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Deliverable 6.1: Future mobility demands in rapidly growing Stage-3 cities and the likely implications for congestion and overall network performance

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1 Introduction

Task 6.1 is described as follows in the CREATE grant agreement.

"Future projections of population and employment for the next 20-30 years will be used to assess the likely deterioration in network conditions (in terms of both congestion and wider indicators of network performance agreed in WP2 and tested in WP3) in Copenhagen and London, in particular, arising from the densification of mobility demand, if these cities do no more than carry on implementing their current Stage 3 transport policy measures" (European Commission Innovation and Networks Executive Agency 2015, p.31).

As will be seen, there are various ways in which the task has evolved from this initial conception. The primary reason for this is the inconsistent level of data available to inform an assessment of future network conditions/performance in the five Stage-3 cities. A second factor is the inherently cyclical and fluid nature of transport planning: it has proved difficult to identify a city that has attempted to assess a scenario consisting only of the continuation of their *current* Stage 3 policy measures, since cities test packages of policies iteratively and, in particular, revise their strategies in response to finding that network conditions under a given scenario may be unsatisfactory. Perhaps the most interesting outcome of this task is some initial thinking concerning the question of where Stage 3 ends and Stage 4 begins. We return to this topic at the end of this report.

London and Copenhagen were identified as having a particular interest in this topic because of high expected population growth (Figure 15), (though all five Stage-3 partner cities contributed to the work). This reflects an assumption that there are practical limits to the effectiveness of Stage 3 as a transport-planning philosophy, one of which may be the sheer numbers of people travelling in a given location.

The remainder of this report is structured as follows:

- In Chapter 2, evidence concerning population and employment projections is set out
- What this may mean for "baseline" travel demand is presented in Chapter 3
- Where information is held concerning resulting future network conditions, this is explained in Chapter 4
- Findings are discussed and tentative conclusions drawn in Chapter 5

An illustrative excerpt from Berlin's Urban Transportation Development Plan is included as Appendix 1.

2 Population & employment projections across the Stage-3 cities

2.1 Berlin

Berlin has adopted a scenario-based approach to projecting its future population. The scenarios reflect differing assumptions concerning political, social and economic factors. They lead to "upper", "base/central" and "lower" projections for the year 2030 (see Figure 1), with the "base/central" projection being adopted as the most likely. The bulk of the growth is expected to come from net migration from within Germany and abroad as opposed to natural growth (surplus of births over deaths) (Senatsverwaltung für Stadtentwicklung und Umwelt 2016, Table 1).

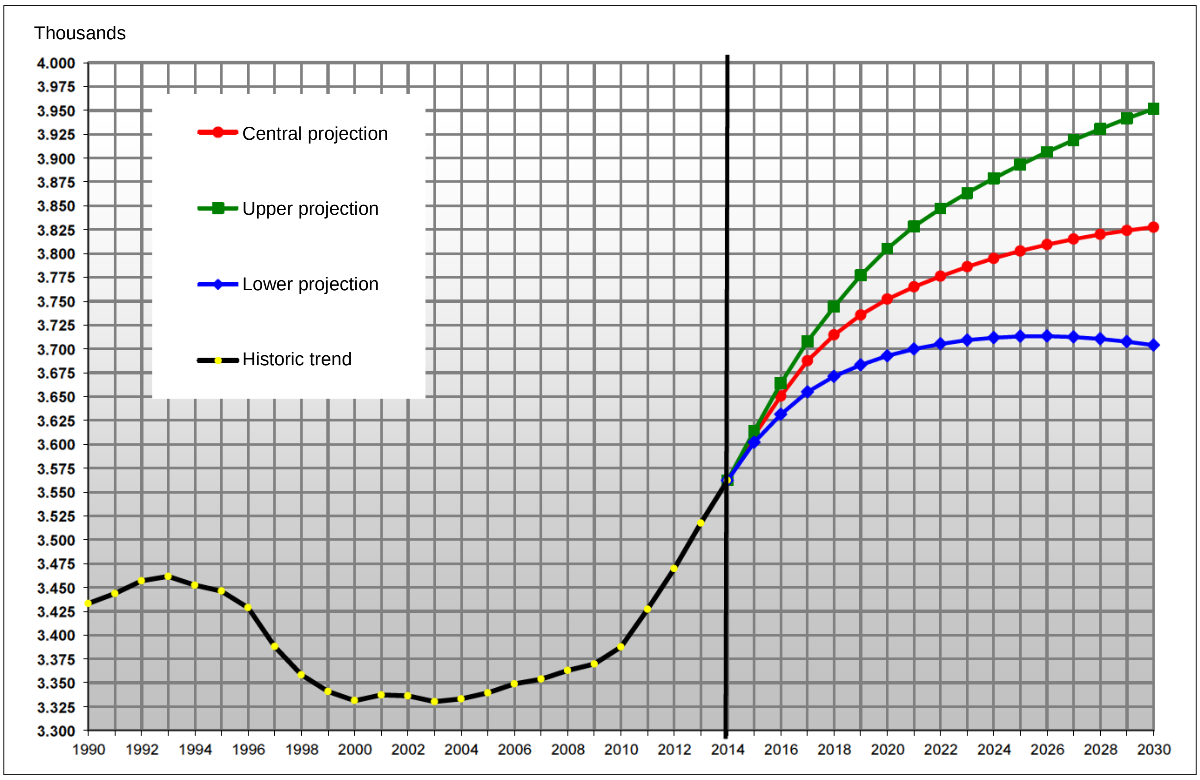

Figure 1 - Three population projection variants to 2030 for Berlin[1]

These general projections exclude refugees, which are dealt with separately, with a time horizon of 2020. Again, scenarios are used; these differ considerably in their underlying assumptions and this leads to a sizeable range between the lower and higher estimates. Figure 2 is a graph showing the combined effect of natural population growth and the two refugee scenarios considered. It can be seen that the refugee scenarios add between 100,000 and nearly 200,000 to Berlin's population by 2020.

[1] Senatsverwaltung für Stadtentwicklung und Umwelt (2016, p.24), key translated from German.

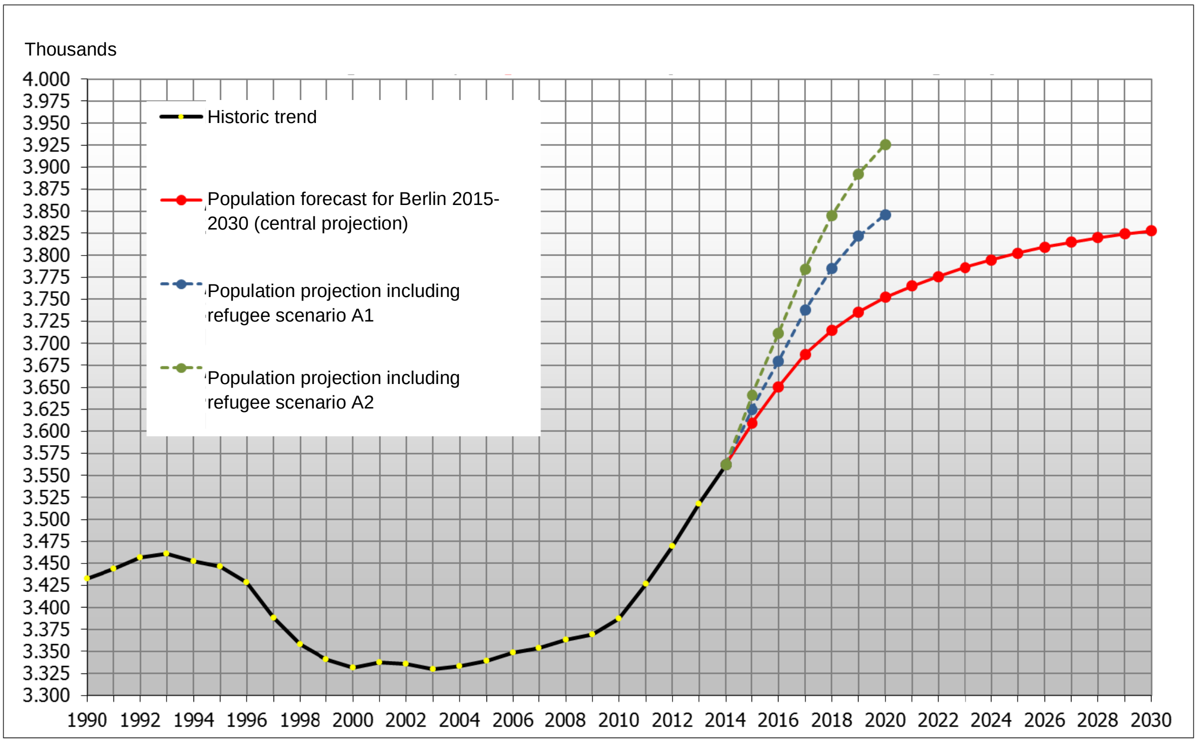

Figure 2 - Population projection to 2030 (central) and refugee projections to 2020[2]

The core population predictions are accompanied by some spatial analysis that shows how growth is expected to be distributed across the city. For example, Figure 3 shows that considerably greater growth is expected in the north-east of the city than in other parts.

Whilst there are no employment projections produced by the city in the public domain, work done at the federal level gives an indication of expected change. The German Ministry of Labour predicted in 2013 a near flat-lining of employment between 2010 and 2030: 2,000 new jobs are expected in this period, growth of 0.1 per cent.[3]

In contrast to this, local projections carried out by the Investment Bank Berlin (IBB) from 2015 predict an increase of more than 260,000 jobs over the same period, driven by expansion of the digital economy. Over the same period, these projections also indicate a substantial increase in the employment rate (Investitionsbank Berlin 2015, pp.20–23). These more positive projections are consistent with the city's recent strong recent economic performance relative to the German average.[4]

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2 Sources: Senatsverwaltung für Stadtentwicklung und Umwelt (2016; n.d.)

3 Bundesministerium fuer Arbeit und Soziales (2013, p.50)

4 https://www.berlin.de/sen/wirtschaft/wirtschaft/konjunktur-und-statistik/wirtschaftsdaten/wirtschaftsleistung/, accessed 16th January 2017.

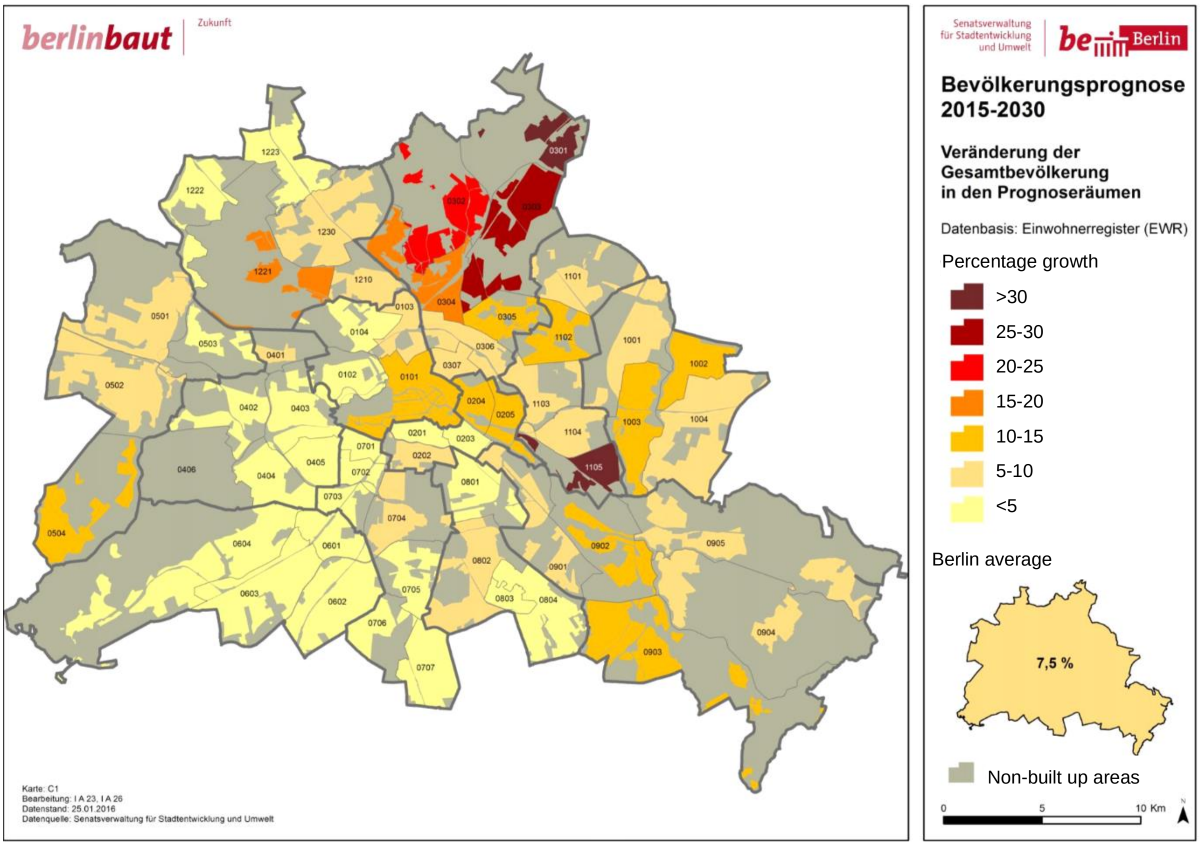

Figure 3 - Distribution of population growth across Berlin 2015-2030 (central projection)[5]

2.2 Copenhagen

Figure 4 predicts the population of Copenhagen will grow at a rate comparable with that of the period 2008 to the present, reaching approximately 670,000 by 2025. This is equivalent to approximately 1.5 per cent per annum on average (arithmetic). In Figure 5, the growth is broken down by age group, showing a substantial initial reduction in the number of people aged 80+, with the trend reversing in 2018. The spatial distribution of population expansion is shown in Figure 6[6], suggesting relatively strong growth in the southern part of the city.

