. After reviewing thousands of pages of municipal 'structuur visies' and political party coalition agreements in Dutch cities, the jury concluded that Utrecht was the winner in the category 'vision'. According to the jury, Utrecht distinguishes itself through a good mix between 'learning by doing' (experimentation) and vision, with a special focus on 'cooperation' (within the municipality as well as cooperation with government agencies at other levels, knowledge institutes, companies and citizens) (see Smart Data City 2015, Mijn-Gemeente 2015, AgendaStad 2015).

In terms of consortium visions or ambitions, there are clear formulations about the future smart city. Smart grids/energy/mobility/charging is a key area of focus (as exemplified by the Smart City grid 030 consortium, and the single Utrecht Smart Mobility Platform aggregating a variety of smart charging experiments by many different actors). One vision gaining traction is the idea of Utrecht as a 'smart and healthy city' with a clear focus on healthcare technology (ie by the Knowledge Cluster Utrecht consortium – no doubt due to the large concentration of health-technology related companies in and around Utrecht). As in other cities such as Amsterdam, the economic board is one of the key actors (for example, it hosts a smart city living lab called FiwareLabNL). While much is framed in terms of smart health or smart governance, some other projects do have a more classic 'eco' focus, with clear ambitions to reduce greenhouse gas emissions and to increase 'liveability' by improving local environmental characteristics.

EXAMPLE OF PROJECTS

SOCIAL CHARGING

Social Charging is a start-up based in Utrecht that seeks to enable drivers of electric vehicles to use each other's charging stations. It does so by providing a mobile communication platform and an app for users to exchange information. Besides acting in its users' interests, another object is to limit the strain and cost of future investments in the electricity grid.

The aim is first and foremost to make electric driving more attractive and user friendly, because electric driving is viewed as 'clean and sustainable', though technical discourses such as helping with 'peak shaving' to reduce future investments in the electricity grid are also mobilized. The big idea is to supply the 'social infrastructure' (which is lacking) on top of the 'technical infrastructure' (which is

partly already in place). The goal is to limit greenhouse gas emissions, improve air quality, reduce costs of the future electricity grid and – as a somewhat different but clearly stated objective – to learn about the behaviour of EV users.

At the centre of this project are two institutional entrepreneurs, though at various stages other actors have become involved, such as Enevalis, Enexis, Greenflux, Smart Power Suite, officials of the four biggest Dutch cities (Utrecht, Amsterdam, Rotterdam, the Hague) and the European Space Agency incubator program. The dynamics of scale and location here are different from other experiments, because this is not clearly related to a particular site; the startup company itself is the experiment. It happens to be based in Utrecht, but other Dutch municipalities are interested as well. It is difficult to 'locate' exactly because the project seeks to establish a social network of EV-users. But the actors involved have ambitions to scale up "to the Randstad region to the whole of Netherlands and eventually to abroad". Whilst Utrecht is seen as the project's home, there are agreements to start a large trial in the Hague.

Social Charging was launched in May 2014 and is currently at a fairly early stage: it is unclear from interviews and documentation whether actual EV drivers are really using the app in daily practice. The institutional entrepreneurs who initiated the start-up talk about technical difficulties and "inventing the wheel yourself" with GPS location technology. So

