frontier economics

PHILIP MORRIS LIMITED

Working towards a smoke-free England

A report prepared for Philip Morris Limited

September 2019

Contents

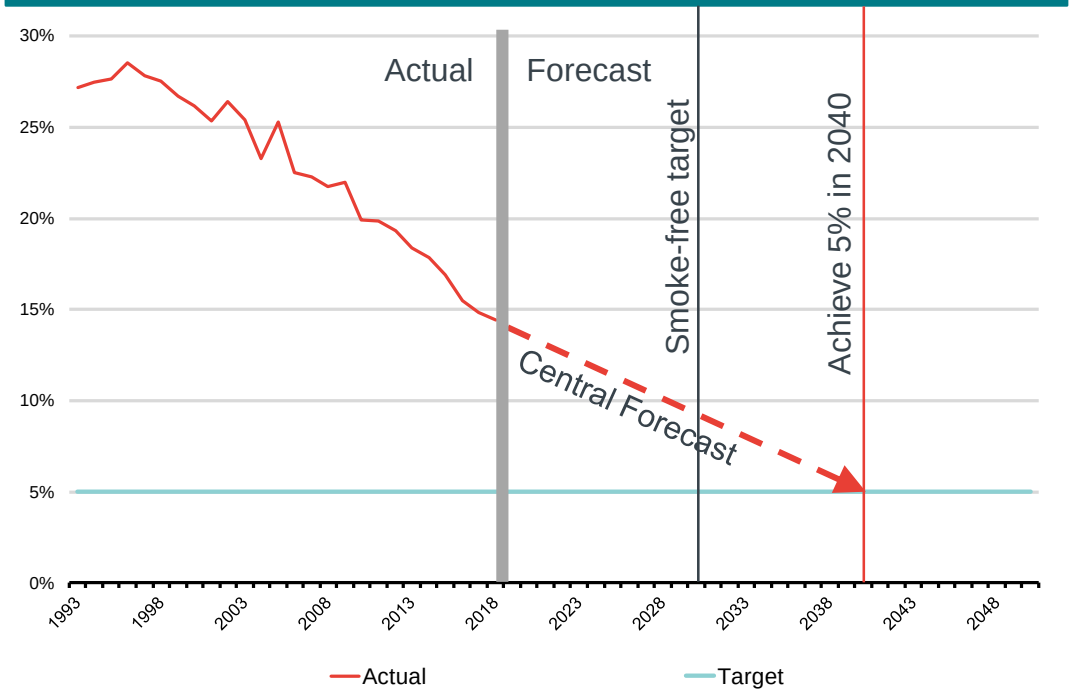
Executive summary: Our central forecast estimates that the England's prevalence will fall below 5% by around 2040

1. Our central forecast is for English smoking prevalence to fall below **5%** by around **2040**. This forecast is based on a continuation of current above-inflation excise increases and known regulatory interventions. This is ten years after the Government's target date to go smoke-free in England.

2. If smoking then continued to decline at the same rate after 2040, it would reach **0%** in around **2050**.

3. Smoking is in long-run decline, but **since 2012 it has declined at almost twice the rate** seen between 1993 and 2011. Smokers switching to e-cigarettes appear to have made a material contribution to that recent trend.

Smoking prevalence forecast for England up to 2050



Source: **Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.**

4. We anticipate that the faster decline in smoking since 2012 will not continue indefinitely. In part this is because the growth of e-cigarettes is now slowing. Data from ASH indicates that there were only **300,000** new vapers in 2018, compared with **800,000** in 2014.

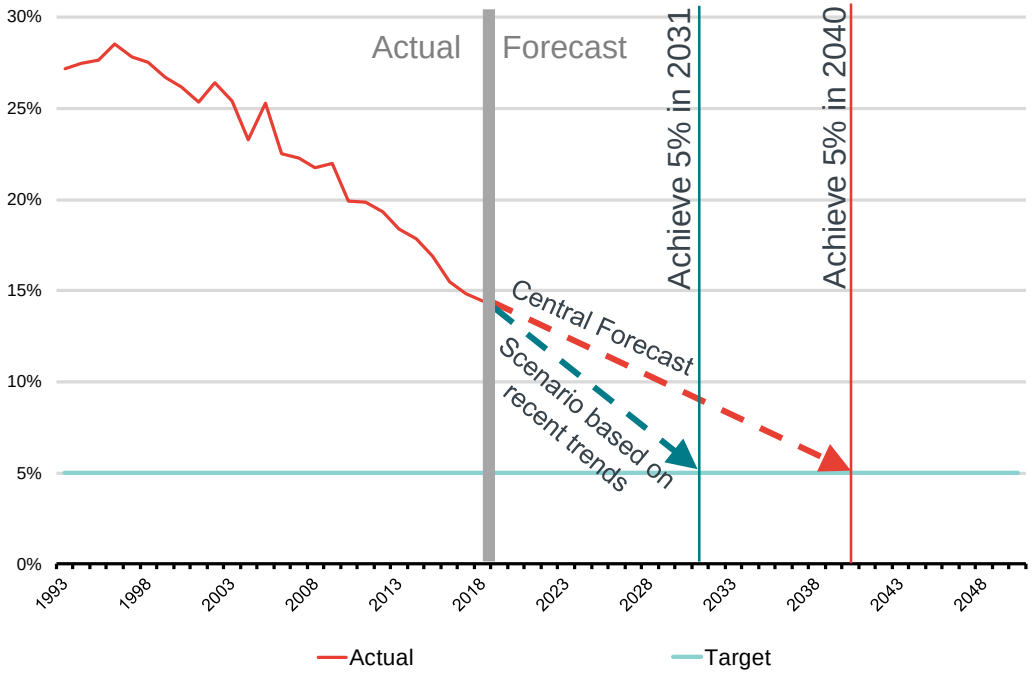
Executive summary: If England is to achieve 5% prevalence by 2030, significant changes are needed

5 Achieving a prevalence rate of 5% by 2030 would require an additional **2.25 million** smokers to quit over and above those we already expect to quit in our central forecast. This is equivalent to around **205,000 extra quitters** each year for a 11 years.[1]

6 **This would require significant changes**, such as:

- A rapid increase in the number of smokers switching to smoke-free alternatives, including e-cigarettes; and/or
- Reversing the decline in smokers quitting through NHS Stop Smoking services, which decreased to 30,700 in 2018 from a peak of 100,000 in 2011; and/or
- Finding other new and effective ways to persuade smokers to quit.

Scenario for achieving 5% prevalence by 2031



Source: Health Survey for England (1993-2009) Annual Population Survey (2010-2018) Frontier calculations

7 The most recent wave of data shows that the **difference between low prevalence areas and high prevalence areas is now bigger than ever**.

[1] Our analysis explores the impact of additional quitters in each year from 2020 to 2030 inclusive.

Frontier were asked to investigate when England might be ‘smoke-free’

In 2017 the Government’s Tobacco control Plan set an ambition to reduce smoking prevalence to 12% of adults by the end of 2022 (DH, 2017). Over the longer term the Government’s ambition is to go ‘smoke-free’ in England by 2030. This has previously been defined as reducing smoking prevalence to 5% or less of the adult population.

Philip Morris International (“PMI”) is also committed to a smoke-free future. It has announced its ambition to help phase out cigarettes by providing less harmful smoke-free alternatives for adults who would otherwise still smoke.[1] Philip Morris Limited, the UK affiliate of PMI, asked Frontier Economics to investigate when England was likely to be ‘smoke-free’, based on current trends and known policy interventions including taxation, plain packaging and NHS Stop Smoking services.

They also asked us to consider the extent to which innovative products can help achieve a smoke-free society. The Government’s Tobacco Control Plan for England emphasised the role of innovation alongside more traditional policies such as NHS Stop Smoking services and enforcement measures.

This report summarises our previously published analysis and our findings using the most up-to-date evidence.

6.36 million

Number of smokers in England in 2018

Source: ONS (2016, 2019a), Frontier calculations

4.16 million

Number of smokers who need to quit today to achieve 5% prevalence now

Source: ONS (2016, 2019a), Frontier calculations

Our approach:

1. Analyse long-term trends in smoking prevalence in England, including the impact of e-cigarettes
2. Forecast future prevalence and progress towards a ‘smoke-free’ goal
3. Consider future role of smoke-free products[2] and NHS Stop Smoking services

[1] PMI has stated that it believes that quitting is best but that switching to smoke-free alternatives is a better alternative than continuing to smoke.

[2] “Smoke-free products” refers to product categories such as e-cigarettes that do not contain tobacco, as well as other novel nicotine delivery systems that do not involve combustion of tobacco, for example, heated tobacco. See Annex 1.

Smoking prevalence in England continues to decline, and the Government is aiming to go smoke-free by 2030

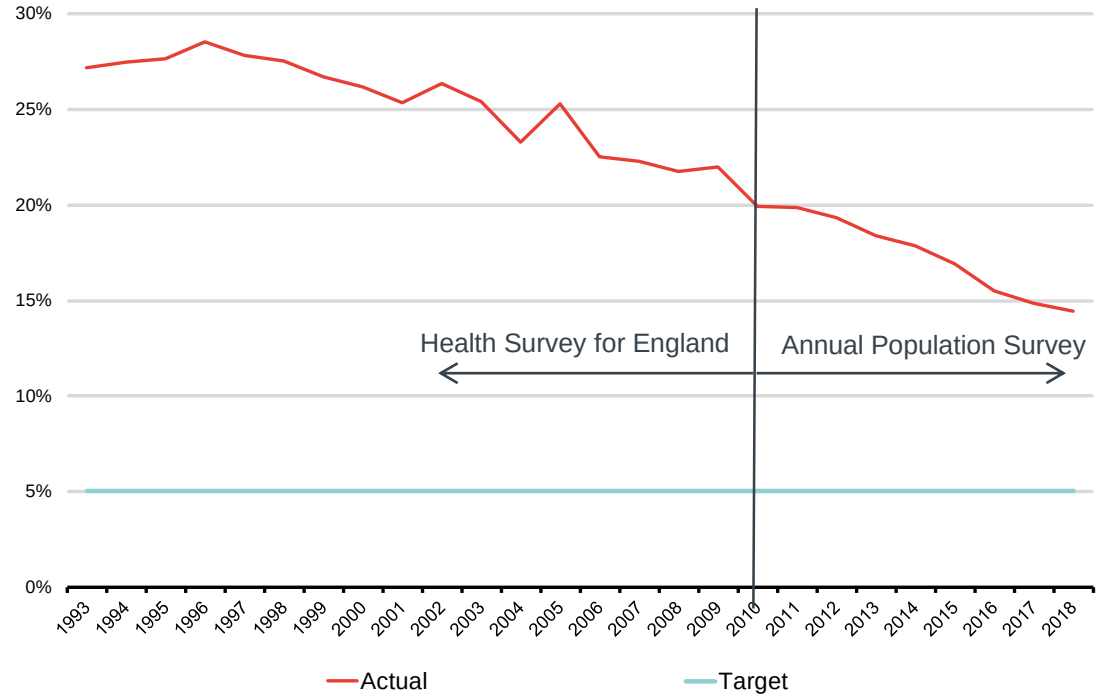
Smoking prevalence in England is in long-run decline. Current prevalence has fallen to approximately 1 in 7 adults. In 2017 the Government announced its ambition to achieve a smoke-free generation, defined as having a prevalence rate of 5% or below:

"Our vision is to create a smoke-free generation. We will have achieved this when smoking prevalence is at 5% or below." [1]

In 2019, the Government set out its ambition for a smoke-free date:

"We are setting an ambition to go 'smoke-free' in England by 2030. This includes an ultimatum for industry to make smoked tobacco obsolete by 2030, with smokers quitting or moving to reduced risk products like e-cigarettes" [2]

Smoking prevalence in England 1993-2018



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.

For the purposes of this analysis, we examine progress towards a smoking prevalence rate of 5% or below, in line with the original smoke-free definition. We also consider when a 0% prevalence rate may be achieved. 0% prevalence could represent a scenario where smoked tobacco is completely obsolete in line with the ambitions recently set out by the Government. We recognise that reducing smoking prevalence may become more difficult to achieve in practice, as some smokers may continue to smoke regardless of plausible policy changes.

[1] Department of Health (2017).

[2] HM Government (2019).

Smoking prevalence has declined faster since 2012 than in the period between 1993 and 2011

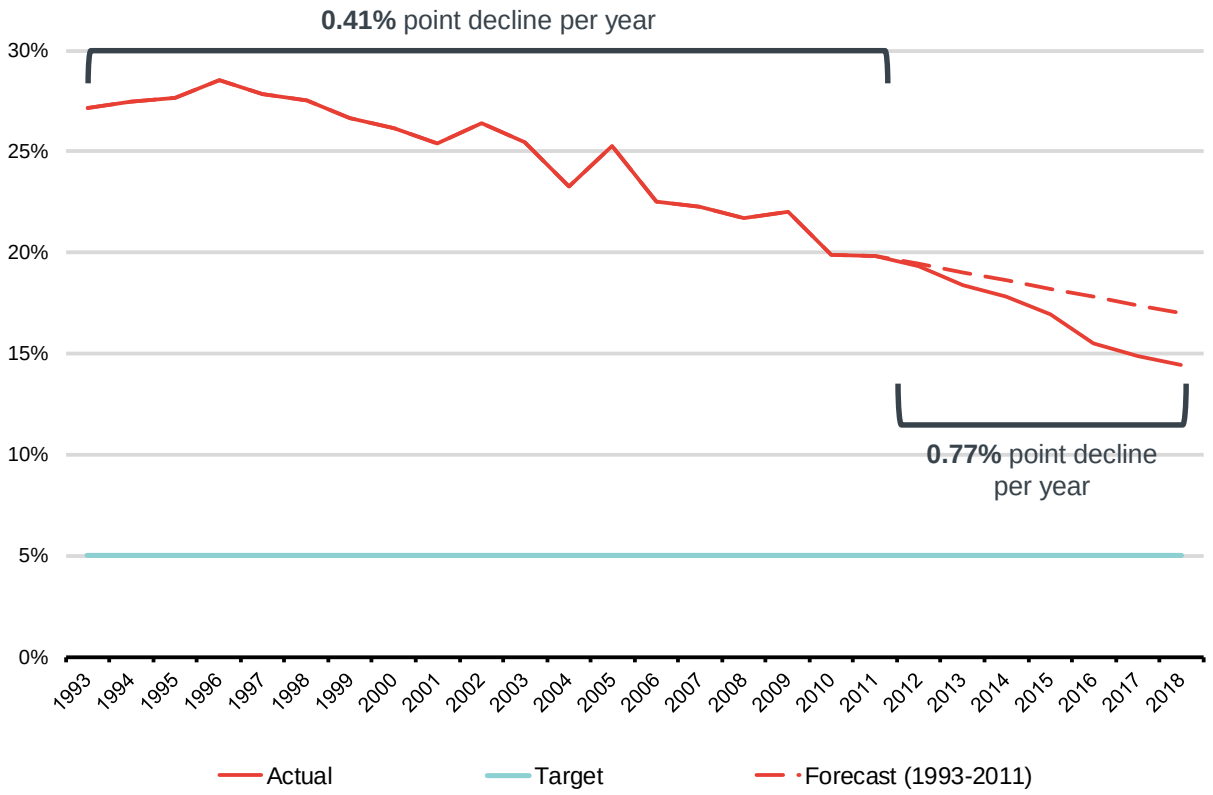
In recent years, smoking prevalence in England has fallen more quickly than the longer-term trend. This is shown in the chart to the right.

Average annual decline in smoking prevalence:

- 1993 - 2011: 0.41 percentage points.
- 2012 - 2018: 0.77 percentage points.

Between 2012 and 2018 the average annual decline in smoking prevalence was almost twice as fast as the earlier period.

Smoking prevalence in England 1993–2011 and 2012–2018



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.

The recent faster decline in smoking prevalence is likely due in material part to greater use of e-cigarettes as a quitting aid

Had the average decline in prevalence from 2012 onwards carried on at the same rate as between 1993 and 2011 (0.41 percentage points per year), prevalence in England in 2018 would have been **17%**.

Instead, smoking prevalence in 2018 was **14.5%**. This additional decline of 2.5 percentage points is equivalent to over 1 million fewer smokers today.

An accelerated decline in prevalence sustained over a long period can have very large effects. For example, had prevalence over the whole period since 1993 fallen by the recent average rate (0.77 percentage points per year), prevalence in 2018 would have been **9.5%**, 5 percentage points lower than the actual rate. This would be equivalent to 2.2 million fewer smokers today.

A material part of the accelerated decline between 2012 and 2018 is likely to be due to the popularisation of e-cigarettes. This is because:

- E-cigarettes are an effective quitting aid, with 1.7 million ex-smokers in Great Britain having fully converted to e-cigarettes (ASH, 2018);[1] and
- Use of e-cigarettes has increased significantly between 2012 and 2018 (ASH, 2018).