As to employment, the city's municipal plan (Københavns Kommune 2015a, p.54) sets out a vision for the development of 2.4 million square metres of commercial space between 2015 and 2027 which, on the basis of the ratio quoted, would allow for 60,000 additional jobs, equating to 5,000 per annum on average. This, it must be acknowledged, is more an aspiration than a forecast. Elsewhere the plan presents a shorter-term goal relating to private-sector jobs in particular: "Twenty thousand new private sector jobs in the period 2011-2020, corresponding to 2,000 jobs per year" (Københavns Kommune 2015a, p.53). These goals can be viewed against the background of there being 352,000 jobs in Copenhagen as of 2015, of which 218,000 were in the private sector, so the shorter-term target represents growth of approximately one per cent per annum in the number of private-sector jobs.

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5 Source: Senatsverwaltung für Stadtentwicklung und Umwelt (2016, p.29), key translated from German

6 Note that this plot is based on a distinct set of projections

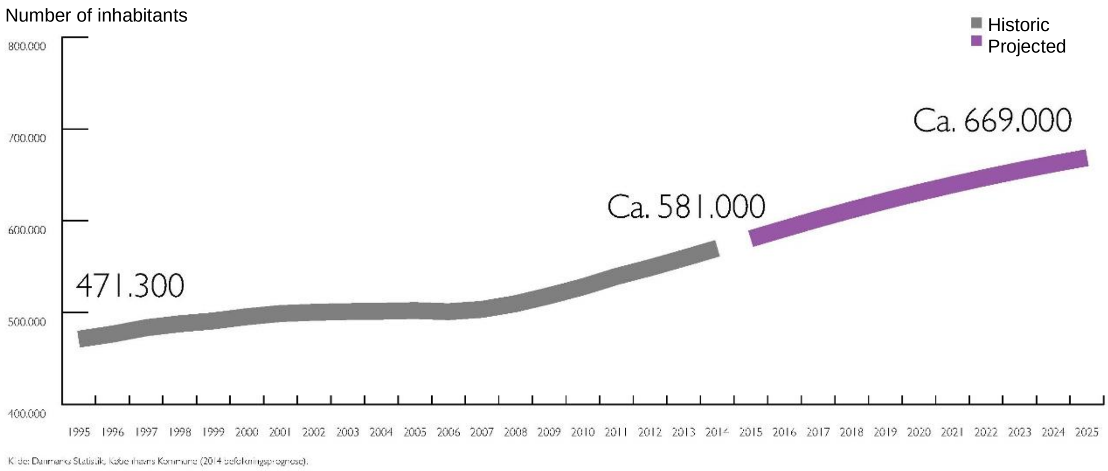

Figure 4 - Copenhagen population projections (2015-2025)[7]

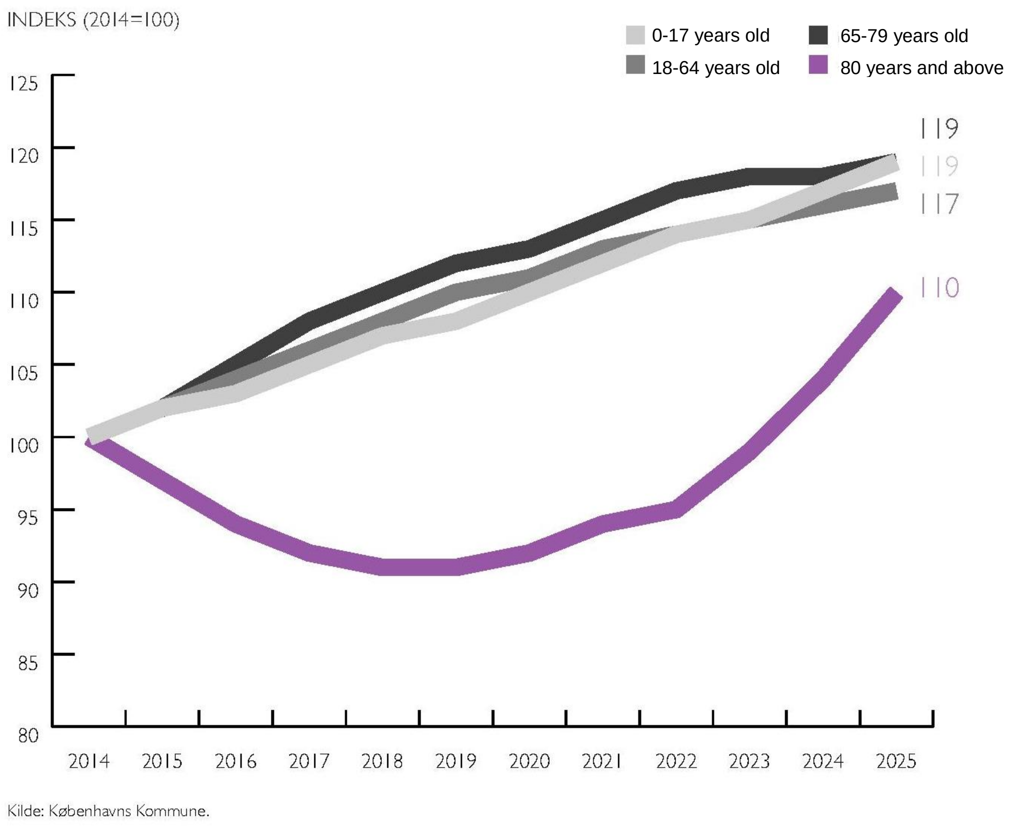

Figure 5 - Copenhagen's projected population growth by age group[8]

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7 Source: Københavns Kommune (2015b, p.4), key translated from Danish

8 Source: Københavns Kommune (2015b, p.7), key translated from Danish

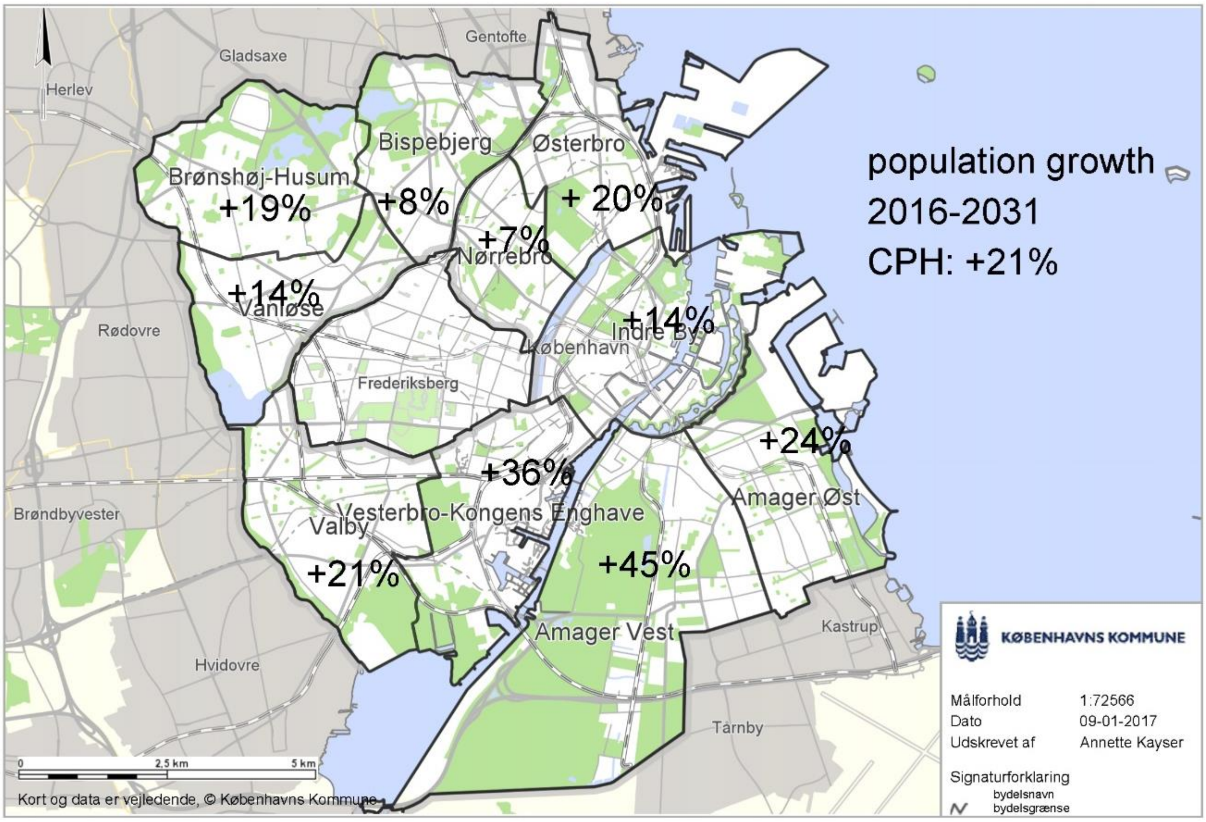

Figure 6 – Spatial distribution of Copenhagen City's projected population growth, 2016-2031[9]

2.3 London

London's population projections are derived using a trend-based model. There are two calculation methods: short-term migration and long-term migration. The former is based on the extrapolation of the migration rate over the last five years for which there are data; the latter on the last ten years' trend. The long-term migration method's projections "are intended to be used for longer-term strategic planning purposes" (GLA Intelligence 2016, p.2) and so are prioritised here. As shown in Figure 7, London is expected to grow steadily, reaching a population of 10 million in the early 2030s. By 2041, the city's population will be near 10.5 million, an increase of 27.8 per cent on its 2011 level. The reader should note that all projections quoted in this report predate the outcome of the referendum on membership of the EU of June 2016.

[9] Citywide population growth 21 per cent 2016-2031. Source: Copenhagen City Council, Technical and Environmental Unit

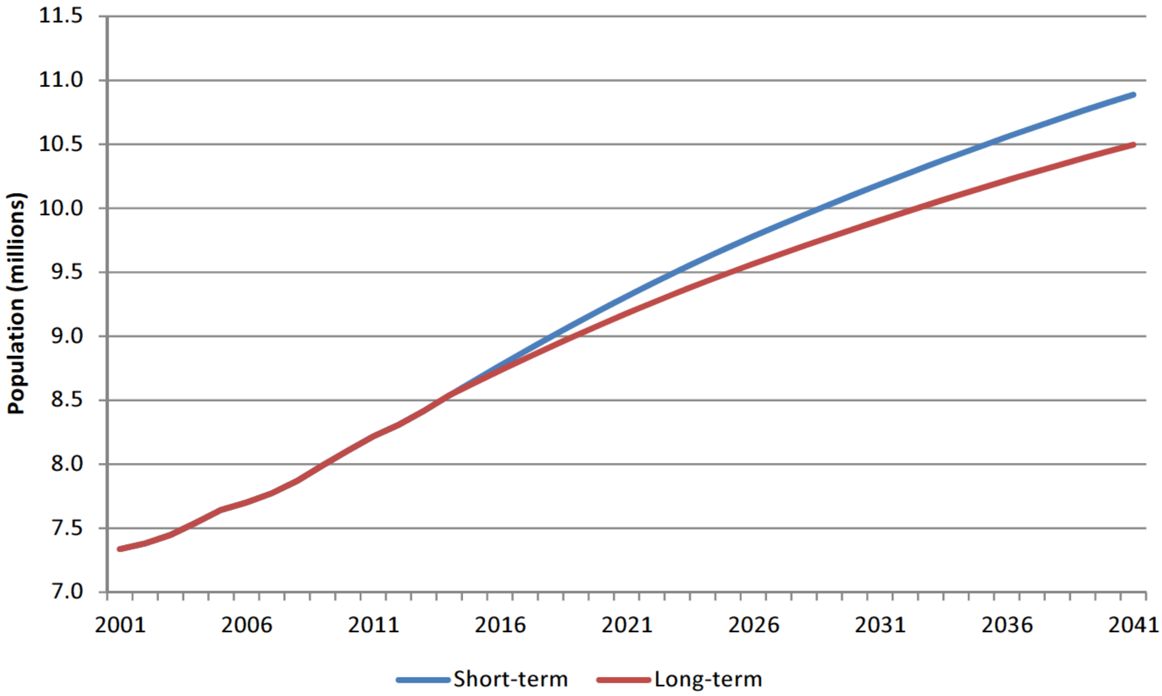

Figure 7 - Population projections for London to 2041[10]

The spatial distribution of the predicted growth in absolute terms is shown in Figure 8. Between 2011 and 2041, Inner London's[11] population is expected to grow by 31.3 per cent compared with Outer London's 25.4. At the individual authority level, the City of London is predicted to grow by the greatest proportion (59.8 per cent) though it is by far the least populous of the 33 authorities. After it, Tower Hamlets (an inner-London borough in the east) is predicted to grow to the greatest extent (52.6 per cent); outer-London Merton is predicted to grow the least (16.8 per cent). These numbers are taken from projections created specifically to support TfL's modelling and differ somewhat from the standard projections for London in predicting proportionally greater increases in the city's defined growth areas.

[10] Source: GLA Intelligence (2016, p.2)

[11] Inner and Outer London are here defined by the Local Government Act 1963. Note that references to Central, Inner and Outer London in Section 4 relate to a different division of Greater London.

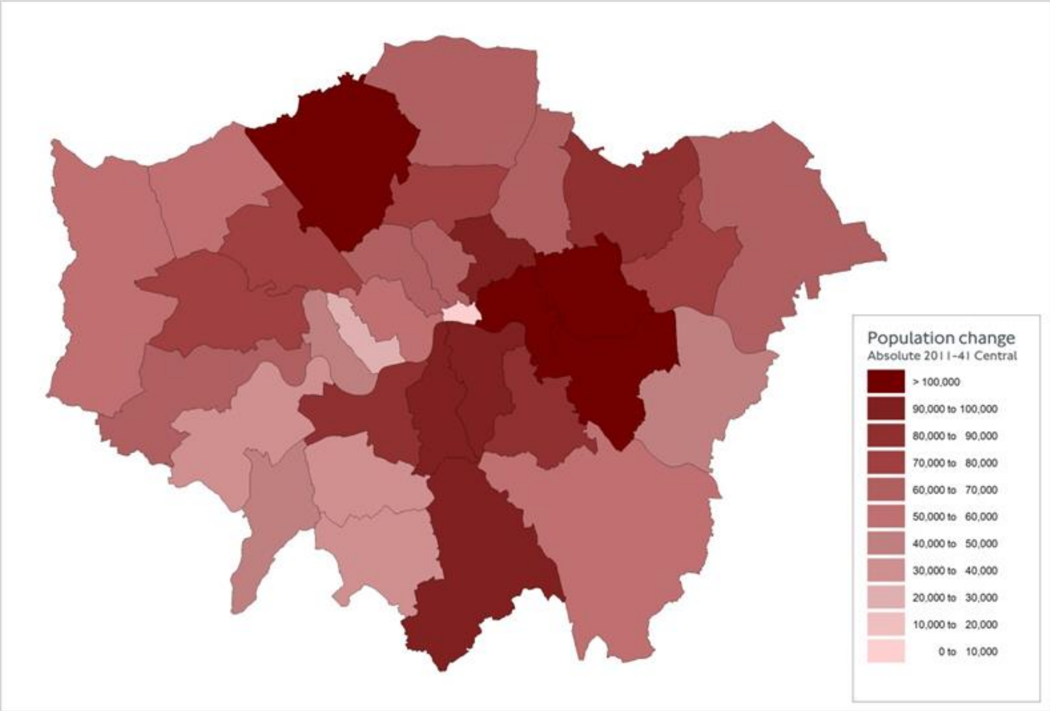

Figure 8 - Spatial distribution of London's absolute projected population growth, 2011-2041[12]

There are also forecasts of London's future employment. Figure 9 shows that London is expected to have approaching seven million jobs by 2041, as compared with the 2015 value of 5,538,000. This equates to an average growth of 45,000 jobs per year. Growth is not expected to be uniform across sectors, however. Figure 10 helps to demonstrate that the already largest sector – *Professional, Real Estate, Scientific and Technical Activities* – is expected to see the greatest proportional growth over the period. Several sectors, all of them already amongst London's smallest, are expected to shrink over the same timescale, with manufacturing contracting to the greatest extent, by two per cent (GLA Economics 2016, p.21).

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12 Map provided by Transport for London, Planning team

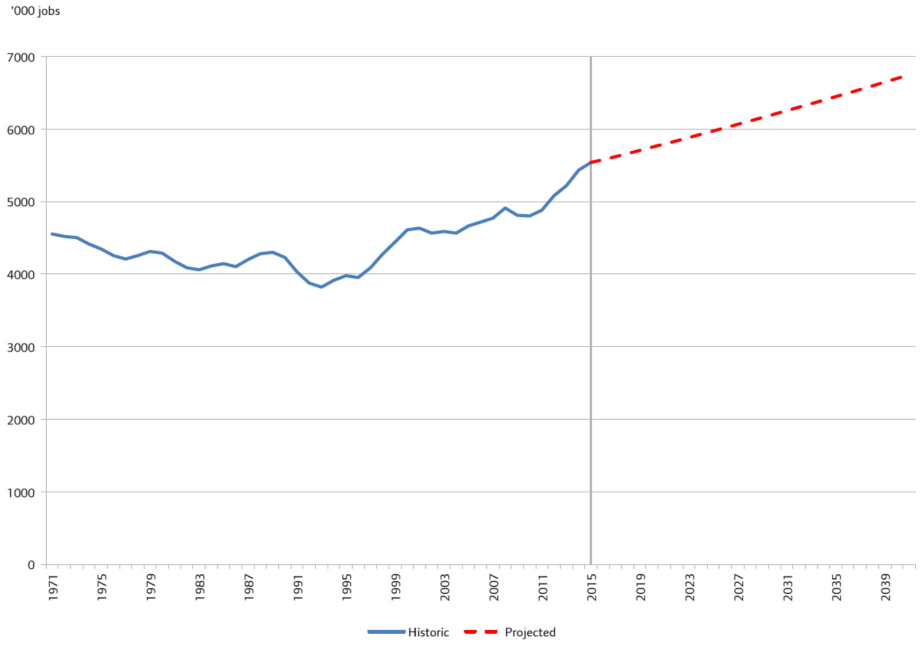

Figure 9 - London's projected employment to 2041[13]

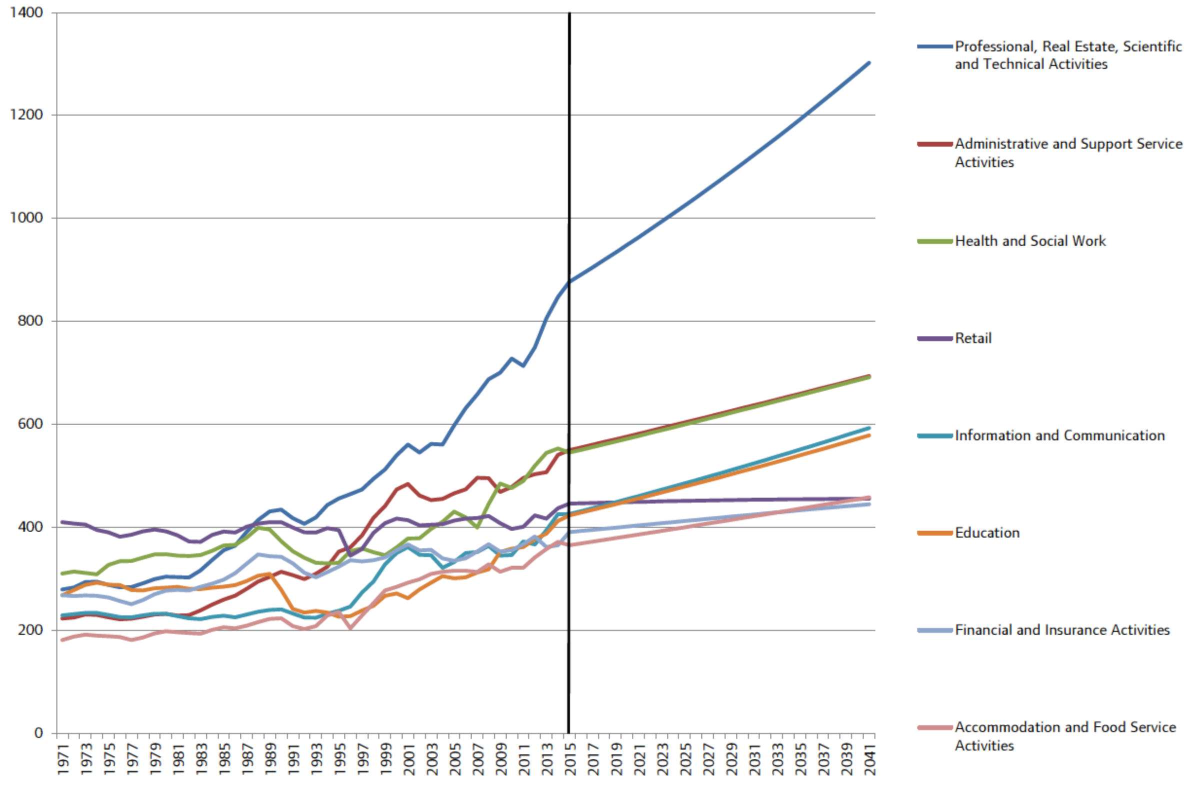

Figure 10 - Employment projections for London's larger sectors, to 2041[14]

13 Source: GLA Economics (2016, p.20)

14 Source: GLA Economics (2016, p.21)

2.4 Paris

Paris lies in the French region of Île-de-France. The region is made up of eight départements, with the city of Paris (75) at the centre. Three départements (92, 93 and 94) make up the inner ring around Paris and the remaining four (77, 78, 91 and 95) the outer ring. The region can be divided into several topographical areas based on characteristics such as level of urbanisation and development density (see Figure 11).

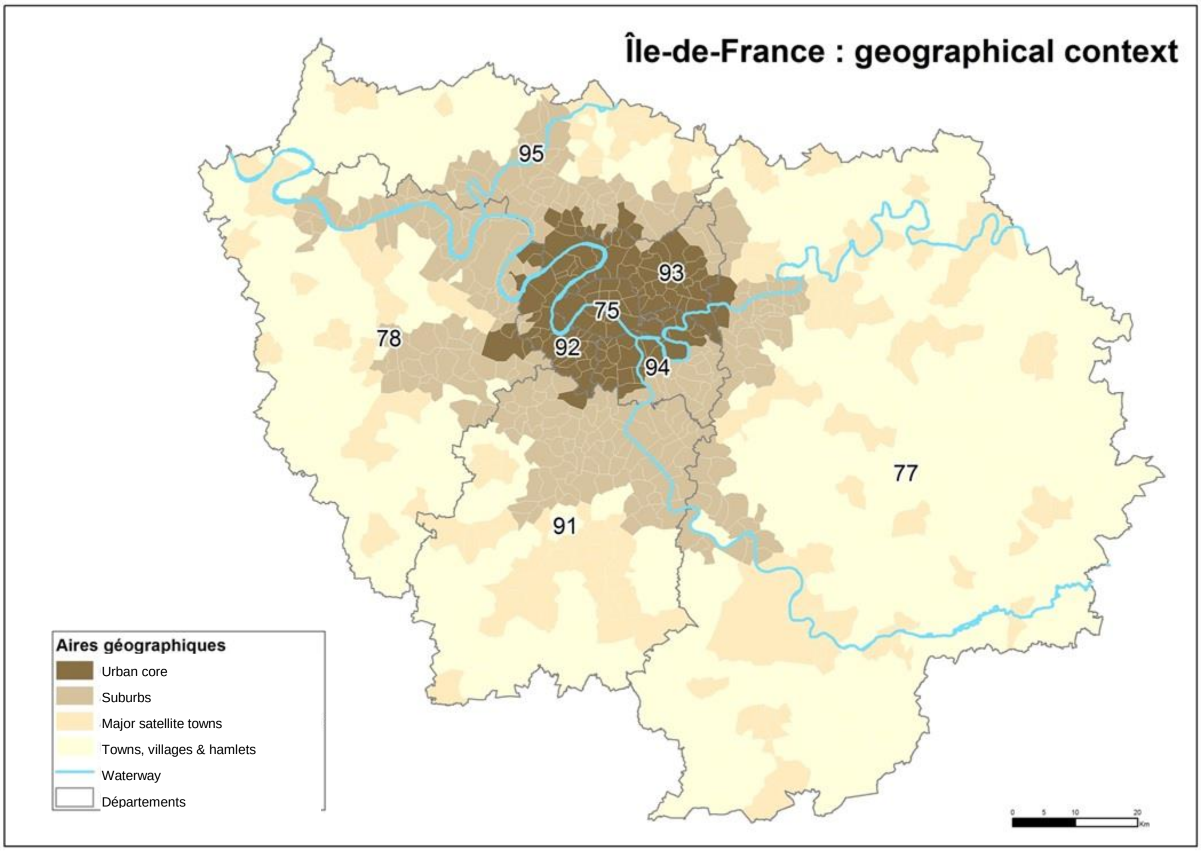

Figure 11 - Urbanisation of Île-de-France by département[15]

The départements vary in their urbanisation mix and this is reflected in the population and employment projections, which are made at the département level. Figure 12 shows two sets of population projections by département for the period 2012 to 2030. "Trend scenario" extrapolates recent growth rates; SDRIF (Schéma Directeur de la Région Île-de-France) derives from the regional plan. At the region level, the Trend scenario predicts growth of 10.1 per cent compared with SDRIF's 7.2 per cent. It can be seen from the figure that the two sets of projections also differ significantly in terms of the predicted location of that growth, most notably in Départements 78, 91 and 92.

[15] Source: IAU île-de-France, Département Mobilité et Transports, key translated from French

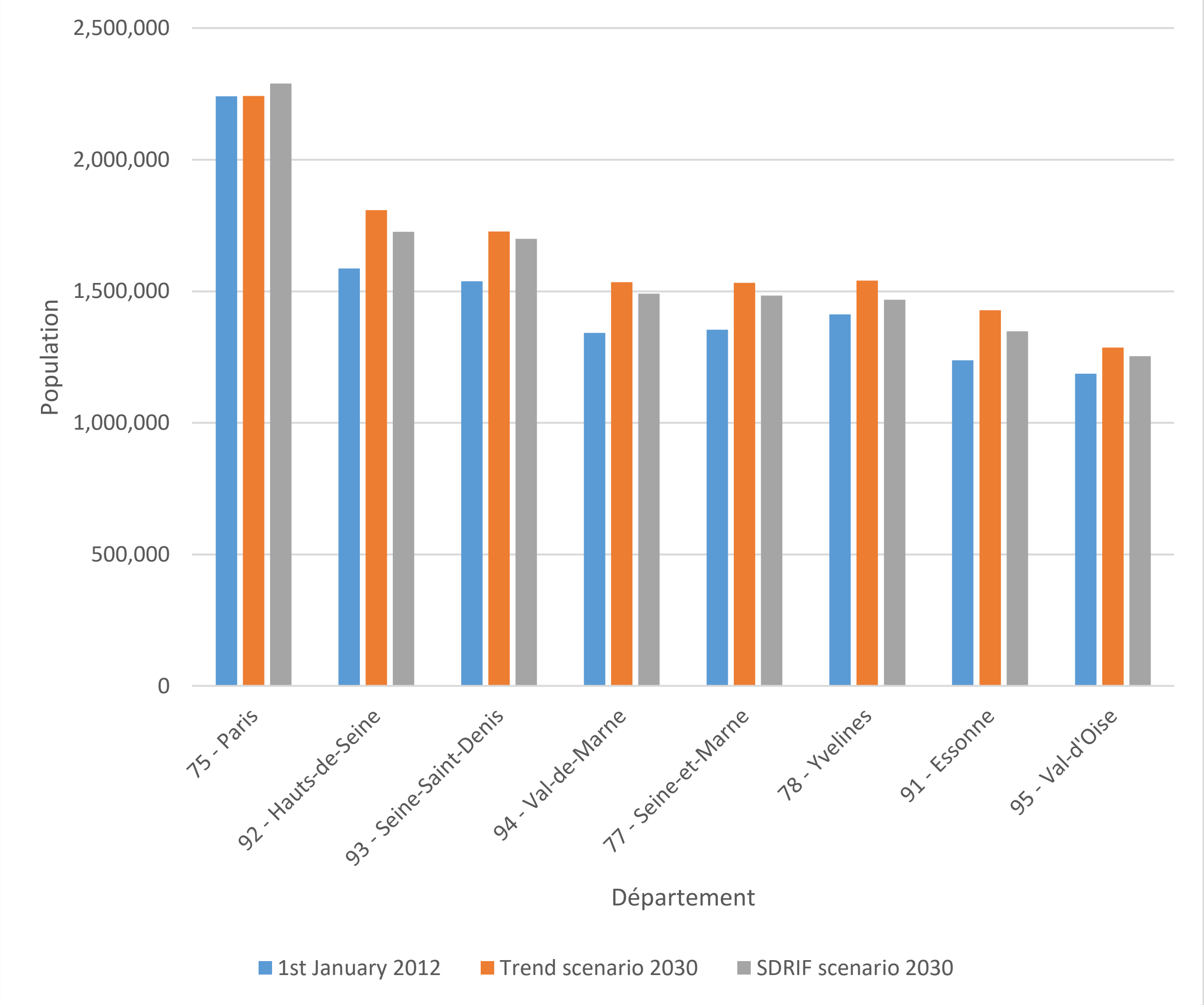

Figure 12 - Île-de-France population projections[16]

A more recent set of population projections at the regional level offer "upper" and "lower" estimates of 13.4 and 12.4 million people in 2030, respectively. These projections extend on to 2060, by which time population may have grown further to 15.6 million (upper) or begun to shrink to 12.2 million (lower) (Conseil régional d'Île-de-France 2013, p.20).

There are also job projections (Figure 13). The "Trend" and SDRIF projections are here consistent at the regional level (predicting 10.8% growth between 2012 and 2030) but distribute this growth in quite different ways: SDRIF predicts growth will be strongest in the "outer ring", suggesting a pronounced decentralisation of the regional economy away from Paris. The "Trend" projections concentrate growth in the "inner ring".

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[16] Source: IAU île-de-France, Département Mobilité et Transports

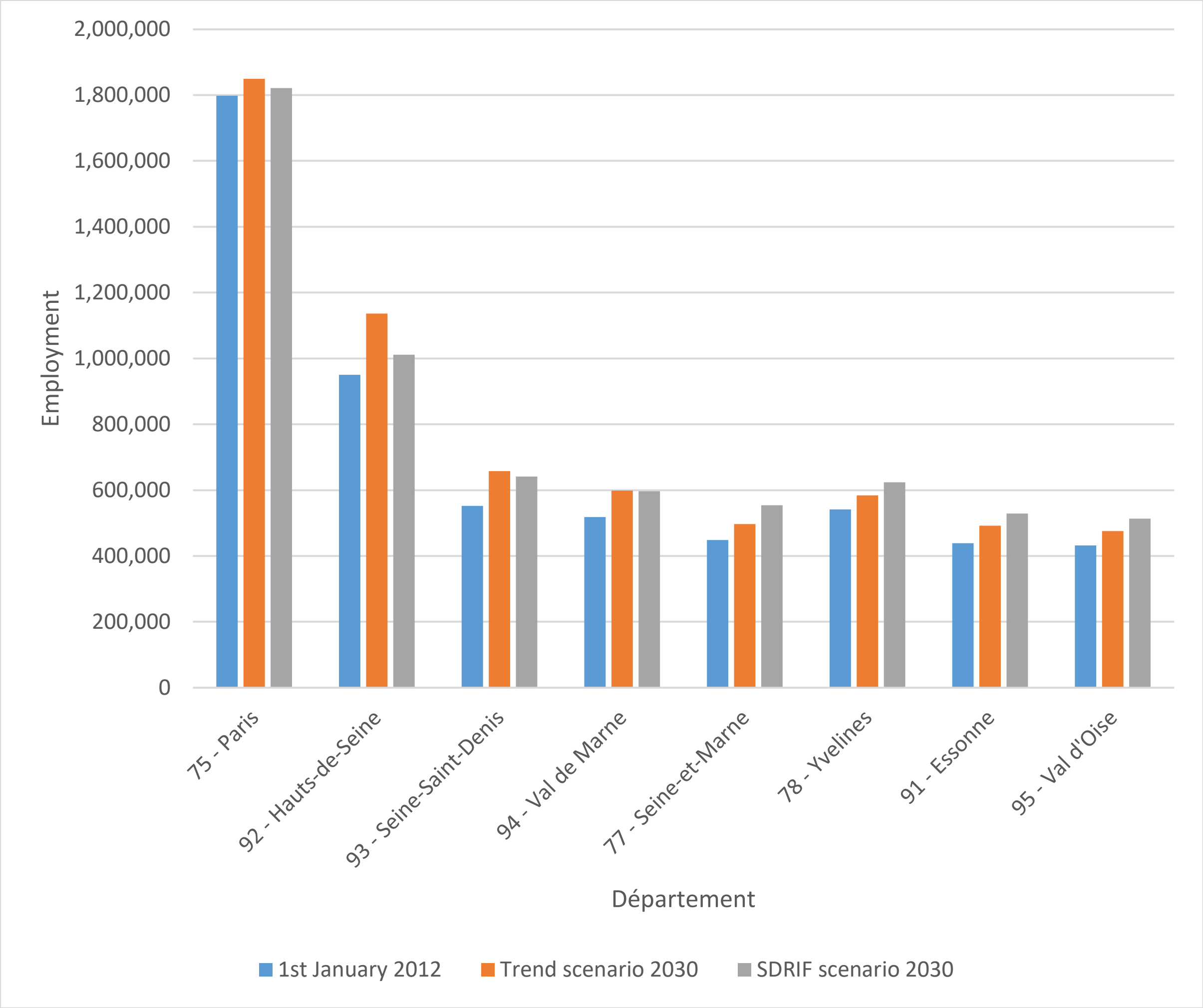

Figure 13 - Île-de-France job projections[17]

2.5 Vienna

Vienna's population projections resemble those of other locations in being based on multiple scenarios. In this case, the "main scenario" (which lies between the growth scenario and the "demographic aging scenario") is used as the reference case. It predicts that the city will have a population of 1.91 million in 2025, as compared with its 2013 level of 1.74 million (Figure 14).

It is understood that there are not formal forecasts of employment numbers in Vienna. Instead, a more general assumption is made that employment will grow at a similar pace to population. One consequence of this is that, whilst the *volume* of commuting can be expected to increase, the pattern (particularly in terms of distance) may remain similar. (Were the numbers of residents and jobs to change at different rates, this would indicate a change in the balance of in- and out-commuting.)

[17] Source: IAU île-de-France, Département Mobilité et Transports

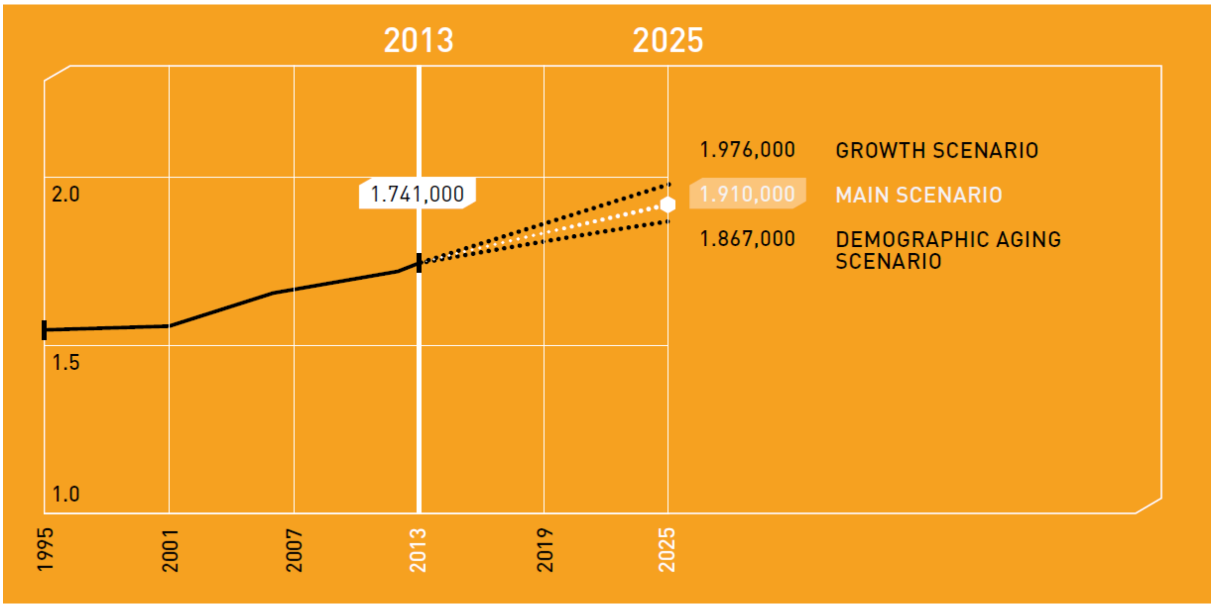

Figure 14 – Population projections to 2025 for Vienna[18]

2.6 Comparisons across locations; discussion

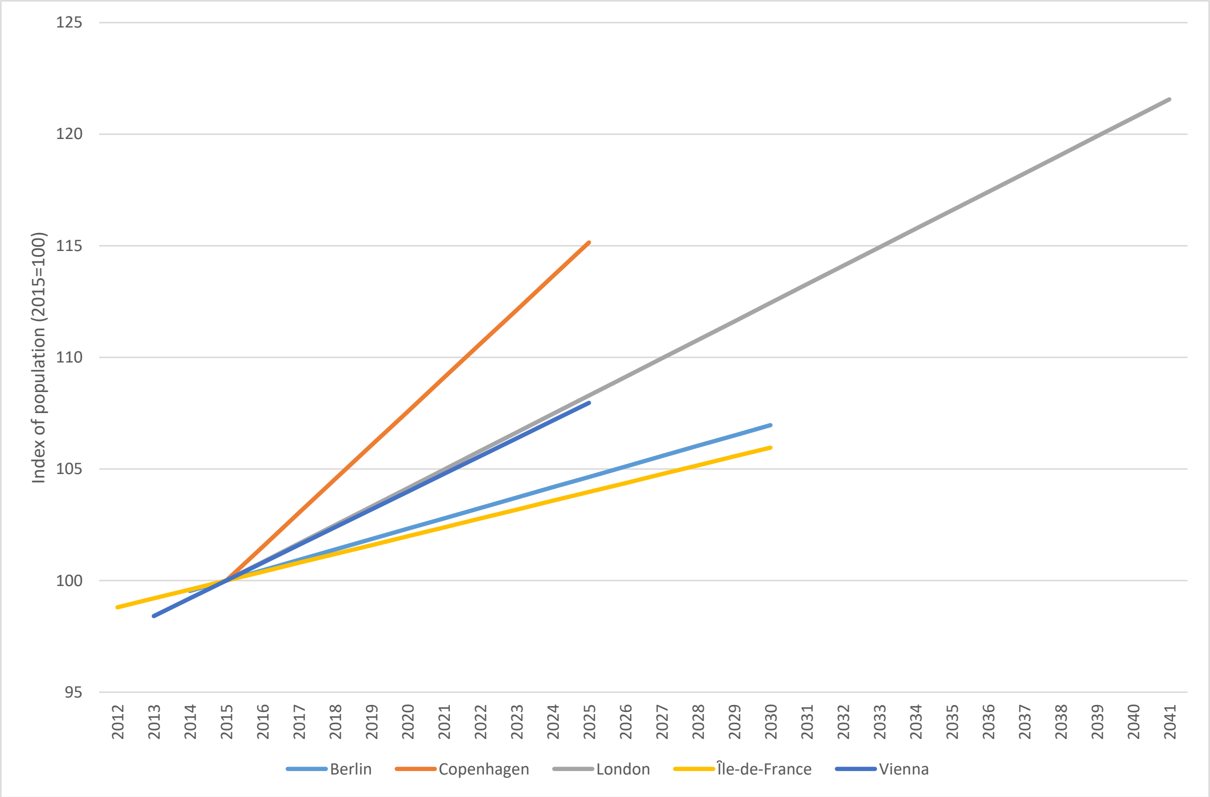

Figure 15 - Population growth rates across the five Stage-3 cities[19]

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18 Source: Vienna Urban Development and Planning Department (2014b, p.15)

19 The chart is simplified to enable comparison: a straight line is drawn between representative starting and finishing years and cities' populations are indexed to their 2015 values. The Berlin values omit estimates of refugee numbers.

In Figure 15, the differing expectations of the five Stage-3 cities are made explicit: Copenhagen displays the highest population growth rate, followed by London. (The data for Berlin have to be treated with caution as they do not include estimates of refugee numbers.)

Whilst it is not the purpose of this report to discuss forecasting methodology, it is worth noting that different methods yield different results. Île-de-France provides an excellent example of this, given that two sets of projections for the same area part ways in several respects. Most of the forecasts reported on here are the result of trend-based models which, broadly, assume that what was true of the past will be true of the future. It is legitimate to ask how well such tools serve their clients. In particular, such models appear inherently conservative; and, in several cases, a "central" scenario is chosen as more likely than either the upper or lower sensitivity test but none of the three departs dramatically from historic patterns.

Several further observations can be made. First, the five cities vary significantly in the extent to which population and the employment market are projected into the future. On the strength of the information here, London appears to devote the greatest effort to this, with data rather patchier for Berlin, Copenhagen and Vienna. This may or may not reflect limited interest in long-range forecasts. Equally, the limited data available in certain locations may help to explain the relative lack of information about either future transport demand or the limited time spent on attempting to predict future network conditions, as discussed in later sections.

A second point deserving emphasis is that the spatial extent of the projections reported here differs greatly. At one extreme, the projections for the Île-de-France region encompass large areas that are rural. At the other, projections for Copenhagen City are limited to the section of the urban core that falls under the city council's jurisdiction, whereas the Copenhagen "metro area" is considerably more extensive. If growth can be expected to vary across levels of urbanisation, this should be borne in mind when comparisons are made between the cities.

Third, whilst all forecasting is inherently uncertain, some Stage-3 cities face more uncertainty than others. Berlin stands out, given that internal policy and external developments will in combination greatly affect the number of refugees who arrive in the city in the coming years. This is reflected in the wide range of estimates and the fact that they do not go beyond 2020.

Finally, most forecasting work is conducted on the basis of attempting to predict impartially what will happen in the future. But, as the jobs projection for Copenhagen shows, there are also cases where aspiration influences the "hard" evidence supporting the likely future of that city's employment market. This conflation of fact and desire can be seen in subsequent stages of the forecasting and planning process.

3 Predicted travel demand

We have seen that population and employment forecasting varies in its extent across the five cities. The same is true of projecting travel demand.

3.1 Berlin

Berlin is in a state of transition in terms of predicting travel demand. Its previous tool, the Gesamtverkehrsprognose ("overall traffic forecast") is in the process of being replaced and we are advised not to rely on the most recent published set of forecasts produced using it, in 2009.

The Urban Transportation Development Plan (UTDP) explains the overall project for Berlin and secures its credentials as a Stage-3 city:

"Since the first urban transportation development plan was drafted (2001-2003), a raft of measures has been implemented which, together with other factors, has successfully put a halt to the long-term trend of automobility growth and increased the share of green and city-friendly ecomobility, which comprises public transport use, cycling and walking. With this, Berlin has taken a major step towards securing mobility, improving traffic flows and, simultaneously, limiting the undesirable effects of traffic" (Senate Department for Urban Development – Division VII n.d., p.1).

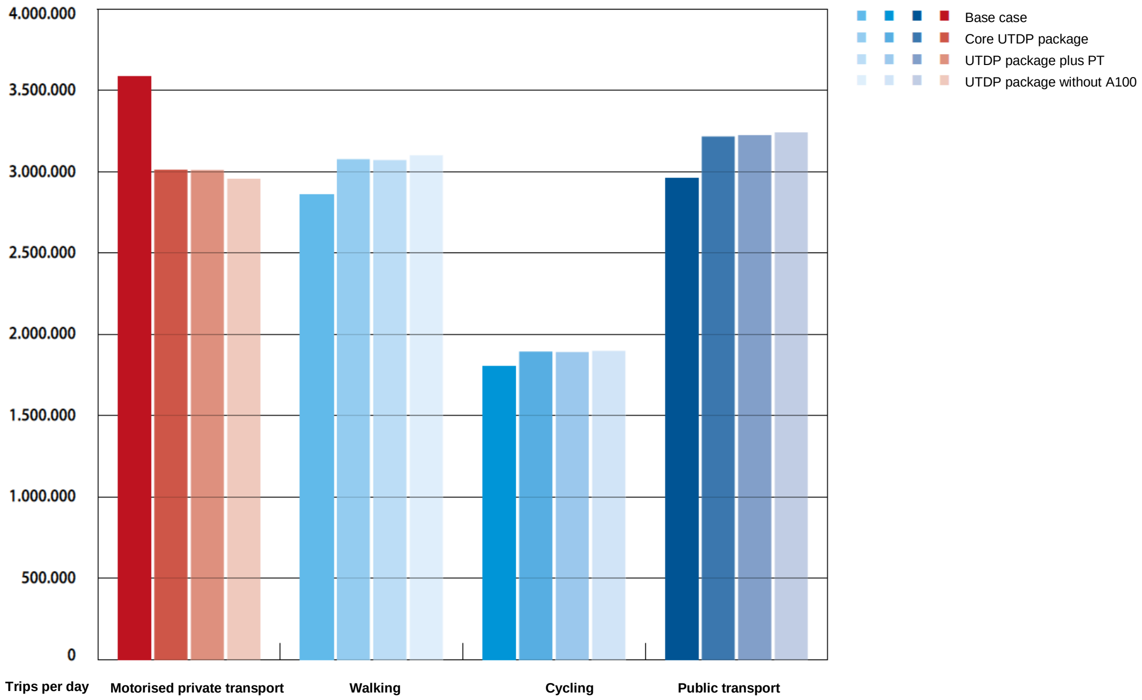

Figure 16 - Comparison of scenarios by modal shares, trips per day, Berlin, 2025[20]

Amongst other things, the Plan sets out how a range of policy packages can be expected to influence travel choices in the city (Figure 16).

The Plan also plots travel demand spatially. Figure 17 shows 2025 weekday public transport flows in the UTDP scenario.

20 Notes on scenarios: "base" is not a do-nothing scenario: it includes some highway infrastructure, public transport and traffic management measures; the UTDP package plus PT has "enhanced" public transport measures; UTDP package without A100 is the UTDP package without two road schemes and associated measures. Source: Senatsverwaltung für Stadtentwicklung (2011, p.92)

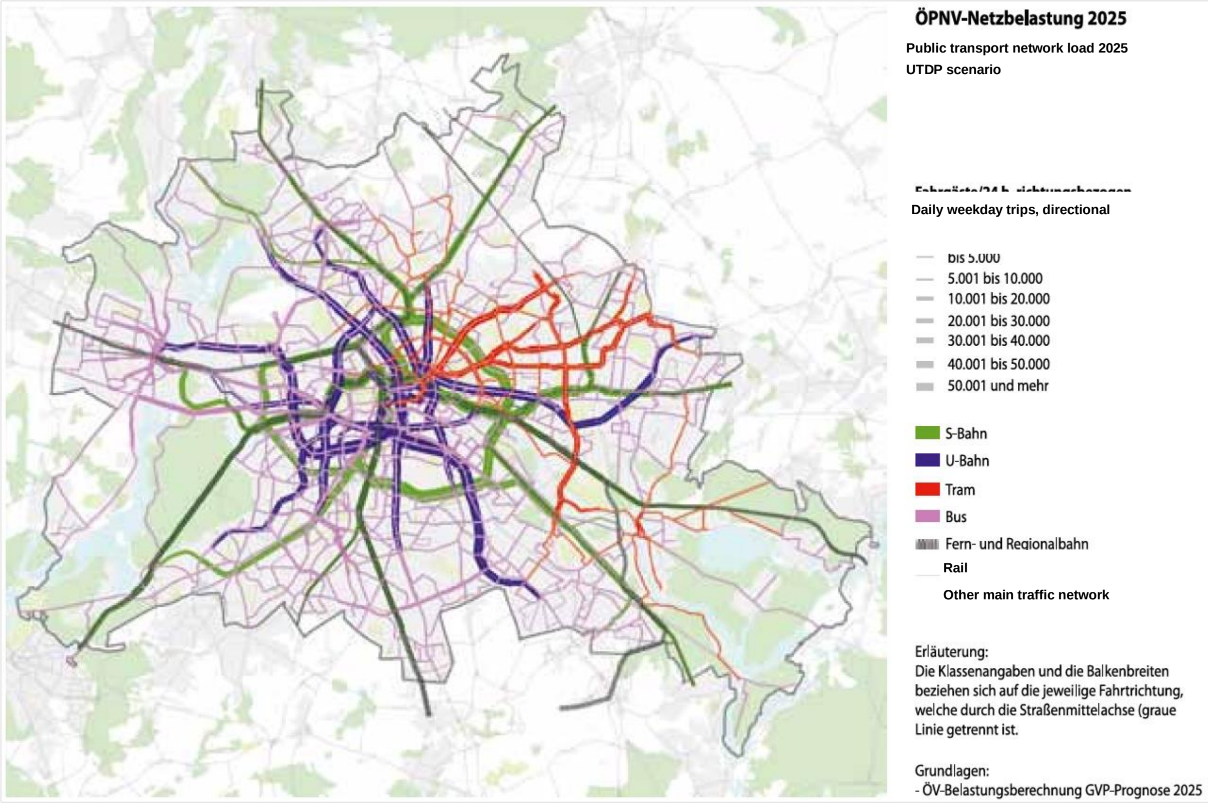

Figure 17 - Public transport flows with UTDP, Berlin, 2025[21]

3.2 Copenhagen

Copenhagen has estimated growth in travel demand as part of its cycling strategy development process (Tetraplan 2016). To do this it used a model with coverage significantly greater than that of urbanised Copenhagen – the combined residential population covered by the model is approximately 1.8 million (2006 estimate[22]), as compared with the 2015 figure of 581,000 for the city itself. The data shown in Figure 19 convey predicted overall growth in daily personal journeys of 11 per cent between 2014 and 2025. The underlying modal shares (Figure 19) are very consistent, with public transport gaining one percentage point at the expense of walking and cycling, both of which lose half a percentage point.