far, an app (the main product of this startup to date) has been developed and is now in the beta phase. Much of the institutional work revolves around developing the platform and attracting funding. The precise situation with regards to funding is difficult to discern from the documentation. €50,000 was obtained from the Smart Mobility Challenge prize. Other prizes were received, such as the Open Data FWD Challenge, and this start-up was also admitted to European Space Agency incubator. According to one of the founders, further funding has become available as the different stakeholders have chosen to participate, but the total amount of investment so far is unclear.
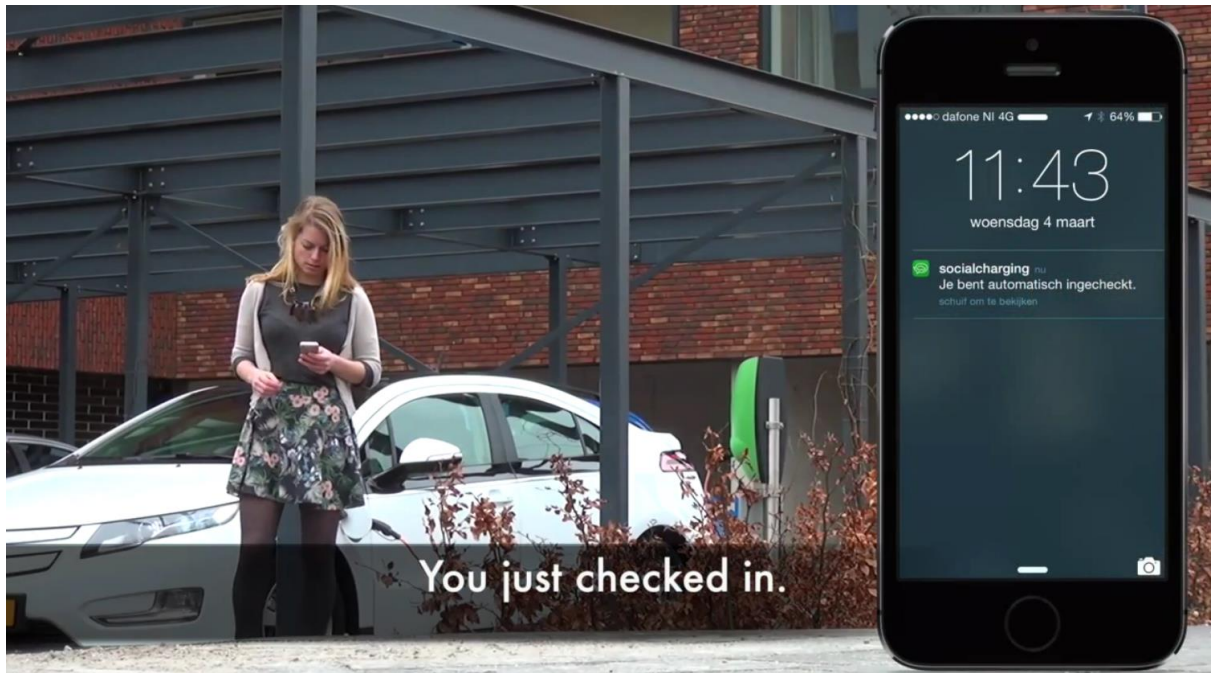
Figure 10: The social charging app (Source: Social Charging https://www.f6s.com/socialcharging)

UTRECHT REFERENCES

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APPENDIX: METHOD FOR SELECTING DUTCH CASE STUDIES

STAGE 1: THE FIRST SIFT (ROUGH SELECTION)

(1) Compilation of a 100K+ city list: A list was compiled of all Dutch cities with a population of more than 100,000 people. The most comprehensive world city list found was the GeoNames list (download.geonames.org/export/dump/cities15000.zip, downloaded 20-01-2016). This yielded 23 cases.

(2) Collecting key reports: Reports were found in Google and Yahoo by looking for the following phrases: 'smart city Nederland filetype:pdf', 'smart cities Nederland filetype:pdf', 'slimme stad Nederland filetype:pdf, 'slimme steden Nederland filetype:pdf'. The documents below are considered the most prominent reports:

- Misterie van Infrastructuur en Milieu (2015) Smart Cities: naar een 'smart urban delta'[13]
  This includes the following examples of ambitions and initiatives of actual Dutch cities: Amsterdam, Delft, Assen, Eindhoven (and to a lesser extent Helmond, Almere, The Hague, Roosendaal, Hoogkerk / Groningen).

- Pamflet 2.nl (2015) 'Smart Cities : hoe slim kan een stad zijn?'[14]
  Mostly conceptual perspectives on the smart city with few examples. The pictures in the report suggest the following cities: Amsterdam, Rotterdam, Eindhoven, Utrecht, The Hague.

- VenhoevenCS (2014) Smart Cities NL: Verkenning naar kansen en opgaven[15]
  This includes the following examples of ambitions and initiatives of actual Dutch cities: Amsterdam, Delft, Assen.

- KPN (2015) De verbonden samenleving in de slimme stad [16]
  This includes the following examples of ambitions and initiatives of actual Dutch cities: Amsterdam, Eindhoven, Rotterdam, The Hague.

- Mulder, E. (2015) Smart cities in Nederland te versnipperd [17]
  This does not include specific examples, but makes the point that the smart city agenda in the Netherlands is too fragmented and that coordination at the national level is required – many interviewees and other documents consulted also echoed this point.

- SmartDataCity (2016) Comprehensive website[18]

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[13] http://www.platform31.nl/uploads/media_item/media_item/36/22/Smart_Cities_krant-1422533241.pdf

[14] https://www.internetboekhandel.nl/base/53/content/9078342153.pdf

[15] http://venhoevencs.nl/wordpress/wp-content/uploads/2015/03/Extract-Dutch_Smart-Cities-NL_VenhoevenCS_lr.pdf
for details of these cases see https://issuu.com/tonvenhoeven/docs/smart_cities_nl_venhoevencs

[16] https://images.direct-email.nl/direct-email.nl/static/201501_Ebook/Whitepaper_Smart_cities_A4_interactief.pdf

[17] http://magazine.automatiseringgids.nl/digitaleeditie/2015/8/20150925____/1_24/lowres_page.pdf

[18] www.smartdatacity.org

Though not really a report, this fairly comprehensive website serves as a platform where municipalities and other actors can showcase their visions and projects (including a prize for the 'best' vision and project) and contains a lot of information. This includes visions and examples from the following Dutch cities: Amsterdam, Utrecht, Breda, Eindhoven, Rotterdam, The Hague.