A PHE commissioned evidence review (McNeill et al., 2018) noted recent increases in quit success rates across England and concluded it is plausible that e-cigarettes have contributed to this.

17%

Prevalence in England in 2018 had trend decline between 1993 and 2011 continued from 2012

Source: Annual Population Survey (2019), Frontier calculations

14.5%

Actual prevalence observed in England in 2018

Source: Annual Population Survey (2019)

9.5%

Prevalence in England in 2018 if trend decline between 2012 and 2018 had begun in 1993

Source: Annual Population Survey (2019) Frontier Calculations

[1]Some of the 1.7 million ex-smokers who have fully converted to e-cigarettes would have quit using other means had e-cigarettes not existed. Quantifying the precise contribution of e-cigarettes to the observed decline in prevalence was beyond the scope of this report.

E-cigarettes are an effective quitting aid

E-cigarettes are used as an aid to reduce cigarette consumption or give up smoking entirely:

- ASH (2018) shows that the most common reason to take up e-cigarettes is to *quit or abstain from smoking*.

There is evidence that e-cigarettes are an effective aid to quitting combustible tobacco products:

- High quality evidence on the effectiveness of e-cigarettes in helping people stop smoking is still limited. The most reliable evidence suggests e-cigarettes containing nicotine may help people stop smoking (Hartmann-Boyce et al., 2018). Combining evidence from two randomised controlled trials (RCTs) – the gold standard to evaluate effectiveness – shows that e-cigarettes can *more than double* the likelihood of long term smoking abstinence when compared with placebo e-cigarettes (Hartmann-Boyce et al., 2016). The authors acknowledge that there is a need for further research in this area.
- Survey evidence is more mixed. Beard et al. (2016) show that increases in the aggregate prevalence of e-cigarette use by smokers has been associated with an increase of the success rate of quit attempts. However, Pasquereau et al. (2017) find no evidence that tobacco users who also use e-cigarette users are more likely to quit smoking relative to tobacco users who do not use e-cigarettes. Rigotti at al., (2018) explore the relationship between use of e-cigarettes and conventional tobacco amongst hospitalised cigarette smokers. They find that use of e-cigarettes use was associated with less tobacco abstinence at 6 months. This could be due to the fact that patients self-selected e-cigarette use.

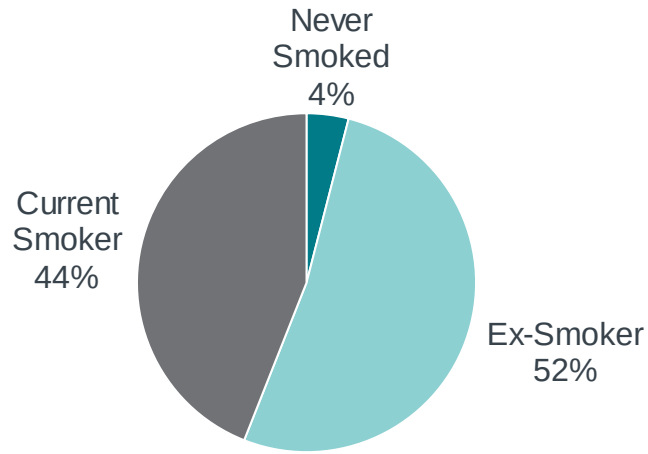
There is evidence e-cigarettes are associated with increased quit attempts, though not all studies show this:

- Regular use of e-cigarettes has been shown to lead to *additional* quit attempts, which would not have been made if e-cigarettes did not exist (Brose et al., 2015). Evidence from some longitudinal studies show that those who smoke and use e-cigarettes regularly are more likely to make a subsequent quit attempt than those who smoke but do not use e-cigarettes (Pasquereau et al., 2017). Johnson et al. (2018) examined population data from 2006-16 and concluded that current e-cigarette use was associated with an increase in quit attempts
- Another study examining aggregate e-cigarette use and total quits attempts found no significant relationship between e-cigarette usage and quit attempts (Beard et al., 2016).

E-cigarettes are almost exclusively used by current or former smokers, and a majority of ‘vapers’ have quit smoking completely

- **96%** of e-cigarette users (‘vapers’) in Great Britain are former or current smokers (ASH, 2018a).
- Only **4%** of e-cigarette users in GB have never smoked.
- While the number of new e-cigarette users in GB has been slowing, a higher proportion of e-cigarette users have **converted to sole use**.
- In 2018, **the majority of current e-cigarette users in GB are ex-smokers** (52%). Over **1.7 million** current e-cigarette users in GB have stopped smoking entirely.
- If all 1.7 million GB e-cigarette users who have fully converted were still smoking instead, prevalence (across GB) would have been **3.3 percentage points higher** in 2018.[1] However we recognise that some of these smokers would have attempted to quit in any case, albeit with less success than using e-cigarettes.
- The Department of Health (2017) estimated that in 2016 **2 million** consumers in England had used e-cigarettes at some point to stop smoking completely.
- A separate study carried out by ASH (2018b) found that use of e-cigarettes remains very low among young people (11-18). E-cigarette use is confined almost entirely to those who currently or have previously smoked tobacco cigarettes.

E-cigarette users by smoking status



Source: ASH (2018)

1.7 million

Smokers in Great Britain who have stopped smoking entirely by switching to e-cigarettes

[1] Based on ONS (2019) population data.
https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland

E-cigarettes are popular among smokers but there are signs that the growth in vaping is slowing

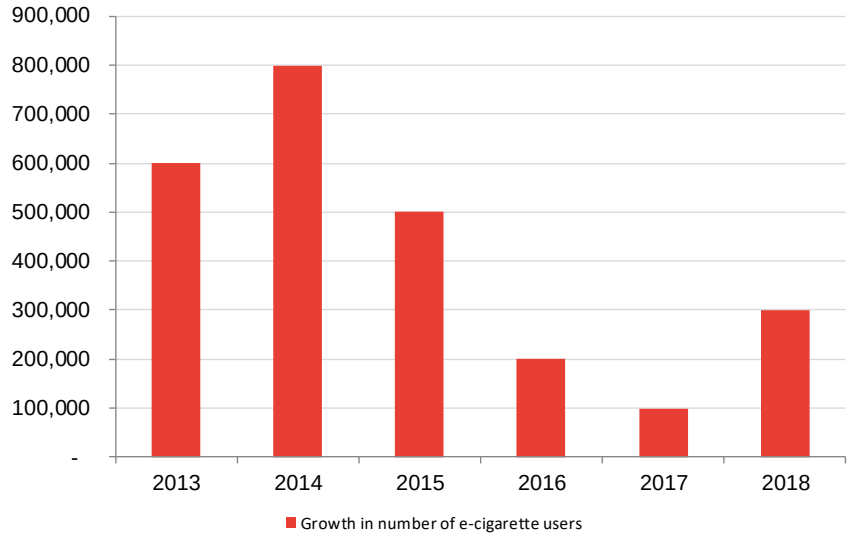
E-cigarette use has boomed but is now slowing down…

- The Smoking Toolkit Study (2019) has found that in 2018 **5.65%** of adults in England currently use e-cigarettes.[1] The ONS report that **6.3%** of English adults are vapers. These figures are broadly consistent with ASH's (2018) estimate that **6.2%** of the adult population in Great Britain use e-cigarettes. This corresponds to 3.2 million adults.
- ASH (2018) also shows the trend in e-cigarette take-up in GB since 2012. There has been rapid growth since 2012 when there were only 700,000 users in GB. Recently the **rate of increase** has **slowed**. In 2017 number of vapers grew by only 100,000. The increase in 2018 was larger (300,000)
- The **majority of cigarette smokers** (63%) in GB have tried e-cigarettes,[2] and the number of new users is slowing. This suggests the future impact of e-cigarettes on prevalence may be limited without intervention.

… due to product satisfaction, price and perceptions of safety

- ASH's (2018) survey of GB vapers suggests more smokers would try e-cigarettes (or try them again) if:
  - product satisfaction were higher;
  - price were lower; and
  - they were more confident about e-cigarettes' safety.

Number of additional new e-cigarette users in Great Britain 2013-18



Annual growth in e-cigarette users	
2013	**86%**
2014	**62%**
2015	**24%**
2016	**8%**
2017	**4%**
2018	**10%**

Sources for all statistics : ASH (2018)

63%

Proportion of smokers who have tried e-cigarettes

[1] Including Heat-not-Burn products and Juul.

[2] ASH (2018).

Our central forecast suggests England may achieve a smoke-free generation in 2040

There has been a steady decline in the rate of smoking among adults in England over the last 20 years.

As a starting point in forecasting future prevalence, we simply projected forward a long-run trend based on the average decline over the whole period between 1993 and 2018. This assumes the more recent, faster decline in prevalence is not sustained, in line with evidence that e-cigarette growth is slowing, and past examples of relatively rapid declines in prevalence not being sustained.[1]

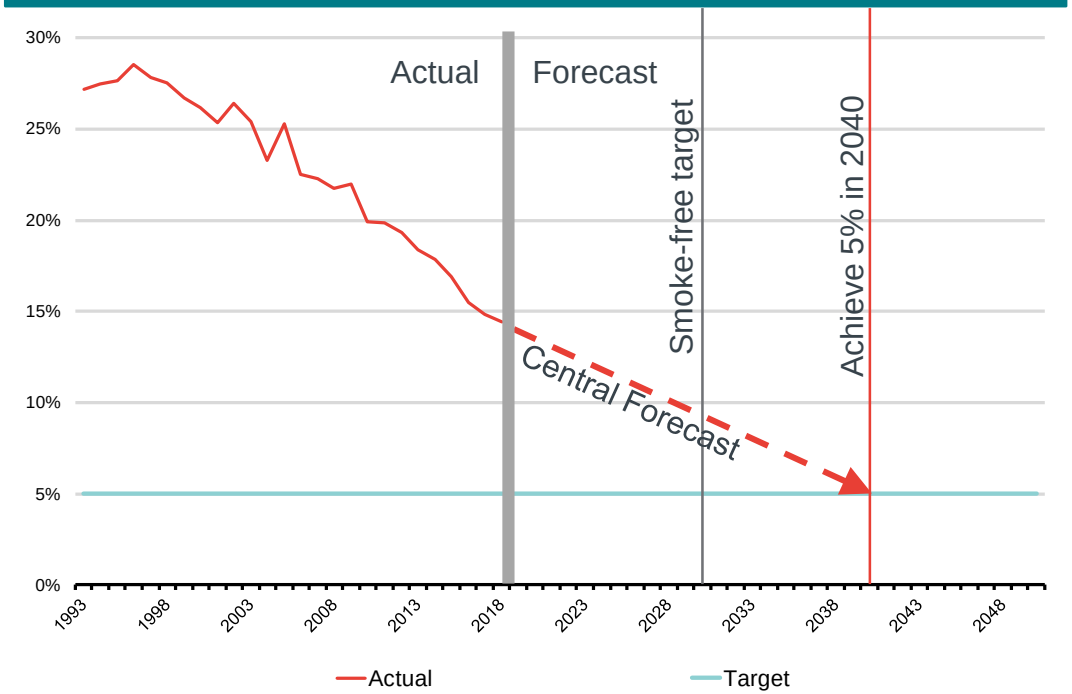
We adjusted this simple trend forecast to account for how the Government (where available) estimates smoking prevalence will be impacted by known or likely interventions in the coming years:

- Changes in excise duties on tobacco products;
- Standardised packaging / the EU Tobacco Products Directive;
- Use of publicly-funded NHS Stop Smoking services.

We undertook a review of the literature and policy impact assessments to generate estimates of how these policies would affect future prevalence relative to the simple extrapolation of past trends.

Our central projection is shown in the chart to the right. We estimate that England will achieve **5% prevalence by 2040.**[2] This is ten years after the Government's target date to go smoke-free in England. If prevalence then continued to decline at the same rate after 2040, smoking would reach 0% in around **2050.** In reality, we recognise that there will probably be increasing difficulty in reducing prevalence as some smokers may continue to smoke regardless of plausible policy changes.

Smoking prevalence forecast for England up to 2050



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.

2040

Date when 5% prevalence ("smoke-free generation") may be achieved

2050

Date when 0% prevalence may be achieved if declines continue at same rate

[1] This can be seen in the chart. The solid red line depicts actual prevalence between 1993 and 2018. There are periods where the observed falls in prevalence are above average and others where they are below average.

[2] A Public Health England blog projected future smoking prevalence in England (Selbie, 2017) and concluded that the 5% target will be reached in 2030 if the trend in prevalence over recent years continues. This differs from our projection primarily because we base our projections on a longer time series of data.

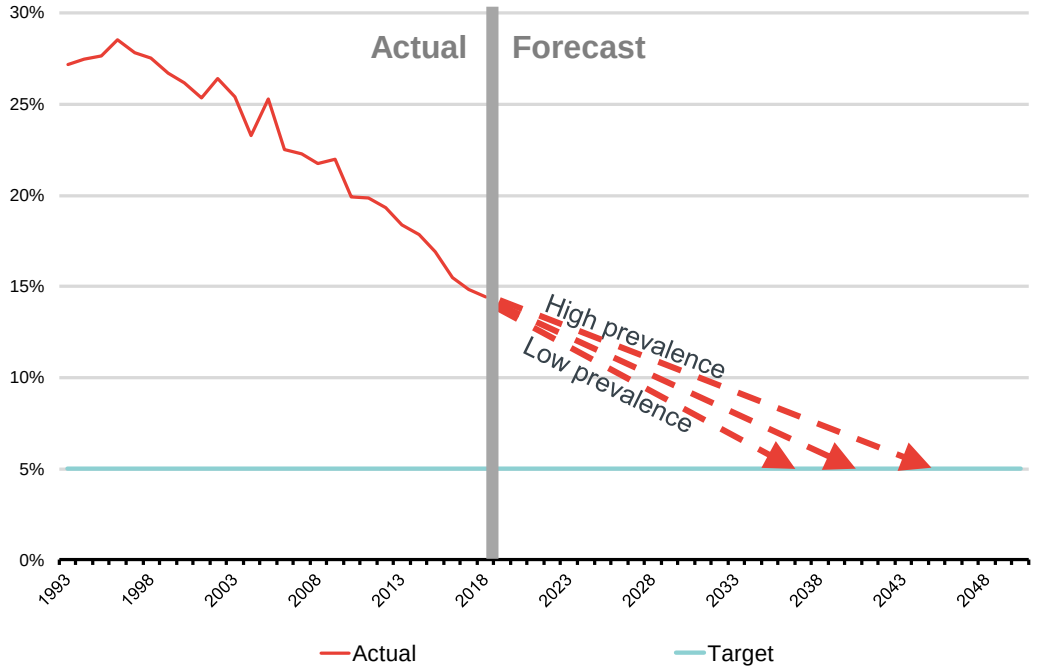
We have tested how our prevalence forecast changes under alternative policy impact assumptions

While our central forecast is based on our estimates of the impact of these policy drivers on prevalence, there is of course considerable uncertainty on the relationship between these policies and prevalence, and how the policies themselves will change in future years.

We therefore model low and high prevalence scenarios for each policy. These are combined in the chart on the right to give overall low and high prevalence scenarios.

It is also important to note that there are a variety of other factors which we have not explicitly included an adjustment for within our model, that may alter prevalence relative to trend in the future. Therefore, it is possible to achieve a 5% prevalence rate even sooner than indicated by our low prevalence scenario if for example there are major societal changes, new government policies or greater switching to e-cigarettes or other novel smoke-free products.

Prevalence forecast 2018-50 – sensitivity analysis



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.

Note: Scenario assumptions are detailed in Annex 4.

