Benchmark: Climate and environmentally friendly urban passenger transport – the concepts of the European Green Capitals 2010-2020

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1 Introduction

It has been widely recognized that there is an urgent need for more sustainable urban transport policy and planning (Banister, 2011, Creutzig et al., 2012, Sims et al., 2014). To understand ambitious policy approaches, "relatively successful" cities (Bratzel 1999) are regularly subject of analyses (e.g. ibid., Bertolini & le Clercq, 2003, Buehler & Pucher, 2011, Buehler et al. 2016a and b, Kindhäuser, 2001). This paper also focuses on relatively successful cities – by reviewing the application documents of the winner cities of the European Green Capital Award (EGCA). Award schemes not only aim to reward leading participants, but likewise aim to contribute to knowledge transfer and the dissemination of good practice examples to non-participants (Bovaird & Löffler, 2009, p. 384). So far award schemes and good practice approaches have received limited attention by research (ibid., p. 383, Macmillen & Stead, 2014, Ammons & Roenigk, 2014, p. 400).

Year and winning city	Applicant cities (finalist cities: bold)	Number of applicant cities
2010: Stockholm	**Amsterdam**, Bordeaux, Bremen, **Bristol**, Cluj-Napoca, Dublin, Espoo, **Freiburg**, **Hamburg**, Hannover, Helsinki, Kaunas, **Copenhagen**, Lisbon, Lodz, Magdeburg, Malmö, Montpellier, Munich, **Münster**, Murcia, **Oslo**, Pamplona, Prague, Riga, Rotterdam, Sabadell, **Stockholm**, Tampere, Toruń, Valencia, Vilnius, Vitoria-Gasteiz, Vienna, Zaragoza	35
2011: Hamburg	Same as 2010 (joint award cycle)	35
2012: Vitoria-Gasteiz	Antwerp, **Barcelona**, Bologna, Budapest, Espoo, Glasgow, Ljubljana, Lodz, **Malmö**, Murcia, **Nantes, Nuremberg**, **Reykjavik**, Rome, Seville, Toruń, **Vitoria-Gasteiz**	17
2013: Nantes	Same as 2012 (joint award cycle)	17
2014: Copenhagen	Antwerp, Brasov, **Bristol**, Brussels, Bursa, **Frankfurt**, Ghent, **Copenhagen**, Ljubljana, Newcastle, Rotterdam, Stoke-on-Trent, Tampere, Thessaloniki, Turin, Trabzon, Vienna, Zaragoza	18
2015: Bristol	**Bristol, Brussels,** Bydgoszcz, Dublin, **Glasgow**, Kaunas, Kutahya, **Ljubljana**	8
2016: Ljubljana	Dabrowa Gornicza, **Essen**, Larissa, **Ljubljana, Nijmegen, Oslo**, Pitesti, Reggio Emilia, Santander, Tours, **Umeå**, Zaragoza	12
2017: Essen	Bursa, Cascais, Cork, **Essen, 's-Hertogenbosch**, Istanbul, Lahti, Lisbon, **Nijmegen**, Pécs, Porto, **Umeå**	12
2018: Nijmegen	Arad, Ghent, **Nijmegen, 's-Hertogenbosch**, Tallinn, **Umeå**, Warsaw	7
2019: Oslo	Arad, Bologna, Florence, Funchal, **Ghent**, Kamza, **Lahti, Lisbon, Oslo**, Pécs, Seville, Strasbourg, **Tallinn**, Wroclaw	14
2020: Lisbon	Aberdeen, Budapest, Bursa, **Ghent**, Guimarães, **Lahti, Lisbon**, Ostrava, Prato, Reykjavik, Seville, Tallinn, Wroclaw	13

Table 1: Applicant, finalist and winning cities of the European Green Capital Award cycles 2010-2020.

This paper reviews and analyses the application forms of the EGCA winning cities to learn about ambitious policy approaches to sustainable and climate-friendly urban transport. The EGCA is a well-established award scheme by the European Commission. It rewards environmentally friendly cities in a competitive application, evaluation and ranking process (Gudmundsson, 2015, p. 2). In the competition, city governments present qualitative and quantitative information about their environmental performance in twelve topic areas that represent a holistic approach to sustainable urban development. Sustainable urban mobility plays an important part of the competition, as several topic areas are directly or indirectly linked to transport (sustainable urban mobility, air quality, noise, climate mitigation, energy performance). For each topic area, the applicant cities present their environmental strategies, measures and indicators. The cities describe their present situation, past development (past five to ten years), targets and planned measures for future development.

The EGCA competition consists of a two-tier evaluation process. First, twelve evaluators from different European countries (one evaluator for each topic area) assess the city applications and rank the cities for their specific topic area from the highest to the lowest. Based on the rankings, the expert panel selects three to five finalists. The shortlisted cities present their action plans and communication strategies to

Figure 1: Distribution of the European Green Capitals 2010-2020 across Europe and numbers of inhabitants.
map basis: Wikimedia Commons (2017). The authors changed colours of the map and added European Green Capitals.

a jury of representatives from European bodies. The jury selects the winner city (see table 1). The winner does not necessarily have to be the best-ranked city across the 12 topic areas, as the jury also takes the specific starting and framework conditions of the cities into consideration.

Eligible to participate are cities of at least 100,000 inhabitants (until 2015: at least 200,000 inhabitants) of the European Union and cities of states connected to the European Union (e.g. Norway, Turkey). Since 2015, the competition "European Green Leaf" recognizes smaller cities (20,000-100,000 inhabitants).

Applicant cities must meet three requirements to win the award:

- High environmental standards.
- Ambitious targets for further environmental improvements.
- Ability to act as a role model to inspire other cities by providing "best practices" to other European cities.

To date, there are eleven European Green Capitals (EGCs) from different European countries of different city sizes (see figure 1).

Climate protection and urban transport are two out of the twelve topic areas. Almost all winning cities have achieved very good rankings in these two indicators compared to their competitor cities (see table 2). To achieve a good ranking, the cities have to show exemplary achievements in reducing greenhouse gas emissions and promoting environmentally friendly transport (walking, cycling, public transport).

The questions of this paper are: Where do the eleven EGCs stand in terms of climate and environmentally friendly urban trans-

City	Ranking "Climate Change"	Ranking "Sustainable Urban Mobility"	Number of applicant cities
Stockholm (2010)	1 (together with Hamburg)	2 (together with two more cities)	35 (the ranking refers to the 8 shortlisted cities), one award cycle for 2011 & 2012
Hamburg (2011)	1 (together with Stockholm)	5 (together with Copenhagen)	35 (the ranking refers to the 8 shortlisted cities), one award cycle for 2011 & 2011
Vitoria-Gasteiz (2012)	1	1	17 (the ranking refers to the 6 shortlisted cities), one award cycle for 2013 & 2014
Nantes (2013)	3	3 (together with Barcelona)	17 (the ranking refers to the 6 shortlisted cities), one award cycle for 2013 & 2014
Copenhagen (2014)	2	1	18
Bristol (2015)	2	1	8
Ljubljana (2016)	5	2	12
Essen (2017)	1	7	12
Nijmegen (2018)	4	1	7
Oslo (2019)	1	1	14
Lisbon (2020)	6	1	13

Table 2: Ranking of the European Green Capitals in the topic areas "climate change" and "sustainable urban mobility".
Source: EGCA Technical Assessment Synopsis Reports for the Award Cycles 2010-2020. Retrieved from European Green Capital Award website: http://ec.europa.eu/environment/europeangreencapital/press-communications/egca-publications/

port? What targets, strategies and measures do these cities pursue for sustainable mobility and climate protection? What EU benchmark do they represent for climate-protecting urban transport?