(3) Helicopter interviews: 5 'helicopters' – people who are in a position to have an overview of the smart city ambitions and initiatives in the Netherlands – were interviewed. This included people well placed at Ministrie Innovatie en Infrastruur, Platform 31, Digitale Steden Agenda, Vereniging Nederlandse Gemeenten and Vicrea.

According to these stakeholders, it is very difficult to get a comprehensive up-to-date overview of the ambitions and especially experiments conducted in Dutch cities under the banner of 'smart city', because the pace of these developments is very fast ("if you start today, tomorrow your overview is already old news"). While the interviewees acknowledged that they do not have the full overview and that they are missing information, they were able to point to cities with the most pronounced smart city ambitions and collections of relevant experiments. There was a consensus view that Amsterdam is the smart city with the highest profile; Eindhoven and Rotterdam are in equal second place; Utrecht and to a lesser extent the Hague were also clearly in the picture; with Assen, Almere, Arnhem and Delft also mentioned explicitly.

(4) Combining the results: Combining the three approaches results in the following 25 cases (the 23 largest Dutch cities with a population over a hundred thousand + Delft and Assen):

Table 2: the 'long list' of cities following stage 1 of the selection process

Almere	Assen	Den Haag	Hoofddorp	Tilburg
Amersfoort	Breda	Eindhoven	Leiden	Utrecht
Amsterdam	Delft	Enschede	Maastricht	Zaanstad
Apeldoorn	Dordrecht	Groningen	Nijmegen	Zoetermeer
Arnhem	Den Bosch	Haarlem	Rotterdam	Zwolle

STAGE 2: THE SECOND SIFT (AMBITIONS, EXPERIMENTATION AND ONLINE PRESENCE)

To be selected, the following properties of cities (or, to be more precise, of key actor coalitions claiming to speak for these cities) needed to be identifiable:

(1) Explicit smart city ambitions: Initial analysis revealed that the term 'smart city' is highly pervasive in Dutch urban policy discourse, and was therefore used as our main point of entry. Table 3 below show which cities, upon first glance, have an explicit smart city ambition/agenda. This means that the municipality or other key actors (national government, important companies or collectives of citizens) have formulated a clear agenda, roadmap, vision or idea behind a set of local smart city experiments.

(2) Implicit eco-city ambitions: Initial analysis also revealed that the term 'eco-city' is hardly used in Dutch urban policy discourse. The initiatives and ambitions found online are mostly on older websites about rural neighborhoods and communes that date back to the 1990s (interestingly these websites emphasize the low-tech, localism and spiritualism as features of these communities – the polar opposite of the current Dutch smart city discourse). Therefore, the use of the term eco-city itself was not a criterion for inclusion. However, in order to take the 'eco' character into account we did look for the presence of certain related terms ('green', 'environment' and 'sustainability') in the smart city ambitions (again, see table 3 below).

(3) The presence of experimentation in multiple domains: In order to qualify, cities needed to have translated part of their ambitions into concrete projects or 'experiments', in line with the overall understanding of the 'smart-eco city' (see Introduction to this report). For the purposes of this sift, an experiment was defined as 'an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of deep uncertainty and ambiguity'.[19] Experimentation in one domain (eg only smart mobility) was not considered sufficient proof of a comprehensive smart city focus. Rather, in order for a city to qualify, there needed to be evidence of experimentation in two or more of the following domains: smart mobility (ICT, clean, also non-motorized), smart people (creativity, inclusivity, education), smart economy (innovation/entrepreneurship, productivity, local/global), smart environment (buildings, energy, urban planning), smart government (supply-demand policy, transparency/open-data, e-gov), and smart living (healthy, safe, culturally vibrant).[20]

(4) Online presence: To get a first idea of how pervasive the 'discursive buzz' around each city, we also made use of web browser search engines. Searches were conducted for the 25 cases identified in the first sift, using the term "<city name> AND 'smart city'", and the numbers of 'hits' thus achieved were recorded. The results for this exercise, based on the Google search facility, are shown in the final column of Table 3. As well as providing a further perspective on the relative prominence of each of these cities in Dutch smart city discourse, it was expected that a stronger presence would also indicate greater availability of information about the city's ambitions and experiments, and thereby facilitate a more comprehensive process of enquiry.