Forecast scenario:	Low	Central	High
Achieve 5% prevalence by:	2037	2040	2045
Achieve 0% prevalence by:	2045	2051	2056

If recent trends continued, prevalence would not fall below 5% by 2030. Achieving 5% by 2030 would require 2.25 million additional quitters

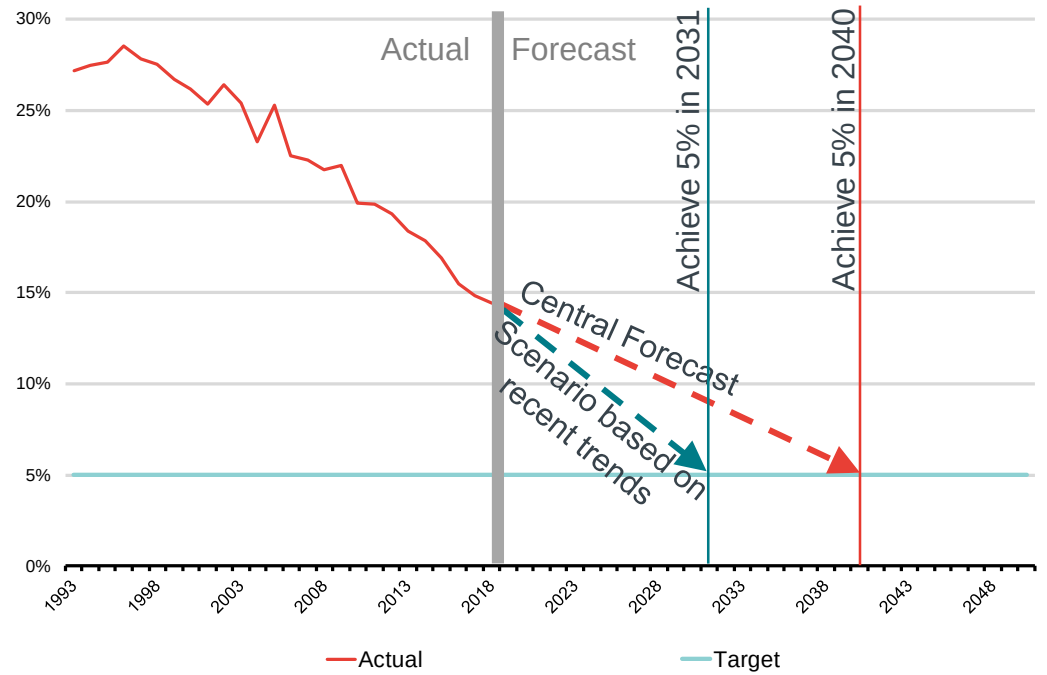
Our central forecast is that prevalence may be reduced to 5% by 2040.Our central forecast assumes that the future rate of decline returns to the long run average observed since 1993, adjusted to account for the impact of known or likely interventions. This is in line with evidence that e-cigarette growth is slowing, and past examples of relatively rapid declines in prevalence not being sustained.

But if the faster trend decline since 2011 (0.77 percentage points per year) were sustained, a prevalence rate of 5% could be achieved much sooner – by 2031, 9 years ahead of our central forecast. However, this is still after the Government's current ambition to go 'smoke-free' in England by 2030 (HM Government, 2019). This highlights the scale of the challenge facing the Government.

Reducing prevalence to 5% by 2030 requires **2.25 million more smokers to quit between 2020 and 2030** than our central forecast.[1]

2.3 million is a very large gap. The **total reduction in smokers observed over the last 5 years is 1.76 million.** Closing that gap would likely require a combination of factors, including renewed faster growth in e-cigarettes and/or other smoke-free technologies.

Scenario for achieving 5% prevalence by 2031



Source: Health Survey for England (1993-2009) Annual Population Survey (2010-2018) Frontier calculations

2.25 million

Additional smokers required to quit by 2030 compared with our central scenario, to reach smoke-free England by that year

[1] As we are using self-reported data to measure prevalence our definition of a quit is based on someone stating that they do not smoke cigarettes at all nowadays.

… which would need quit attempts to become more successful

Reducing smoking rates depends on a combination of:

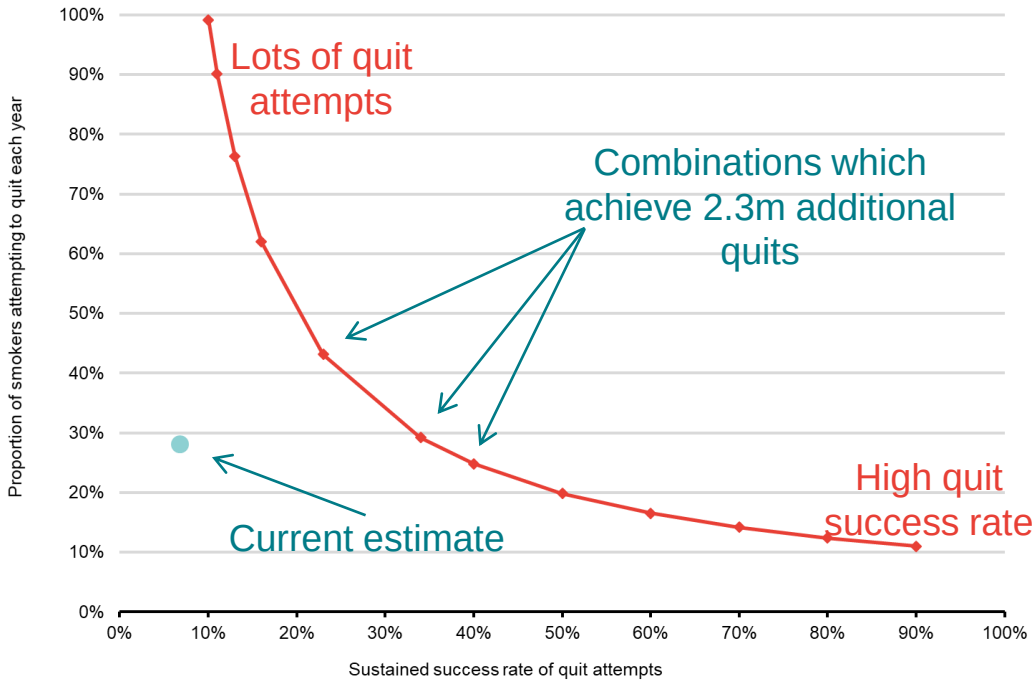
- the number of smokers trying to quit;
- the success rate of those quits and;
- reduced initiation.

Around 28% of smokers attempt to quit each year. In the short term approximately 15-20% of these people succeed, either unaided or using a quitting aid.[1] Longer term (6-12 months), sustained quit success rates are lower, around 7%.[2] Successfully reducing prevalence to 5% through **2.3 million more smokers quitting** could be achieved by either:

- **Higher quit success rate:** It would require **a sustained quit success rate of around 35%** over an 11 year period from 2020-30 assuming 28% of smokers attempt to quit each year (as currently).
- **Higher quit success rate *and* more quit attempts** (over an 11 year period from 2020-30): The chart to the right shows the different combinations of quit attempts and success rates which could achieve 2.3 million additional quits:
  - doubling the number of attempts to 60% of smokers, requires a sustained success rate to 17%; and
  - even with 100% of smokers attempting to quit each year, the sustained success rate would still need to be around 10%.

This illustrates the size of the challenge facing policy-makers.

Quit attempts and quit success rates to achieve a 'smoke-free' England by the end of 2030



Note: Estimate of current proportion of smokers attempting to quit each year is from the Smoking Toolkit Study (2018). Estimates of sustained success rate of quit attempts is based on aids used in most recent quit attempt also from the Smoking Toolkit Study (2018). The long term success rate of each aid (except e-cigarettes) is based on West & Owen (2012). The long term success rate of e-cigarettes is based on Hartmann-Boyce et al. (2016).

Our analysis is population-wide. We show in Annex 2 that prevalence varies significantly amongst different groups. In reality a segmented approach (by income and other characteristics) is likely to be needed to achieve a 5% prevalence rate.

[1] The 15-20% figures come from recent waves of UCL's Smoking Toolkit Study (2019). We understand these figures to be of mixed duration as they refer to the proportion of smokers who have quit in the last 12 months who are still not smoking at the time of the survey. This explains why it is higher than the long term quit success rate figures.

[2] Frontier calculations using West & Owen (2012), Hartmann-Boyce et al. (2016) and Smoking Toolkit Survey (2019).

Greater use of e-cigarettes and novel smoke-free products could assist in delivering a smoke-free England earlier…

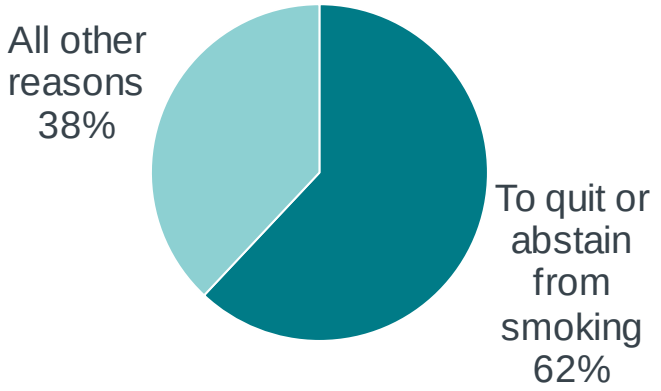
There is significant potential for innovative smoke-free products[1] to support greater reductions in smoking. As shown in the charts on the right, the most common single reason for using e-cigarettes is to quit or abstain from smoking.

In the future, smokefree products could include entirely new products in categories such as heated tobacco or other novel nicotine delivery systems. It could also include further reductions in prevalence from existing products like e-cigarettes.

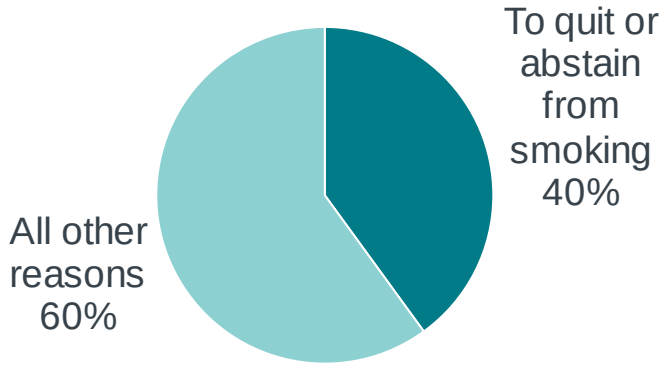
As noted on Slide 11, evidence from Random Control Trials shows that e-cigarettes can more than double the likelihood of long term smoking abstinence when compared with placebo e-cigarettes.

Reasons for using e-cigarettes

Current e-cigarette user and **ex-smoker**



Current e-cigarette user and **current-smoker**



Source: ASH (2018)

[1] Examples of some of these products are contained in Annex 1.

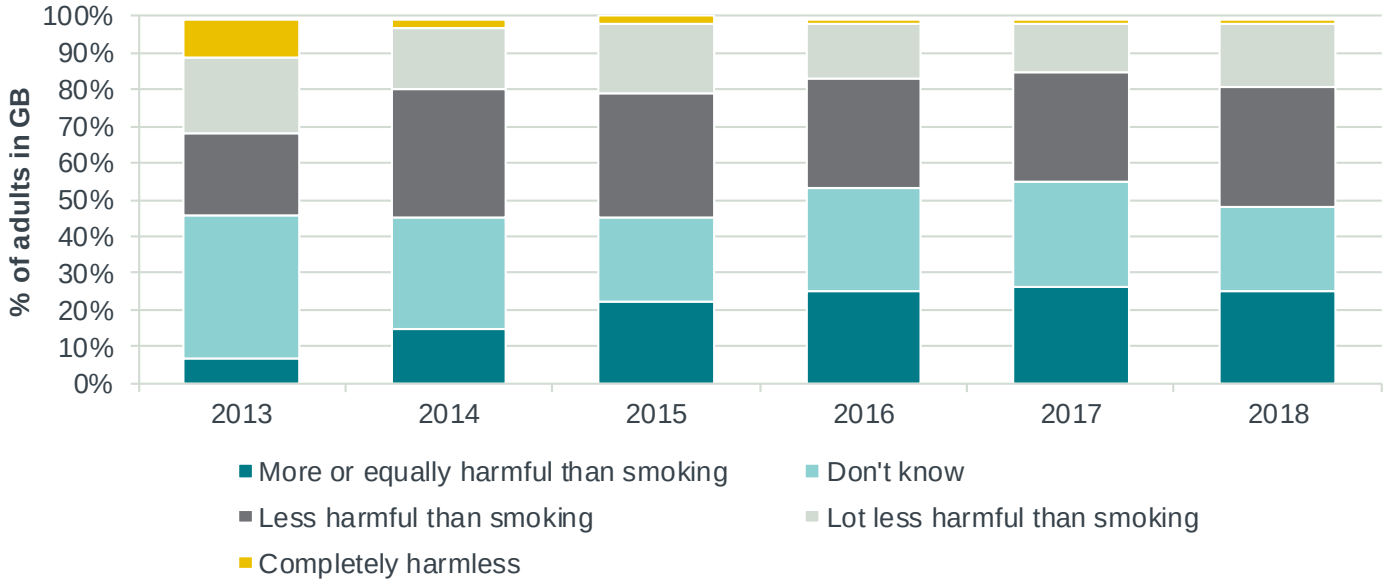
… although more work will need to be done to reassure the public about the relative risks of new products

There is evidence that people are misinformed about the relative health risks of e-cigarettes and combustible tobacco, which could hinder further take-up.

Public Health England concluded that the best estimates show e-cigarettes are 95% less harmful to health than combustible cigarettes.[1]

However, according to ASH (2018), currently only 17% of adults in Great Britain correctly identify that e-cigarettes are a lot less harmful than cigarettes (see chart). This is higher than the equivalent figure in 2017 (13%) but lower than the 2013 figure (21%). This shows that a significant proportion of the public are consistently ill-informed.

Public perception of harm from e-cigarettes in Great Britain



Source: ASH (2018)

Note: Figures do not always sum to 100% due to rounding

A review of evidence commissioned by PHE (McNeill et al., 2018) stated that widespread misperceptions about the relative risks of nicotine and tobacco need to be addressed and corrected.

[1] McNeill et al. (2015)

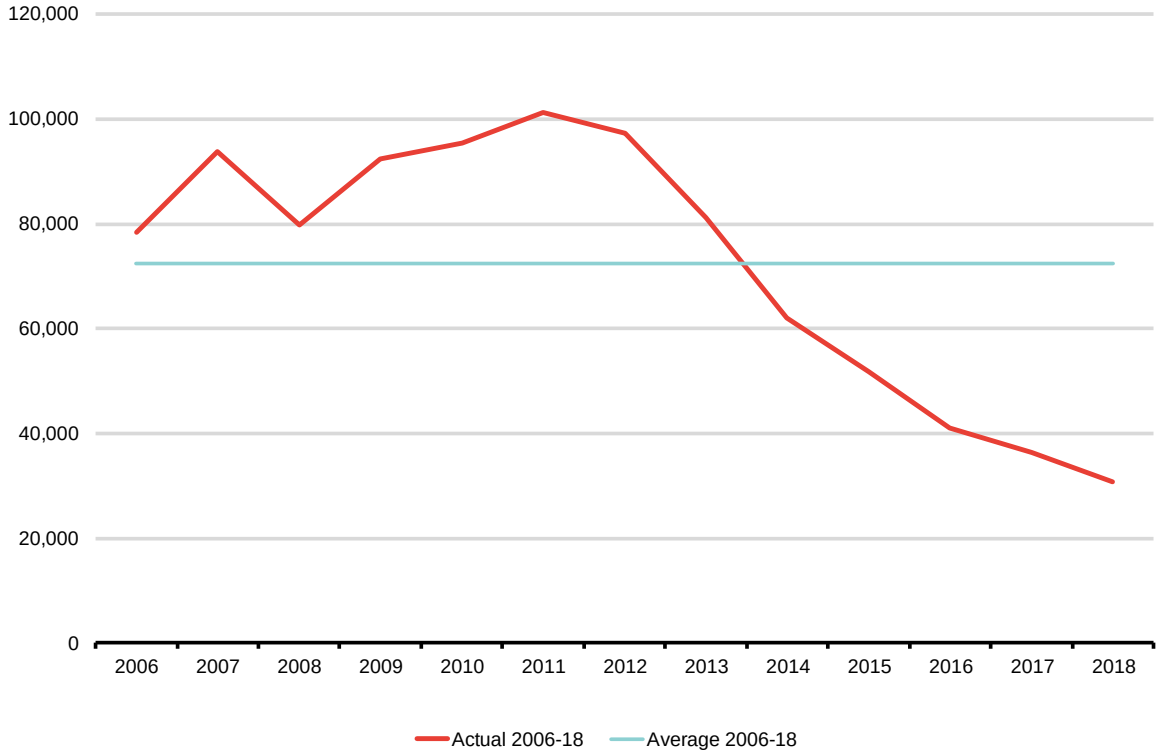
NHS Stop Smoking services are also an effective aid to smokers quitting, but the number of participants has declined in recent years

Helping 2.25 million smokers quit is a challenge for which there is unlikely to be any single solution, and so it is probable that alternative products will not be enough in isolation.

NHS Stop Smoking services could be part of the solution. NHS Digital (2019) reports 4-week success rates for quit attempts of 51%. Although some of these quitters will return to smoking, we estimate that the long term quit success rate is around 12.8%.[1]

In recent years, the numbers using NHS Stop Smoking services has declined sharply both in absolute terms and as a proportion of smokers. Successful quits peaked at around 100,000 in 2011 but fell to around 30,700 in 2018. The average for 2006 to 2018 was approximately 72,400 quits per year.[2]

Successful quits using NHS Stop Smoking services, England 2006-18



Source: NHS Digital (2019), Frontier analysis.