2 Materials and Methods

The paper evaluates the application forms of the eleven EGCs for the topic areas "Sustainable Urban Mobility" and "Climate Change: Mitigation". Furthermore, the topic areas "Air Quality" and "Noise" are screened to identify additional information related to sustainable mobility. The application forms are publicly available on the EGCA website.

In addition, documents and online information that has been published as part of the competition are researched, for example the technical assessment reports of the expert panel and the jury statements that describe reasons for selecting the winner cities. Particularly for the earliest EGCs, the authors also review up-to-date city documents to update modal shift and greenhouse gas mitigation developments and targets.

The paper cross-evaluates the documents regarding realized modal shifts and greenhouse gas mitigations and future targets. The cross-evaluation draws conclusions to what extend the EGCs realize measures of the avoid-shift-improve concept and what benchmark they represent sustainable urban passenger transport.

3 Results

3.1 City evaluations

3.1.1 Stockholm (2010)

The City of Stockholm (912,000 inhabitants) was awarded the first "European Green Capital 2010". Sweden's capital won against 34 competitor cities by being a green, clean city by the water, by having a long historical track record of integrated urban management and by having ambitious future plans (RPS, 2009, p. 3).

The growing city plans to build 11,000 residential units for 25,000 additional inhabitants in the construction project Hammarby Sjöstadt. Building density and mixed-use settlement structures shall facilitate the use of environmentally friendly transport modes and lead to low transport volumes (City of Stockholm, 2008, pp. 17 & 94).

Stockholm makes use of the push and pull approach to achieve modal shifts. For most urban streets, there is a tempo limit of 30 km/h (ibid., p. 15). Since 2006, there is a weekday congestion charge for cars. Through the congestion charge, traffic volumes and emissions were reduced by 10 to 15% (ibid., p. 16). Considerable improvements of public transport (more trains, busses, public transport stops, signals, real-time-information, communication and marketing) have lead to an increased trip-based share of public transport (from 57% to 64%) whereas car use has decreased (from 43% to 36%) (1998-2008) (ibid., p. 14). Cycling has been consequently promoted and significantly increased in the last ten years, due to the expansion of cycling paths, tempo 30 streets, new bicycle stands and bike sharing systems. Stockholm aims to become one of the leading cycling cities in Europe (ibid., p. 18).

Since 1994, Stockholm pursues a clean vehicle strategy. In 2009, 7% of all cars ran on ethanol, biogas or as a hybrid electro or low emission vehicle. All city busses run on biogas or ethanol. 50% of waste-lorries and 40% of taxis are bio-fuelled or hybrids (ibid., p. 20). All rail vehicles use electricity from certified renewable electricity (ibid., p. 16). Until 2025, the entire public transport sector shall be fossil-fuel-free (ibid., 2015, p. 14).

Stockholm has reduced its overall per capita CO2eq emissions from 1990 to 2005 by one quarter (-26%). In the same time period, transport CO2eq emissions were reduced by one fifth (-19%) (ibid., p. 4). By 2050, Stockholm aims to become a climate neutral city ("fossil fuel free city") (ibid., p. 3).

3.1.2 Hamburg (2011)

Hamburg (1.8 m inhabitants) is the second largest city of Germany and a harbor city with a lot of green. Hamburg was chosen the European Green Capital 2011 because of high environmental standards and ambitious future plans (RPS, 2009, p. 3).

Hamburg develops its settlement structures transport-efficiently according to the "axis model" and aims for inner urban development (City of Hamburg, 2008b, p. 7f.). The city constructs housing preliminarily in vicinity to public transport stops (ibid., p. 6). On the recycling site "HafenCity" in the harbor area, which is one of Europe's largest urban development projects, 5,500 housings and a new public transport railway connection are built on 1.57 km2. 40,000 jobs shall be created (ibid., 2009, p. 6).

Public transport has been significantly expanded: New local rail lines were built, service frequencies were increased (5-minutes subway interval), the operating period was extended (around the clock service on weekends), 150 additional bus stops were established as well as a fast metro bus line network with 22 bus lines (ibid, 2008b, p. 6 f .). Through these measures, the number of public transport users rose (+16% from 2003 to 2007) (ibid., p. 6).

The city promotes cycling by building qualified cycling paths (1,700 km separate cycling paths on streets, tempo-30 streets (45% of the road network), opening one-way-streets for cyclists, velo routes) (ibid., pp. 1-4), the creation of 14,000 bike stands at subway stations and a public bike rental system with 1,500 bicycles at 130 rental stations (ibid., pp. 5 & 10). Cycling in Hamburg increased from 1984 to 2006 by 60% (ibid., p. 5). The target is to increase the share of cycling from 12% in 2008 to 25% in the 2020s (SPD, Bündnis 90/Die Grünen, 2015, p. 36).

Besides having a tempo-30 limit on 45% of the urban road network (City of Hamburg, 2008b, p. 4), no further restrictive measures against car traffic are reported. Hamburg improves the environmental efficiency of its bus fleet (new vehicles having Euro 5, retrofits of old vehicles) and trains its staff to drive fuel-efficient to reduce emissions (ibid., pp. 3 & 7). From 1990 to 2006, Hamburg has reduced its overall per capita CO2-emissions by one quarter (-25%) (ibid., 2008a, p. 1) and its transport emissions by one third (-31%) (ibid., p. 2). Hamburg aims to reduce its per capita CO_2-emissions by 40% until 2020 and by 80% until 2050 compared to 1990 (ibid., p. 11). On the occasion of the 2015 Paris Climate Conference, Hamburg committed itself to halving carbon emissions by 2030 (ibid., 2016, p. 4).

3.1.3 Vitoria-Gasteiz (2012)

The City of Vitoria-Gasteiz (242,000 inhabitants) is the growing capital of the autonomous Bask region in northern Spain. It was awarded "European Green Capital 2012" because of environmental achievements in green public areas, biodiversity and water management (RPS, 2018c). Vitoria-Gasteiz is a compact city that allows for short distance mobility. 25% of the road space is pedestrian zone. Walking makes up more than 50% of all trips in the city (City of Vitoria-Gasteiz, 2010, pp. 14f.). The city focuses on the qualitative improvement of public space and the redistribution of road space from motorized private transport to environmentally more friendly transport modes (ibid., p. 16).

Sustainable mobility is promoted through push and pull measures. Parking fees were tripled (time period not specified), extended spatially and newly introduced for city center residents (ibid., p. 23). Furthermore, so-called "super blocks" were established. Super blocks are urban districts with restricted access for cars, parking fees and reduced speed levels (10 to 20 km/h on inner roads) that aim to prioritize walking and cycling (ibid., pp. 22 & 28).