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[19] Sengers, F., Berkhout, F., Wieczorek, A.J., Raven, R.P.J.M. (2016) Experimenting in the city: Unpacking notions of experimentation for sustainability. In: Evans, J., Karvonen, A., Raven, R.P.J.M. (eds.) *The Experimental City*. Routledge: London.

[20] This categorization of the smart city in domains is based on 'The Smart City wheel' by Boyd Cohen – though there are many such subdivisions of smart city domains with slightly different categories, this one is chosen because it also appears in a prominent Dutch smart city report.

Table 3: Summary results from first two 'sifts' (continued on following pages)

City	Explicit smart city ambitions?	Implicit eco-city ambitions?	Experiments in multiple domains?	Popu-lation	Online presence (number of Google hits)
Almere*	Yes, definitely [21]	Not explicitly	Yes	176.432	(79.100)
Amersfoort	Yes, to some extent [22]	Yes, but not primarily	Yes	139.914	(70.200)
Amsterdam	Yes, definitely [23]	Yes, but not primarily	Yes	741.636	(1.010.000)
Apeldoorn	Yes, to some extent [24]	Yes, but not primarily	Yes	136.670	(37.300)
Arnhem	Yes, to some extent[25]	Yes, explicitly	Yes	141.674	(83.000)
Assen	Yes, definitely [26]	Not explicitly	Yes	67.329	(55.400)

[21] http://webwereld.nl/overheid/238-almere-wil-een-smart-city-worden (Almere economic Board signed a letter of intention to cooperate with a few big tech companies – Philips, Cisco, IMB, Living PlanIT – to develop two smart city testing sites ('proeftuinen') – see especially the movie below on Almere's smart city framing). http://www.almeresmartcity.nl/ (also see the vision and website of 'Almere smart society'; the idea for doing this is copied from Amsterdam and its smart city platform website). For framing see http://www.almeresmartsociety.nl/archive (this overview with projects show barely any environmental / sustainability concern).

[22] https://www.fiware.org/2015/11/30/dutch-cities-collaborate-on-open-and-agile-smart-cities/ (Along with several more high profile Dutch smart cities, Amsersfoort has signed the Open & Agile Smart Cities (OASC) letter of intent). http://kennislabvoorurbanisme.nl/wp/?page_id=122#.Vxd-OHoWP_Q (There is also an urban knowledge lab in Amersfoort, experimenting to contribute specifically to Amersfoort as a sustainable and smart city) http://www.cohere.eu/10-autos-tegelijk-laden-parkeergarage-arnhem-centraal-dankzij-smart-charging/ (projects include smart mobility / smart charging).

[23] http://amsterdamsmartcity.com/about-asc (the municipality is part of a wider consortium of actors). The key elements of the framing are: sensor city, innovation platform, living lab. Amsterdam is the only Dutch city with a clear overarching smart city platform that keeps track of experiments and projects.

[24] https://www.rvo.nl/sites/default/files/bijlagen/0402.1285%20Factsheet%20Smart%20Power%20City%20Apeldoorn_WT_web.pdf (Apeldoorn is implicated as 'smart power city', due to pilot projects with smart grids. For more examples in the smart energy domain see http://www.smartcities-infosystem.eu/concerto/sites-projects/concerto-sites/apeldoorn).

[25] http://tki-switch2smartgrids.nl/wp-content/uploads/2013/12/Uitvraag-kwartiermaker-GD-SmEC.pdf (The municipality of Arnhem is part of a consortium on smart energy cities, along with Amsterdam, Enschede, Eindhoven and Groningen). Framed as part of a so-called 'green deal'. http://tki-switch2smartgrids.nl/wp-content/uploads/2013/12/Uitvraag-kwartiermaker-GD-SmEC.pdf with a large number of projects on smart grids (energy combined with mobility).

[26] http://stichtingsensorcity.nl/partners (Key actors: municipality and consortium of other actors. Framing: smart, innovation, social, sustainable; 'a smart city is a city where social and technological infrastructures and solutions facilitate and accelerate sustainable economic growth'). Also see http://www.smartdatacity.org/assen/. For framing see http://stichtingsensorcity.nl/historie (innovation, technology and economy focused. Solving 'various societal challenges' is mentioned once or twice, but this is not unpacked).