Percentage of all smokers who quit using NHS Stop Smoking services	
2011	1.25%
2018	0.44%

Source: NHS Digital (2019), Frontier analysis.

[1] West & Owen (2012) report that out of 100 individuals who quit for 4 weeks, 30 will succeed in quitting for 4 weeks, 30 will succeed in quitting for 12 months, and around 21 will succeed in quitting for life. We convert 4-week success rates reported by NHS Digital to long term success rates using a factor of 0.25.

[2] All figures are based upon 1-year quit success rates, using Frontier estimates.

Greater use of NHS Stop Smoking services could also assist in delivering greater reductions in smoking prevalence

The Tobacco Control Plan notes that local stop smoking services "continue to offer smokers the best chance of quitting". We therefore considered the impact that increased participation could have in reducing prevalence.

Our forecasts for expected future smoking prevalence include the impact of NHS Stop Smoking services, with our central forecast assuming that the number of quits remains constant at recent levels of around 30,700 per year.[1]

However, greater use of NHS Stop Smoking services could help to deliver a smoke-free England:

- **Return to 2006-18 average (over 2x current levels):** If participation in NHS Stop Smoking services returns to the average observed between 2006 and 2018, this would achieve around 458,700 *additional* quits by 2030.[2]
- **Return to 2011 peak usage (over 2.5x current levels):** If participation returned to its peak level of 2011, achieving around 100,000 quits per year, this would deliver around 762,300 *additional* quits by 2030.
- **Expand to 2.35 times 2011 peak usage (over 7.6x current levels):** If NHS Stop Smoking services were increased to achieve around 204,300 quits per year (i.e. 2.35 times the 2011 peak), this would deliver an *additional* 2.25 million quits by 2030. This would require a very significant increase in use of NHS Stop Smoking services, suggesting that these services alone will not be enough to achieve a smoke-free generation by 2030.

NHS Stop Smoking services quits, per year	Equivalent to	Additional quits relative to central forecast, per year	Total additional quits 2020 to 2030
30,700	2018 level	0	0
72,400	2006-18 average	41,700	~458,700
100,000	2011 peak	69,300	~762,300
235,000	2.6 x peak	204,300	~2.25 million

[1] See Annex 4 for more detail.

[2] Additional quits relative to Frontier's central long-run forecast.

There are several types of smoke-free products currently available

E-cigarettes

- E-cigarettes provide nicotine for inhalation in a vapour generated by heating a solution containing water, nicotine, propylene glycol, vegetable glycerine and some flavouring. RCP (2016) identify three categories:
  - *Cigalikes*: these were mostly disposable and similar in appearance to a combustible cigarette.
  - *Second generation e-cigarettes*: rechargeable with a more powerful battery and a refillable tank.
  - *Third generation e-cigarettes*: larger with more complex tank and two heating elements.

Heated tobacco products

- In heated tobacco products processed tobacco is heated but not burned as temperatures are set below that of combustion. HMT (2017) outlined three broad types of heated tobacco products:
  - Processed tobacco heated directly to produce a vapour.
  - Processed tobacco designed to be heated in a vaporiser.
  - Devices that produce vapour from non-tobacco sources, where the vapour is then passed over tobacco.

Novel non-tobacco nicotine products

- RCP (2016) highlighted a number of new non-tobacco nicotine products which are in development:
  - Metered-dose inhaler: uses propellants to deliver small droplets of nicotine to the respiratory tract. Similar in size and shape to a combustible cigarette. Consists of a small pressurised container with an aerosol containing nicotine, propylene glycol and a propellant.
  - Nicotine Salt Inhaler: a device in which a nicotine reacts with a weak organic acid to generate a respirable nicotine salt. These can be either electronic or non-electronic devices.

This list is not exhaustive and we expect new products to be developed over time.

We use two sources of smoking prevalence data to look at trends and underpin our forecasts

Health Survey for England

- Annual survey collected by NHS Digital, looking at the changes in the health and lifestyles of English people.[1]
- Smoking prevalence data (for those aged 16+) is available over the period 1993 to 2017.
- Sample size was 7,936 individuals in the most recent (2017) data.
- A respondent is classified as a smoker if they answer yes to: "Do you smoke cigarettes at all nowadays?"

Annual Population Survey

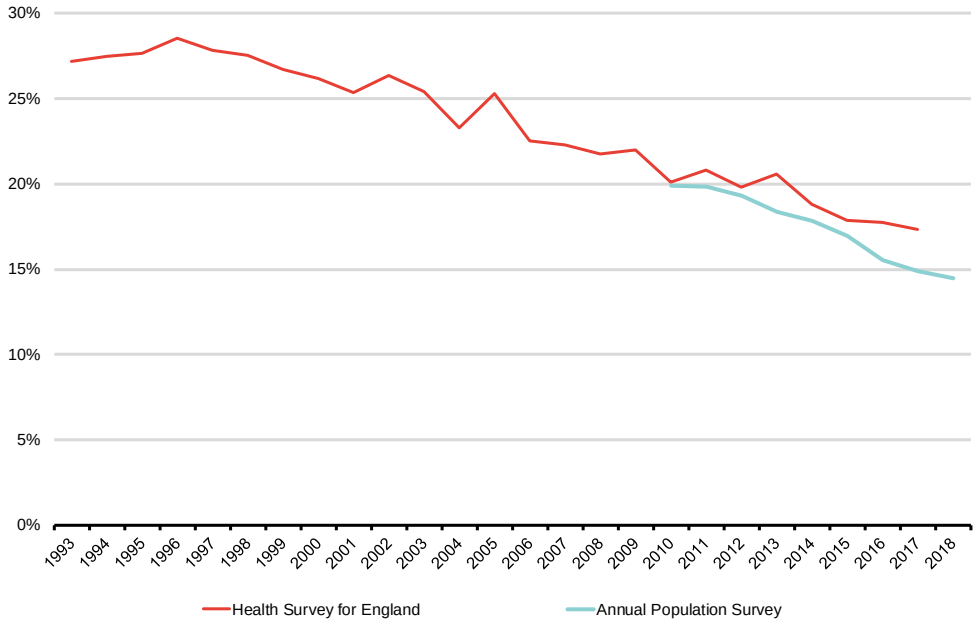
- Continuous household survey covering the UK collected by ONS.[2]
- Smoking prevalence data (for those aged 18+ in England) is available over the period 2010 to 2019.
- Sample size of 152,816 English individuals in the 2018 data.
- A respondent is classified as a smoker if they answer yes to: "Do you smoke cigarettes at all nowadays?"

Approach

To produce our long term forecasts we want to use a long series of accurate, up-to-date data.

- We use prevalence data from the Health Survey for England (HSE) covering 1993 to 2009. We then combine this with prevalence data from the Annual Population Survey (APS) covering 2010 to 2018 to produce a long time series (25 years). Trends are based on projecting forward the combined data series from 1993-2018.
- We prefer the APS prevalence estimates to the HSE estimates in later years, both because it has a larger sample size and contains 2018 data. The APS and the HSE both report very similar prevalence estimates in 2010 (20.1% and 19.9% respectively).
- Since 2010 the APS prevalence estimates have fallen at a slightly quicker rate than the HSE's estimates. This could be because of sampling differences and differences in the age population covered.

Smoking prevalence in England 1993-2018



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018),

[1] NHS Digital (2018).

[2] ONS (2019 A).

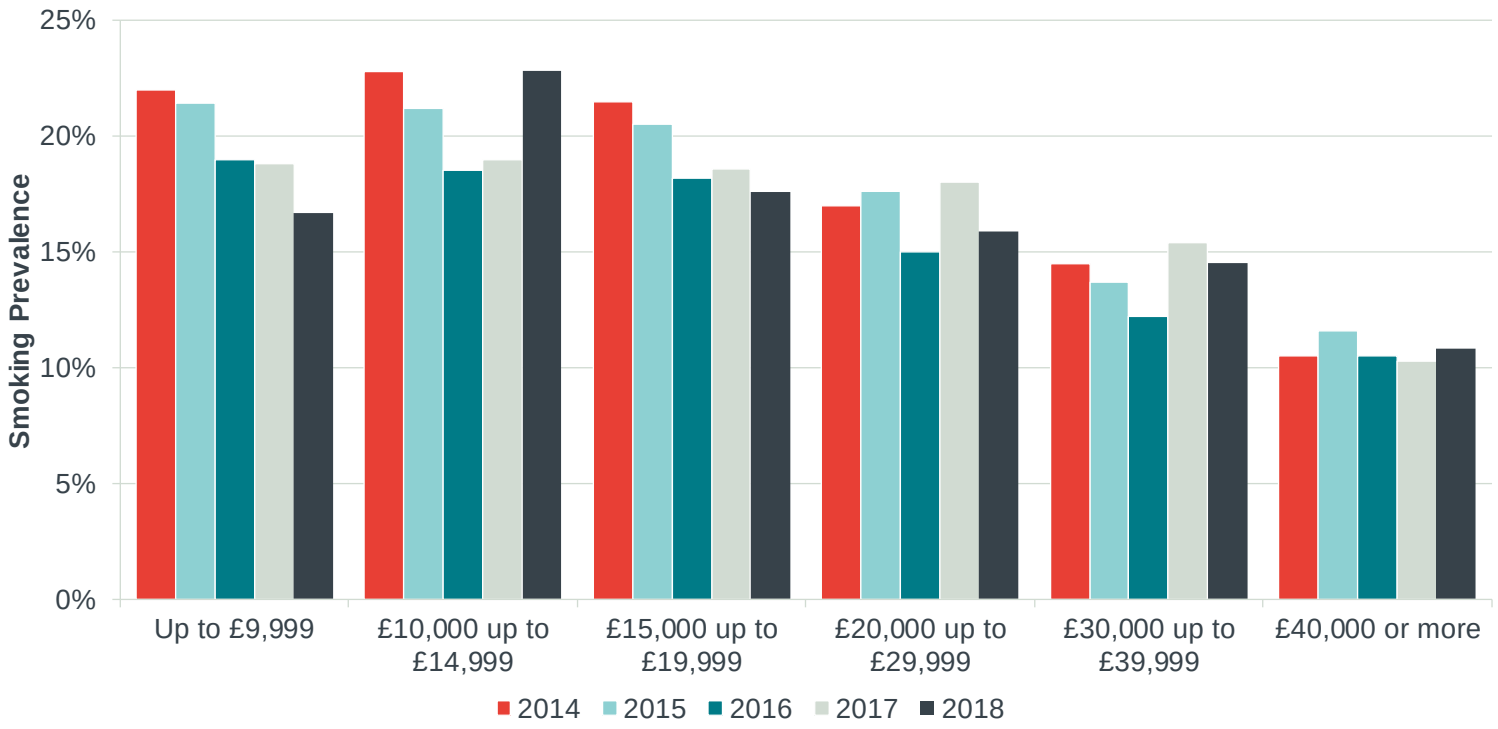
People with higher levels of income in England are less likely to smoke than those who earn less...

As shown in the chart individuals earning higher incomes are less likely to smoke than those who earn less.

However, those in the lowest income group (<£9,000) have experienced the biggest drop in prevalence since 2014.

Year-to-year changes in prevalence amongst specific groups need to be treated with caution. Dividing respondents into different income groups leads to relatively small sample sizes. For example, there were only 704 individuals in the £30,000-39,999 income category in 2018. As a result the majority of changes from one year to the next will not be statistically significant.

Smoking Prevalence by Income Group (ONS, 2018 C)



Source: ONS (2019 C) Opinions and Lifestyle Survey

... but those who earn less have seen the biggest recent falls in prevalence

Smoking prevalence has fallen significantly amongst both men and women

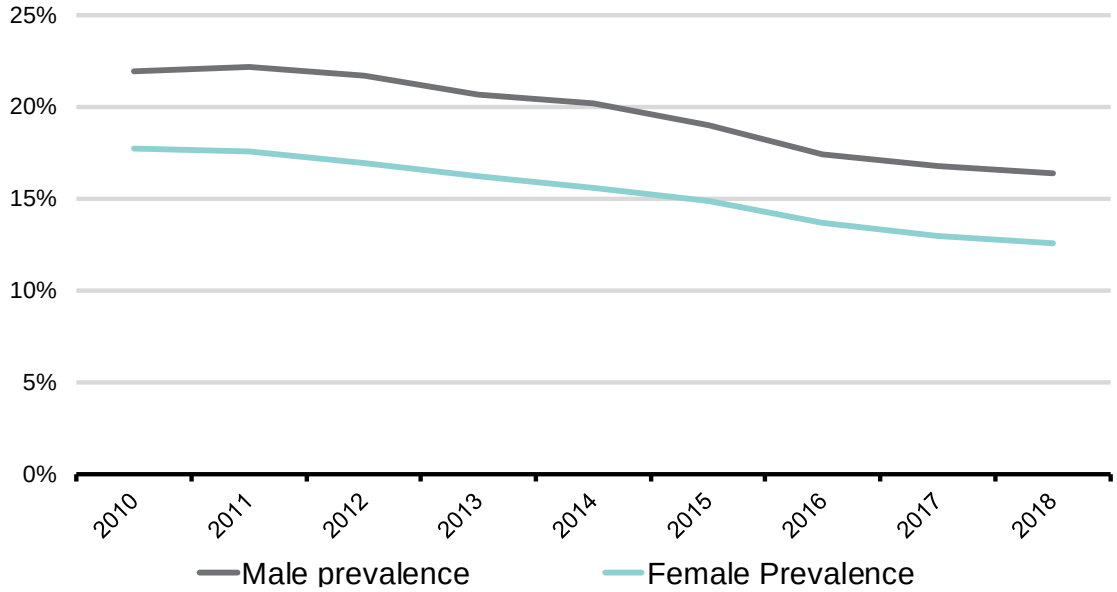
Men continue to smoke more than women. 16.4% of men classify themselves as a smoker. The equivalent figure for women is 12.6%. The male prevalence rate is therefore 3.8 percentage points higher than the female prevalence rate.

Smoking rates amongst both men and women have fallen consistently in recent years. In 2010 22% of men and 17.8% of women smoked.

The rate of decline across both genders is similar. The prevalence gap in percentage point terms has remained roughly constant.

Achieving smoke-free status across all of England will require further reductions in prevalence particularly amongst groups more likely to smoke including men and those living in deprived areas.

Smoking prevalence by gender in England 2010-2018



Source: Annual Population Survey (2010-2018), Frontier calculations.

16.4%

Male prevalence (2018)

12.6%

Female prevalence (2018)

Current evidence suggests that e-cigarettes are significantly less harmful to health than smoking tobacco

Impact on health for e-cigarette users

- Public Health England (PHE) published an independent review (McNeill et al, 2015) on the role and impact of e-cigarettes. Their review concluded that the best estimates show e-cigarettes are 95% less harmful to your health than combustible cigarettes. This estimate draws principally on Nutt et al (2014) which used an international expert panel to estimate relative harm of e-cigarettes. In 2018 PHE published an updated review of evidence (McNeill et al., 2018). The authors came to the same conclusion that "v*aping poses only a small fraction of the risks of smoking and switching completely from smoking to vaping conveys substantial health benefits over continued smoking*"
- A separate report by the Royal College of Physicians (RCP, 2015) came to the same conclusion. They agree that the hazard to health arising from long-term vapour inhalation from the e-cigarettes currently available is unlikely to exceed 5% of the harm from smoking tobacco. Also, the authors note that technological developments and improved production standards could reduce the long-term hazard of e-cigarettes in the future.
- Glasser et al (2017) conduct their own systematic review of evidence on e-cigarettes and find that e-cigarettes pose substantially less harm to smokers than cigarettes, while further research is needed to assess long-term effects.