Public transport is promoted through the construction of the first two urban tram lines (2008) and the re-organization of the bus network by introducing ten-minute service intervals (2009) (ibid., p. 16). Additionally introduced were: new bus lines, bus priority at traffic lights, 100% accessibility of the public transport fleet for people with disabilities and an integrated fare and payment card for the entire public transport system (ibid., p. 20f.). Trip numbers in public transport increased by 45% (2009-2010) (ibid., p. 16).

Walking and cycling are promoted through the construction of walking and cycling paths, bike stands and the introduction of a public bike rental system (2009) (ibid., pp. 21 & 26). The city plans to integrate the public bike rental system into the public transport system. Furthermore, the bike

rental system shall be extended so that the next rental bike is reachable within a five minutes walk (ibid., p. 26). The trip-based modal share of cycling has been increased from 1% (2002) to 3% (2006) to 12% (2014) (City of Vitoria-Gasteiz, 2015, p. 6). Until 2020, the trip-based share of cycling shall be increased to 15% (ibid., p. 2).

Vitoria-Gasteiz has increasing per-capita emissions (ibid., p. 5). In the long-term, Vitoria-Gasteiz aims to become a CO2-neutral city. Until 2050, CO_2 emissions shall be reduced by at least 50% compared to 1990 (ibid., p. 10).

3.1.4 Nantes (2013)

Nantes (292,000 inhabitants) is the sixth largest city of France and European Green Capital 2013. The title was given to Nantes for its sustainable transport policy that has lead to considerable reductions of air pollution and CO_2 emissions (RPS, 2018b).

The former industrial city focuses on culture and sustainability for structural change. The city pursues an integrated urban planning and transport approach and aims to realize mixed functions to reduce traffic volumes and strengthen environmentally friendly transport modes (City of Nantes, 2010b, p. 34).

Nantes is a pioneer city in France to promote sustainable urban mobility. The cycling and public transport networks were notably extended (+22% public transport network 2000-2008; +66% cycling paths 2001-2009) (ibid., pp. 22 & 28). Nantes was the first French city to reintroduce the tram (ibid., p. 20). Nantes promotes carpooling in the Nantes metropolitan region by providing a website for carpooling (ibid., p. 36). In 2008, a public bicycle renting system was established (89 stations, 790 bicycles) (ibid., p. 22). Nantes wants to increase the trip-based share of cycling from 5% (2012) to 15% (2030) (ibid., p. 36; ibid., 2014, p. 24).

Nantes is supporting mobility management for companies (ibid., 2010b, pp. 30f.). From 2004 to 2014, the city developed mobility plans with 362 companies (104,000 employees, 33% of the employees in the Nantes metropolitan region) (ibid., 2014, p. 50). Nantes has set the target to reduce the share of car commuters by 5% within 3 years (ibid., 2010b, p. 30). Nantes has already reduced the trip-based share of car use from 62% (2002) to 52% (2012) and wants to further reduce it to 42% in 2030 (ibid., p. 34). To reach the target, also restrictive measures are implemented that aim to improve the quality of public space: Streets are converted to public squares and zones with 30 km/h speed limits are introduced (ibid., p. 30). To improve transport efficiency, Nantes promotes electrified public transport (79 tramlines) and the conversion of busses to natural gas (80% of the bus fleet) (ibid., p. 27).

Per capita CO_2eq emissions of Nantes have slightly increased compared to 1990 (4.2 tons CO_2eq in 1990; 4,8 tons CO2eq in 2009) (ibid., 2010a, p. 5). Transport causes 26% of CO_2eq emissions (ibid., p. 6). Until 2025, Nantes wants to reduce CO_2eq emissions by 25% compared to 1990 (ibid.).

3.1.5 Copenhagen (2014)

Copenhagen (580,000 inhabitants) is the capital of Denmark and a green city by the sea. It was awarded European Green Capital 2014 because it represents a successful role model, particularly for the green economy, and because it has an efficient communication strategy (RPS, 2012, p. 4f.).

With its integrative urban and transport planning, Copenhagen reduced the trip-based share of car use from 36% to 33% (2007-2010), despite an increase of inhabitants and workplaces in the city (City of Copenhagen, 2011b, p. 4). To achieve modal shifts, Copenhagen consequently implements the push and pull principle for modal shifts with a clear political will and accompanied by communication campaigns (ibid., p. 8).

The city has introduced speed limits that also include the primary road network (ibid., 2011d, p. 3). Traffic lanes were taken away from motorized private transport and are used as separate cycling or bus lanes (ibid., p. 8). The area with parking fees was extended threefold (time period not specified) and prices were increased (ibid., p. 3). The effect of the extended

parking fees was that car traffic to and from the inner city could be reduced by about 6% (2007-2009) (ibid., p. 7). In Copenhagen, the first environmental zone of Denmark was introduced in 2008 to limit air pollution from lorries and busses (ibid., 2011c, p. 4).

The well-established public transport system consists of local trains, the unmanned subway and a dense network of express busses with separate bus lanes and priority at traffic lights. Currently, a subway ring is being built that shall open in 2019 and that shall be further extended (ibid., 2011b, p. 1).

Copenhagen aims to be the "World's Best City for Cyclists" (ibid., p. 1). In the decade 2002 to 2012, the number of public transport passengers increased by 10% (ibid., p. 6) and the number of cyclists by 13% (ibid., p. 4). The number of kilometers cycled increased in Copenhagen by 30% (1998-2012), despite an average decrease in cycling of 30% throughout Denmark (ibid., p. 4). Until 2025, the trip-based share of walking, cycling and public transport shall be increased to 75% and the share of car use shall be reduced to 25% (ibid., 2015a, p. 13).

Copenhagen had the target to reduce its overall per capita CO2eq emissions from 2005 to 2015 by one fifth (-20%) (ibid., 2011a, p. 4) and exceeded this target by reducing carbon emissions by 21% already in 2011 (ibid., 2012, p. 4) and 38% in 2015 (ibid., 2016, p. 9). Until 2025, Copenhagen aims to become a carbon neutral city (ibid., 2011a, p. 6). To reach carbon neutrality, also compensation measures are calculated (ibid., 2012, p. 14).

3.1.6 Bristol (2015)

In 2015, Bristol was European Green Capital. Bristol is the growing, eighth largest city of Great Britain (430,000 inhabitants) and lies in the south west of England. Bristol was awarded the title because of its investment plans for energy and transport, declining emissions despite a growing economy, the successful increase of cycling, the transformation of the harbor area to a livable neighborhood and the intensive involvement of citizens (RPS, 2013, p. 4f).

Since the 1980s, former industrial sites in the harbor were developed to modern residential areas and culture centers by applying integrated urban and transport planning (City of Bristol, 2012b, p. 13 f.). Bristol has increased urban population densities by 10% and over 5,000 homes were built in the city center (2002-2012) (ibid., 13). For sustainable mobility, Bristol combines hard and soft measures in a push and pull approach. The city of Bristol supports the privately organized public transport companies by priority bus lanes, real-time information and an improved regional bus network (ibid., p. 9).