City	Explicit smart city ambitions?	Implicit eco-city ambitions?	Experiments in multiple domains?	Popu-lation	Online presence (number of Google hits)
Breda	Yes, to some extent [27]	Yes, but not primarily	Yes	167.673	(117.000)
Delft	Yes, definitely [28]	Yes, explicitly	Yes	99.737	(136.000)
Dordrecht	Yes, definitely [29]	Not explicitly	Yes	119.260	(79.500)
Den Bosch[30]	Not found [31]	-	-	134.520	(27.000)
Den Haag [32] (The Hague)	Yes, definitely [33]	Not explicitly	Yes	474.292	(255.000)

[27] 'Smart city' is mentioned explicitly in the *structuurvisie 2030* as part of the digital city development (https://prezi.com/ug5zzxeoccan/copy-of-plan-van-aanpak-structuurvisie-breda-2030/), and high level policy-makers at the municipality are working on establishing smart city partnerships with other Dutch cities and with large corporations (https://prezi.com/rwsinugmgyk1/breda-smart-city/). Breda also had an award winning project on smart sewage (http://www.bndestem.nl/regio/breda/breda-is-slimste-binnenstad-van-nederland-1.4968964). There are also many more examples of smart city projects in Breda on mobility and tourism (http://www.smartdatacity.org/smart-city-voorbeelden-uit-breda/) and on smart grids (http://jouwenergiemoment.nl/top/jouw-energie-moment/breda).

[28] See http://www.delft.nl/Bedrijven/Stad_van_innovatie/Delft_Smart_City and http://media.delft.nl/pdf/Eindrapport age%20Delft%20Smart%20City.pdf (municipality smart city vision and report). Framed with key words as 'climate proof' and 'energy neutral'. The Delft vision is a good example of how smart city (data as a solution to what problem?) can become what Maarten Hajer calls smart urbanism (data used to solve a societal problem). See http://media.delft.nl/pdf/Eindrapportage%20Delft%20Smart%20City.pdf

[29] http://www.i-real.nl/totaaloplossingen-voor/vastgoed-management/gemeente-dordrecht-steeds-meer-smart-city/, https://www.bewonersaanzet.nl/wijkensites.dordrecht/up/ZeibkofJC_Presentatie_Smart_City_Dordrecht_20150129.pdf

[30] also called s-Hertogenbosch (in Dutch mostly Den Bosch).

[31] This is the only larger Dutch city where none of the links on the first pages of Google (search command: Den Bosch smart city) led to currently operational web pages.

[32] also called 's-Gravenhage (in Dutch mostly called 'Den Haag' and in English 'The Hague').

[33] There is a smart city vision of a municipality-led consortium (http://www.binnenlandsbestuur.nl/digitaal/nieuws/smart-city-den-haag-begint-niet-met-technologie.9475469.lynkx. For full road map see: https://www.google.nl/url ?sa=t&rct=j&q=&esrc=s&source=web&cd=8&ved=0ahUKEwiB2NLzsbvMAhXqLMAKHRMBAeQQFghaMAc&url=https%3A %2F%2Fwww.ngi-ngn.nl%2FAfdelingen%2FInformatie-Management%2FVerslagen%2FDe-CIO-als-strategische-innovator %2FBijlagen%2F3c-20140318-Notitie-Roadmap-Smart-City-Den-Haag-2tempel.pdf&usg=AFQjCNHZQh-EO8AnGmvJ3vhhujqTwXjzxA&cad=rjt). For the perceived relevance of the smart city, see: (http://www.gemeente.nu/Organisatie/Nieuws-in-Organisatie/2015/4/Smart-Cities-We-gaan-elkaar-niet-meer-beconcurreren-1753589W/). There is a special focus on security, not only in the framing of the broader muncial vision, but specifically through the alliance of The Hague Security Delta (https://www.thehaguesecuritydelta.com/). For examples on projects see http://www.smartdatacity.org/smart-city-voorbeelden-uit-den-haag/ and http://www.denhaag.nl/home/bewoners/to/Smart-City-Pilotprojecten.htm. Allegedly, the municipality is conducting at least 18 smart city projects (http://www.smartdatacity.org/impressie-bezoek-jury-slimste-binnenstad-van-nederland-aan-den-haag/).

City	Explicit smart city ambitions?	Implicit eco-city ambitions?	Experiments in multiple domains?	Popu-lation	Online presence (number of Google hits)
Eindhoven	Yes, definitely [34]	Yes, but not primarily	Yes	209.620	(221.000)
Enschede	Yes, to some extent [35]	Not explicitly	Yes	153.655	(48.900)
Groningen	Yes, definitely [36]	Yes, but not primarily	Yes	181.194	(124.000)

