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A climate mitigation strategy analysis of the most- and least sustainable cities of the Netherlands

A strategy content analysis of Amsterdam, Enschede, Rotterdam and Zwolle

Colophon

Title:	A climate mitigation strategy analysis of the most- and least sustainable cities of the Netherlands
Author:	Martijn Oud
Contact:	m.oud@student.rug.nl
Student number:	S3430553
Bachelor:	Spatial Planning & Design
University:	Rijksuniversiteit Groningen
Faculty:	Faculty of Spatial Sciences
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Supervisor:	Prof. dr. J. (Johan) Woltjer
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Abstract

This research assesses four Dutch cities on their sustainability strategies. The Netherlands has high energy consumption per capita while the share of renewable energy is the lowest of all EU countries, resulting in high greenhouse gas emissions per capita. EU legislation for climate action is proposed and Dutch legislation is put into practice. However, cities are currently not subject to legal obligations regarding climate change. Because cities are critical factors in the climate transition, their sustainability strategies need to be assessed. This research develops indicators for the economic and environmental sustainability of cities. Monitored data for these indicators on all cities are collected, the two best and lowest scoring cities relative to the Netherlands are selected for strategy content analysis. In respective order; Amsterdam, Zwolle, Rotterdam and Enschede. Results have shown that All cities have set ambitions that are in line with current assessment and all cities except Enschede have comprehensive strategies to reach their ambitions.

1. Introduction

1.1 Background information

Carbon dioxide levels are increasing at alarming rates. In 2019 carbon dioxide levels reached 410,5 ppm, signaling a 148% increase compared to preindustrial carbon dioxide levels. Global mean temperature rose with 1,2 °C compared to the 1850-1900 baseline (WMO, 2020). If we keep on emitting greenhouse-gasses (GHG) at the current rate, models predict a 4 °C increase in temperature in 2100 (IPCC, 2014). This temperature increase will be paired with inhabitable regions on earth due to heat stress, desertification, and floods along with all sorts of other problems causing a chain reaction of climate related disasters (Vince, 2009). In 2016, 196 countries signed the Paris Agreement, a legally binding international treaty aiming to limit global warming to 2 °C, preferably to 1,5°C compared to preindustrial temperature levels. One year before, the United Nations developed the 2030 agenda for sustainable development, consisting of 17 goals containing economic, ecological, social, and institutional goals. A country that has ambitious national and city policies regarding climate change is the Netherlands (Heidrich et al, 2016; Reckien et al, 2014). However, compared to other European countries, the Netherlands is lagging behind in reaching the SDG targets, especially when it comes to environmental sustainability. In the Netherlands, the Central Bureau for Statistics (CBS) keeps track of the progress of the SDG's. Monitoring if the nation gets closer to the goals as well as comparing the data with other countries. According to the latest report (CBS, 2020), only 53 of 171 measured indicators are moving towards their target, which is 31 percent. 59 percent of the indicators show no significant change, leaving 10 percent of the indicators moving away from their target. Energy consumption is trending downwards, the share of renewable energy is trending upwards and GHG emissions are trending downwards. However, compared to EU countries the Netherlands places in 23rd out of 28, 28th out of 28, and 24th out of 28 respectively, indicating that the Netherlands is one of the worst scoring EU countries per capita on SDG 7, i.e., renewable energy, and SDG 13, i.e., climate action(CBS, 2020). This is problematic because energy use is the largest contributor to GHG emissions (IPCC, 2014) while estimated energy use will increase with 1.3% each year to 2040 (IEA, 2019). Cities have a vital role in reducing energy consumption and emissions. In 2014, cities consumed between 67-76% of global energy use while about 50% of the population lived in cities (IPCC, 2014). Urban population is predicted to increase to 66% of the global population by 2050, and emissions because of energy consumption are predicted to increase around 22% by 2040 (OPEC, 2017). It is no surprise that according to the World Urban Campaign, 'the battle for a more sustainable future will be won or lost in cities' (WUC, 2016). Therefore, cities need to utilize low-carbon developments such as reducing fossil energy use, improving energy efficiency and advocating low-carbon life (Mi et al., 2019).

1.2 Research problem

In 2019, the first ever Climate Law in the Netherlands was installed to provide a legal framework for national policy. The law entails a 49% reduction of emissions in 2030 and 95% reduction in 2050 with 1990 as reference year (National Climate Law, 2019). This law is binding on national level, but not on provincial and municipal level, while much of the efforts towards sustainable development have to take place locally, at the municipal level (Gustafsson & Ivner, 2018). The minister of Economic issues and Climate consults with administrative bodies such as municipalities, who make policies for cities, and subsequently create a covenant that could be called an intention agreement. Thereafter, the municipalities create, or reflect on, their own goals, resulting in a variety of strategies with different goals with regards to the three pillars of sustainability: environmental, economic, and social sustainability. However, cities are not yet legally obliged to reduce GHG emissions.