Walking and cycling are promoted through the construction of cycle paths, cycling training for children and adults, speed limits and the qualitative improvement of public space (ibid., p. 9 f.). In 2008, Bristol was named Great Britain's Demonstration Cycling City in a national government scheme and 22 million pounds (about 30 million Euro) government and local money was invested in cycling (2008-2011) (ibid., p. 9, BBC, 2008). The trip-based share of cycling increased in the inner city area by 30% and for trips to work by 46% (2007-2010) (City of Bristol, 2012b, p. 10).

Bristol implemented speed limits of 20 mph (about 32 km/h) in two model projects in residential areas that cover one sixth of homes in the city (ibid., p. 9). The successful pilot projects shall now be extended city-wide (ibid., p. 4). Bristol reduces street space for cars and uses it for environmentally friendly transport modes, reduces parking lots in the inner city and supports mobility management for citizens and employees (ibid., p. 10 f.).

Bristol has reduced its overall per capita CO_2 emissions by 19%, compared to national reductions of 12% (2005-2010) (ibid., 2012a, p. 2). Transport emissions were reduced by 15% (2005-2010): 10% correspond to the national trend and 5% are Bristol's additional local effect. The overall CO_2 emissions shall be reduced by 40% until 2020 and by 80% until 2050 compared to 2005 (ibid., 2012a, p. 1).

3.1.7 Ljubljana (2016)

Ljubljana (278,000 inhabitants), European Green Capital 2016, is the capital of Slov-

enia that became independent in 1991. The city has many students and is the economic and cultural center of the country. Ljubljana won the title because of the significant sustainability transformations made during the previous 10 to 15 years with an intensive promotion of environmentally friendly transport modes and the protection and conservation of green and recreational areas (RPS, 2014, p. 4).

Ljubljana prioritizes environmentally friendly transport modes in the city center by restricting access of motorized vehicles in the inner city ("Ecological Zone") and by reallocating parts of a main road for environmentally friendly transport modes (City of Ljubljana, 2013b, pp. 5 ff. & 13). In residential areas, super block systems are established that comprise one-way-streets, shared space zones, speed limits (10 km/h to 30 km/h) and reduced parking for cars in public space (ibid., p. 8 f.). In 2012, Ljubljana received the "European Prize for Urban Public Space" for its successful upgrades of public space (ibid., p. 5).

The use of public transport in Ljubljana is promoted by the extension of the bus network into the suburbs, the introduction of new bus lines, bus priority at traffic lights, real-time information at public transport stops and the introduction of an integrated payment card (ibid., p. 9 f.). Walking and cycling in the city center are prioritized (ibid., p. 13 f.). The public bicycle renting system was established in 2011 (308 bicycles, 33 renting stations). The first hour of usage is free of charge (ibid., p. 3).

Ljubljana set ambitious targets for the future trip-based modal split: one third walking/cycling, one third public transport, one third motorized private transport shall be achieved by 2020 (ibid., p. 5) (2013: 35% walking/cycling, 14% public transport, 51% motorized private transport) (ibid., 2015). Energy and environmentally efficient vehicles are increasingly used in Ljubljana: 29% of the bus fleet has Euro V or EEV standard (ibid., 2013b, p. 4), 23% of the city administration's vehicle fleet is energy efficient (ibid., p. 11).

Ljubljana has slightly decreasing CO_2eq emissions (2004-2011). In 2011, the overall CO_2eq emissions per capita are 7,1 tons (ibid., 2013a, p. 2). The CO_2eq emissions of the transport sector are 2,7 tons (ibid.). Until 2020, the overall CO_2eq emissions shall be reduced by 20% compared to 2008 (ibid., p. 15).

3.1.8 Essen (2017)

Essen (581,000 inhabitants) was selected European Green Capital 2017 because of its consistent good environmental performances across the twelve topic areas. The city belongs to the Ruhr Metropolitan Region (5.1 million inhabitants) and has a heavy industrial past. It convinced the jury by its transformations to a cleaner and greener city (RPS, 2015, p. 4).

Essen wants to retain the retail structures of the city center and the district centers with a "Retail Master Plan 2011" that aims to create a "city of short distances" to reduce urban traffic volumes (City of Essen, 2014b, p. 11).

Essen implements push and pull measures for modal shifts. The trip-based share of walking, cycling and public transport shall be increased from 46% to 75% and the share of motorized private transport shall be reduced from 54% to 25% (2011-2035) (ibid., p. 10).

Essen extended the cycling network, opened 267 one-way-streets for cyclists, runs the public bicycle renting system "metropolradruhr" (400 rental bikes at 52 rental stations) and organizes cycling campaigns (ibid., pp. 8-11). The fast cycling path "Radschnellweg Ruhr" that is currently being built crosses the Ruhr Metropolitan Region from east to west (101 km) and will run through the City of Essen (ibid., p. 11 f.).

Essen expands its public transport service, particularly through new tram lines and new night tram lines, a 100% low floor bus fleet with stepwise improved EEV standards, priority for tramlines at traffic lights, improved train station areas and a barrier-free conversion of 76 bus and 16 tram line stops. Furthermore, the city extends dynamic passenger information at public transport stops, introduced a job ticket for currently 18,430 employees in 130 companies and runs campaigns for

flexible, intermodal and multimodal mobility and new resident packages (ibid., pp. 5 f.). Despite a demographic decline, public transport passenger numbers in Essen increased from 122.8 million (2011) to 124.1 million (2013) (ibid., p. 9).

Restrictions against cars are implemented to support modal shifts, for example by the low emission zone of the Ruhr Metropolitan Region, residential parking in some city districts (ibid., p. 7) and tempo 30 speed limits at night time on selected main traffic roads (ibid., 2014c, p. 9).

Essen has reduced its overall CO_2 emissions by 23% from 10.1 to 7.8 tons per capita (1990-2011) (ibid., 2014a, p. 2). To become a "Low Carbon City", Essen aims to reduce CO_2 emissions by 40% until 2020 and by 95% until 2050 compared to 1990 (ibid., p. 3).

3.1.9 Nijmegen (2018)

Nijmegen (171,000 inhabitants) is a growing city that is compartmented by rivers, canals and railways (City of Nijmegen, 2015b & c). Large parts of the city center were destroyed during Second World War and rebuilt until the 1980s. Nijmegen's sustainable mobility planning was one of the essential reasons for being awarded European Green Capital 2018 (PRACSIS, 2016, pp. 3 f.).

Nijmegen integrates spatial and transport policy, for example by realizing car free bus corridors and bike connections (City of Nijmegen, 2015b, p. 8). To manage transport demand, Nijmegen has introduced limited traffic zones: All roads are designed as either access roads that cluster car traffic with separate cycle paths (50 km/h, length: 70 km) or residential streets with limited traffic (max. 30 km/h, length: 630 km) (ibid., pp. 5 f.).

Significant investments in cycling infrastructure have been made: Nijmegen is building a network of cycle superhighways in the city (43 km of 79 km built) (ibid., p. 4) and to neighboring municipalities, for example to Arnhem (18 km) (ibid., p. 7). Since 2010, six new bike tunnels, a bicycle bridge and fly-over junctions have been realized (ibid., pp. 4 & 7). The quality and quantity of bicycle parking has been improved with 8,700 new bicycle parking spaces at the central station including an automated parking system for 4,000 bikes, increased bicycle parking in the city center (from 500 to 2,700) and increased free guarded parking facilities (from 360 to 2,500 in 2014) (ibid., p. 8).