Impact on health from passive use of e-cigarettes

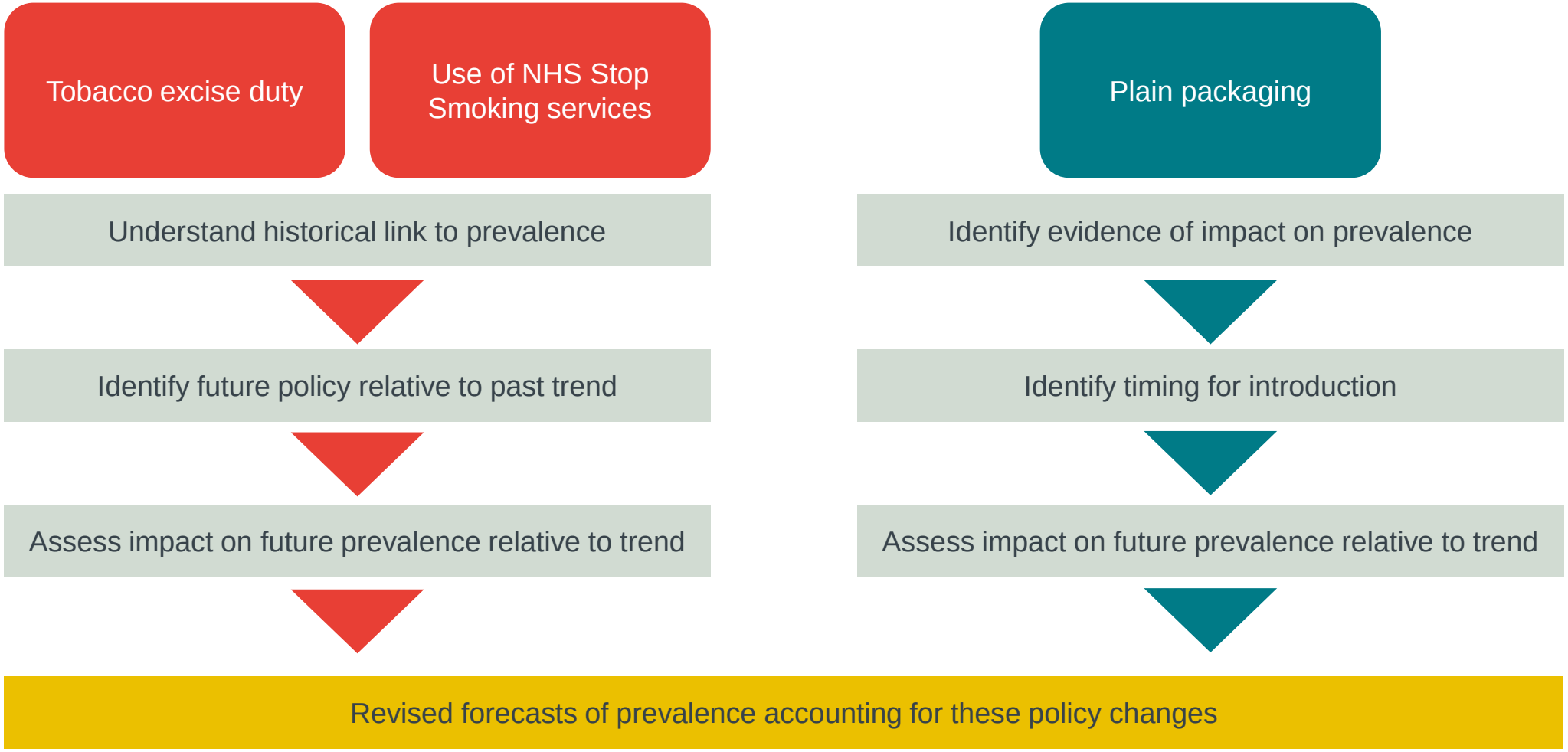
- McNeill et al (2015) consider the potential effects of passive vaping. Based on a review of existing evidence they conclude that e-cigarettes release negligible levels of nicotine into ambient air with no identified health risks to bystanders. McNeill et al. (2018) reinforce this finding and conclude that there has been no identified health risk of passive vaping to date.
- Hess et al (2016) undertake a systematic review of the literature on passive use of e-cigarettes and conclude that the current evidence shows the potential for health impacts from passive exposure to vapours from e-cigarettes, but that the risk is likely to be lower than from combustible cigarettes.

Our new review reinforces the finding that vaping is a fraction of the risk of smoking, at least 95% less harmful, and of negligible risk to bystanders.

PHE (2018)[1]

[1] https://www.gov.uk/government/news/phe-publishes-independent-expert-e-cigarettes-evidence-review

We account for the impact of three policy interventions on the long-run trend in smoking prevalence



Excise duty: we model above-inflation rises, in line with recent historical trends

Hypothesis: excise duty has been increasing in real terms in the UK. These increases lead to higher prices. We expect tobacco excise duties to continue to rise faster than inflation.

Evidence:

- We want to estimate whether future taxes on cigarettes are likely to grow faster or slower than previous trends. This will allow us to estimate deviations from the straight line prevalence trend (which already factors in the historical impact of taxes).
- Our modelling approach is outlined in detail on the following slide.
- Since 2011 excise duty on cigarettes has been rising by RPI plus 2%.[1] This is higher than the long run average and is planned to continue until at least 2020.[2]

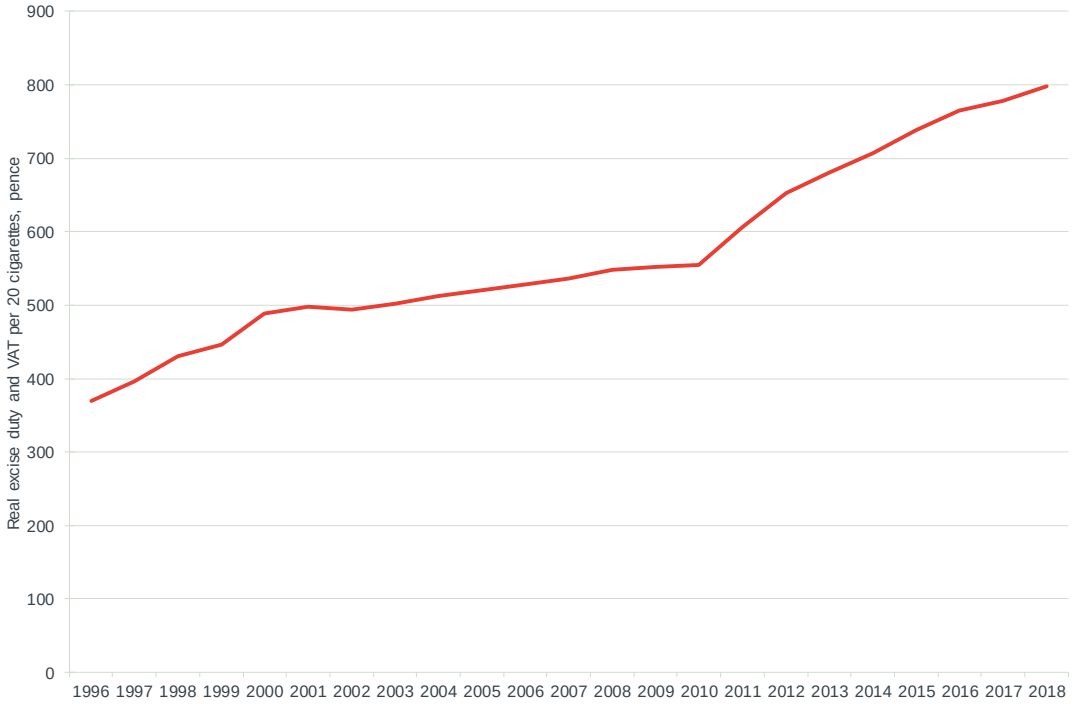
Modelling scenarios:

- Our central scenario assumes that excise duty will continue to rise by RPI plus 2% for the entire forecast period in England. This corresponds with a real growth rate of 3.40% per year of total tax.[3] This is approximately in line with the growth rate of total tax (VAT and excise duty) seen over the entire period.
- We use two illustrative scenarios to test the sensitivity of this central assumption. We assume, with announced policy, RPI+2% until 2020, but then allow for slightly faster or slower growth in excise duties. Our low prevalence scenario assumes 4.00% overall growth rates of total tax per year. Our high prevalence scenario assumes 3.00% overall growth rates of total tax per year.

Impact on prevalence by 2029:

- Central scenario: prevalence 0 percentage point reduction in prevalence relative to the long-run trend.
- Low prevalence scenario: prevalence 0.2 percentage points lower than long-run trend.
- High prevalence scenario: prevalence 0.3 percentage points high than long-run trend.

UK cigarette excise duty and VAT: 1996-2018 (2018 prices)



Source: IFS (2017), HMRC (2019), ONS (2019 B), Frontier calculations.

[1] Except in 2012 when there was a one-off increase of RPI plus 5%. This refers to cigarettes only. Roll-your-own tobacco has been sometimes subject to higher rates of excise growth.

[2] https://www.gov.uk/government/speeches/chancellor-george-osbornes-budget-2014-speech

[3] Based on recent real growth rates when the RPI plus 2% policy was in place.

Excise duty: our modelling involves calculating the change in demand associated with above or below-trend increases in price

	Difference in CAGR[1]		Pass-through		Tax Proportion of Price		Prevalence Price Elasticity Demand		Annual reduction in trend prevalence
Example **England Low Prevalence Scenario*:***	**0.44%**	✘	**100%**	✘	**80%**	✘	**-0.53**	=	**-0.19%**
Evidence	Under the low prevalence scenario we model the impact of a **4%** growth rate in real tax applied to cigarettes. This is **0.40%** higher than the long run trend of **3.56%**		A reasonable assumption is that tax increases are fully passed on (Gilmore et al., 2013).		Excise duty and VAT as a proportion on price currently (Frontier calculations). Assumed to stay constant over time. In reality this may vary slightly by scenario. This will not materially affect the results.		HMRC PED is **-1.05** (Czubek & Johal, 2010). Generally, **half** the impact of higher prices comes from reduction in prevalence (Ross et al., 2011, Goodchild et al., 2016).		This is resulting annual reduction in prevalence (as a proportion of the baseline prevalence rate) beyond the linear trend

[1] CAGR = Compound Annual Growth Rate

NHS Stop Smoking services: we model future use based upon recent trends

Hypothesis: publicly-funded NHS Stop Smoking services help people to quit smoking; if take-up declines, this will increase smoking prevalence relative to the long-run trend.

Evidence:

- Use of NHS Stop Smoking services has declined since 2011.[1] The reasons for this are unclear, but may include increased costs of provision; greater use of e-cigarettes; and lower smoking prevalence.
- Our analysis of the best evidence suggests that reductions in usage are not due to falls in spending.[2] Future spending on services is unknown.

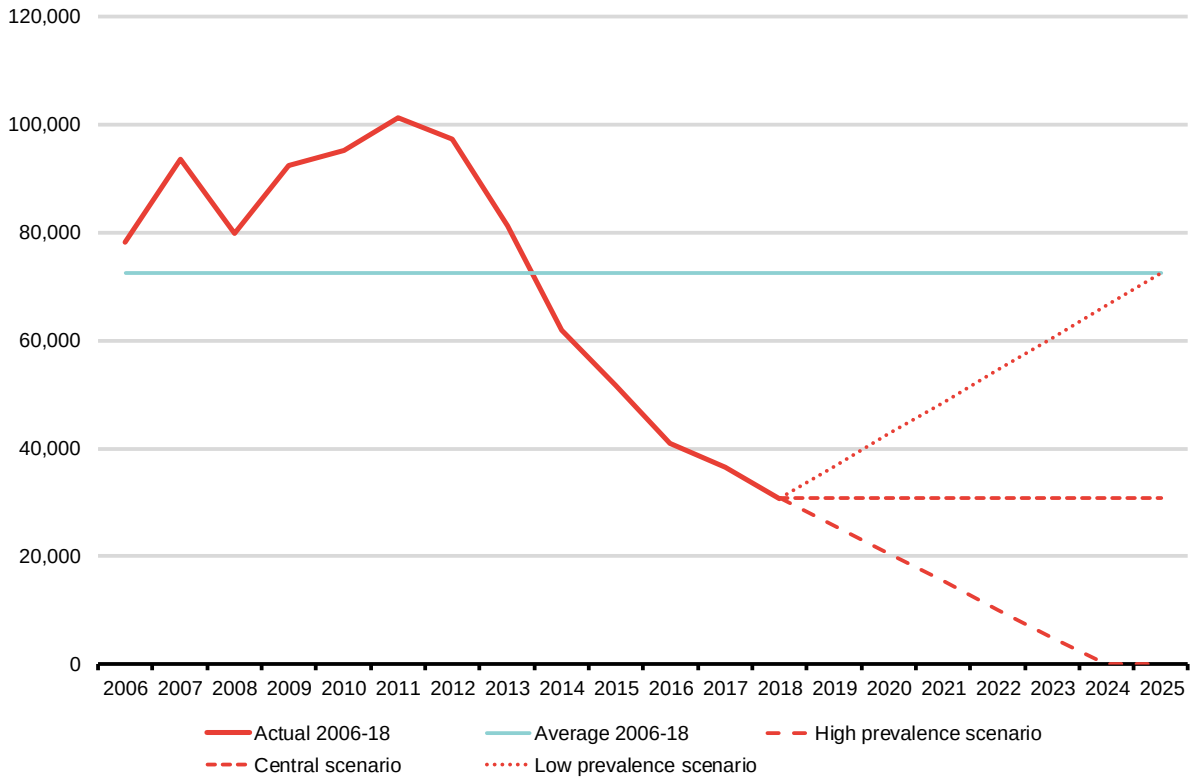
Modelling scenarios:

- We have modelled three scenarios for future use all of which imply a high prevalence relative to the long run trend:
  - **High prevalence scenario**: Use declines at the trend rate seen between 2006 and 2018, falling to almost zero by 2024.
  - **Central scenario**: Use plateaus at 2018 levels (~30.7k successful quits).
  - **Low prevalence scenario**: Use increases back towards the average 2006-18 level, by 2025.

Impact on prevalence by 2029:

- High prevalence scenario: 1.54 percentage points higher than long-run trend
- Central scenario: prevalence 0.99 percentage points higher than long-run trend
- Low prevalence scenario: prevalence 0.28 percentage points higher than long-run trend

Successful quits using NHS Stop Smoking services, England 2006-2025



Source: NHS Digital (2019), Frontier analysis.

Note: West & Owen (2012) report that out of 100 individuals who quit for 4 weeks, 30 will succeed in quitting for 4 weeks, 30 will succeed in quitting for 12 months, and around 21 will succeed in quitting for life. We convert 4-week success rates reported by NHS Digital to long term success rates using a factor of 0.25.

[1] NHS Digital (2019)

[2] NHS Digital (2017), Frontier calculations

Standardised packaging and the EU Tobacco Products Directive: we account for a one-off reduction in smoking prevalence spread over five years, as anticipated by the Government, as well as the possibility of zero impact

Hypothesis: in line with Government estimates, the introduction of standardised tobacco packaging and the EU Tobacco Products Directive will lead to reduced demand for tobacco and thereby reduce prevalence relative to the long-run trend.

Evidence:

- Standardised packaging has been introduced in Australia, France, Hungary, Ireland, Norway, and the UK. In England, branded manufacturing ceased in May 2016, and branded retail ceased in May 2017.
- Evidence on the impact of standardised packaging is limited, but since the policy is not the focus of this report, our central scenario assumes the impact anticipated by the Government is correct, while acknowledging other outcomes are possible, including zero impact, as reflected in the scenarios described below.
- The EU Tobacco Products Directive (TPD) introduced a range of regulations on packaging and labelling, ingredients used in products, and widened the scope of previous regulations to cover new products. The impact of TPD packaging and labelling regulations overlap significantly with the impact of standardised packaging. Like standardised packaging, the EU TPD in the UK was phased in between May 2016 and May 2017. The EU TPD Impact Assessment estimated that it would lead to **a reduction in tobacco consumption of 1.7-2.6% over five years**.
- The UK Plain Packaging Impact Assessment (DH IA) assessed the **combined impact** of standardised packaging and the EU TPD, suggesting **a reduction in tobacco consumption of 5.7% over five years**.[1] For our central scenario, we decided to follow the UK Impact Assessment calculations, adjusted for more recent prevalence data. This leads us to estimate a one-off 0.5 percentage point impact on prevalence.

Modelling scenarios:

- High prevalence scenario: 0 percentage point reduction in prevalence relative to the long-run trend.
- Central scenario: 0.1 percentage point reduction in prevalence relative to the long-run trend.
- Low prevalence scenario: 0.2 percentage point reduction in prevalence relative to the long-run trend.

The above figures refer to the cumulative impact over the projection period (2019-2050). The total estimated impact of plain packaging will be higher because 3 years of the 5 year impact period have already occurred.