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21 Source: Senatsverwaltung für Stadtentwicklung (2011, p.94)

22 http://www.statistikbanken.dk/BEF1A (accessed 16 January 2017)

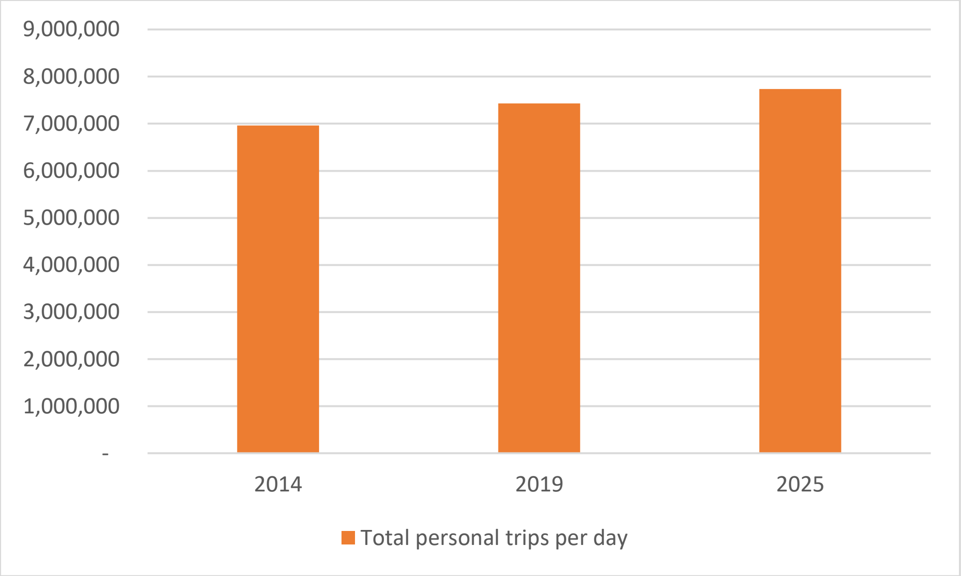

Figure 18 – Total daily personal trips, Copenhagen region, 2014-2025[23]

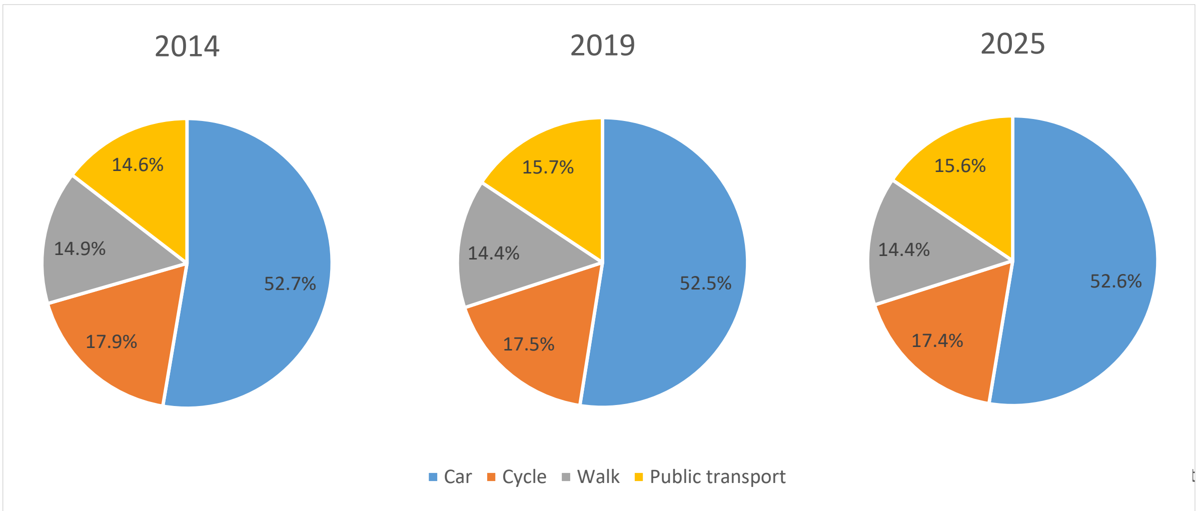

Figure 19 – Mode shares of personal trips in Copenhagen region, 2014-2025[24]

3.3 London

Transport for London carries out extensive analysis of future demand for (and supply of) transport in London. Figure 20 shows the predicted growth in trip volumes between 2011 and 2041. Whilst the total volume of trips is predicted to increase by 27 per cent, the volume of car journeys is forecast not to change, reflected in car's diminishing mode share (a fall of eight percentage points). In contrast, strong growth is expected in both cycling and public transport use, with walking continuing to represent a quarter of journeys.

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[23] Source: Tetraplan (2016)

[24] Source: Tetraplan (2016)

Despite the prediction that the number of car *trips* will remain static, overall motorised traffic is nonetheless expected to increase in part because of predicted growth in van traffic. In the period between 7am and 7pm on a weekday, car traffic (veh-km) is predicted to increase by nine per cent over the 30-year period (as a result of increasing trip distance) and overall traffic by 15 per cent. Beneath these London-wide figures are some striking variations, with car traffic expected to drop in both central and inner London, growing only in outer London (Transport for London n.d.).[25] This spatial factor helps to explain the increasing trip distance underlying increased car vehicle-km: journey distances are typically greater in outer than inner/central London.

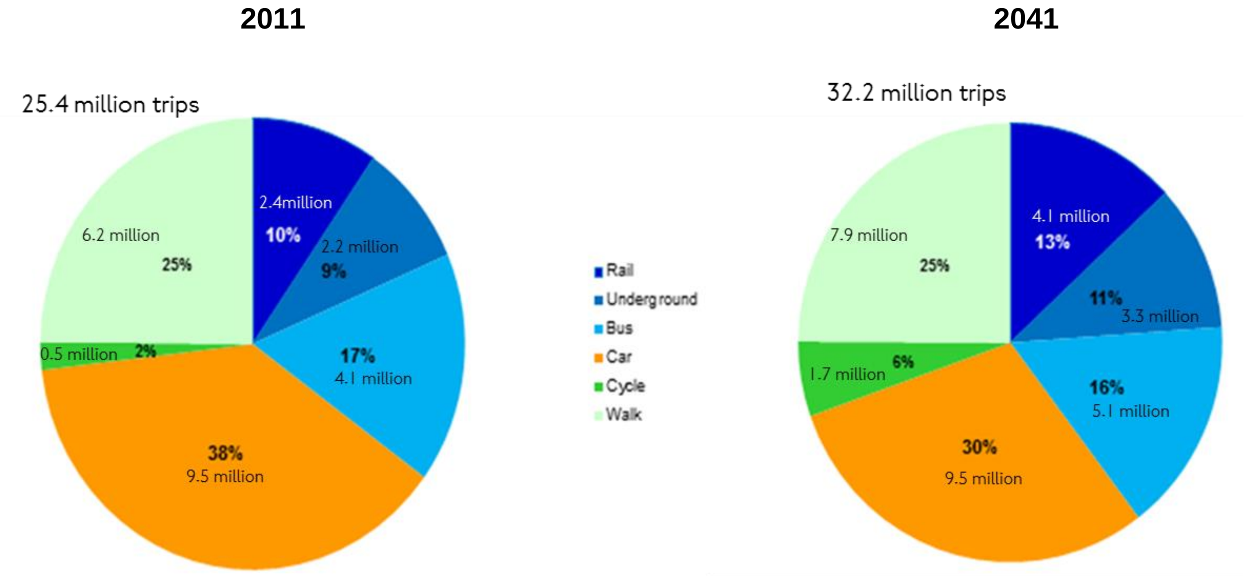

Figure 20 - Forecasts of trip volume and mode share, London, 2011 & 2041[26]

3.4 Paris

In Île-de-France, forecasts have not been produced for overall travel demand. Individual studies are conducted as part of infrastructure scheme appraisals, but these rely on the assumption that mobility behaviour will continue as at present, which is inappropriate given that, between 2001 and 2010, the mode share of car in Paris fell by six percentage points and that of walking rose by five, in the context of strong overall growth in mobility of 17 per cent.

Whilst they are not forecasts, the region has set some targets for future mode shares as part of its Sustainable Urban Mobility Plan (SUMP), created in 2014 (Conseil régional d'Île-de-France 2014). As Figure 21 helps to show, against a background of overall growth in personal trips of seven per cent between 2010 and 2020, the SUMP seeks:

- Twenty per cent growth in trips by public transport (an increase in mode share from 20.2 to 22.6 per cent)
- Ten per cent growth of walk and cycling (mode share increasing from 40.5 to 41.5 per cent)
- A decrease of two per cent in trips by private motorised modes (mode share decreasing from 39.3 to 36.0 per cent)

[25] Central, inner and outer London are broadly as defined in the London Plan (Greater London Authority 2016).

[26] Source: Transport for London (n.d.)

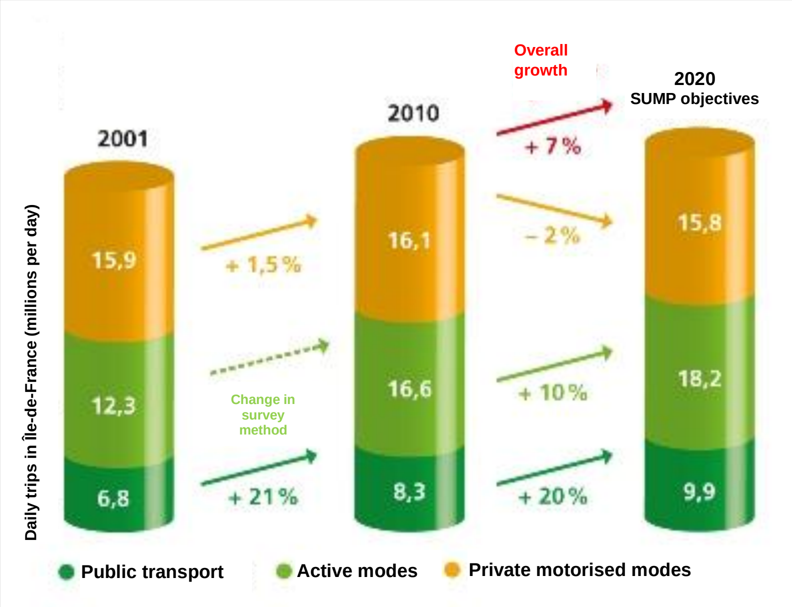

Figure 21 - Targets for 2020 from Sustainable Urban Mobility Plan, Île-de-France[27]

3.5 Vienna

According to Vienna's urban mobility plan, a 12 per cent increase in trips is expected between the base year of 2013 and 2025. This is largely attributable to population growth.[28]

City officials told colleagues at BOKU that a "do-nothing" strategy would mean that car use would remain at its 2013 level of 28 per cent. In contrast, if the measures envisaged in Vienna's urban mobility plan are implemented, this is expected to take the mode share of private car down to the target of 20 per cent by 2025 (Figure 22). By our calculations, a reduction in car trips of 28.6 per cent against a fixed base (as implied by a drop in mode share from 28 to 20 per cent) would more than compensate for overall growth in mobility of 12 per cent. So meeting the 80:20 objective could be expected to deliver a reduction in overall highway traffic at the same time.

The issue is whether the objective is achievable. Vienna's challenge, as with the other cities, is to keep improving and expanding the networks for public transport, walking and cycling in order for new demand to be absorbed without a deterioration in levels of service.

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27 Source: Conseil régional d'Île-de-France (2014, p.54), key and labels translated from French

28 This can be deduced from the statement that a static mode share for motorised individual transport would result in an increase in car trips of 12 per cent over that period (Vienna Urban Development and Planning Department 2014a, p.16).