Considering the lack of progress of the Netherlands towards reaching the indicator's targets, the role of cities towards a sustainable future and the absence of binding regulation for city policy, it

is vital that city policies are evaluated in detail on their sustainability strategies. The urgency needed to change future energy use in cities cannot be emphasized enough. Reckien et al. (2014) argue that too little knowledge is available on the development of mitigation plans. Since, a multitude of studies have focused on single cities and some on city-to-city cooperation, in which affiliated cities across the globe can learn from each other (Mi et al., 2019). However, knowledge on CO2 mitigation strategies and actions in cities is lacking (Croci et al, 2017). While Reckien et al. (2014) found Dutch cities' policies ambitious, they only took their targets into account and not the strategies to reach those targets. Therefore, this study will research the climate mitigation strategies of cities in the Netherlands in detail with a scorecard analysis of the strategy documents.

Research question: To what extent are the policies on climate mitigation of Dutch cities in line with the SDG's and current assessments of economic and environmental sustainability, how do their policies differ and what can the cities learn from each other?

Sub questions:

- Which indicators monitor economic and environmental sustainability in cities?
- What are the current assessments of the economic and environmental sustainability of Dutch cities?
- What are the current strategic plans on climate mitigation of cities?

1.3 Structure of the thesis

Following this introductory chapter, important concepts and indicators are discussed in the theoretical framework. Research methods, data collection, assessment and analysis techniques are discussed in the methodology chapter. Subsequently, cities will be selected based on an assessment and expectations for their strategies are discussed. The findings of the strategy content analysis are discussed in the results chapter. The thesis will then be concluded. Thereafter, in the last chapter, limitations and improvements are found.

2. Theoretical framework

2.1 Definitions

As is stated in the introduction, the Netherlands performs poorly, compared to EU nations, on energy consumption per capita, share of renewable energy and GHG emissions per capita. Decreasing energy consumption and increasing the share of renewable energy are actions taken to reduce GHG emissions and mitigate changes in climate (Smit et al, 2000). In other words, climate mitigation is '' anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2001). Mitigation actions can be broadly categorized in five areas: efficient use of energy, use of renewable energies, carbon sequestration, reduced sources of emissions through land use management and carbon capture and storage (Tompkins et al, 2013). This research will focus on the first two as most reductions are possible with those actions (IPCC, 2007). There is growing understanding that climate mitigation actions can be combined with sustainable development. Energy efficiency for example is often economically beneficial while reducing the pressure on the environment through a reduction of emissions. Climate mitigating actions that reinforce sustainable development are particularly prevalent in the building and transportation sectors (IPCC, 2007). Therefore, sustainable development is possible through the lens of climate mitigation actions. Climate mitigating actions can be combined with environmental, economic, and social sustainable development, the latter mainly applies to developing countries (IPCC, 2007). As the Netherlands is a developed country, this research focuses on environmental and economic sustainability.

Many definitions on sustainability and development are available, many of which lack theoretical underpinnings, causing ambiguities and no scientific consensus on the definition of environmental sustainability (Purvis et al, 2019). Therefore, it is important to understand the history of the concept, provided with a clear definition. Daly (1991) approached sustainability from an economic perspective; 'A 'steady-state economy' neither depletes the environment beyond its regenerative capacity nor pollutes it beyond its absorptive capacity, but instead tries to achieve a state of equilibrium with it'. According to Basiago (1999) all contemporary sustainability thinking is based on Daly's holistic view of economics. In 1980, the IUCN's World Conservation Strategy stated that 'for development to be sustainable it must take account of social, ecological, and economical factors (IUCN, UNEP and WWF, 1980). In 1987 the Brundtland commission (WCED, 1987) defined sustainable development as: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Which is a prevailing definition as it still stands on the UN website. These three notions were formalized by the World Summit on Sustainable Development (UN, 2002), renamed as the three P's; People, Planet and Prosperity.

According to (Moldan, Janoušková and Hák, 2012), the term environmental responsible development was probably first coined by scientists at the World Bank (World Bank, 1992). Goodland (1995) in return rebranded the term to environmental sustainability and elaborated on the definition: 'environmental sustainability seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans.'

Economic sustainability regards the question of how we can meet the current economic needs without harming economic opportunities in the future. To elaborate: ''in meeting the basic economic needs of all in the present, a sustainable economy must not deprive future generations of opportunities to meet their basic economic needs as well. A sustainable economy must be able to maintain its productivity and value to society indefinitely, essentially forever'' (Ikerd, 2012). Therefore, he argues, polluting fossil fuel-based energy needs to be replaced by clean energy. This means that environmental and economic sustainability have a common goal in transitioning to an

efficient and green energy system.

Based on data from 2016, energy use accounts for 73,2% of global emissions. The highest energy consuming and emitting sectors are energy production, transportation, the built environment, and industry (Climate Watch, 2016; WRI, 2020), of which the former three sectors are the most relevant for reducing emissions in cities (Croci, 2017). These four sectors are taken into account in the analysis. As mentioned above, reducing GHG's entails reducing energy consumption i.e., increasing efficiency and substituting fossil energy by renewable energy. Renewable energy is defined by the International Energy Agency (IEA) as energy derived from natural processes that replenish at a faster rate than that they are consumed (IEA, 2002). This definition includes the following resources: solar, wind, ocean, hydropower, biomass, geothermal, biofuels and hydrogen derived from renewable resources. The concepts and their relations are depicted in figure 1. The common goals of environmental and economic sustainability are shown where their circles overlap. The mitigation actions depicted in the rectangle are the most emission reducing actions.