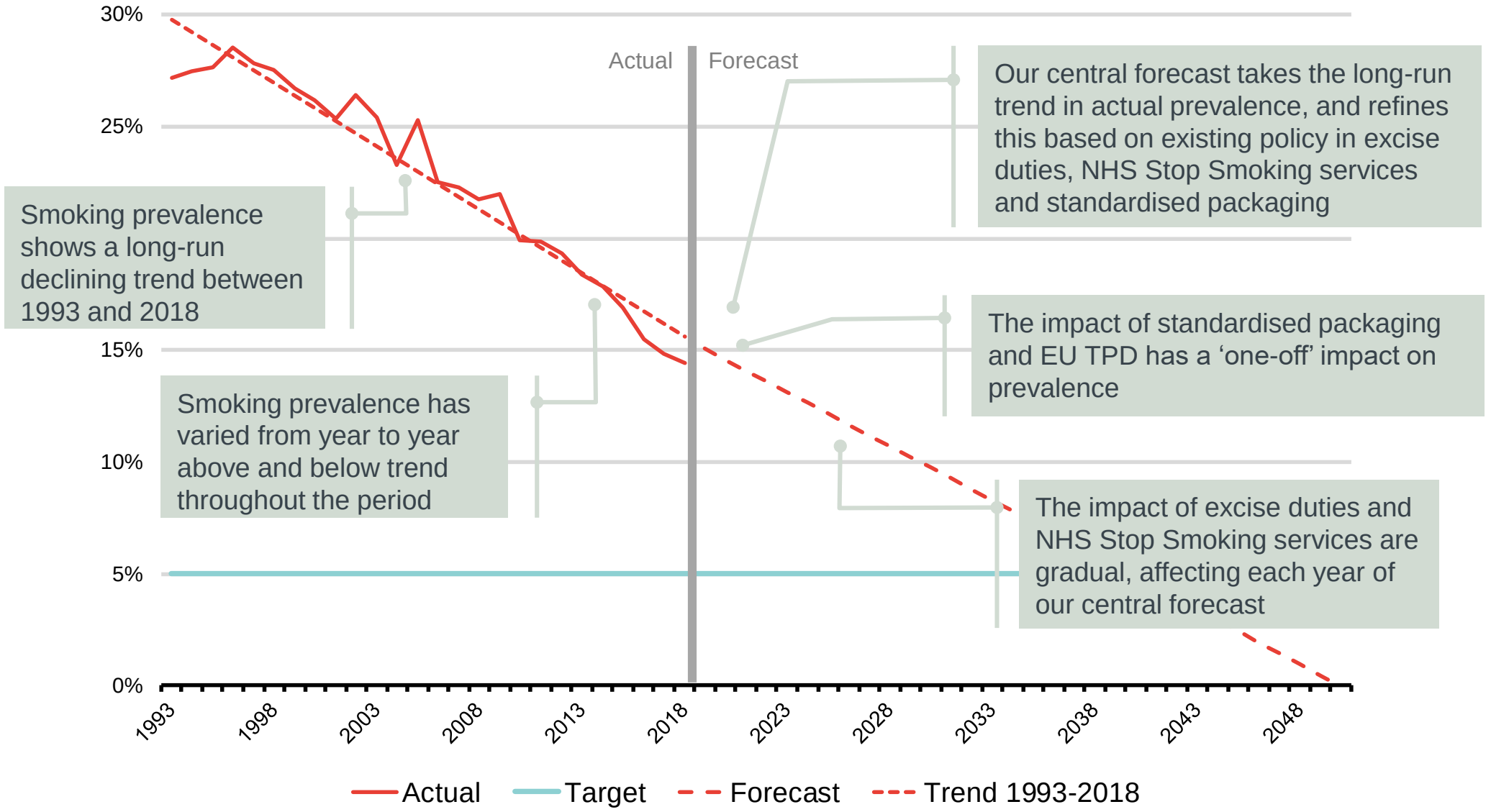
Additional note on calculations: The Department of Health (2015) Impact Assessment is based upon the following proportionate (rather than percentage point) impacts upon prevalence:

- 1.90% impact of EU TPD over 5 years;
- 4.80% impact of standardised packaging over 2 years; and
- an overlap of 1.00% between these two figures (see paragraphs 219 and 372 of the DH IA).

In line with the DH IA, we assume that two-fifths of the impact of EU TPD (0.36%) and half of the impact of standardised packaging (1.90%) is already observed in our latest (2017) prevalence figures (see paragraph 221 of the DH IA), but that the remainder of the EU TPD impact and the standardised packaging impact is observed from 2018 onwards. We multiply the remaining 3.04% by the 2016 prevalence figure to estimate the remaining future impact at 0.5 percentage points.

[1] https://www.gov.uk/government/publications/impact-assessment-opinion-standardised-packaging-of-tobacco-products-final and https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/403493/Impact_assessment.pdf

Our central forecast builds upon long-run smoking prevalence trends, adjusted for existing policy in three areas



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2018), Frontier calculations.

Frontier explored geographic variation in prevalence across England and investigated when areas might be ‘smoke-free’

Our projection analysis within the main body of the report is population-wide and considers England as a whole. The Government aims to reduce smoking to 12% by the end of 2022 and to be “smoke-free” by 2030. Both of these objectives are assessed at the national level. However, in reality prevalence varies across the country and different areas will reach smoke-free status at different rates.

We used ONS (2019) [1] prevalence data published at the Local Authority level to explore current patterns of prevalence and recent trends (2011-2018). The ONS data is published at the Lower Tier Local Authority (LTLA) level (England is divided into 317 areas). [2] Due to sample size limitations we aggregated this data to the Upper Tier Local Authority (UTLA) level (England is divided into 151 areas). In 2018 the definitions of the both LTLA’s and UTLA’s were updated slightly. The number of UTLA’s has increased (from 92 to 151) – primarily driven by dividing urban areas such as London/Manchester into smaller regions. All analysis is aligned with the new definitions. Our approach is described below. The remainder of this Annex sets out our findings.

English Upper Tier Local Authorities

1

Analyse current prevalence across each Local Authority

2

Examine recent trends in smoking prevalence within each Local Authority

3

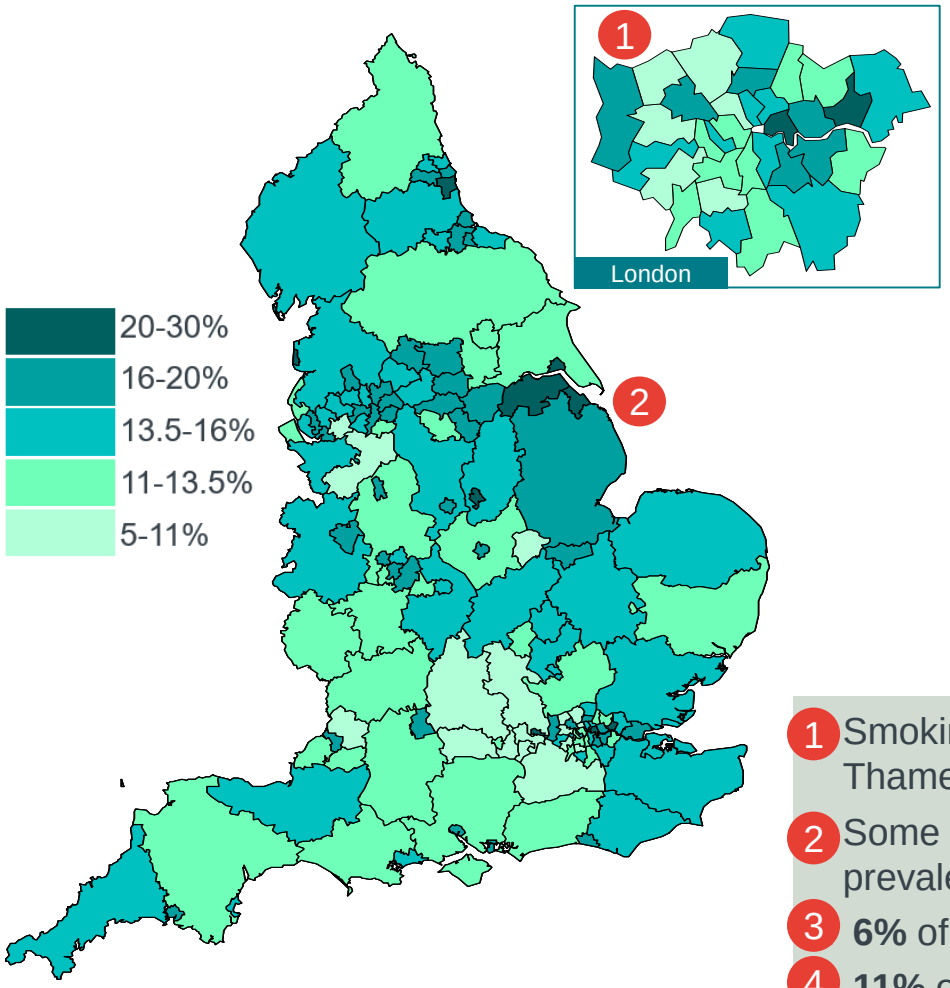
Consider when each locality is likely to reach smoke-free status

[1] The ONS data for 2011 is drawn from ONS (2018) and has been matched to the current UTLA’s / LTLA’s by calculating weighted averages.

[2] The only English Local Authorities which are not included in the ONS dataset are the City of London and Isles of Scilly due to insufficient sample sizes.

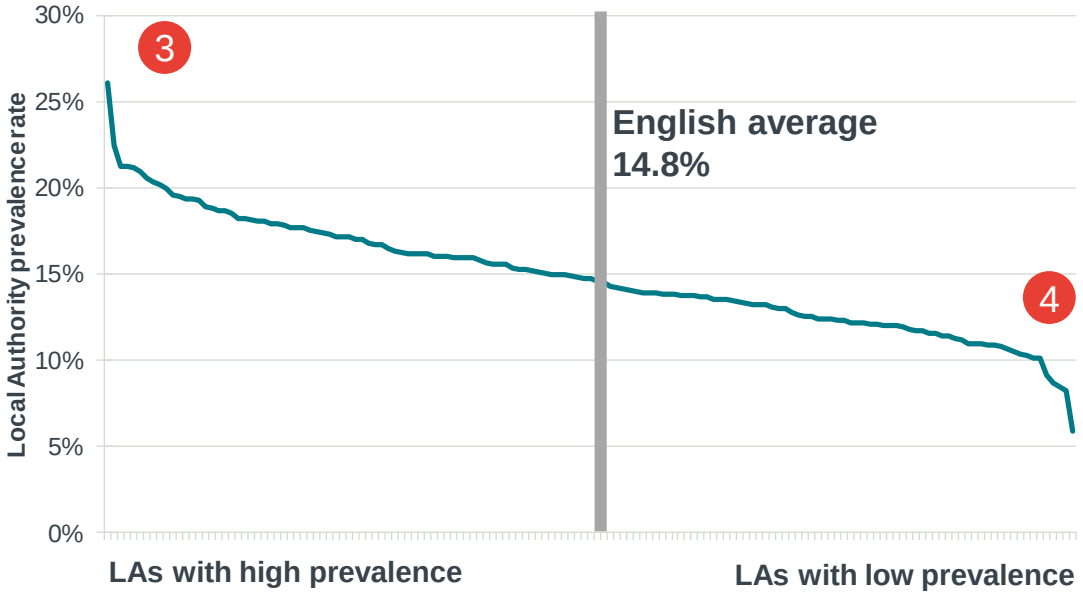
There is considerable variation in prevalence rates both within and between regions.

2018 smoking prevalence pattern by Upper Tier Local Authority



Source: ONS (2019), Frontier calculations

2018 smoking prevalence pattern by Upper Tier Local Authority



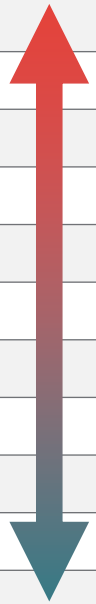
Source: ONS (2019), Frontier calculations

1. Smoking prevalence in London ranges from **6%** in Richmond Upon Thames up to **22%** in Barking and Dagenham.
2. Some Northern regions of England tend to have relatively high prevalence rates.
3. **6%** of Local Authorities have a prevalence rate over 20%**.**
4. **11%** of Local Authorities have a prevalence rate between 5 to 11%.

The prevalence gap between different areas around the country is getting wider…

Highest and lowest Local Authority prevalence rates

Local Authority	Prevalence Rate
Kingston upon Hull	26.1%
Barking and Dagenham	22.4%
Slough	21.3%
North East Lincolnshire	21.2%
Blackpool	21.1%
..	.
Ealing	9.2%
Cheshire East	8.7%
Windsor and Maidenhead	8.4%
Wokingham	8.2%
Richmond upon Thames	5.9%



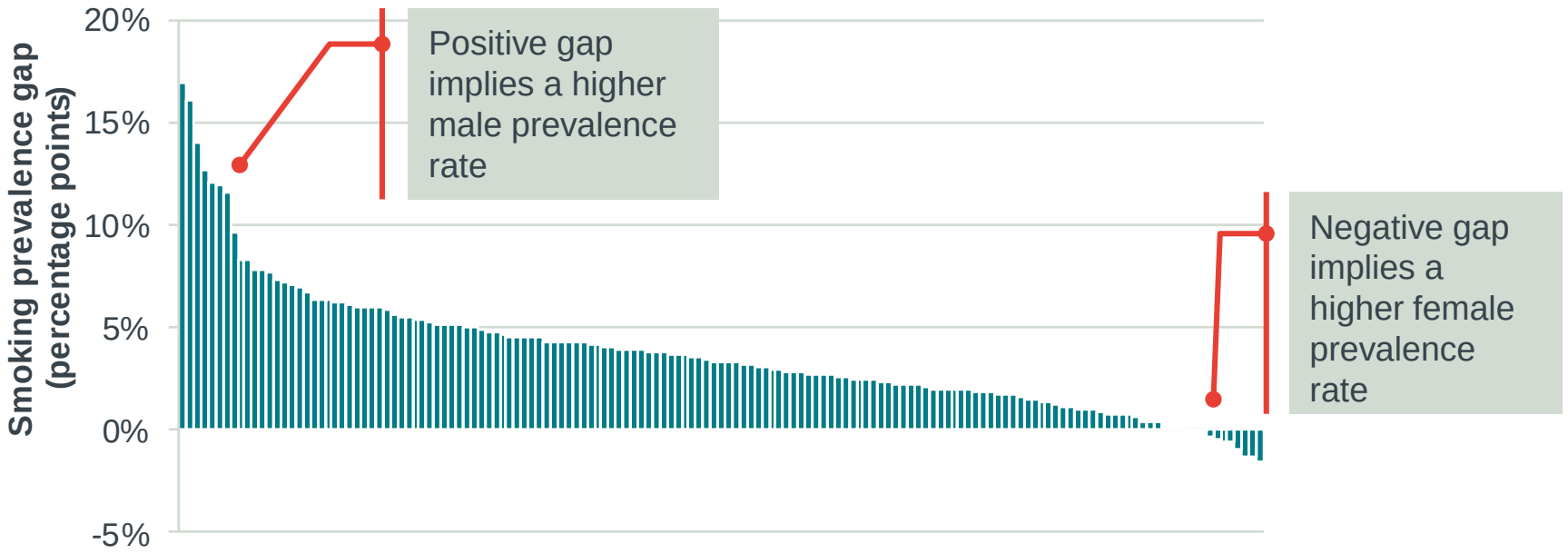
- The most recent wave of data shows that the difference between low prevalence areas and high prevalence areas is now bigger than ever.
- The average prevalence rate across the five Local Authorities where smoking is most common is **22.4%**, whereas the equivalent figure in the three Local Authorities where smoking is least common is only **8.1%**. A gap of **14.3%** points. Last year the equivalent figure was **13.3%** points.
- The total reduction in prevalence that England as a whole has achieved over the last 25 years (12.7% points) is less than the differential between high prevalence areas and low prevalence areas (14.3% points).

Source: ONS (2019), Frontier calculations

[1] The English Indices of Deprivation 2015 are based on 37 separate indicators, organised across seven distinct domains of deprivation which are combined, using appropriate weights, to calculate the Index of Multiple Deprivation. The domains cover Income, Employment, Health & Disability, Education, Skills & Training, Crime, Housing and Living Environment.

Men smoke more than women in almost every local authority

Gap between male and female smoking prevalence (percentage points) in each UTLA 2018



- The average prevalence rate for men across England is **16.4%**. The equivalent rate for women is **12.6%**.
- Men are more likely than women to smoke in **93%** of English UTLA's. This gap is relatively large (>10% points) for Tower Hamlets, Newham, Brent, Hammersmith and Fulham, Luton, Haringey.
- Women are more likely to smoke in six UTLA's (Southampton, Croydon, Bromley, Enfield, Wigan, County Durham). However, these gaps are very small and are not statistically significant.