In the city, cycling is the main transport mode for short distances and makes up 37% of all trips shorter than 7,5 km (2003-2005,), compared to 30% by car (ibid., p. 1). For commuting trips, the trip-based modal share of cycling increased from 54% to 64%, whereas travelling by car decreased from 34% to 22% (2005-2013) (ibid., pp. 2 f.).

Nijmegen has developed a rapid bus transit system with separate bus lanes that, in addition to the train system, transports travellers between the region and the city since 2008 (ibid., p. 8). All busses are Euro V low emission busses and run on natural gas (ibid.).

Nijmegen reduced its overall CO_2 emissions by 11,3% (2008-2014) and committed to reduce CO_2 emissions by 20% until 2020 (ibid., 2015a, p. 1). Until 2045, Nijmegen wants to reduce CO_2 emissions by 100% compared to 2008 (ibid.).

3.1.10 Oslo (2019)

Oslo (658,000 inhabitants) is the growing capital of Norway. Ambitious urban mobility plans were one of the essential reasons for being awarded "European Green Capital 2019" (RPS, 2017, p. 4).

Oslo aims to enable car-free living through coordinated land-use and transport planning, for example through the densification at public transport hubs, the extension of the metro system to residential development areas and the transformation of old industrial areas (City of Oslo 2016b, pp. 1 & 6 ff.).

Oslo has started very early to consequently promote sustainable mobility: A toll ring was introduced in 1990 (ibid., 2016c, p. 10). 93% of the revenues are used for investments in sustainable transport modes (ibid., 2016b, p. 14). The trip-based modal share of public transport increased from 21% to 32%, while car use decreased from

45% to 34% (2005-2015) (ibid., p. 7). Car use shall be further reduced by 20% until 2019 and by 33% until 2030 compared to 2015 (ibid., p. 11). Cycling shall be increased from 7% in 2015 to 16% in 2020 and 25% in 2025 (ibid.)

The City of Oslo implements restrictive measures against car use: Parking fees were raised by 50% in the city canter (2016) (ibid., p. 8), 300 parking lots were removed to build bicycle lanes (2015/2016) (ibid.) and speed was limited to 30 km/h in central parts of the city (ibid.). In 2019, private cars will be removed from a 1.7 km2 area in the city canter (ibid., pp. 11 f.). The City of Oslo runs a public bike rental system and a support scheme for electrical bikes (ibid., p. 5). There is public transport priority at almost 300 traffic lights, public transport lanes were separated from other traffic and public transport frequencies were increased (ibid., p. 6). 70% of the buses have Euro V, 20% have Euro VI (ibid., p. 3). By 2020, all buses shall meet Euro VI (ibid., p. 12). For air quality reasons, diesel vehicle bans and higher toll ring charges can be applied on days with poor air quality (ibid.). By 2020, public transport in Oslo shall be fossil-free (ibid., p. 8).

Over 30% of new cars sold in Oslo in 2015/16 were electric vehicles (ibid., p. 4). The city intensively promotes electric cars by the installation of 2,000 charging points through city ownership and financial incentives, free parking in municipal car parks, no charges on toll roads and the exemption from 25% value added tax (VAT) on purchase and leasing (ibid., pp. 4 & 9). Norway produces more electricity from hydropower than it consumes (ibid., 2016a, p. 1).

The city of Oslo has decreased its per capita CO_2 emissions from 2.5 to 2.3 tones (1990-2013) (ibid., 2016a, p. 1). The city aims to reduce CO_2eq emissions by 50% until 2020 (however, including a carbon capture and storage project) and by 95% until 2030 (ibid., 2016a, p. 2).

3.1.11 Lisbon (2020)

Portugal's capital Lisbon (548,000 inhabitants), a southern European city located by the Atlantic sea, is a hilly, compact and walkable city with historic buildings and narrow streets. The jury chose Lisbon as European Green Capital 2020 because it has demonstrated how sustainability and economic growth can go hand in hand, despite facing an economic crisis (RPS, 2018a, p. 3).

Lisbon aims to provide sustainable and inclusive mobility (City of Lisbon, 2017b, p. 6) by developing a "City of Neighborhoods" (ibid., p. 5). Public squares and streets are revitalized (21 of 150 squares finished in 2016/2017), streets are renewed (ten of 100 are finished), new lifts and escalators and six pedestrian-cycling bridges were built (ibid., pp. 2 & 7). The riverfront is being rehabilitated for pedestrians and cyclists and 400 crosswalks are levelled and made accessible (9.000 further crosswalks planned) (ibid., p. 2).

The City launched a bike sharing system with 140 stations and 1,400 bikes (2/3 electric) in 2017. Cycling paths are renewed and newly built. There is free bicycle transport on most public transport (ibid., p. 4)

Lisbon restricts car use: on-street parking fees were extended by 56% up to 84,000 parking lots (2017) and revenues are used for cross-funding sustainable transport (ibid., p. 2). Several streets were converted into pedestrian areas. Four car restricted areas and seven 30 km/h and shared space zones were introduced (25 additional planned) (ibid., pp. 7 f.).

After a public transport company was municipalized in 2017, free services for children (<13 years) and a 15 Euro monthly ticket for seniors (>65 years) were introduced (ibid., p. 1). Since 2004, there are free door-to-door bus services for elderly persons living in historic areas (ibid., p. 8). One third of the municipal fleet is electric (ibid., 2017c, p. 5). Charging points installed by the city are free of charge (ibid., 2017b, p. 9). Approximately 30% of Lisbon territory is a low emission zone (ibid., p. 7).

Lisbon has reduced its per capita CO_2eq-emissions by 42% (2002-2014) and aims to further reduce them by 70% until 2030 and by 100% until 2050 (ibid., 2017a, pp. 2-4).

3.2 Cross evaluation

The cross evaluation of the eleven EGCs shows similar overall tendencies. In all eleven EGCs, urban transport and particularly urban passenger transport are key elements for a better environment and an increased urban living quality. This is why appropriate transport measures are implemented – in all cities based on clear political decisions for environmentally friendly urban transport strategies. Such strategies are in many of the analyzed cities pursued for quite a long period of time.

All eleven cities understand their local transport concepts as a contribution to climate protection and the mitigation of urban greenhouse gases. The cities do not have specific transport-related mitigation targets. Thus, their overall mitigation targets apply analogous also for urban transport.

Some cities also have per capita emission reduction targets. Hamburg and Stockholm show the largest per capita emission reductions in their past development and aim for further reductions (figure 2). Copenhagen aims to reach complete climate neutrality by 2025 (including compensation measures) (City of Copenhagen, 2012, p. 14).

Bristol, Ljubljana, Nijmegen and Oslo do not have any per capita targets. For Copenhagen, the target "climate neutrality" was transferred to per capita target. For reaching "climate neutrality" in Copenhagen, also compensation measures are calculated (City of Copenhagen, 2012, p. 14). CO_2eq emissions of Nantes refer to the metropolitan region of Nantes Métropole (24 cities). Sources: City applications documents.