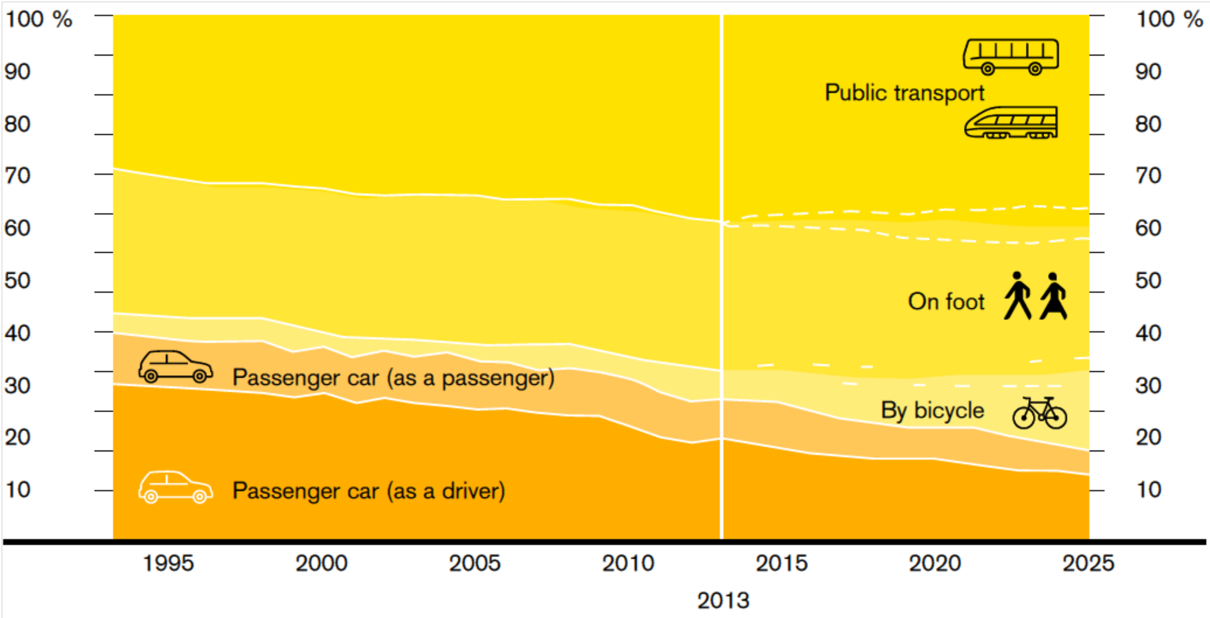

Figure 22 - Personal travel mode shares, actual (to 2013) and targets, Vienna[29]

[29] Source: Vienna Urban Development and Planning Department (2014a, p.22)

4 Predicted network conditions

Whilst all of the five cities use transport models to a greater or lesser extent, those interviewed varied in their confidence in the models. The ways in which models are used also varies. In the case of Copenhagen and Vienna, for example, it appears that detailed modelling is carried out when a particular scheme is being assessed. This will produce quite specific and localised quantitative data concerning the likely impact of the scheme on the size, nature and location of travel demand. But city-wide data on network performance are not routinely produced. Vienna has produced an estimate of growth in car use under a "do nothing" scenario but it is not clear what lies behind this number.

In contrast, Berlin's UTDP contains projections of air quality, noise and accessibility for the various policy scenarios; they have been derived using transport models, amongst other analytical tools. What is not made public are the underlying data on network performance: if NO_2 emissions are likely to fall, this will be a function of fleet composition and traffic volumes but also traffic speed/smoothness; data on the last of these are not part of the Plan document. We shall return to this point.

Whether London analyses future network conditions more than other cities is not certain though it seems likely given that it appears to gather more evidence than other cities on the underlying causes. A certain amount of information has been provided by Transport for London (TfL) concerning their forecasts of network conditions. TfL has shared data for 12-hour delay rate on the road network and for rail crowding. These are taken from an internal report so cannot be seen either as final or as representing a definitive policy position.[30] Instead, they represent a work in progress, particularly given the recent election of a new mayor, with officers attempting to respond to new policy directions whilst at the same time keeping the network viable. The scenario being assessed includes population and jobs growth previously discussed, and a range of schemes, both committed and planned, as summarised in the latest version of the TfL Business Plan (Transport for London 2016).

Figure 23 shows what TfL's suite of models predicted for highway delay rate (seconds/km) in 2031 against a baseline of 2007, as reported by the Roads Task Force (2013). Increases are expected across London, with the greatest growth predicted for the East and the Central zones. More recent unpublished data on rail crowding similarly indicate an overall increase between 2011 and 2041, with growth most pronounced again in the east of London. It seems significant that these data are being used as a *planning tool*, to inform the selection and balancing of policies with a view to arriving at a coherent strategy for the future. This helps to explain that they are regularly revised (with resultant inconsistencies in start dates and planning horizons).

In contrast, other cities seem to adopt a more vision-based approach. For example, Vienna is committed to achieving its goal of 80:20 (80 per cent mode share for sustainable transport compared with 20 per cent for car) but appears to rely less on modelling/forecasting to validate its proposed strategy. Copenhagen similarly has in its Climate Plan 2025 a goal of 75 per cent share for sustainable modes. The impression is that, should progress towards these targets falter, the transport policies in these cities' plans will be increased in intensity to correct the situation.

Future network performance is a sensitive subject and it is therefore understandable that cities do not advertise a likely deterioration in levels of service. Even if such an increase is inevitable regardless of cities' best efforts, one can readily imagine that this might be exploited by the media and those critical of a city's governance.

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[30] For this reason, the figures on delay reported below are from earlier work whose outputs are in the public domain.

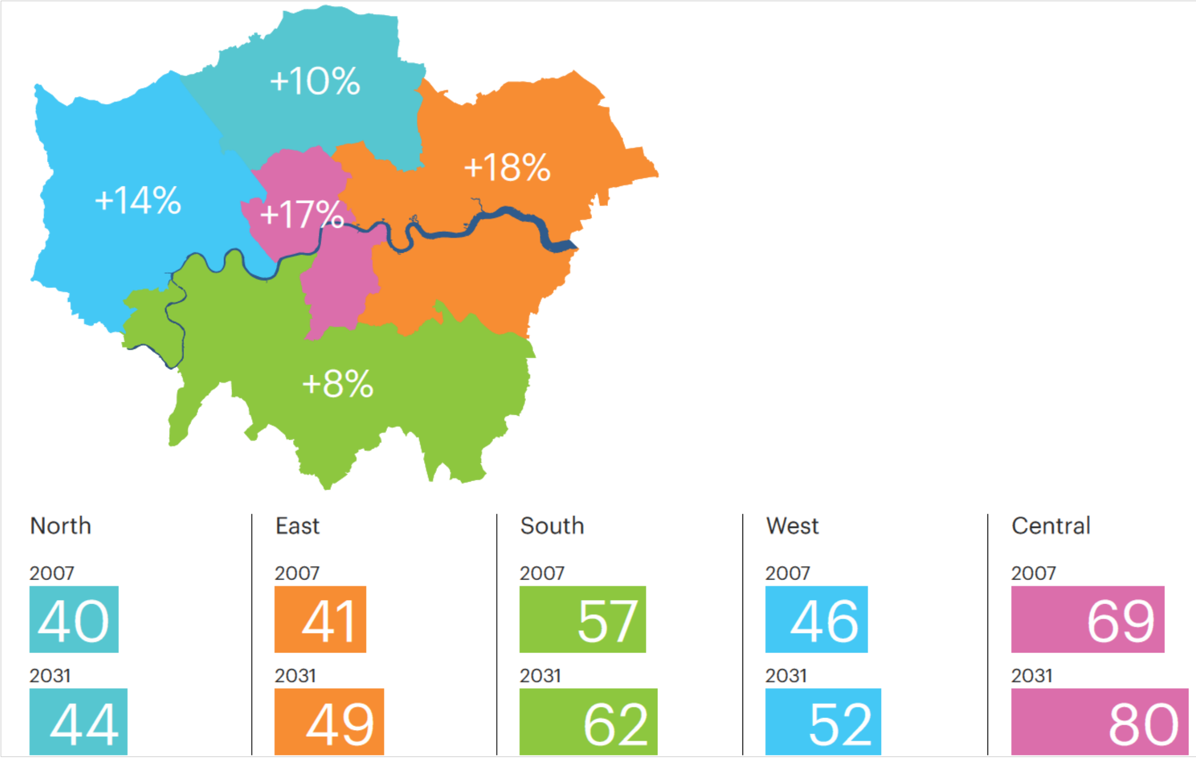

Figure 23 - Indicative increase in delay (seconds per km travelled) experienced by motorised traffic, London, 2007 and 2031[31]

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31 Lower half of figure shows 2007 level of delay by area, with the forecast 2031 level beneath. Forecast by TfL's strategic models based on committed transport investment and forecast growth to 2031. Source: Roads Task Force (2013, p.39)

5 Discussion

5.1 Approaches to planning

The investigation reported in this document suggests that cities approach their transport planning differently. This range of practice is illustrated by two flowcharts.

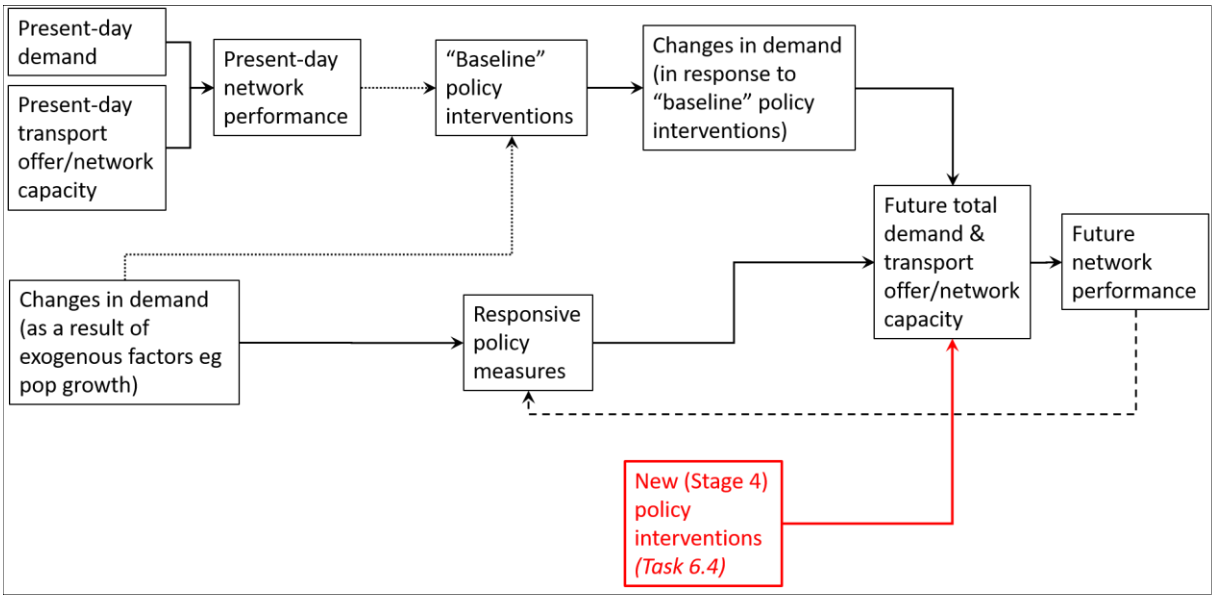

Figure 24 – "Empirical" approach to transport planning

In the "empirical" approach (Figure 24), "baseline" policy interventions (i.e. those that derive from the prevailing policy context) are informed to some extent both by present-day network performance and expected changes in the drivers of demand. The term "to some extent" is deliberate and is conveyed by the dotted lines in the diagram, since baseline policy will be to some extent the result of *aspiration* or *vision*. Alongside the baseline policy measures, a set of responsive policy measures is designed specifically to "steady the ship" in view of expected changes in population, employment, land use, etc. These two sets of policy measures will be designed to complement each other. They are modelled in combination and this produces forecasts first of future demand/transport offer and then of network performance. There is a feedback loop which allows iteration of the responsive policy measures. This will be necessary where the baseline measures and/or the initial set of responsive measures lead to predicted network performance that falls shorts of the required standard. All of the above is assumed to be taking place in a Stage-3 context; the additional red box signifies the future introduction of Stage-4 interventions. Of the five partner Stage-3 cities, London appears to apply this model to the greatest extent though it is currently in transition following the election of a new mayor in 2016.

Figure 25 is an attempt to summarise a more vision-based and less empirical process; this appears to be more the approach of Copenhagen and Vienna, say. Here, the "vision" is informed (again, *to some extent*) by present-day conditions and an understanding of future exogenous change. The vision-related interventions, together with those exogenous changes, determine the future demand and transport offer. These, in turn, determine future network performance. Less effort is spent on attempting to model these elements than in the more empirical approach. Instead, it is understood that network conditions and other selected indicators will be monitored and, if performance dips beneath a threshold of acceptability, the policy mix will be adjusted accordingly. The presence of Stage 4 is somewhat different in this approach, in that it emerges first in the form of a vision which then informs the selection of suitable policy interventions.