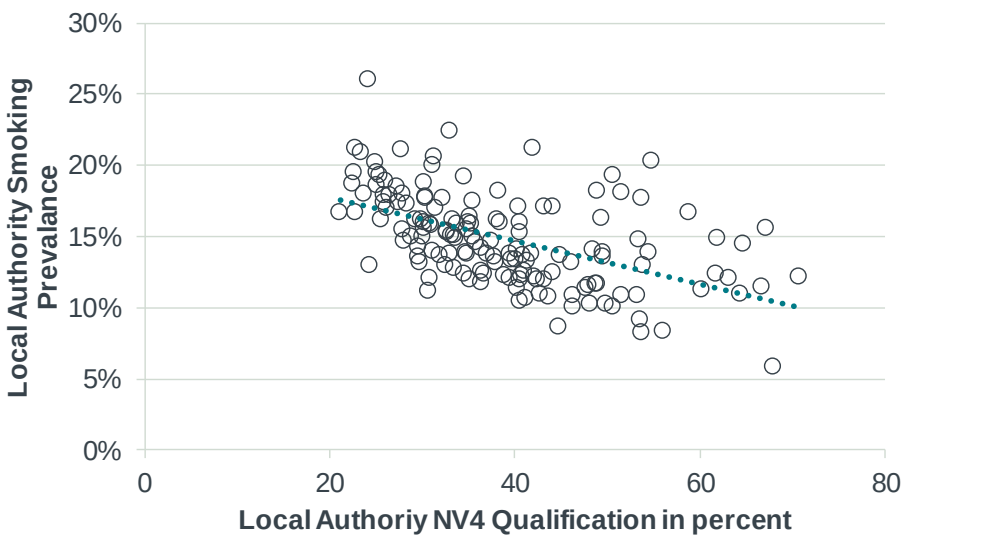
Source: ONS (2019) Frontier calculations

Prevalence rates continue to be strongly associated with other demographic factors

Local Authority prevalence vs. deprivation

- There is a strong positive relationship between the smoking prevalence rate of a Local Authority and the level of deprivation[1] of that area. More deprived areas tend to have a higher proportion of smokers relative to less deprived areas.
- Approximately half of the variation in prevalence around England can be explained by variation in deprivation.

Local Authority prevalence vs. qualification



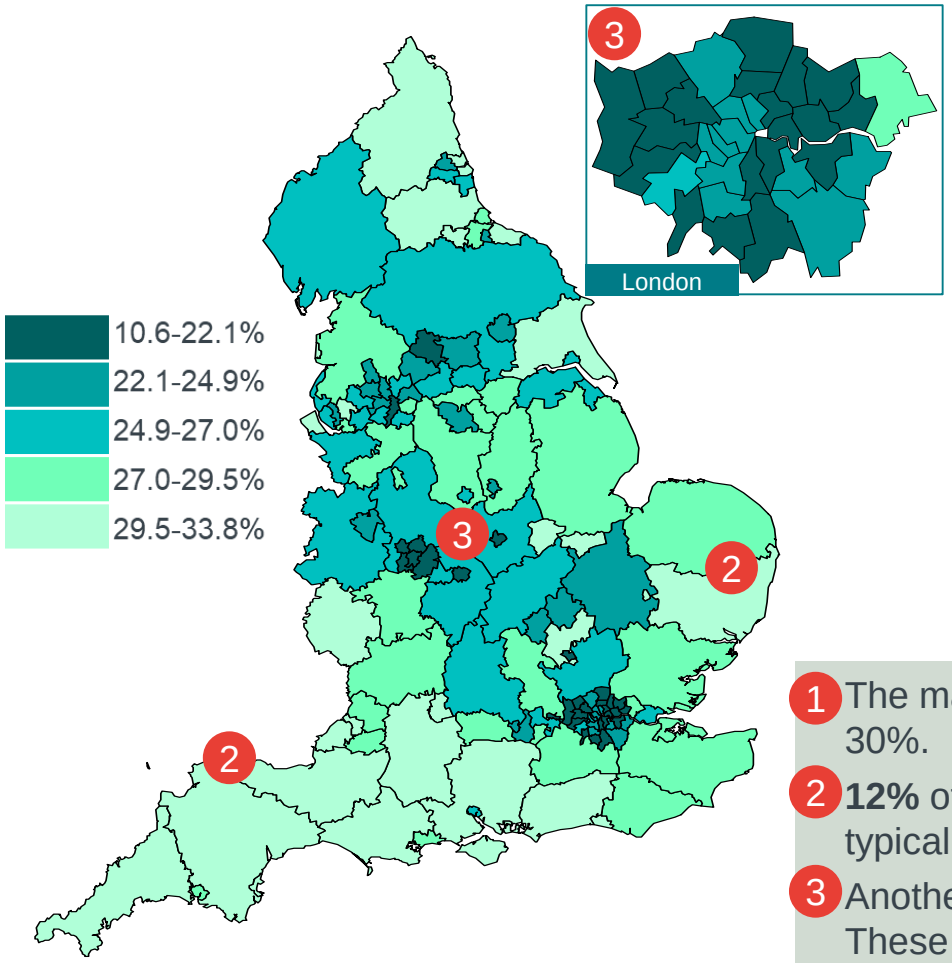
- Areas with a higher proportion of university educated adults have lower smoking prevalence rates.
- Areas with a higher proportion of adults with no qualifications have higher smoking prevalence rates.

Source: ONS (2019) Frontier calculations

[1] The English Indices of Deprivation 2015 are based on 37 separate indicators, organised across seven distinct domains of deprivation which are combined, using appropriate weights, to calculate the Index of Multiple Deprivation. The domains cover Income, Employment, Health & Disability, Education, Skills & Training, Crime, Housing and Living Environment.

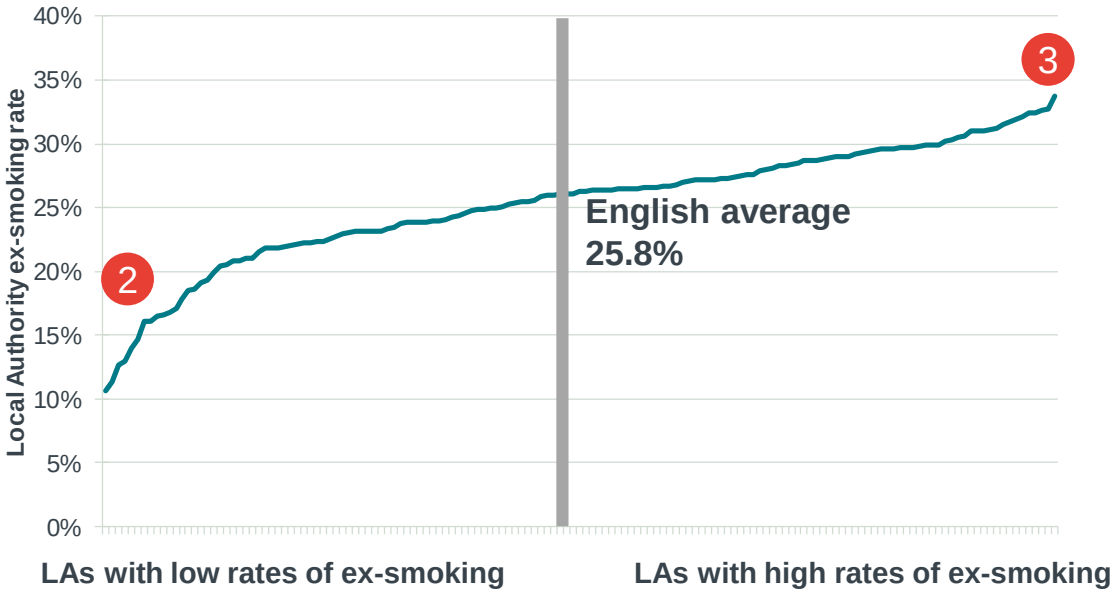
The proportion of ex-smokers also varies around the country

2018 ex-smoking rates by Upper Tier Local Authority



Source: ONS (2019), Frontier calculations

2018 ex-smoking rates by Upper Tier Local Authority

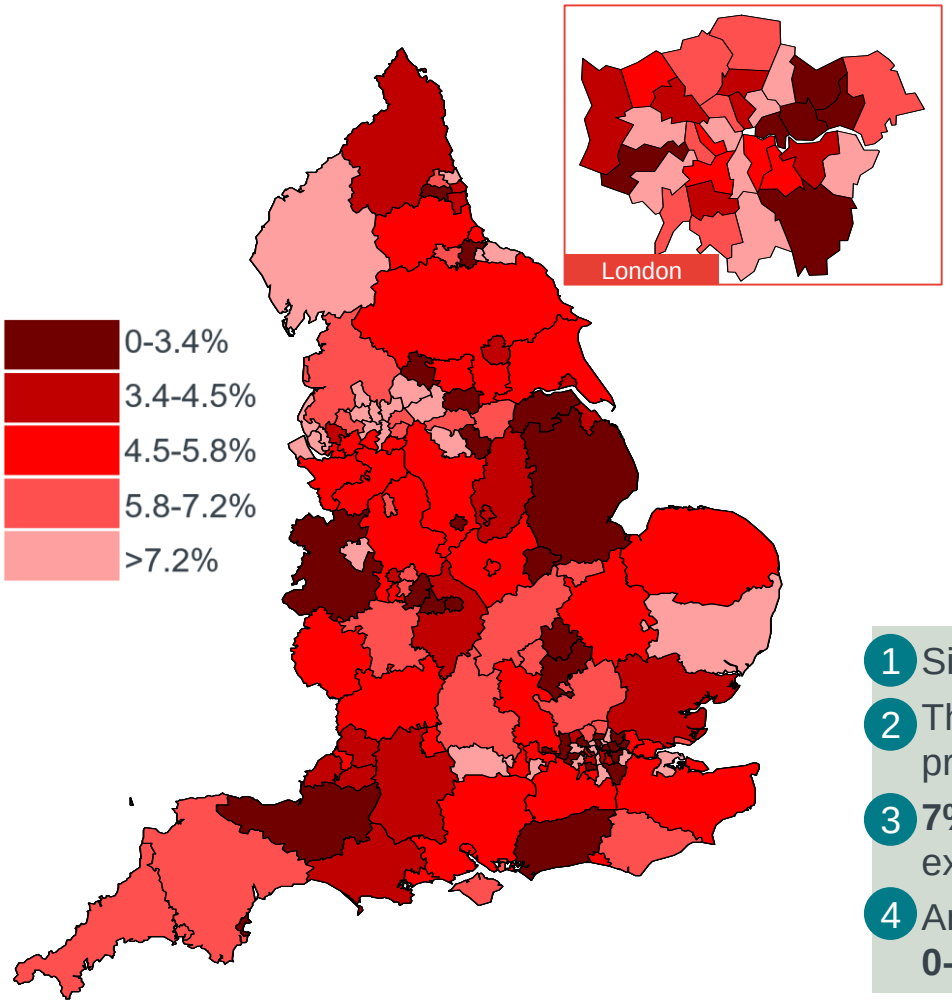


Source: ONS (2019), Frontier calculations

1. The majority of Local Authorities have ex-smoking rates between 20 and 30%.
2. **12%** of Local Authorities have ex-smoking rates above 30%. These are typically rural areas such as Cornwall (32.4%) and Suffolk (32.5%).
3. Another **12%** of Local Authorities have ex-smoking rates below 20%. These are primarily concentrated in London (Newham 10.7%) and other urban areas (Birmingham, 16.6%).

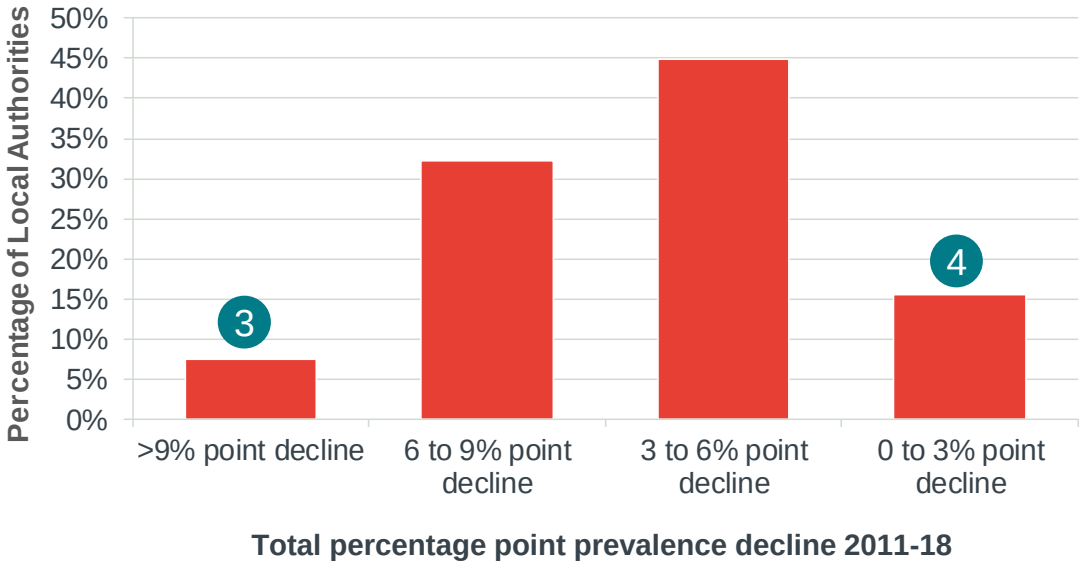
All Local Authorities have experienced declines in smoking prevalence over the last seven years. The declines have occurred at different rates.

Pattern of 2011-18 percentage point changes in prevalence by Upper Tier LA



Source: ONS (2018), ONS (2019), Frontier calculations

Magnitude of 2011-18 LA percentage point changes in prevalence

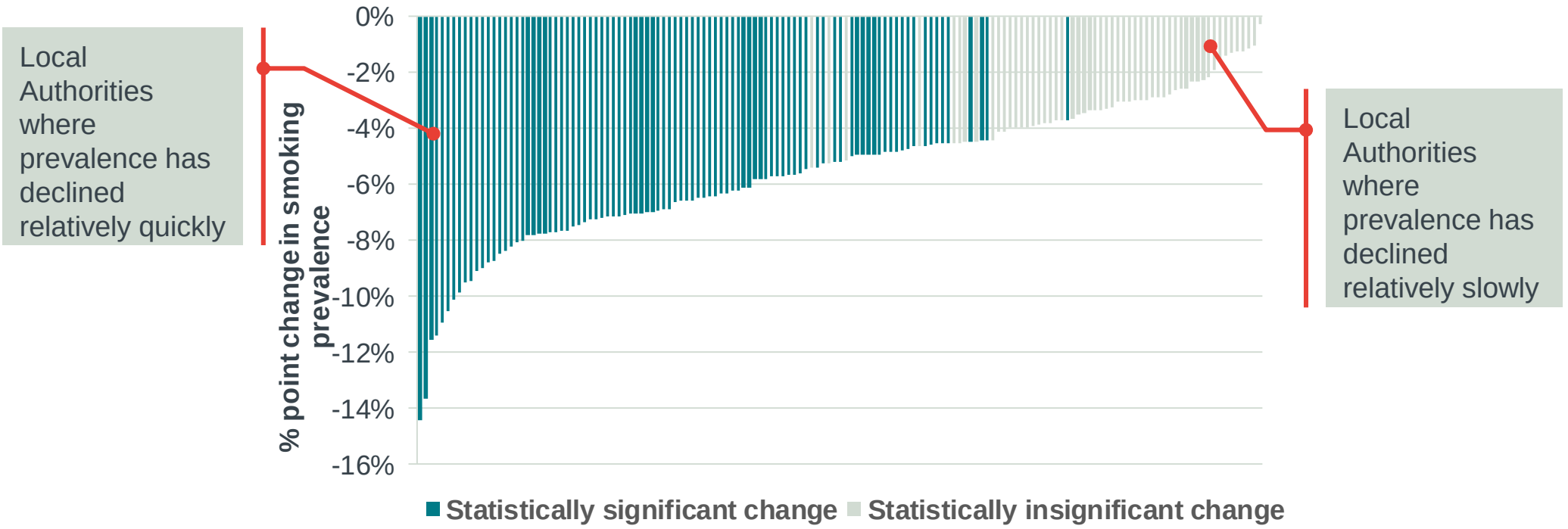


Source: ONS (2018), ONS (2019), Frontier calculations

1. Since 2011 smoking prevalence across England has fallen by 5.4%.
2. There is no Upper Tier Local Authority where smoking is now more prevalent than was the case in 2011.
3. **7%** of Local Authorities have experienced a decline of prevalence in excess of **9%** over the six years from 2011-2018.
4. Another **15%** of Local Authorities experienced a decline of only **0-3%** over the same period.