[34] The mayor of Eindhoven is one of the most outspoken advocates of the smart city. The city also received €6 million from the EU to set up a cooperative smart city project with Manchester, Stavanger and other 'follower cities' – interestingly Tianjin eco-city is involved as an 'observer city' to learn about best practices in this project (http://triangulum-project.eu/index.php/lighthouse-cities/city-of-eindhoven-netherlands/); https://www.cursor.tue.nl/nieuwsartikel/artikel/eindhoven-europese-smart-city/) – and the city received an earlier grant from IBM smarter cities (https://smartercitieschallenge.org/assets/cities/eindhoven-netherlands/documents/eindhoven-netherlands-summary-2012.pdf). The annual budget reports of the municipality reveal that the municipality is investing an additional €1,8 million in smart city projects for the period 2016-2018 (https://e52.nl/smart-city-ook-zichtbaar-in-begroting-eindhoven/). The city also received 350.000 dollar from IBM as part of the IBM Smarter Cities Challenge (to be spent on improving safety and security in the city, see http://www.smartdatacity.org/eindhoven/). There is also a pronounced experimental approach (http://triangulum-project.eu/index.php/lighthouse-cities/city-of-eindhoven-netherlands/; also see https://stadvanmorgen.files.wordpress.com/2015/12/report-spotlight-on-smart-city-eindhoven-draft.pdf), and a variety of experiments and living labs especially on smart lighting (see http://www.eindhoven.nl/inwonersplein/leefomgeving/slim-licht/Eindhoven-as-living-lab-for-intelligent-lighting-1.htm) and on smart mobility . The experiments are located in various living labs (for a comprehensive map see concentrated in a number areas pointed out as living labs (see http://destaatvaneindhoven.hetnieuweinstituut.nl/mapping), http://www.eindhoven.nl/artikelen/Collaboration-in-living-labs-.htm and http://www.eindhoven.nl/artikelen/Forerunner-in-Europe.htm).

[35] http://digitalestedenagenda.nl/dutch-cities-join-open-and-agile-smart-cities/ (Along with several more high profile Dutch smart cities, Amsersfoort has signed the Open & Agile Smart Cities (OASC) letter of intent. And Enschede is one of the front runners in terms of open data here). http://www.duurzaambedrijfsleven.nl/infra/10509/enschede-zet-in-op-smart-city-technologie (Enschede is also part of smart city consortium with Heidelberg and Palo Alto). https://www.cogas.nl/green-deal-smart-energy-cities/ (Enschede is also part of the green deal smart energy cities, along with municipalities Amsterdam, Arnhem, Eindhoven, and Groningen and several tech companies). http://www.actmedialab.nl/projecten/tffbridge/ (the inner city has a living lab with two pilot projects)

[36] http://digitalestedenagenda.nl/dutch-cities-join-open-and-agile-smart-cities/ (Along with several more high profile Dutch smart cities, Groningen has signed the Open & Agile Smart Cities (OASC) letter of intent. (The neighborhood of Hoogkerk has long been the site smart grid pilot projects – under the header of 'powermatching city'). http://www.cityoftalent.nl/en/smart-users-city/our-vision-on-innovation (Under the headers of 'Smart Users' city' a consortium led by the municipality seeks to attract global talent – reminiscent of the creative city strategies of other cities). Groningen is very much involved in smart grids and smart energy, with projects that are expert-led as well as projects that are citizen-led (http://www.smart-circle.org/portfolios/smart-energy-city/). The city also signed a smart city MoU with Huawei (http://www.metering.com/city-of-groningen-and-huawei-sign-mou-to-implement-smart-city-concept/). Along with several other cities in Northen Dutch and German cities, Groningen is also part of the EU consortium 'smart regions north' (http://www.smart-regions-north.eu/. For pilot projects here, see http://www.smartcities.info/groningen).

City	Explicit smart city ambitions?	Implicit eco-city ambitions?	Experiments in multiple domains?	Popu-lation	Online presence (number of Google hits)
Haarlem*	Yes, to some extent [37]	Not explicitly	Yes	147.590	(71.400)
Hoofddorp	Not found	-	-	132.734	(65.200)
Leiden	Not found [38]	-	-	119.713	(220.000)[39]
Maastricht	Yes, to some extent [40]	Not explicitly	Yes	122.378	(117.000)
Nijmegen	Yes, to some extent [41]	Yes, but not primarily	Yes	158.732	(75.100)

[37] Haarlem is working closely with the Amsterdam Smart city consortium in two projects (Watt for Watt and the new pilot in the neigberhood of Schalkwijk). A vision is being developed for the Amsterdam Metropolitan Region (MRA) to which Haarlem also belongs. Experiments on smart energy (watt for watt: http://amsterdamsmartcity.com/projects/detail/id/28/slug/watt-for-watt) and on smart security (GIS overlastmonitor: http://www.geonovum.nl/onderwerp-artikel/smart-city-toepassingen).