Data availability of transport per capita emissions varies between the different cities (figure 3). Some cities show decreasing transport per capita emissions (Bristol, Hamburg, Nantes, Oslo, Stockholm), other cities do not provide sufficient data to assess timely developments (Copenhagen, Essen, Nijmegen, Vitoria-Gasteiz).

Table 3 provides an overview of the different push and pull measures that the EGCs have reported to be implementing. Table 4 summarizes the main avoid, shift and improve measures of the eleven EGCs. All cities understand their transport actions as a contribution to reduce urban greenhouse gas emissions.

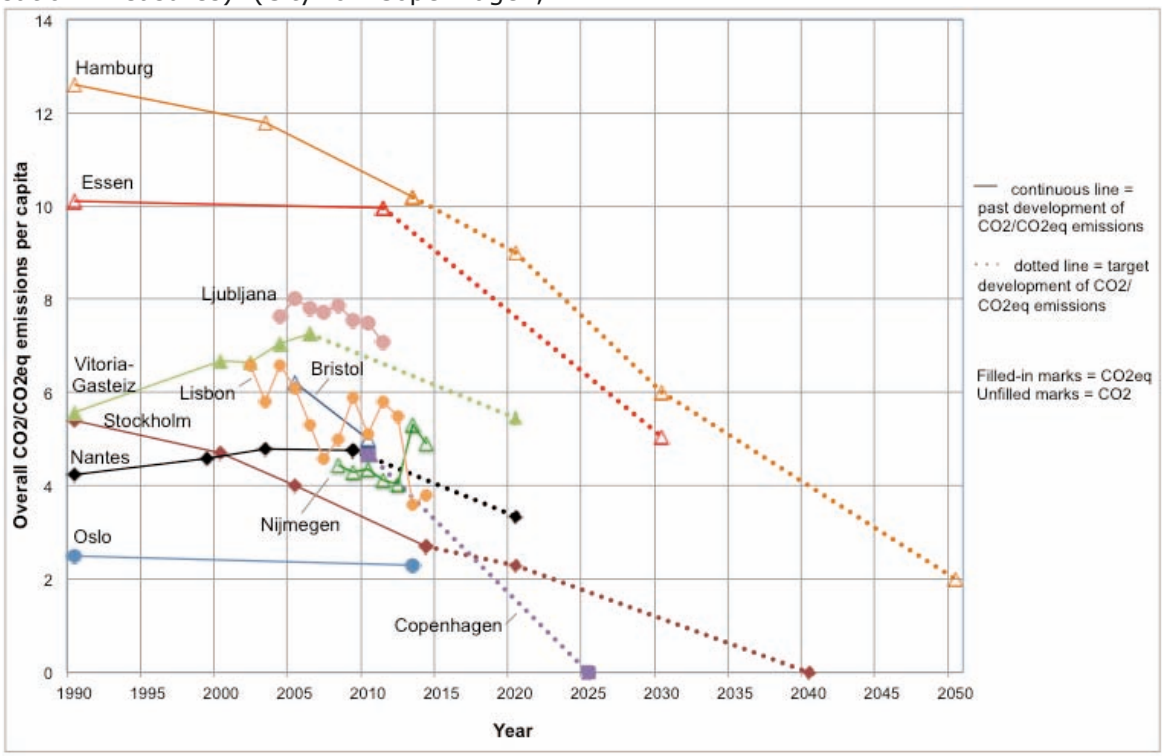

Figure 2: Per capita emissions of the European Green Capitals 2010-2020, past developments and future targets.

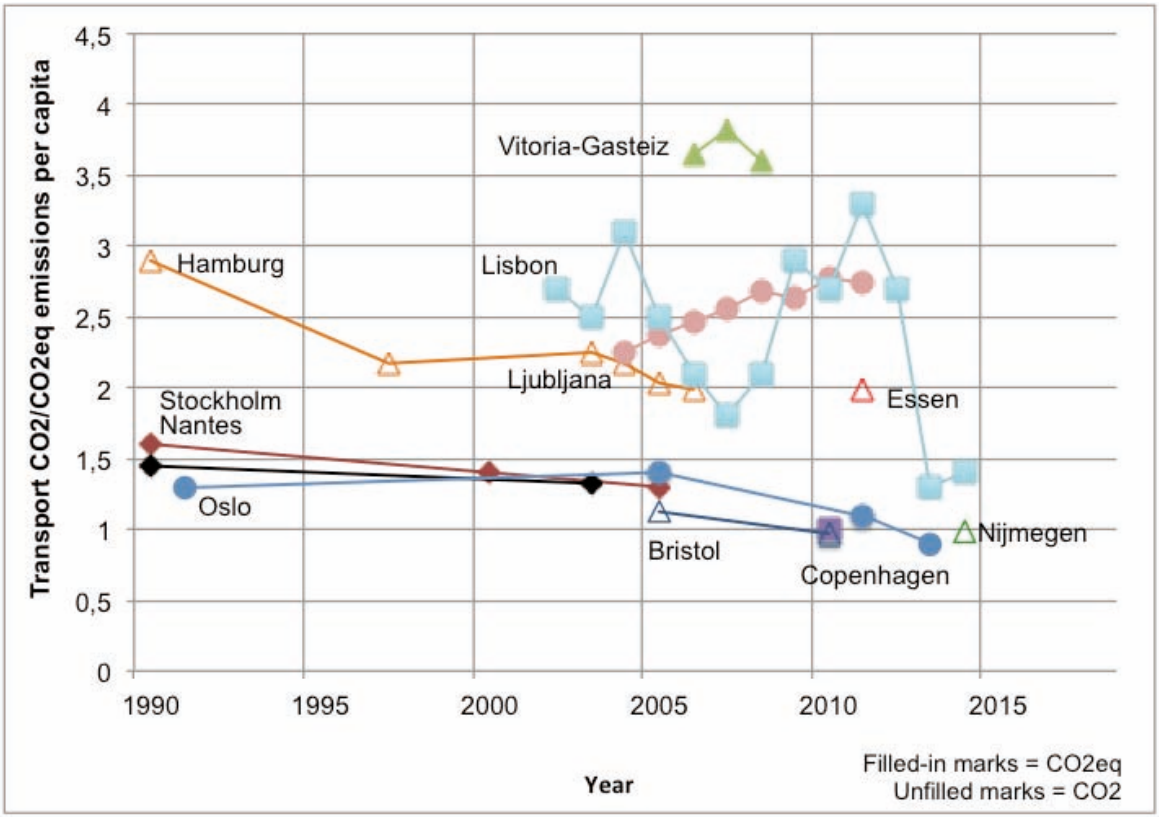

Figure 3: Per capita transport emissions of the European Green Capitals 2010-2020.
Sources: City applications.