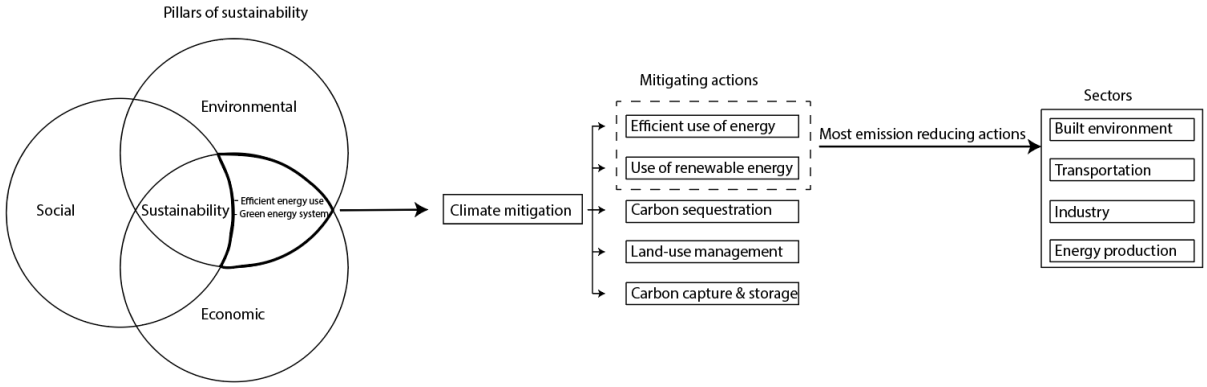

Figure 1: Conceptual model

2.2 Indicators

To assess sustainability strategies, data is needed that quantifies the complexity of our environment to meaningful information. Absolute values can provide an idea of what is acceptable. Therefore, Galloppin (1997) argues to develop numeric values for sustainability to give it meaning. This is realized with indicators (Cutaia, 2016). Sustainability indicators are able to summarize the complexity of our environment, help towards achieving targets and address weaknesses (Godfrey and Todd, 2001; Pupphachai and Zuidema, 2017). Subsequently, these indicators can also be used for strategy content analysis, to determine whether plans are made to improve the value for particular indicators (De Sherbinin, Reuben, Levy, & Johnson, 2013). According to Liu, the indicators should adhere to the following principles (Liu, 2014); Reflect sustainability concept, measure quality corresponding to specific sustainability goals, based on timely information, based on reliable information, and reflect a strategic view. While these principles apply to sustainable development goals, they do not differ for urban sustainable development, apart from their spatial focus, as there are no special criteria for the urban factor (Verma and Raghubanshi, 2018). As is discussed above, the highest energy consuming and emitting sectors will be analyzed, being energy production, transportation, the built environment, and industry. The 'built-environment' and 'transportation' sub-sectors are split for a more in-depth analysis. This research roughly follows the 'sector split-up' of the Sustainable Energy Action Plan (SEAP) created for cities affiliated with the Covenant of Mayors (2010). The sub-sectors cover the whole sector to which they belong and are therefore chosen for this research. The built environment consists of dwellings, public buildings (e.g., municipal own buildings, schools) and tertiary buildings, the latter is referred to as business/commercial buildings. The transportation sector on urban scale is split up in

private transport, public transport, and business/commercial-related transport. Together, they make up the indicators and code scheme for this research. Table 1 contains the indicators.

Table 1: Indicators/code scheme

Categories	Subcategories	Further subcategories
Energy consumption	*Built environment*	Dwellings
		Business/commercial buildings
		Public buildings (e.g., municipal, schools)
	Industry	
	Transportation	Private transport
		Public transport
		Business/commercial transport
Renewable energy	*Built environment*	Dwellings
		Business/commercial buildings
		Public buildings
	Industry	
	Transportation	Private transport
		Public transport
		Business/commercial transport
	Energy Production	

3. Methodology

3.1 Research Design

To answer the research questions, this research consists of three phases. The first phase is a literature research to develop the sustainability indicators. The second phase of the research is an evaluation of Dutch cities based on the indicators provided by the literature research. The reason for phase two is to create context for the third phase, which is the strategy content analysis. It is important to have knowledge of the current situation of cities before evaluating their strategies for the future. It would be unfair to judge a city on a lack of vision on a particular indicator if that city already has a well-functioning system on that subject. Moreover, assessing the current situation of cities provides knowledge of the best and worst scoring cities, allowing for a careful selection of cities. This leads to increased potential for low scoring cities to learn from high scoring cities. In the third and last phase, the strategies of the selected cities will be analyzed. Data collection will be discussed per phase. No ethical considerations need to be made because people are not evolved in this research and I am not involved in policy- or decision making for these cities.