[38] Leiden did not sign the smart city covenant of the Dutch Digital City Agenda – to the dismay of one member of the Green Party in the local council (http://docplayer.nl/3777458-Quickscan-duurzaamheid-gemeente-leiden.html). Interestingly, a link with Groningen smart city is mentioned in a discussion in the municipal council. Groningen is seen as a city that resembles Leiden and from which Leiden can learn in the area of smart city. (https://www.google.nl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjW_5PI_r3MAhVFlCwKHYgEAJ0QFggcMAA&url=http%3A%2F%2Fgemeente.leiden.nl%2Fnc%2Fbestuur%2Fcollegebesluiten%2Fcollege%2Factie%2Ffile%2Fdatum%2F15012013%2Fbestand%2F1103726%2Ftype%2Fpdf%2Fshash%2Ffb9ab60b%2F&usg=AFQjCNHVs4YW-l5ou_HohtuCl4dQ7GFj7Q&bvm=bv.121099550,d.bGg&cad=rjt).

[39] This number is high because the Dutch word 'leiden' also means 'to lead' (many of the hits here are about taking charge rather than about the city of Leiden).

[40] A recent decision from the mayor on new parking near the station states that the smart city concept should be taken into account (http://ruimtelijkeplannen.maastricht.nl/24D046B9-9C1D-4792-9F96-3337B98B441C/b_NL.IMRO.0935.bpFietsstallingCS-vg01_septoebijlage9.pdf). Maastricht is one of two Dutch cities featuring in one international smart city ranking (http://blog.econocom.com/en/blog/so-what-exactly-is-a-smart-city-and-where-do-new-technologies-come-in/). The city is also part of an ongoing European JPI project on living labs for smart city governance (http://www.cosmopolis.be/research/smarterlabs-improving-anticipation-and-social-inclusion-living-labs-smart-city-governance). For experiments on security, see http://www.axis.com/files/brochure/bc_casestudies_safecities_en_1506_lo.pdf.

[41] While there are no clear smart city ambitions from the municipality as yet (https://www.google.nl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&ved=0ahUKEwi2tPDEhL7MAhUE3iwKHaTZCa0QFghEMAU&url=http%3A%2F%2Fwww2.nijmegen.nl%2Fmmbase%2Fattachments%2F1641483%2FC20150414o_2.02_PI50_Vragen_fractie_PvdA_-_Nijmegen_Smart_city.pdf&usg=AFQjCNEIzT1rb4e-nql_eOl_Ib_ephpdAQ&bvm=bv.121099550,d.bGg&cad=rjt), other municipal politicians are saying that the city should formulate these explicitly. Projects are taking place, such as on smart lighting (http://www.nrgm.nl/in-print/intelligent-illumination/) smart bike parking (http://www.smartdatacity.org/tag/nijmegen/) and on Internet of Things (https://www.computable.nl/artikel/nieuws/infrastructuur/4898652/250449/nijmegen-start-met-smartcity-concept.html)

City	Explicit smart city ambitions?	Implicit eco-city ambitions?	Experiments in multiple domains?	Popu-lation	Online presence (number of Google hits)
Rotterdam	Yes, definitely [42]	Yes, explicitly	Yes	598.199	(347.000)
Tilburg	Yes, definitely[43]	Don't know	Not found	199.613	(71.800)
Utrecht	Yes, definitely [44]	Yes, explicitly	Yes	290.529	(231.000)
Zaanstad*	Yes, definitely [45]	Yes, explicitly	Yes	140.085	(56.400)
Zoetermeer	Yes, to some extent [46]	Not explicitly	Yes	115.845	(50.100)
Zwolle	Yes, to some extent [47]	Not explicitly	Yes	111.805	(51.300)

* Part of the Metropolitan Region Amsterdam (MRA)

[42] For examples of projects, see http://www.smartdatacity.org/smart-city-voorbeelden-uit-rotterdam/ and http://www. smartdatacity.org/rotterdam/.

[43] In DSA Smarter City Covenant as responsible for the open data initiative (http://www.digitalestedenagenda.nl//wp-content/uploads/2013/03/P13004-DSA-Convenant-Totaal-0603-incl-handt-DEF.pdf) and in cooperation with Huawei to develop smart city concept (http://www.emerce.nl/nieuws/tilburg-smart-city For political discussions around privacy, see https://tilburg.groenlinks.nl/nieuws/er-een-smart-city-ruimte-voor-privacy, and for emerging debates on this in the city see http://www.castonline.nl/mobi.php?content_type=agenda&meta_url=tilburg-als-smart-city) .

[44] For examples of projects, see http://www.smartdatacity.org/smart-city-voorbeelden-uit-utrecht/.