Neither model should be seen as an attempt to describe precisely the practice of any city. It is to be expected, for example, that vision will play at least some role in the empirical planning process and that forecasting will inform a more vision-based approach. They are presented in these contrasting forms for illustration.

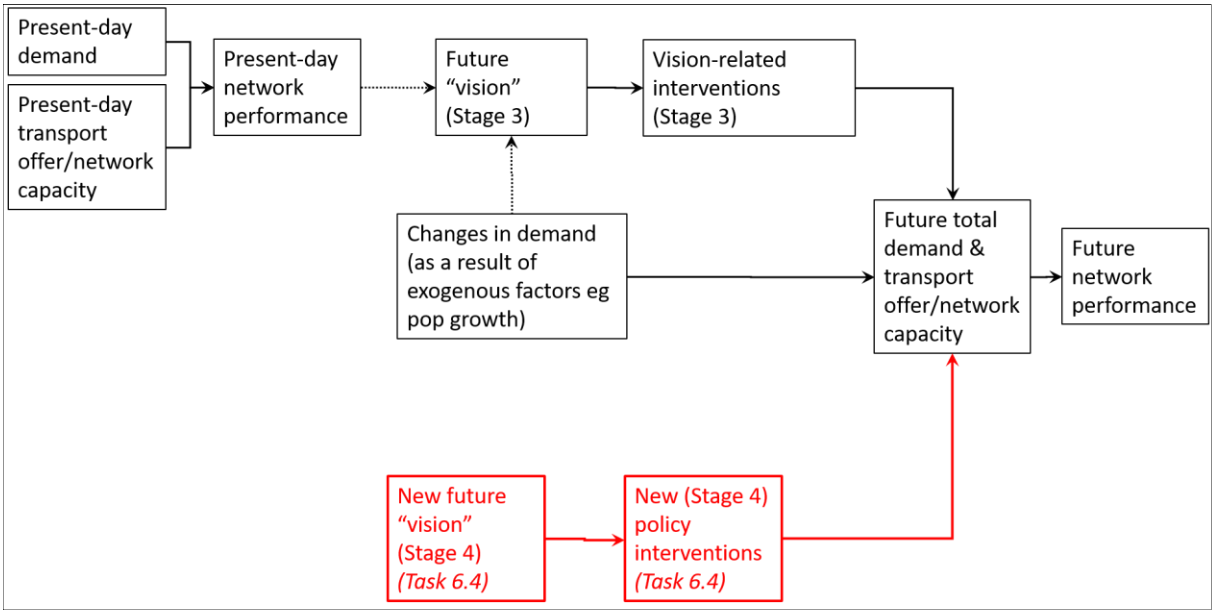

Figure 25 – "Vision-based" approach to transport planning

5.2 Stage 3 into Stage 4

Task 6.1 was predicated on attempting to understand what "business as usual" would mean for Stage-3 cities in the future in terms of network conditions and performance. We have in the event obtained limited information on this front and it seems this is for three reasons:

- Cities vary in the extent to which they forecast future network conditions, with some using forecasting tools only to appraise specific (i.e. not city-wide) interventions
- Whilst certain cities may develop such evidence, they are understandably reticent about making it public given that it may not be "good news"
- There is evidence that cities "iterate" their policies in response to predictions of network conditions

The third point makes the definition of "business as usual" problematic. The impression is that there is considerable latitude in Stage-3 policies: if London discovers that its initial package of policies does not lead to an acceptable set of network conditions, it can adjust these policies within the Stage-3 paradigm in order to arrive at a more satisfactory balance.

The question, then, is whether Stage-3 policies have a limit. Is there a point when all the tools available will have been applied to their maximum extent and still the network will not perform acceptably given the pressures on it? Alternatively, might the limits of public and/or political acceptability be reached before such policies have delivered acceptable network conditions? An obvious example is road pricing, whose level and/or spatial extent could, in principle, both increase arbitrarily in order to price off traffic but at the possible cost of political upheaval and/or civil unrest.

Before we attempt to answer this question, let us consider Berlin's outline of the mission statement for its Urban Transportation Development Plan, which takes the form of a vision for the city in 2040. This is reproduced in full at Appendix 1 for reference.

In Berlin in 2040, car use has reduced to the absolute minimum[32] as part of a "clean, quiet and post-fossil transport system" which operates within a "mobility culture of cooperation" arising from business response to smart incentives from government and the residents themselves being "open to innovations". "Work places and times are less rigid" so individual travel is also less so; commercial traffic has equally been rationalised and become more sustainable as part of a "new economic reasonableness" (Senate Department for Urban Development – Division VII n.d., pp.5–6).

Is Berlin's vision Stage 3 or Stage 4? Much of what is written is recognisably Stage 3: car use is discouraged, walking and cycling are promoted and quality of the civic environment is given a strong emphasis. But certain themes seem new and at least represent a new *context* within which Stage 3 might be articulated. In fact, city officials argue that this vision, despite its elements of innovation, is more grounded in Stage 3 than the more recent Urban Development Concept Berlin 2030 (Senate Department for Urban Development and the Environment 2015). Whilst this latter document has broader coverage and so provides less detail on transport, it does offer some clues – "city-friendly and future-proof in terms of mobility"; "people will be able to travel around the city safely and intelligently" (Senate Department for Urban Development and the Environment 2015, pp.8–9).

To return the question posed, do Stage-3 policies have a limit? We ask the question in part because the proposition has been that reaching this limit would motivate (perhaps necessitate) the invention of Stage 4. The simple answer at this point is that we do not know, but it seems quite possible that we shall not reach a "wall" with Stage 3. Just as this stage is an evolution of Stage 2 (and Stage 2 and evolution of Stage 1 for that matter), we may find that Stage 4 is an evolution of Stage 3: not so much a paradigm shift as a paradigm *development*.

A separate question is raised by the Berlin document concerning the minimal role of the car. If it is to be used only when absolutely necessary, what level of use does this imply? And who will be empowered to determine what a "necessary" use is? The answers will be informed by our understanding of the changes new technologies bring (Tasks 6.2 and 6.3) but is also a central consideration in developing our thinking about Stage 4.

5.3 Conclusion

We started work on Task 6.1 expecting to obtain a great deal of data concerning policies and their likely effects on future network performance in the context of exogenous change. We hoped to be able to make extensive and intelligent comparisons across cities enabling useful inferences concerning the relationship between the nature of the transport network, extent of exogenous change and the suite of available policy tools.

In the event, we have learnt that practice varies across cities and that the preoccupation of some with forecasting the future is not universally shared. This is a very helpful, if unexpected, finding. We have also, in passing, started to formulate meaningful questions concerning what Stage 4 might be and how the transition towards it might take place. This sets the stage very well for Task 6.4 which will conclude this work package.

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[32] "The car is only the chosen method of transport into the city when absolutely necessary" (Senatsverwaltung für Stadtentwicklung und Umwelt 2014, p.3)

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Appendix 1 – extract from Berlin's UTDP

Turn the clocks forward to ***2040***. Berlin is a varied, lively, and socially diverse city, home to a wide range of culturally, socially and ethnically influenced milieus. It offers space for encounters as well as for contemplation. Work places and times are less rigid. Supply and recreational activities take place at very different places and very different times. As a result, mobility needs have become more varied and flexible. These new mobility requirements face economic conditions marked by a scarcity of funds. In many areas – and not only in terms of transport –the city and its residents have had to change their thinking to secure long-term ***sustainable mobility for all***. Increasingly, people organise their mobility without being fixed on one particular mode of transport; every day, they take a decision anew on how to combine the forms of transport that can best meet their needs. This has led, first and foremost, to reduced car use in the inner city, and a growth in pedestrian and bicycle traffic, as well as greater use of the public transport network. A mobility culture of cooperation supports the city's efforts to ensure green mobility which is barrier-free, socially just, and needs-oriented.

The mix of uses and diversity of cultural functionality have been expanded. New city quarters have been created in the inner city and outer districts, strengthening the polycentric city structure. The local neighbourhoods have kept their characteristic qualities, expressing the diversity of their residents. Over the last years, the distance between the various urban functions has still successfully been kept to a minimum. In particular, compact and traffic-efficient spatial structures enable active mobility for weaker members of society and improve conditions for pedestrians and cyclists. This **liveable major city** is regarded as one of the most pedestrian-friendly metropolises in Europe.

For many people, the ***attractive inner city*** is a popular place to live and work. The newly developed areas around the Main Station and the River Spree have been harmoniously integrated into the urban structure. With bundling and diversion measures freeing the eastern city centre from through traffic as well, the main axes formerly dominated by cars have been redesigned as multi-use boulevards. Now, the only car traffic in the inner city is important for its function, and unable to be regulated in any other way. The city-friendly and efficient organisation of commercial traffic in and around the inner city maintains the flow of goods and services and contributes to productivity. In return, an attractive environment with high amenity values encourages retail stores and tourism.

As one of the initial focuses on innovation in the city, ***commercial traffic*** was given an ***efficient, effective and green structure.*** Here, businesses themselves provided a main impulse, increasing efficiency and introducing translocation and bundling in reaction to exacting environmental demands and higher energy prices. For their part, the Federal Government and the European Union improved the competitive conditions for rail traffic and shipping, facilitating a turnaround in the choice of transport mode for many types of goods. In choosing locations for new settlements, businesses take the impact of transportation into account, in terms of the goods transported as well as commuter and commercial passenger traffic. Here, new economic areas, such as the creative sector, have set new trends: Workplace mobility management is applied to optimise business trips, information and communications technologies are implemented where their potential can best be used, and cycle couriers are used in particular for delivering smaller, faster deliveries within the city. Smaller companies and trades which, for instance, depend on transporting materials, employ efficient, green and affordable vehicles.

A broad raft of measures has also been implemented in passenger transport over the last years in Berlin, resulting in a ***clean, quiet and post-fossil*** transport system. There is no longer any contradiction between urban mobility and environmental protection. Green traffic management ensures that air and noise pollution on main arterial roads remains below the threshold values. Urban and environmental requirements are given precedence in realising new infrastructure construction projects. This is also the result of a new economic reasonableness which has grown out of the city's financial situation and has led to firmly establishing the principle of prioritising the quality assurance of existing infrastructures. Numerous environmental traffic measures are aimed at strengthening life quality and launch the age of post-fossil mobility - a goal also supported by Berlin's residents. Since, in addition to other factors, the transport sector pursues a principle of cost transparency and openness, growing numbers of households have opted for life without car ownership. Moreover, they do not miss having a car - thanks to the availability of a wide range of mobility services which are easy to combine: from the ‘classic public transport network’ or car-sharing with green cars and (extensively available hire) bikes to a newly discovered pleasure in walking. Here, a significant contribution has been made by encouraging emobility powered by regenerative energies.

Developing and implementing ***innovations and new transport technologies*** supports the implementation of the transport policy Mission Statement. Private and public-sector actors, as well as the users, all work together to tap technical, organisational and institutional potential and leverage it for the city and industry. The transport and mobility research landscape, both locally and internationally networked, has been a contributory factor here. There is an international demand for its ‘Made in Berlin’ transport products and services, which represent a key economic factor for the city. The Berlin residents themselves are open to innovations and test them in everyday life for their suitability and user-friendliness.

Berlin is more than just a city. Together with the federal state of Brandenburg, it forms an entire multifaceted integrated region offering a wealth of contrasts. This ***well-connected metropolitan region*** is a result of measures including a joint regional development plan, as well as an integrated approach to the common transport area. Settlement areas are primarily located along the rail routes, the city and the environs enjoy an excellent network of local public transport services, and the areas away from Berlin are connected by regional transport with the city and each other. In this way, residents across the region benefit from improved mobility, and the impact of the traffic to Berlin is directed into acceptable channels. Residents in the federal state of Brandenburg can easily reach the capital city if they work there, shop there, or want to take advantage of the cultural amenities. In return, the Berlin residents profit from their easy access to the attractive countryside in the surrounding area; local tourism has experienced a boom.

As a place to live, a travel destination and a business location, the city and region are ***internationally accessible*** – by water, land and air. The Berlin Brandenburg airport is an important hub in the international airport network. Berlin and the federal state of Brandenburg are connected via fast rail links with the national and European metropolitan regions, driving forwards economic, scholarly and cultural cooperation. Here, the close network and cooperation between the Berlin region and its neighbouring European regions have played their part, in particular, through putting forward a coordinated front to the Federal Government and the European Union to overcome those rail infrastructure and service deficits which still exist.

(Senate Department for Urban Development – Division VII n.d., pp.4–6)