Strategy	Push or pull	Measure	Stockholm	Hamburg	Vitoria-Gasteiz	Nantes	Copenhagen	Bristol	Ljubljana	Essen	Nijmegen	Oslo	Lisbon
Avoid	Pull	Land recycling		X				X		X		X	
Avoid	Pull	Inner development		X				X					
Avoid	Pull	Density	X					X				X	
Avoid	Pull	Mixed-use development	X			X							
Shift	Push	Traffic calming / tempo 30 (or slower)	X	X	X	X	X	X	X	X	X	X	X
Shift	Push	Redistribution of urban space			X		X	X	X			X	X
Shift	Push	(Extended area of) parking fees			X	X	X			X		X	X
Shift	Push	Increased parking fees			X		X					X	
Shift	Push	Reduction or restricted number of parking lots	X		X	X		X	X			X	
Shift	Push	City toll / congestion charge	X									X	
Shift	Push	Car-free zones / zones with restricted car access			X				X		X	X	X
Shift	Pull	Public transport network extension	X	X	X	X	X		X	X	X	X	X
Shift	Pull	More frequent public transport service			X	X	X	X		X		X	
Shift	Pull	Extended hours of public transport service		X						X			
Shift	Pull	Acceleration (for exempla priority bus lanes, priority at traffic lights)			X	X	X	X	X	X	X	X	
Shift	Pull	Public transport real-time information	X				X	X	X	X		X	X
Shift	Pull	Public transport accessibility (barrier-free design)			X	X			X	X			X
Shift	Pull	Upgrade and refurbishment of public transport stations/stops/tracks	X				X			X	X	X	
Shift	Pull	Integrated public transport tariffs/ tickets	X		X	X		X	X	X			X
Shift	Pull	Extension of park & ride facilities			X	X		X	X				X
Shift	Pull	Public transport communication and marketing	X	X	X		X		X	X			

Shift	Pull	Expansion of cycling infrastructure (e.g. paths, bridges)	X	X	X	X	X	X	X	X	X	X	X
Shift	Pull	Improved quality of cycling paths		X			X				X		X
Shift	Pull	Construction of fast cycling paths/ velo routes	X	X						X	X		
Shift	Pull	Additional/improved bicycle parking facilities	X	X	X	X			X		X		
Shift	Pull	Public bike sharing system	X	X	X	X	X		X	X		X	X
Shift	Pull	Opening of one-way-streets for cyclists		X					X	X			
Shift	Pull	Promotion of pedelecs/ electric bicycles				X				X		X	X
Shift	Pull	Communication for cycling	X	X	X	X	X	X	X	X			
Shift	Pull	Extension/improvement of pedestrian infrastructure	X	X	X		X	X	X				X
Shift	Pull	Qualitative improvement/ barrier free design of public space		X	X	X		X	X	X			X
Shift	Pull	Shared space			X	X			X				X
Shift	Pull	Mobility management											
Shift	Pull	Promotion of car sharing	X		X		X			X			X
Shift	Pull	Promotion of car pooling			X	X				X			
Improve	Push	Low emission zone			X	X				X			
Improve	Pull	Renewal and technical retrofit of the bus / municipal vehicle fleet	X	X		X	X		X	X	X	X	X
Improve	Pull	Promotion and installation of infrastructure for efficient and climate friendly vehicles	X		X		X	X	X	X		X	X
Improve	Pull	Dynamic traffic control / Intelligent Transport Systems (ITS)		X			X				X	X	X

Table 3: Transport measures implemented by the European Green Capitals 2010-2020.

	Push approach: measures by cities	Pull approach: measures by cities
AVOID transport volumes by reducing the number and length of trips	None	• Land recycling and inner development; density and mixed-use development of large new construction areas (*Bristol, Hamburg, Stockholm*)
SHIFT trips from motorized private transport to environmentally more friendly transport modes	• Tempo 30 (or slower) (*all cities*) • Redistribution of urban space from motorized private transport to environmentally more friendly transport modes (*Copenhagen, Ljubljana, Nantes, Vitoria-Gasteiz)* • Parking fees (extended areas, increased fees) (*Copenhagen, Lisbon, Vitoria-Gasteiz*) • Reduced number of parking lots (*Bristol, Copenhagen, Ljubljana, Oslo*) • City toll (*Oslo, Stockholm*) • Zones with restricted access for cars (*Lisbon, Ljubljana, Oslo, Vitoria-Gasteiz*)	• Extension of public transport system, particularly through network extension, more frequent service, extended hours of service, acceleration, real-time information (*all cities*) • Public transport marketing through tariffs and advertisement (*Copenhagen, Essen, Vitoria-Gasteiz*) • Promotion of cycling (*all cities*), especially through expanded cycling path networks, improved cycling paths, new bicycle parking facilities; public bike rental services, cycling campaigns • Promotion of walking (*Copenhagen, Lisbon, Ljubljana, Nantes, Stockholm, Vitoria-Gasteiz*) • Mobility management (*Bristol, Essen, Nantes, Nijmegen*) • Qualitative improvement of public space (*Bristol, Lisbon, Ljubljana, Vitoria-Gasteiz*)
IMPROVE vehicle efficiency and way of driving of motorized private transport and public transport	• Low emission zone (*Copenhagen, Essen, Lisbon, Stockholm*)	• Renewal and technical retrofit of the bus / municipal vehicle fleet (*Essen, Hamburg, Ljubljana, Stockholm)* • Promotion and installation of infrastructure for efficient and climate friendly vehicles (*Lisbon, Oslo, Stockholm, Vitoria-Gasteiz)*

Table 4: Push and pull approaches of the European Green Capitals 2010-2020.

The strategy of traffic avoidance is pursued particularly in Stockholm and Hamburg by applying the concept of a "city of short distances" in large-scale new building and land recycling projects, where high density and mixed-use settlement structures are realized. So far, there are no concepts that aim at avoiding transport by rebuilding or reorganizing existing urban districts.

The strategy to shift motorized individual transport to environmentally more friendly transport modes (walking, cycling, public transport) is pursued by all eleven cities. For this purpose, all cities pursue a combined push and pull approach with incentives for environmentally friendly transport modes and stringent restrictions against motorized private transport. A wide range of measures is implemented. All eleven cities have clear concepts to expand the urban public transport system and to promote cycling. Most cities have explicit strategies to promote walking. All eleven cities flank their improved sustainable mobility options by restrictive measures against motorized private transport in different ways and to different extend.

In all cities, data about the urban modal split is available. In some cities, the modal split has been monitored for quite a long time period. In some cities, modal split data demonstrates that the implemented measures have lead to considerable reductions of the modal share of urban car use (Hamburg, Nantes, Oslo, Vitoria-Gasteiz) (see figure 4). Some cities have concrete, operationalized mid-term modal shift targets. Modal spilt targets are formulated either for all transport modes (Copenhagen, Essen, Ljubljana, Nantes) or for specific transport modes (e.g. for cycling in Hamburg, Nantes, Oslo, Vitoria-Gasteiz).

The strategy of technical or organizational transport improvements is – to different degrees – pursued by all eleven cities for motorized private transport and public transport.