[45] Zaanstad has ambitions to be climate neutral in 2020 and to do so the municipality supports a number of smart city pilot projects in the area of energy, such as E-harbors (an innovative type of energy contract, see http://amsterdamsmartcity.com/projects/detail/id/50/slug/e-harbours-zaanstad?lang=nl) and Optimus (an EU project on saving energy in municipal buildings, see http://optimus-smartcity.eu/zaanstad). Zaanstad should be seen should be seen as part of the Amsterdam Metropolitan Region and in that capacity, the city spearheads the smart grid agenda (http://amsterdamsmartcity.com/partners/detail/id/125/slug/gemeente-zaanstad?lang=nl) .

[46] The municipality is tied to the Smarter City covenant (http://www.g32.nl/DATABANK/Nieuwsarchief/2013/Zoetermeer_roept_op_tot_samenwerking_op_eHerkenning_en_e_facturering). Zoetermeer has two relevant smart city projects on e-governance (Regelluwe Stad; for details on how the dealings between government and entrepreneurs can be managed more efficiently with digital technology, see http://regelluwestad.digitalestedenagenda.nl/wp-content/uploads/sites/5/2014/01/Verantwoord-Zoetermeer-trekker-van-Regelluwe-Stad.pdf) and on smart parking (SENSIT, on installation of sensors and making data publicly available; see http://www.parking-net.com/parking-news/nedap-identification-systems/zoetermeer-smart-parking). For its other projects on e-billing and e-recognition, see http://www.g32.nl/DATABANK/Nieuwsarchief/2013/Zoetermeer_roept_op_tot_samenwerking_op_eHerkenning_en_e_facturering.

[47] The municipality hosted a living lab called Sense for Society on sensors, 'the Internet of Everything', and citizen participation (see http://www.geonovum.nl/nieuws/living-lab-meet-zwolle and http://www.geonovum.nl/nieuws/slim-zwolle-zet-sensoren-voor-een-gezonde-aangename-stad). Zwolle was the first Dutch city to organize all IT shops under one app according to the 'smart-mobile-shopping' concept (see http://www.marketingfacts.nl/berichten/zwolle-de-eerste-stad-in-nederland-waar-alle-winkeliers-in-een-app-zijn-ter, and the programme promoted on the Smart Data City http://www.smartdatacity.org/zwolle-de-eerste-stad-in-nederland-waar-alle-winkeliers-in-een-app-zijn-terug-te-vinden/), and also has a forthcoming smart city pilot with Huawei (see http://www.tenict.nl/smart-city-initiative/) and a project involving citizen participation in smart mobility (http://www.goudappel.nl/actueel/2015/06/29/enquete-zwolle/) .

STAGE 3: SHORT-LIST SELECTION (THE FINAL FOUR)

The first two stages suggested that many Dutch cities in the list shown in Table 2 would qualify as interesting cases that deserve to be explored in more detail. However, only four cases really stood out as candidates for our short list of cities to profile in this report: Amsterdam, Rotterdam, Eindhoven, and Utrecht.

As shown in the previous section, the long list selection was based on the presence and quantity of (1) ambition, (2) experimentation and (3) online 'buzz'. If we look in more detail at these three attributes we see that there are only 5 Dutch cities with a population of over 200.000 people and over 200.000 Google smart city hits in the Netherlands (Amsterdam, Rotterdam, The Hague, Utrecht and Eindhoven). Looking also at the quality of the documents found and listening back to the helicopter interviews, it became clear that these cities were the most interesting candidates. From these five cities, the choice was made to drop The Hague because much of its smart city rhetoric prioritizes 'safety and security' instead of eco/sustainability (mainly due to the project and the actors involved in The Hague Security Delta), and because the city was fairly late in formulating clear smart city ambitions (this was evident from the dates on the documents and was also observed during a round-table discussion between high-level policymakers from Dutch cities at the 2015 Smart City event in Amsterdam).

The smaller Dutch cities (< 200.000) did not make it to the short list either for a variety of reasons. For example, for Den Bosch, Hoofddorp and Leiden it was difficult to find online sources that reveal how the smart city concept is actually mobilized, the extent of their ambitions, or what experimentation is actually taking place on the ground. Assen 'sensor city' and Almere 'smart society', meanwhile, have clear smart city ambitions but these are not framed in terms of sustainability. It should also be noted that some small cities (Almere, Haarlem, Zaanstad) might also be seen as incorporated in the Amsterdam case if we take the Metropolitan Region Amsterdam (MRA) as the case study.

Alongside these reasons for not selecting the Hague and the non-MRA small cities as case studies, there were also active reasons for choosing Amsterdam MRA, Rotterdam, Eindhoven and Utrecht as the four main contenders, as outlined in Table 1 (see Introduction to this report).

Our project partners:

Our funders: