# Transforming Cities:
# The potential of everyday cycling

## Methodology and results

January 2019

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# 1 Introduction

This paper sets out some of the impacts that would result if, by 2040, there has been a substantial increase in the levels of cycling in each of the seven original Bike Life cities.

These impacts are calculated using the methods from Bike Life 2017 and amending the inputs to align with a projected scenario until the year 2040.

Although this paper details the method used to estimate these benefits, an awareness of the method used for estimating the benefits for the 2017 Bike Life reports is assumed. More information can be found at: www.sustrans.org.uk/bikelife. It is also important to note from the outset that, although care has been taken to avoid any indefensible inflating factor, the approach taken has been 'broad brush' and the results should be interpreted accordingly.

# 2 Current cycling levels

We take as our starting point the level of cycling in each city as established by Bike Life 2017. This includes *all* cycling, regardless of age or trip purpose. For context, the average number of *non-leisure* trips per person per week (regardless of mode) is referenced. This data is taken from the National Travel Survey (DfT, 2017).

Table 1 Cycling trips in 2017

| City | Population (000's) | Total bicycle trips (2017) | All-purpose bicycle trips per person per week (TPPPW) | Total all mode non-leisure trips per person per week (from NTS) |
|---|---|---|---|---|
| Belfast | 340 | 6,700,000 | 0.4 | 18 |
| Birmingham | 1,111 | 19,500,000 | 0.3 | |
| Bristol | 449 | 26,100,000 | 1.1 | |
| Cardiff | 357 | 12,100,000 | 0.7 | |
| Edinburgh | 499 | 15,300,000 | 0.6 | |
| Greater Manchester | 2,756 | 34,800,000 | 0.2 | |
| Newcastle | 293 | 8,800,000 | 0.6 | |

The economic benefits of this level of cycling are calculated using an approach that estimates the gain to society of each kilometre cycled, compared to the impact of each kilometre driven by car. The method used to calculate these 'societal gains' can be found online at www.sustrans.org.uk/bikelife.

The resulting economic benefits associated with the 2017 level of cycling are shown in Table 2.

Table 2 Economic benefits of cycling trips in 2017

| City | Net value of miles cycled yearly (includes miles that could have been driven and miles that could not of been driven) | External value of all miles cycled yearly (includes miles that could have been driven and miles that could not of been driven) |
|---|---|---|
| Belfast | £16,100,000 | £7,300,000 |
| Birmingham | £56,100,000 | £25,400,000 |
| Bristol | £62,300,000 | £28,300,000 |
| Cardiff | £27,900,000 | £12,700,000 |
| Edinburgh | £23,900,000 | £11,800,000 |
| Greater Manchester | £70,400,000 | £33,300,000 |

| | | |
|---|---|---|
| Newcastle | £24,400,000 | £11,500,000 |

In addition to the societal benefits, Bike Life 2017 used Sport England's MOVES tool (Sports England, 2016) to estimate the impact of the current level of cycling on healthcare costs to the NHS, based on the reduction of eight types of disease (type 2 diabetes, coronary heart disease, cerebrovascular disease, breast cancer, colorectal cancer, dementia, depression and hip fracture).

Table 3 shows the outputs of this tool, as published in the 2017 Bike Life report.

Table 3 Cost savings to the NHS of cycling trips in 2017

| City | Cost saving | Cases of disease avoided |
|---|---|---|
| Belfast | £400,000 | 58 |
| Birmingham | £1,400,000 | 212 |
| Bristol | £1,400,000 | 211 |
| Cardiff | £700,000 | 103 |
| Edinburgh | £700,000 | 106 |
| Greater Manchester | £2,800,000 | 414 |
| Newcastle | £600,000 | 87 |

# 3 Creating the future cycling scenario

To estimate the economic benefits of achieving the ambitious but achievable cycling in our cities by 2040, we first define the parameters of the projected scenario and then use them as inputs to the Societal Gain model and the MOVES tool.