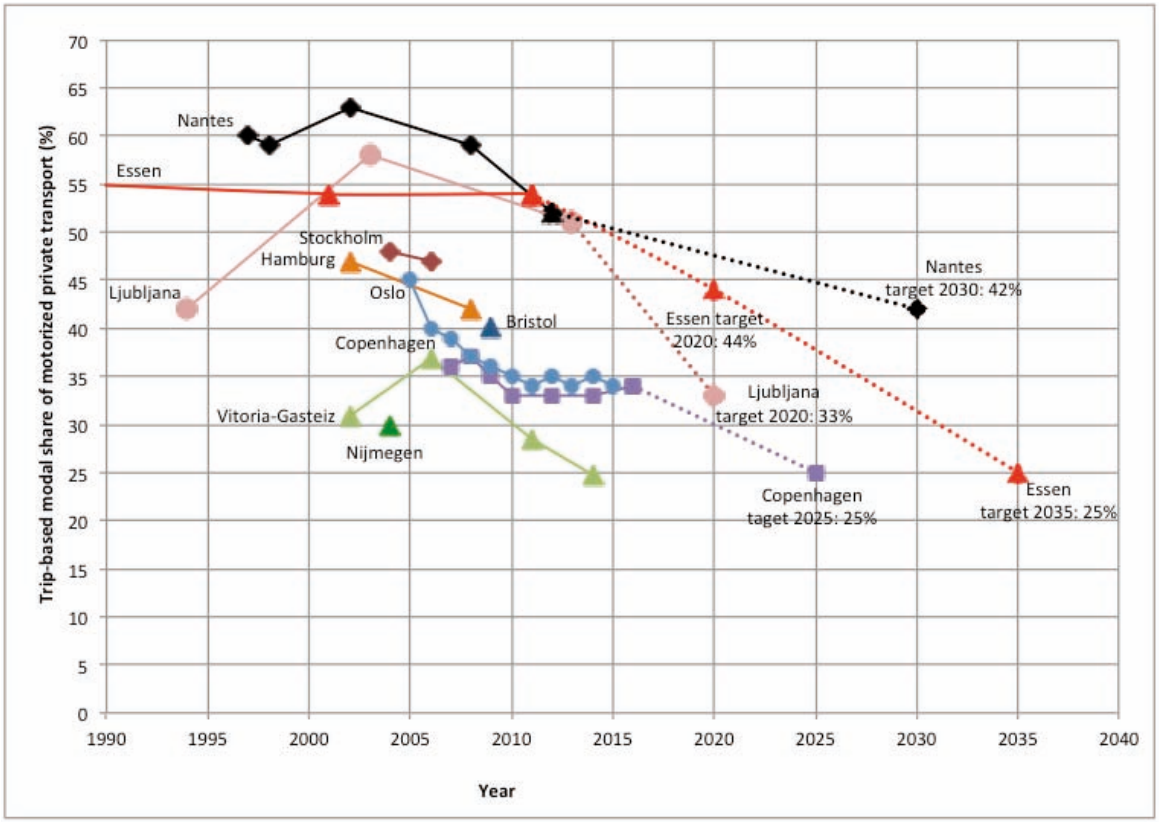

Figure 4: Modal share of motorized private transport of the eleven European Green Capitals 2010-2020.
Lisbon is not included in the figure because only modal split data for commuting trips are available.
Sources: City applications and documents.

4 Discussion and Conclusions

This section aims to reflect upon the benefits and limitations of this analysis and ask the question what further steps should be taken by research, policy and practice for learning purposes.

A benefit of the analysis is that for the first time a descriptive outline ("big picture") of the city concepts of the eleven EGCA winner cities is available regarding sustainable and climate-friendly urban transport. The authors argue that the analysis provides solid up-to-date information about the city strategies, policies and – if data is available for a long enough time – about actual city developments regarding core indicators like the urban modal split and transport greenhouse gas emissions. It is the merit of the competition that information about the sustainability actions of local governments, that can be considered leading in sustainable urban development in Europe, is freely accessible on the internet in English language and thus available for analysis. Without the competition, this information might not be accessible, for example due to language barriers if official documents are available only in national languages. Certainly, not all of the eleven cities can be considered leading in sustainable urban mobility, as mobility is only one part of the competition. Nevertheless, the jury explicitly mentioned transport actions as reasons for choosing five of the eleven cities as EGCs (Bristol, Copenhagen, Ljubljana, Nijmegen, Oslo).

Limitations are that the analysis provides a rather rough overview of the range of measures implemented than detailed information about each measure, because the city applications are kept short due to a word limit. It often remains unclear to what extend measures have been implemented (small or large scale). It cannot be examined if the information provided by the cities is correct and complete. Here, the authors have to trust in the rightness of the city applications. Another limitation is that information provided as part of a city competition describes, as it is in the nature of things, only one-sidedly the sustainable urban transport policies. Information about weaknesses and counteracting practices are – needless to say – not reported (Giffinger et al. 2010, p. 300; Macmillen & Stead, 2014, p. 81).

Award schemes like EGCA aim to contribute to intra- and inter-organizational knowledge transfer (Bovaird & Löffler, 2009, p. 384). Research acknowledges that, generally, knowledge sharing tools which include elements of comparison, such as awards, benchmarking, city rankings and good/best practices, may "indeed help to move forward the transport policy agenda" (Gudmundsson, 2005, p. 669 relating to benchmarking, see furthermore Bovaird & Löffler, 2009, Drew, 1997, Giffinger et al., 2007, Macmillen & Stead, 2014). In order to increase knowledge generation effects of the EGCA analysis, further steps should be taken by research, policy and practice:

(1) Research should extend this descriptive analysis of "what" transport concepts the EGCA cities have realized by analyzing "how" they have managed to do so. Studies should contextualize the EGCA cases into the political, administrational and cultural processes at work that have facilitated implementation (Bovaird & Löffler, 2009, p. 386, Macmillen & Stead 2014 , p. 85). Studies should ask: What can we learn from the EGCA cities about success factors, strategies to overcome barriers and advantageous actor constellations?
(2) In practical terms, cities should organize and participate in knowledge sharing formats to learn about the "real practicalities" (Bovaird & Löffler, 2009, p. 397) and "unwritten lessons" (Marsden et al., 2011) of how ambitious transport strategies can be implemented, e.g. through the exchange of tacit knowledge about positive and negative implementation experiences (Ammons & Roenigk, 2014, pp. 311, McGuinness et al, 2012, p. 7). Knowledge sharing formats should investigate what other European cities can learn from the EGCs. What is transferable and what is too different to learn from each other, particularly in the highly complex field of transport policy (Gudmundsson, 2005, p. 669 & 686, Macmillen & Stead, 2014, p. 80)? The European Commission should support such mutual learning processes. Suitable exchange formats can be dialogue platforms and twin conferences, site visits and peer-

to-peer exchange (Ammons & Roenigk, 2014, p. 325, Bovaird & Löffler, 2009, p. 385 & 397, Giffinger et al., 2007, p. 10, Marsden et al., 2011, McGuinness et al., 2012, p. 7).

(3) Besides analyzing the relatively sustainable transport concepts of the EGCA winner cities, research and policy should likewise analyze the absolute dimensions of change needed in cities to reach normative targets (Drew, 1997, p. 429, Macmillen & Stead, 2014, p. 85), such as the decarburization target to keep "the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (Paris Agreement, see UNFCCC, 2015, p. 3) and air quality standards for urban health protection (EU Directive 2008/50/EC; World Health Organization 2006). So far, it has not yet been sufficiently answered what change is required in terms of modal shift, avoid-shift-improve-measures and rates of change (scale and pace) to reach such ambitious targets.

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