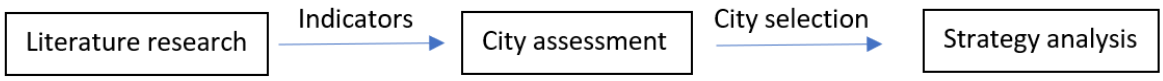

Figure 2: Research design

3.2 Literature research

In the first phase, a literature research is conducted to define important concepts and to determine the indicators. These indicators will be used for the sustainability strategy analysis. Furthermore, the determined indicators will be used for identifying monitored indicators with which the cities will be assessed. Sources are mainly derived from Scopus and Google Scholar.

3.3 Evaluation of current situation

In the second phase, the monitored indicators that cover most of the determined indicators are collected for all cities with more than 100,000 inhabitants. Bigger cities tend to be less environmentally sustainable (Zoeteman, Mommaas and Dagevos, 2016) than smaller cities. Therefore, bigger cities are more interesting for this research. The data for the indicators are retrieved from publicly accessible datasets from the CBS, Klimaatmonitor, RDW and RWS. The collected indicators are referred to as the secondary dataset of this research and the indicators are shown in Table 2. Not all determined indicators are covered by the compiled dataset, because of lack of data or incomparability.

Table 2: Monitored indicators derived from various organizations.

Monitored indicators	**Year**	**Source**
Renewable energy [%]	2019	Klimaatmonitor
Renewable electricity [%]	2019	Klimaatmonitor
Renewable warmth [%]	2019	Klimaatmonitor
Percentage renewable energy transport	2018	Klimaatmonitor, calculated by Swing
Percentage electric cars [%]	2019	RDW
Dwellings with solar panels [%]	2019	CBS
CO2-emission traffic excluding highways [ton per 1.000 residents]	2019	RWS
Average 'heat consumption' dwellings [gj]	2019	Klimaatmonitor
Average electricity consumption dwellings [gj]	2019	Klimaatmonitor
Energy consumption dwellings per resident [gj/resident]	2019	CBS
Energy consumption mobile machinery per resident [gj/resident]	2019	CBS
Energy consumption traffic per resident (incl. highways) [gj/inwoner]	2019	CBS
Number of registered cars per resident	2019	CBS
CO2-emission per dwelling	2019	Klimaatmonitor

The data of each city is compared to a reference number, which is the national average. Subsequently, the city gets a score, reflecting a (much) higher or lower value than average. A scorecard evaluation allows for a display of all the indicators in a graphical overview in such a way that comparison is possible (Thissen & Walker, 2013)..

The scoring card is made up of five possible categories, or scores, dependent on the value of a city relative to the average and dependent on the direction of the variable. E.g., Higher carbon dioxide emissions than average is bad but higher share of green energy is good. The scoring system is visualized in Table 3. Different ranges for the categories have been experimented with, the chosen ranges allow for distinguishing cities without giving a skewed view of performance. After determining the range for every indicator, color is used to visualize the level of performance for a given indicator as is shown in Table 3. Scores are summed up and placed in a ranking model. The two highest and lowest scoring cities will be selected, provided that sustainable strategy documents are available for the given cities.

Table 3: Score model for city assessment

Value	Points
Average +/- 5% = Neutral	0
5 to 25% better than average	1
5 to 25% worse than average	-1
>25% better than average	2
>25% worse than average	-2

3.4 Strategy content analysis

The third phase is a strategy content analysis of the strategy documents published by the municipalities of the four selected cities: Amsterdam, Enschede, Rotterdam and Zwolle. The documents are discussed below:

- Amsterdam: 'Nieuw Amsterdams klimaat' Routekaart Amsterdam Klimaatneutraal 2050. This is Amsterdam's sustainable strategy document, published in 2020, with ambitions for the long-term accompanied by actions for the short-term. Amsterdam identified four 'transitionpaths', built environment, mobility, electricity and harbor & industry.
- Enschede: 'Actieplan duurzaamheid'. This document is published in 2015, including some long-term (2030) ambitions, but mostly short-term (2018) ambitions. This document has since not been updated. Enschede focuses on biodiversity, circular economy, sustainable mobility, energy, green growth and climate adaption.
- Rotterdam: 'Rotterdams Klimaatakkoord' This document is published in 2019 and consists of concrete plans for the coming 10 years and ambitions for the long-term. The strategy is built around the following pillars: Harbor and industry, built environment, mobility, clean energy and consumption.
- Zwolle: 'Zwolle gives energy'. This document is published in 2017 with plans and ambitions for the short- and long-term. Zwolle has five main subjects: Making the built environment energy efficient, large-scale energy production, energy infrastructure and storage, emission free mobility and a broad cooperation.

These documents are analyzed with Atlas.ti coding software, which is a method for analyzing qualitative data by creating categories (codes) in which to deploy pieces of text (markings) from the policy documents that fit a particular code. The codes resemble the sustainability indicators, in this way assessment of inclusion or exclusion of indicators is possible. If an ambition/target for a particular indicator is included, a score of one point will be given. E.g., 'Inner-city transportation is emission-free in 2040'. If this ambition is not accompanied by a strategy or concrete measures, one point will be assigned. This can range from one measure such as 'increasing number of electric charging stations' to an in-depth strategy. If an ambition/target is accompanied by a strategy or concrete measures, two points will be assigned, see Table 4.

Table 4: Score model for strategy content analysis

Strategy content	Points
Not mentioned	0
Normative plan (Objective/Target)	1
Instrumental plan (How?)	2

4. Assessment of cities & expectations

4.1 Assessment of cities

This section discusses the analysis of the current situation of cities based on monitored indicators. This assessment, by no means, tells the whole story of the sustainability of cities. Some indicators were not taken into account due to a lack of data. Some indicators did not fit within the scoring system (e.g., lack of comparability) and for some categories monitored indicators are not yet available. However, this assessment does give an indication on energy consumption, share of renewable energy and CO2-emissions. The cities have been assessed relative to the Netherlands on fourteen indicators. Minimum and maximum scores respectively are -2 and 2, resulting of a maximum range of -30 to 30 points.

Amsterdam is a clear frontrunner with 13 points, as is visible in Table 5. Almere and Zwolle both have 6 points, but Zwolle's strategy document is more comprehensive, therefore Zwolle is selected. Rotterdam and Enschede scored the least number of points and are hence selected as the two lowest scoring cities. It would be interesting to research the underlying reasons for their scores, however, this is beyond the scope of this research.

Table 5: Scores of cities

City	Points
Amsterdam	13
Zwolle	6
Almere	6
Amersfoort	5
Den Haag	4
Leiden	1
Eindhoven	1
Nijmegen	1
Zoetermeer	1
Arnhem	0
's-Hertogenbosch	0
Breda	-1
Apeldoorn	-1
Tilburg	-2
Utrecht	-3
Groningen	-5
Haarlem	-7
Rotterdam	-11
Enschede	-14

4.2 General Expectations

The Netherlands has displayed sustainability ambitions by signing the Paris agreement, adopting a national climate law and an EU climate law is in the pipeline (EU commission, 2020). However, as is mentioned above, the Netherlands is lagging behind at critical SDG's regarding climate mitigation and therefore has a long way to go. Therefore, expectations for mitigating strategies are high. The performance of cities on specific indicators is visible in Table 6. Based on these values, some expectations can be derived. It is important to note that high or low scores relative to national averages are not directly considered to be good or bad. E.g., Amsterdam has scored one point for the percentage of renewable energy indicator with 8,2 percent compared to an average of 7,2 percent. However, if Amsterdam's value of 8,2 percent would have been the national average, it would still put the Netherlands at the bottom of the EU countries (CBS 2020). Therefore, every Dutch city is expected to have comprehensive strategies regarding renewable energy. Furthermore, cities with high emissions tend to set higher targets for reduction (Croci et al, 2017).

Table 6: Scoresheet of highest and lowest ranking cities

	Netherlands	Amsterdam	Zwolle	Rotterdam	Enschede
Renewable energy [%]	7,4%	8,2%	5,7%	4%	3,6%
Renewable electricity [%]	17,6%	14,8%	9,5%	9,1%	3,5%
Renewable warmth [%]	5,6%	6,7%	4,4%	3,4%	3,1%
Renewable energy transport [%]	4%	3,7%	4,8%	2,5%	4,8%
Percentage electric cars [%]	1,3%	3,1%	,9%	,9%	,5%
Dwellings with solar panels [%]	12,3%	3%	16,5%	2,9%	8,6%
CO2-emission traffic excl highways [ton/r]	6700	4500	4600	18200	4100
Average 'heat consumption' dwellings [gj]	41,08	31,04	36,25	32,53	41,77
Average electricity consumption dwellings [gj]	9,83	7,37	8,99	8,25	9,75
Energy consumption dwellings per resident [gj/r]	22,82	19,48	20,3	19,53	25,18
Energy consumption mobile machinery per resident [gj/resident]	2,65	1,72	2,06	5	6,07
Energy consumption traffic per resident [gj/r]	37,42	18,03	28,42	43,28	51,62
Number of registered cars per resident	0,49	0,27	0,43	0,35	0,55
CO2-emissions per dwelling	2,89	2,39	2,91	2,44	3,12
Points		13	6	-11	-14

4.3 Expectations for Amsterdam

Although Amsterdam performs relatively well, strategies for renewable energy consumption and production are expected to be comprehensive. Amsterdam's scores for share of renewable electricity, share of renewable energy for transport and share of dwellings with solar panels are relatively low. Emphasis on these indicators is to be expected. Furthermore, Amsterdam is part of C40 Cities Climate Leadership Group, a network of megacities collaborating, sharing knowledge on sustainable action on climate change (C40). This increases Amsterdam's expectations.

4.4 Expectations for Enschede

Enschede is the lowest scoring city on the list. A combination of high energy consumption per capita and a minimal share of renewable energy is a recipe for high CO2-emissions per capita. This is confirmed by relatively high CO2-emissions per dwelling. Enschede has just two of the fourteen indicators in the green, therefore, Enschede's sustainability strategy is expected to be ambitious on all aspects.

4.5 Expectations for Rotterdam

Although Rotterdam has relatively good scores regarding 'energy consumption of dwellings' and 'number of cars per resident', all other indicators turned red. Indicating that Rotterdam has a low share of renewable energy in the built environment, industry and transport. Moreover, Rotterdam has remarkably high CO2-emissions for transport, therefore Rotterdam is expected to have extensive plans for decreasing CO2-emissions and increasing the amount of renewable energy. Rotterdam is also part of the Covenant for Mayors on Climate & Energy.

4.6 Expectations for Zwolle

Zwolle scores relatively well on all indicators except renewable energy resources and percentage of electric cars. Compared to the other cities, Zwolle scores high on the amount of dwellings with solar panels. Although Zwolle scores relatively well, expectations for sustainable strategies are still high as is argued in the general expectations section.

5. Results

The results of the sustainability strategy are shown in Table 7. All cities have set future ambitions in their strategies. Sectors that are discussed by every city are the built environment, transportation, and renewable energy production, which are the most relevant sectors to reduce emissions in cities (Croci et al, 2017). Energy efficiency and renewable energy in the private transport sector are covered in depth by every city. No city got maximum points for reducing energy consumption in public buildings which tends to be the first subsectors that municipalities focus on (Reckien, 2018). Furthermore, only Amsterdam and Rotterdam discuss their industry sector. Although the industry sector of Enschede and Zwolle are much smaller than the other two cities, it is remarkable that their industry sector is not included in their strategies. The sectors will be discussed per city below.

Table 7: Scoresheet strategy content analysis

Group	Sectors	Subsectors	A'dam	Enschede	R'dam	Zwolle
Energy consumption	*Built environment*	Dwellings	2	1	2	2
		Business/commercial buildings	2	2	2	2
		Public buildings (e.g., municipal, schools)	1.5	1	0	1,5
	Industry		2	0	2	0
	Transportation	Private transport	2	2	2	2
		Public transport	2	1	2	2
		Business/commercial transport	2	0	2	2
Renewable energy	*Built environment*	Dwellings	2	1	2	2
		Business/commercial buildings	2	1	2	2
		Public buildings	2	0	0	1.5
	Industry		2	0	2	0
	Transportation	Private transport	2	2	2	2
		Public transport	2	1	2	2
		Business/commercial transport	2	1	1	2
	Production		2	1	2	2
Total points			29.5	14	25	24.5

5.1 Amsterdam

5.1.1 Energy consumption

Built environment (5,5/6). Amsterdam almost scores the maximum possible points in the built environment sector. The city aims to reduce energy consumption of buildings by making them more energy efficient. House owners have access to energy consultation, energy loans, and collective buying opportunities. The city thus creates financial help for its residents. Moreover, Amsterdam is exploring ways to legally enforce less energy consumption. Activating overarching business organizations and maintaining the Law of environmental management stimulate businesses to decrease energy consumption. Sustainability criteria will by increased for businesses. Extensive plans are made for making municipal buildings more energy efficient, however, other public buildings and facilities are not mentioned, therefore, a score of 1,5 points is assigned.

Industry (2/2). To decrease carbon dioxide emissions, Amsterdam aims to capture and store

it underneath the North Sea. Furthermore, increasing prices of energy must lead to a reduction of energy consumption.

Transportation (6/6). Amsterdam's solution for reducing energy consumption in the private transportation sector is all about increasing bicycle trips by increasing cycling routes and making them wider, and reducing car trips by environmental zones, traffic circulation plans, increasing parking fees and decreasing parking norms for buildings. In total, there are 27 measures for banning cars, for commercial related transport this means logistic hubs instead of direct delivery at houses. Further transport is done by electric vehicles or bicycles. Moreover, Amsterdam is expanding car-sharing as a replacement for car ownership. In the future, offices are constructed without parking facilities for cars. Public transport will become cheaper and more attractive.

5.1.2 Renewable energy

Built environment (6/6). Amsterdam is replacing natural gas dependent systems with city heating systems based on geothermal energy, among others. Businesses in the neighborhoods are also incorporated. There are legal norms in place for building energy neutral buildings. Amsterdam provides legal exemption for sustainable solutions which do not yet fit within legislation. In 2030, halve of solar panel potential roofs need to be accommodated by solar panels. The city developed a platform that helps citizens in realizing solar panels on their roofs. Amsterdam organizes collective buying opportunities and makes deals with corporations to install solar panel on every newbuilt building. Municipal buildings have a contract with Greenchoice, one of the leading energy companies in terms of renewable energy.

Industry (2/2). The harbor industry zone will deliver green energy, with solar panels and hydrogen production. The zone will house energy storing and carbon dioxide capturing facilities. Industrial processes will be electrified as much as possible.

Transportation (6/6). Current climate zones for polluting vehicles will expand, more charging stations for electric vehicles will be facilitated and measurements against polluting boats are taken. Busses and taxis are currently in the process of becoming emission free by 2025. Bigger transport should be powered by hydrogen in the future, the first garbage trucks are already powered by hydrogen.

Production (2/2). New sustainable sources for city heating are currently being developed. Solar panels will be placed on suitable roofs, (road)slopes and parking facilities. The latter in combination with electric charging stations. Wind turbines will be replaced by bigger wind turbines.

5.2 Enschede

5.2.1 Energy consumption

Built environment (4/6). Enschede has normative plans to increase sustainability of buildings, but the ambition lacks a strategy. A clear plan for dwellings is absent. Enschede supports businesses by connecting them and providing information. Two points are assigned for business/commercial buildings. A plan is initiated for making their public buildings energy efficient, one point is assigned because a strategy is not yet constructed.

Industry (0/2). Industry is not mentioned.

Transportation (3/6). Enschede strives for 10% less car traffic by a cycling campaign, improving cycle network and turning roads into bicycle streets. Furthermore, Enschede aims to create 'mobility points' at strategic places where modal shifts from car to other modals is possible. In the future the city wants to prohibit motorized vehicles in the center. However, there are no measures for public transport and business/commercial related transport.

5.2.2 Renewable energy

Built environment (2/6). Objectives are made for dwellings, however, a strategy for achieving the objectives is absent. For businesses, the objective is to maintain the law of environmental management, no further strategies. Public buildings are not mentioned.

Industry (0/2). Industry is not mentioned in their strategy.

Transportation (4/6). Enschede aims to stimulate emission free cars by increasing charging stations per neighborhood. The city focuses on Mobility as a Service with mobility points, that could potentially function as logistic hubs. Two points are assigned to private transportation. The city wants sustainable public transport but it 'assumes' public transport becomes sustainable and therefore gets one point. Moreover, one point for the ambition of emission-free city logistics.

Production (1/2). Enschede aims to produce more renewable energy, the strategy involves appointing appropriate places for solar and wind energy production. No further concrete plans.

5.3 Rotterdam

5.3.1 Energy consumption

Built environment (4/6). Rotterdam's objective is making dwellings and businesses energy efficient. The city aims to make 15.000 dwellings sustainable. This is done through various deals with housing corporations and stimulating homeowners. The city brings together businesses and specific goals are better isolation, better installations, and efficient lighting. There is no mention of public buildings in the strategy.

Industry (2/2). The city aims to reduce energy consumption of industry by capturing and storing carbon dioxide underneath the North Sea. Moreover, Rotterdam uses the concept of energy cascading to provide dwellings, businesses and other industry with warmth generated by industrial processes.

Transportation (6/6). Rotterdam aims to reduce private transport energy consumption by incentivizing car-sharing and bicycle-sharing. Car-sharing suited to businesses will be developed. One important street will be transformed to a one-way street and there are experiments with 'carless school zones', incentivizing parents to bring their children with bicycle. Moreover, the city reduces trips for garbage collecting for businesses by clustered gathering as well as reducing the number of trips for municipality workers. The strategy is however less rigorous than Amsterdam's on banning cars.

5.3.1 Renewable energy

Built environment (4/6). Rotterdam's main strategy is to diminish natural gas use. Natural gas systems will be replaced by city heating systems in 10,000 dwellings. Organizations have been founded with the purpose of accelerating solar panel installation on roofs. Rest warmth from the harbor is re-used for businesses and greenhouses.

Industry (2/2). The harbor industry will be the place for production, import and application of green and blue hydrogen energy. The municipality provides consultation on financing and legislation for accelerating projects on renewable energy. Waste streams, biomass and carbon dioxide will be used in industrial processes. Industrial processes requiring less than 300 °C will be electrified.

Transportation (5/6). Mobility as a Service fueled by renewable energy and a modal shift to bicycle and public transport is the primal strategy for Rotterdam. Rotterdam has an extensive strategy for zero-emission public transport and more efficient (delivery) city logistics

Production (2/2). The city has extensive plans for zero-emission energy production with hydrogen, solar panels in the city and harbor area, wind-energy and solar panels on parking places.

5.4 Zwolle

5.4.1 Energy consumption

Built Environment (5,5/6). Zwolle aims to make dwellings and other real-estate energy efficient by creating advantageous financial constructs for residents, such as a lending contract on sustainable solutions. For businesses, the city has a sectoral approach and informs, consults, and stimulates businesses in reducing energy and costs. The city has a clear plan for its municipal buildings, but not on other public buildings. Therefore 1,5 points are assigned to public buildings.

Industry (0/2). Not mentioned in the strategy.

Transportation (6/6). Zwolle has an extensive mobility strategy document, its main goals are reducing polluting trips by stimulating people to walk, cycle or use public transport. Public transport will be expanded. The city aims for zero-emission city logistics with environmental zones and logistic hubs.