The two main areas to consider for the parameters of the scenario are a) the level of cycling defined in the future and b) the changes that can expect to have occurred to the other inputs to the tools by 2040.

## 3.1 Level of cycling

This section considers how the levels of cycling will increase between 2017 and 2040.

### 3.1.1 Number of cycling trips

The primary change in the scenario is an increase in the total number of cycle trips being made in these cities. This section sets out the specifics of the scenario considered.

The Cycling and Walking Investment Strategy (DfT, 2017) sets a target for levels of cycling to have doubled by 2025, from 800m to 1.6bn stages per year[1]. The Bike Life scenario takes this doubling as

[1] "The basic unit of travel in the National Travel Survey is a trip, which consists of one or more stages. A new stage is defined when there is a change in the form of transport. Counting cycle or walking stages rather than trips allows us to include journeys that involve cycling or walking but where this is not the main form of transport (for example, cycling to a railway station to catch the train to work)."(DfT, 2017)

a starting point and assumes that an ambitious but achievable target is a doubling of cycling approximately every eight years to 2040[2].

Because the baseline Bike Life data uses total annual cycling trips as the metric of levels of cycling, the same metric is used in the scenario, despite the inconsistency with the CWIS target, which is based upon stages. The scenario accounts for the effect of changing populations in each of the cities by applying the 'doubling' factor to the trips per person per year. The official population projection[3] for each of the target years is then used to estimate the total number of trips for each city.

Table 4 Growth in cycling trips 2017-2040 under the projected scenario

| City | Baseline total cycling trips 2017 | Projected total cycling trips 2025 | Projected total cycling trips 2032 | Projected total cycling trips 2040 |
|---|---|---|---|---|
| Belfast | 6,700,000 | 13,700,000 | 27,600,000 | 55,800,000 |
| Birmingham | 19,500,000 | 42,000,000 | 88,000,000 | 184,200,000 |
| Bristol | 26,100,000 | 57,100,000 | 120,800,000 | 254,800,000 |
| Cardiff | 12,100,000 | 26,600,000 | 56,800,000 | 121,800,000 |
| Edinburgh | 15,300,000 | 33,300,000 | 70,000,000 | 146,400,000 |
| Greater Manchester | 34,800,000 | 73,600,000 | 151,800,000 | 312,800,000 |
| Newcastle | 8,800,000 | 18,500,000 | 38,500,000 | 78,900,000 |

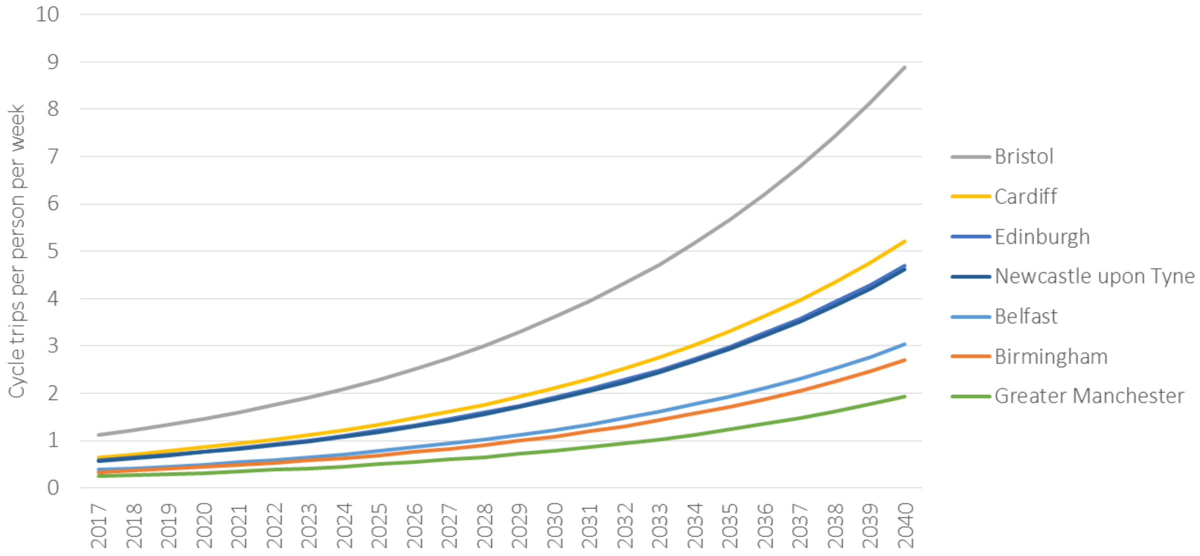
For ease of comprehension, Table 5 and Chart 1 below shows these figures as trips per person per week (all-purposes, including recreational cycling). For context, in 2015, the NTS shows that individuals made approximately 18 *non-leisure* trips per week (DfT, 2015).