5.4.2 Renewable energy

Built environment (5,5/6). New buildings will not be heated by natural gas and the city has clear plans for a city heating system to heat buildings in a sustainable manner. The city is scoring relatively well on solar panels on dwellings. However, more solar panels will be installed on dwellings and other real-estate. Two points are assigned to both dwellings and business buildings because of instrumental plans. The plans are marginal, however. The city works together with schools to increase the share of renewable energy, no further plans are mentioned for public buildings. Therefore, 1,5 points are assigned.

Industry (0/2). Not mentioned in the strategy.

Transportation (6/6). Zwolle incentivizes electric cars by providing more electric charge stations. A tendering period has been organized to get contractors for emission-free busses. New hydrogen storage facilities need to provide the busses with fuel.

Production (2/2). The city will install solar panels on parking places and (road)slopes and geothermic heating systems are being developed. Aqua thermic and waterpower energy solutions are being explored.

6. Conclusions

Overall, the ambitions of every city are in line with the current assessments of cities relating to SDG 7 and 13. The strategies to reach the ambitions vary in comprehensiveness. Amsterdam touches upon almost every indicator in great depth. Rotterdam and Zwolle could improve their strategies in some sectors while Enschede's strategy does not met its ambitions.

The expectations for Amsterdam are met, the city almost scores maximum points on their sustainability strategy, showcasing their ambitions for the future. Normative objectives are supported by in-depth instrumental plans. It stands out that Amsterdam is aware of their strengths, weaknesses, opportunities, and threats by addressing all of them for every indicator. Furthermore, Amsterdam describes their role as municipality is per plan in great depth. Amsterdam's sustainability strategy is therefore a clear, transparent, hands-on approach.

The expectations for Enschede are not met. Despite a low assessment on sustainability, the city does not show a sign of urgency in their strategy. The strategy document was published in 2015 with most of its objectives set for 2018. Meanwhile the strategy is not revised or updated, which is odd because some plans deliberately have no concrete measures because the city is waiting for

technological innovations. The city scores especially poor on renewable energy. However, Enschede lacks extensive plans for increasing the share of renewable energy in the built environment, industry, and through production. Despite relatively high energy consumption for transportation and dwellings, the plans are marginal. Enschede could learn from Zwolle's and Amsterdam's strategies, with financial constructs enabling citizens to make their houses more sustainable. Enschede could learn from the other cities in terms of environmental zones to reduce traffic emissions for example. Further recommendations for many indicators could be given to Enschede, but the main recommendation would be to change their slow approach to a 'hands-on approach' while accepting possible changes due to technological innovation instead of waiting for technological innovation. A factor that could explain Enschede's lack of urgency, is the Dutch approach of 'decentralize if possible and centralize if needed, leaving the municipalities with much room for their policies regarding climate change (Reckin, 2014). Sustainability strategies are influenced by the environmental perspective of political bodies in place at municipal level, who might find sustainability incompatible with economic growth or other interests. (Tang et al, 1997; Eriksson, 2016).

The expectations for Rotterdam are mostly met, with 25 out of 30 points. The low scoring indicators in the assessment are all addressed except for renewable energy and energy consumption for public buildings. Rotterdam could take Amsterdam as example, who consider how the municipality can set the right example, in this case for municipal-owned property. Furthermore, Rotterdam stands out for its energy cascading system, its emphasis on MaaS and its concrete plans by developing many deals for all sectors.

Zwolle mostly met its expectations, with 24,5 points. The city addresses the low scoring indicators but a strategy for industry is absent. The share of renewable energy indicators scored relatively low, but these indicators are mostly addressed. Plans regarding renewable energy for the built environment are marginal, Zwolle could learn from Rotterdam's deals and Amsterdam's extensive approach.

7. Discussion

The ranking system on which the assessment for the cities is based, is by no means conclusive. Some indicators did not end up in the assessment due to a lack of data or incomparability due to a heterogeneous distribution of e.g., industry in the country. This leads to an incomplete perspective on reality. Therefore, it is possible that the ranking would be different if more indicators could have been used. Nevertheless, the assessment does give a perspective on the performance of cities on most indicators. This perspective in turn generates future expectations and provides context to the analysis of the sustainability strategy contents.

Although assessment through a scorecard system is a valid method, it is subject to subjectivity. The value of what is better or much better than average is not objectively or scientifically determined. In determining this, an attempt is made in balancing the distinguishability of cities while not skewing the relative performance of cities.

The analysis of the four cities is based on the municipality's main climate transition strategies. I recognize that there may be other strategies underway or on the municipality's website, however, this research assesses the strategy documents.

The energy strategy domain is generally not well connected to policy domains that could have critical impact on energy efficiency, such as urban form and the spatial layout of cities (Asarpota & Nadin, 2020). A 'compact city' with good public transport could result in less energy use per capita than a dispersed urban layout depending more on personal transport (Williams et al, 2000). This is not taken into consideration in this research, this should be considered in future research.

In further research, other Dutch cities should be taken into account. In order to reach the

targets of the climate law, it is important that all cities are monitored and assessed to identify cities that are lagging behind regarding climate mitigation. Furthermore, future research could study why particular cities (do not) express urgency in their strategies to accelerate the process to climate mitigation and prevent bottlenecks.

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