Table 5 Growth in cycling trips per person per week 2017-2040 under the scenario

| City | Baseline 2017 | Projected 2025 | Projected 2032 | Projected 2040 |
|---|---|---|---|---|
| Belfast | 0.4 | 0.8 | 1.5 | 3.0 |
| Birmingham | 0.3 | 0.7 | 1.3 | 2.7 |
| Bristol | 1.1 | 2.3 | 4.3 | 8.9 |
| Cardiff | 0.6 | 1.3 | 2.5 | 5.2 |
| Edinburgh | 0.6 | 1.2 | 2.3 | 4.7 |
| Greater Manchester | 0.2 | 0.5 | 0.9 | 1.9 |
| Newcastle | 0.6 | 1.2 | 2.2 | 4.6 |
| Aggregated[4] | 0.4 | 0.8 | 1.6 | 3.3 |

[2] Note there are 23 years between 2017 (the baseline) and 2040, a period that is not divisible by 8. It is assumed a doubling of cycling will be achieved between 2025 and 2032, a period of 7 years.
[3] Sourced from the national statistics authority for each nation.
[4] Calculated by summing the number of cycle trips in the 7 cities in each year, dividing the total by the total population of the cities in that year, dividing the resulting figure by (365/7).

Chart 1 Growth in cycling trips per person per week 2017-2040 under the scenario




### 3.1.2 Number of individuals

One of the inputs to the MOVES tool is the number of individuals making the cycling trips. It is not possible to apply the same exponential doubling factor used in the trip projection as in would mean assuming that, by 2040, the whole population was cycling. Instead, it is assumed that the baseline proportion of the adult population who are bike riders (those who have cycled at least once in the last four weeks) will have tripled by 2040. The resulting proportion is capped at 80% to reflect the proportion of the population who may be unable/unwilling to cycle. This is based on the proportion of households in Copenhagen who have access to a bicycle (City of Copenhagen, 2015). The figures used are shown in Table 6.

Table 6 Proportion of adult population who are bike riders

| City | 2017 | 2040 |
|---|---|---|
| Belfast | 18% | 54% |
| Birmingham | 15% | 45% |
| Bristol | 31% | 80% |
| Cardiff | 25% | 74% |
| Edinburgh | 28% | 80% |
| Greater Manchester | 21% | 63% |
| Newcastle | 22% | 67% |

This means that the additional trips are being made by a combination of new cyclists and existing cyclists making more trips.

It is also assumed that the age groups that the bike riders fall into remain the same in 2017 and 2040. For example, if 36% of bike riders in Belfast are aged 31-45 in 2017, the same is assumed in 2040.

For the purposes of the inputs to the MOVES tool, and in the absence of suitable data, it is also assumed that by 2040 the total number of cycling trips will be evenly split between male and female cyclists. The gender split for the interim years will be linearly interpolated from the 2017 and 2040 values.

### 3.1.3 Trip length and duration

In addition to the number of trips being made in 2040, a forecast of the length and duration of these trips is required for the models. It is assumed that, as cycling becomes more popular for everyday trips, average trip length will fall from the 2017 figure. For instance, in Denmark, where people make many more trips by bicycle, the average trip distance is just 3.2km (DTU, date unknown).

The NTS data show that the weighted average distance of the trips under 5 miles is just over 2.5 miles (4.1km). Using the average cycling speed from DfT's WebTAG (14kph), if these trips were made by bicycle they would take 17.5 minutes per trip. We therefore assume that, on average, trips will involve cycling for a total of 15 minutes at an average speed of 14kph, covering a distance of 3.5 kilometres. This is used for all seven cities, despite the difference in 2017 trip distance (Table 7).

Table 7 Average trip length (km)

| City | 2017 | 2040 |
|---|---|---|
| Belfast | 5.4 | 3.5 |
| Birmingham | 6.5 | 3.5 |
| Bristol | 5.4 | 3.5 |
| Cardiff | 5.2 | 3.5 |
| Edinburgh | 3.8 | 3.5 |
| Greater Manchester | 4.8 | 3.5 |
| Newcastle | 6.5 | 3.5 |

## 3.2 Other inputs

This section details how other inputs to the tools will have changed between 2017 and 2040.

### 3.2.1 Total kilometres cycled that could have been made by car

The method used for Bike Life 2017 to estimate the proportion of cycled kilometres that could have been made by car assumes that a bicycle trip that is made by an individual from a household with access to at least one car could have been made by car. The number of kilometres that could have driven is then calculated by applying the proportion of households with access to at least one car to the total bicycle kilometres cycled by these households for each trip purpose.

Replicating this approach for the projected scenario requires an estimate of the proportion of the population in 2040 who will be living in households with access to at least one car. The Department of Transport forecast that car ownership is set to increase by 25% between 2010 and 2040 (DfT, 2015).

However, this does not seem to reflect findings that, among young people, demand for car travel has been falling over the last two decades (Commission on Travel Demand, 2018). The impacts of new technologies such as autonomous vehicles and car sharing are also not accounted for. In addition, the achievement of the scenario itself may inevitably have an impact on car ownership.

As a result, the projected scenario simply assumes that the proportion of kilometres that could have been driven from the 2017 figures will apply in 2040 as well. The same approach is taken for calculating the number of trips that could have been made by car in 2040.

### 3.2.2 Total leisure cycle kilometres

The projected scenario uses the proportional relationship between total cycle kilometres and total leisure cycle kilometres from the 2017 data to estimate the total leisure cycle kilometres in 2040. This assumes that this relationship remains the same between 2017 and 2040.

### 3.2.3 Vehicle emissions

The volume of pollutants emitted by motorised vehicles are unlikely to remain static between 2017 and 2040. Higher polluting vehicles will be phased out and technological solutions will improve.

The Department of Business, Energy and Industrial Strategy projects[5] that greenhouse gas emissions from the transport sector will have fallen by 12% by 2035 (BEIS, 2018). We therefore assume that the emissions of greenhouse gases and particulate matter per kilometre will have fallen by the same amount by 2040.

# 4 Interpolating the benefits of cycling between 2017 and 2040

The scope of the scenario is not just 2040, but also the intervening 23 years between Bike Life 2017 and 2040. It is assumed that the cities meet each of the ‘doubling’ targets for the interim years, and that the progress between the current scenario in 2017 and the projected scenario is exponential.

As a result, it is possible to estimate the impact of cycling each year between 2017 and 2040 by means of an exponential interpolation between the impacts calculated in 2017 (those reported in Bike Life 2017) and 2040 (those calculated as detailed in this document).

The formula for the exponential interpolation takes the form:

$$y = c * (d/c)^{((x-a) / (b-a))}$$

where a and b are the range of x values, and c and d are the range of y values.[6] Note that the ‘doubling’ factor does not follow an exponential function exactly, because of the compression of the second doubling period into seven years. For the purposes of this exercise however, the exponential function is considered to be the line of best fit.

# 5 Results

This section details the results of the Societal Gain model and the MOVES tool, when they are applied to the projected scenario.

[5] The reference case is based on central projections for the key drivers of energy and emissions, such as fossil fuel prices, Gross Domestic Product (GDP) and population. Projections of emissions outside of the power sector are based on applying standard statistical techniques to project forward energy demand and emissions based on trends and relationships identified in past data. These are adjusted to take account of the estimated impact of implemented, adopted and agreed (as at July 2017) Government policies. (taken from UPDATED ENERGY AND EMISSIONS PROJECTIONS 2017, Department for Business, Energy & Industrial Strategy)

[6] Taken from http://www.pmean.com/10/ExponentialInterpolation.html

## 5.1 Societal gain model

Table 8 shows the benefits of achieving the scenario by 2040 for each of the seven cities. The values are presented as the net value as they account for the difference in the impact of miles cycled that could have been driven.

Table 8 Economic benefits of cycling between 2017 and 2040

| City | Net value of miles cycled that **could have been driven** | Net value of **all** miles cycled (Includes miles that could have been driven, miles that could not of been driven and leisure miles) |
|---|---|---|
| Belfast | £804,000,000 | £1,124,000,000 |
| Birmingham | £1,573,000,000 | £3,628,000,000 |
| Bristol | £2,933,000,000 | £4,627,000,000 |
| Cardiff | £1,134,000,000 | £2,194,000,000 |
| Edinburgh | £1,664,000,000 | £2,324,000,000 |
| Greater Manchester | £4,783,000,000 | £5,625,000,000 |
| Newcastle | £613,000,000 | £1,524,000,000 |
| Aggregate[7] | £14,000,000,000 | £21,000,000,000 |

Table 9 shows the economic benefits of cycling per year by 2040.

Table 9 Economic benefits of cycling in 2040

| City | Net value of miles cycled that **could have been driven** | Net value of **all** miles cycled (Includes miles that could have been driven, miles that could not of been driven and leisure miles) |
|---|---|---|
| Belfast | £73,000,000 | £101,000,000 |
| Birmingham | £141,000,000 | £314,000,000 |
| Bristol | £274,000,000 | £430,000,000 |
| Cardiff | £111,000,000 | £210,000,000 |
| Edinburgh | £177,000,000 | £246,000,000 |
| Greater Manchester | £459,000,000 | £542,000,000 |
| Newcastle | £54,000,000 | £129,000,000 |
| Aggregate[8] | £1,300,000,000 | £2,000,000,000 |

## 5.2 MOVES tool

Table 10 shows the savings to the NHS of achieving the scenario by 2040. Note the cost savings are presented as negatives as they are calculated as the budget reductions that result.

[7] Rounded to the nearest £billion
[8] Rounded to the nearest £100 million.

Because of the nature of the MOVES tool, a slightly different method was employed to estimate these benefits. Where inputs to the tool are not explicitly mentioned, values were taken from the 2017 iteration of Bike Life.

- For each city, we have modelled the number of additional people cycling every year between 2017 and 2040 using the method detailed above. This can be split into the four age bands in MOVES (16-30, 31-45, 46-60 and 60+).
- Using the 16-30 age band as an example, for each city we take the sum of the additional cyclists aged between 16-30 from the years 2017 – 2020 and use the MOVES tool to estimate the impacts using a 20 year Time Horizon (taking us from 2020 to 2040).
- We then take the sum of the additional cyclists aged between 16-30 from the years 2021 – 2025 and estimate the impacts using a 15 year Time Horizon (TH), taking us from 2025 to 2040.
- This is also done for the years 2026-2030 (a 10 year Time Horizon), 2031-2035 (a 5 year TH) and 2036-2040 (a 1 year TH). For the purpose of inputs to the MOVES tool it is assumed that the additional cyclists in each cohort are cycling at the 2040 trip duration regardless of when they start cycling between 2017 and 2040.
- We acknowledge that these are very long time periods for estimating health benefits, but as per the rest of this exercise, the figures are intended to be indicative and 'broad brush'.
- This process is then replicated for the other age bands (31-45, 46-60 and 60+). The sum of all the benefits would then give the overall benefits for that city of increased cycling between 2017 and 2040.

Table 10 Total cost savings to the NHS of cycling trips between 2017 and 2040

| City | Cost saving | Cases of disease avoided |
|---|---|---|
| Belfast | -£15,000,000 | 1,600 |
| Birmingham | -£49,000,000 | 5,200 |
| Bristol | -£56,000,000 | 6,000 |
| Cardiff | -£33,000,000 | 3,500 |
| Edinburgh | -£42,000,000 | 4,400 |
| Greater Manchester | -£106,000,000 | 11,300 |
| Newcastle | -£20,000,000 | 2,100 |
| Aggregate | -£319,000,000 | 34,000 |

## 5.3 Additional results

In addition to the economic benefits, the Societal Gain model produces other outputs which are tabulated below. The methodology for calculating these outputs can be found in the Bike Life 2017 documentation.

Table 11 Total trips that could have been made by car in 2040

| City | Total trips per year (million) | Equivalent miles of tailback every day | Equivalent $m^2$ of parking space used every day |
|---|---|---|---|
| Belfast | 42 | 172 | 665,000 |
| Birmingham | 100 | 407 | 1,574,000 |
| Bristol | 175 | 715 | 2,761,000 |
| Cardiff | 81 | 330 | 1,274,000 |

| | | | |
|---|---|---|---|
| Edinburgh | 82 | 336 | 1,299,000 |
| Greater Manchester | 236 | 964 | 3,723,000 |
| Newcastle | 46 | 186 | 718,000 |
| Aggregate | 761 | 3,110 | 12,012,000 |

Table 12 Total greenhouse gas savings in 2040

| City | Tonnes of GHG (CO2e) | Carbon footprint equivalent |
|---|---|---|
| Belfast | 20,000 | 4,000 |
| Birmingham | 38,000 | 8,000 |
| Bristol | 73,000 | 16,000 |
| Cardiff | 30,000 | 6,000 |
| Edinburgh | 47,000 | 10,000 |
| Greater Manchester | 123,000 | 26,000 |
| Newcastle | 14,000 | 3,000 |
| Aggregate | 345,000 | 73,000 |

Table 13 Total air pollution savings in 2040

| City | Kilogrammes of PM | Kilogrammes of NOX |
|---|---|---|
| Belfast | 5,000 | 41,000 |
| Birmingham | 9,000 | 83,000 |
| Bristol | 18,000 | 157,000 |
| Cardiff | 7,000 | 66,000 |
| Edinburgh | 11,000 | 96,000 |
| Greater Manchester | 28,000 | 253,000 |
| Newcastle | 4,000 | 33,000 |
| Aggregate | 81,000 | 729,000 |

For context, in 2016 UK emissions of NOx were 893,000 tonnes of which 300,000 tonnes are from road transport (DEFRA, 2018). The seven cities under this scenario would save 729 tonnes of NOx in total. The population of these cities accounts for 9% of the UK population. If we assume that the emission of NOx is distributed evenly across the whole population, then 9% of 300,000 tonnes of NOx is 27,000 tonnes. So a saving of 729 tonnes is 2.7% of NOx emitted by the population of the seven cities. However, it is likely that this is an underestimate as urban dwellers make fewer and shorter trips so road transport NOx is unlikely to be even distributed across the population, and therefore fewer than 27,000 tonnes will be emitted by the residents of the seven cities.

In addition to the Societal Gain and MOVES tools, we can use the World Health Organisation's Health Economic Assessment Tool (HEAT) to estimate the number of early deaths avoided every year by 2040 by the increase in cycling (Table 14).

Table 14 HEAT outputs

| City | Number of deaths per year prevented by 2040 |
|---|---|
| Belfast | 31 |
| Birmingham | 89 |
| Bristol | 147 |
| Cardiff | 68 |
| Edinburgh | 85 |
| Greater Manchester | 168 |
| Newcastle | 40 |
| Aggregate | 628 |

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