The majority of observed declines are statistically significant

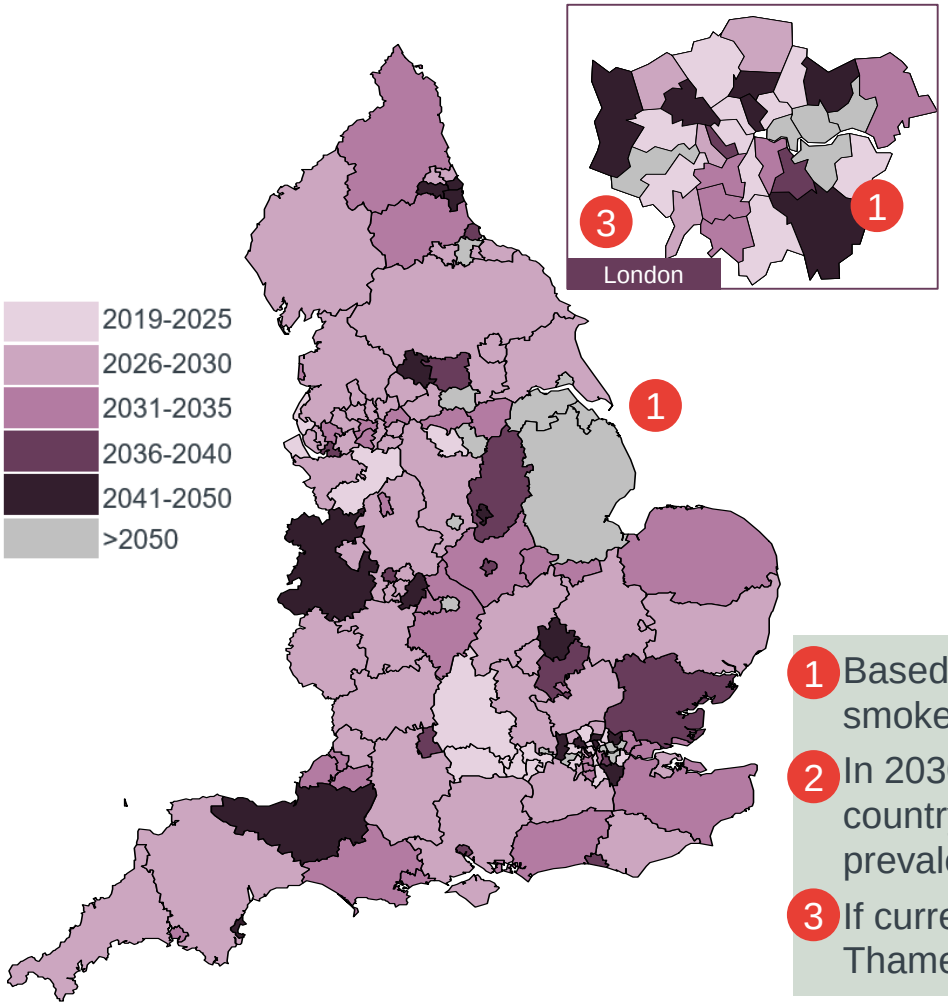
2011-18 percentage point changes in smoking prevalence in each Upper Tier Local Authority



- **63%** of Local Authorities experienced a statistically significant decline during 2011-18. This implies that the observed decline is extremely unlikely to have occurred by chance and represents genuine progress towards a smoke-free target rather than random variation.
- We identified statistical significance using a standard methodology. Significance will depend on the magnitude of the decline (larger declines are more likely to be significant) and the sample size of respondents in each Local Authority (areas with more respondents will have more precisely determined prevalence rates)

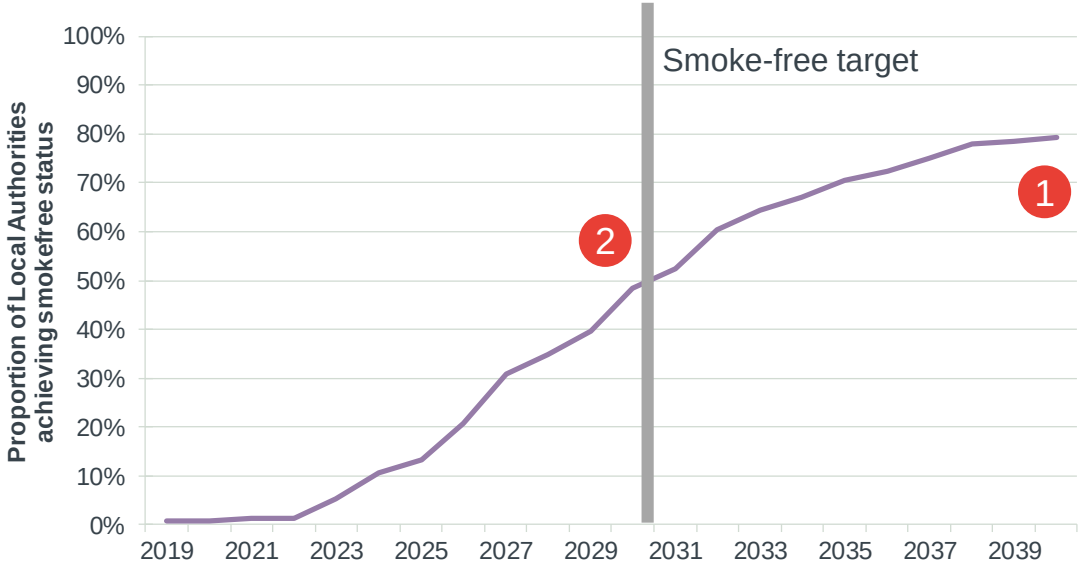
If recent trends continue we expect different areas to reach smoke-free status at different times

Expected year to reach smoke-free status (5%) by Upper Tier LA



Source: ONS (2019), Frontier calculations

Cumulative proportion of LAs reaching smoke-free status by year

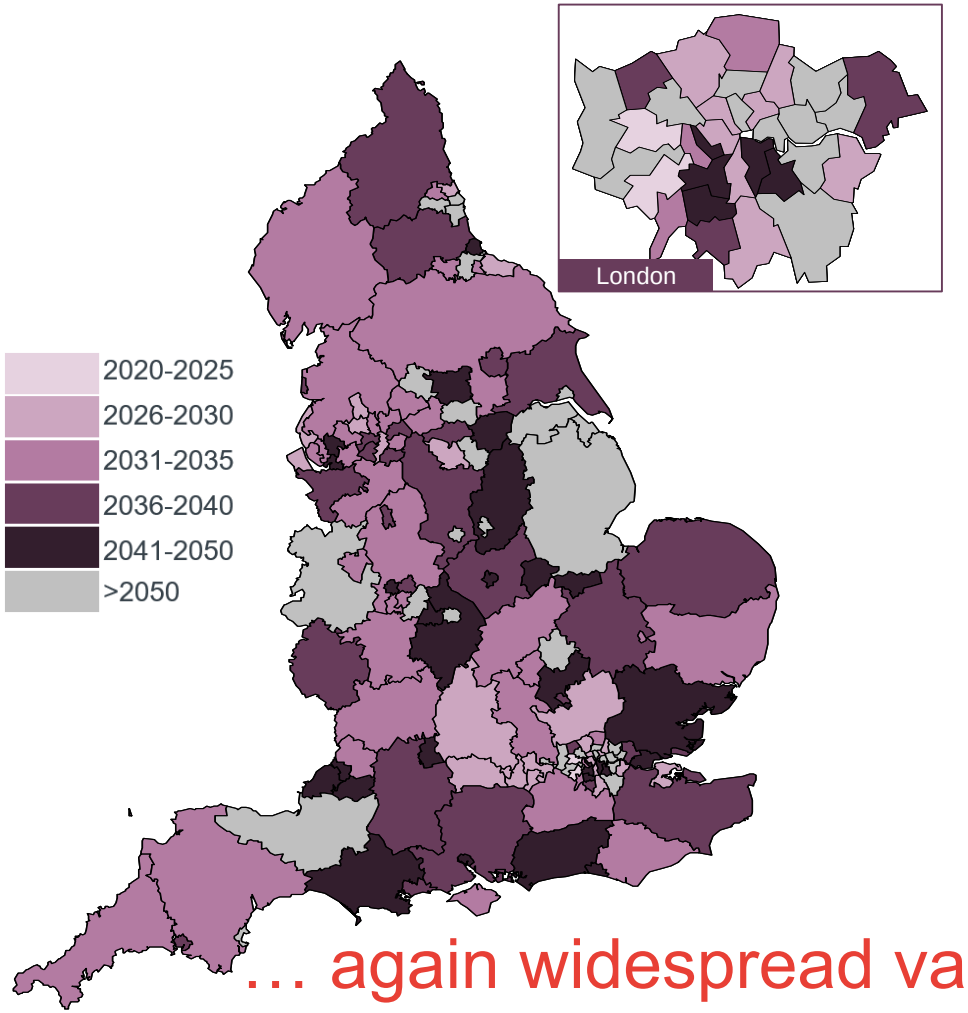


Source: ONS (2019), Frontier calculations

1. Based on recent trends **21%** of Local Authorities will not have reached smoke-free status by 2040.
2. In 2030 when the Government hopes to go smoke-free across the entire country a large proportion of Local Authorities (**48%**) will have prevalence rates above 5%.
3. If current trends continue the prevalence rate for Richmond Upon Thames may fall below 5% as early as next year.

We also investigate when Local Authorities may achieve 0% prevalence, assuming recent trends continue for even longer…

Expected year to reach 0% prevalence by Upper Tier LA



- We also consider when a 0% prevalence rate may be achieved. 0% prevalence could represent an alternative more ambitious definition of ‘smoke-free’ than 5%. However, we recognise that reducing smoking prevalence may become more difficult to achieve in practice, as some smokers may continue to smoke regardless of plausible policy changes.
- Based purely on recent trends **17%** of Local Authorities may reach 0% prevalence before 2030.
- A separate group of Local Authorities will not reach 0% prevalence until after 2050 (**21%**).

… again widespread variation is evident across the country

Source: ONS (2019), Frontier calculations

Even within the Inner London Upper Tier Local Authorities there is wide variation in current prevalence levels

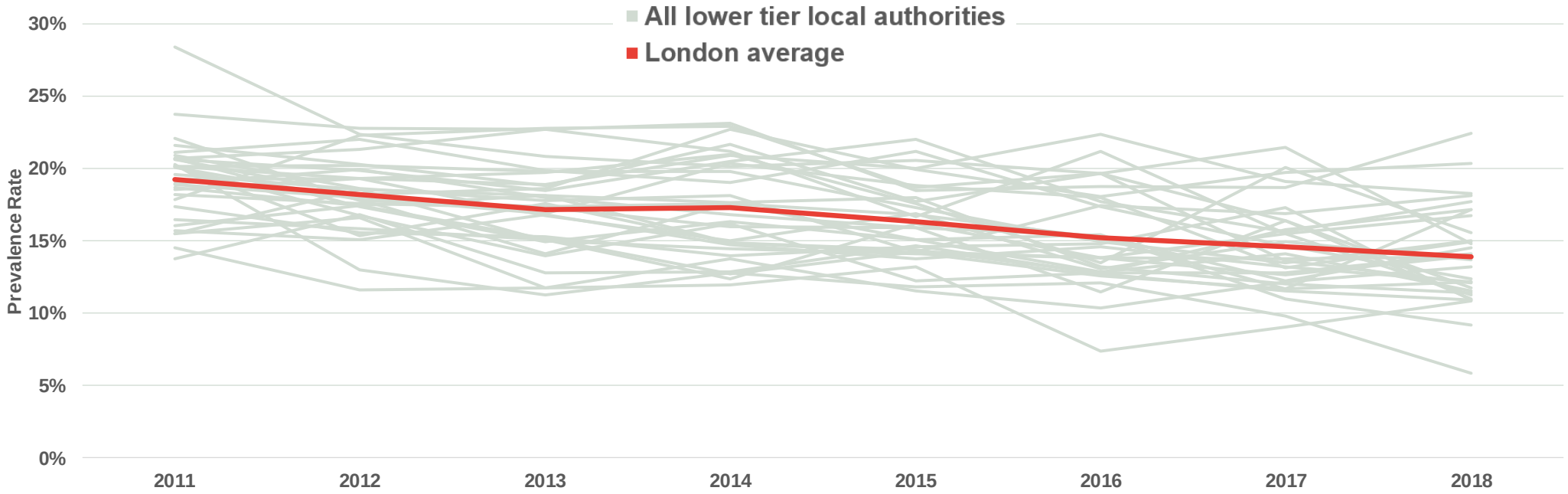
Current prevalence in London's Local Authorities

Source: ONS (2019), Frontier calculations

- The average prevalence rate across all of London is **13.9%**.
- However the rate in Richmond Upon Thames is as low as **5.9%** and the equivalent figure in Barking and Dagenham is **22.4%**.

Within the Inner London Upper Tier Local Authority there is wide variation in current prevalence and rates of decline…

2011-18 trend in smoking prevalence in London

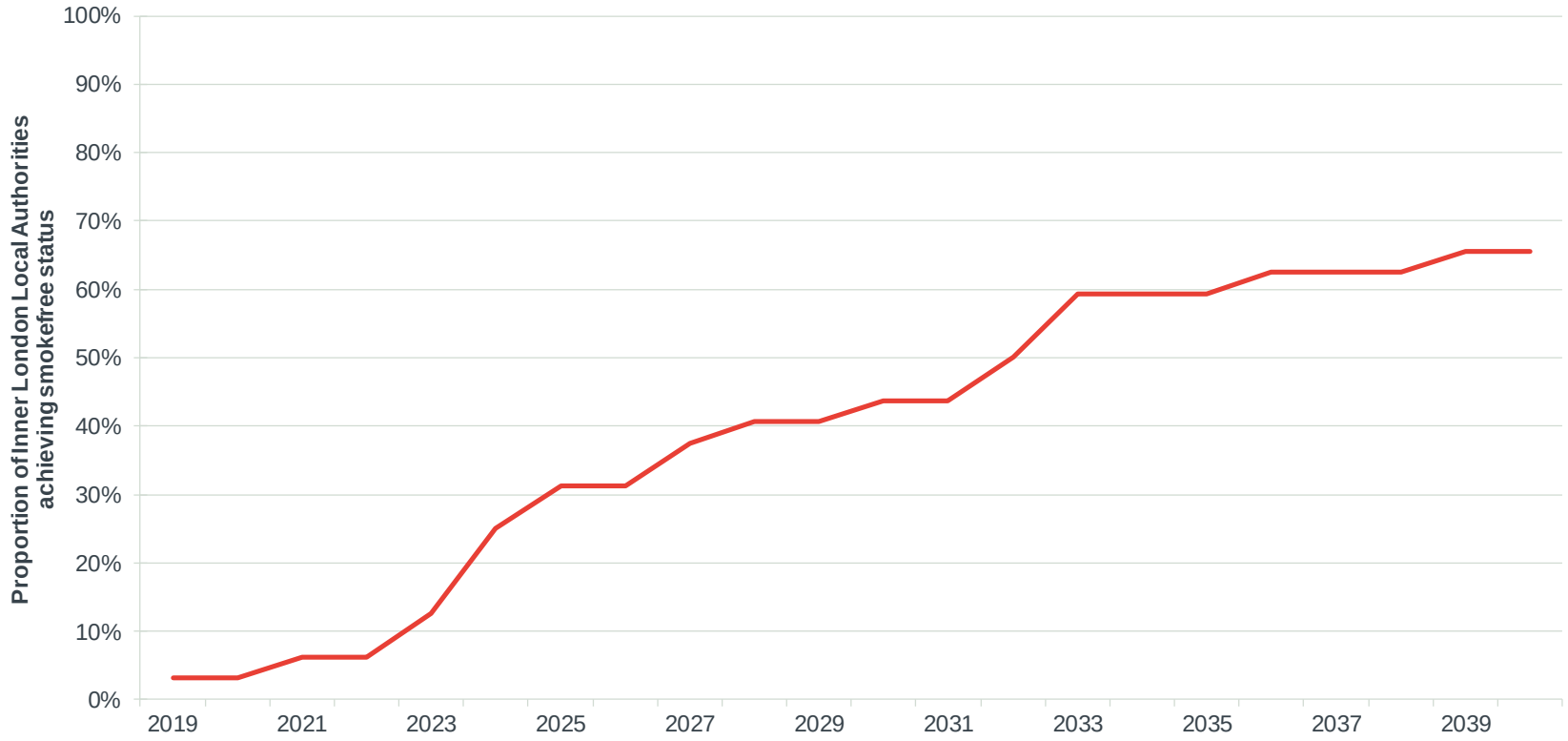


Source: ONS (2018), ONS (2019), Frontier calculations

- The average prevalence in London has fallen by **5.4%** points from 2011-18.
- The largest absolute decline was in Richmond where prevalence fell by **14.4%** points over the last seven years. In contrast the rate of smoking prevalence in Tower Hamlets decreased by **0.2%** points over the entire period.

… this pattern leads to differences in when we expect each Lower tier London Local Authority will fall below 5% a prevalence rate

Date by which London's Local Authorities will achieve smoke-free status (5%)



Source: ONS (2019), Frontier calculations

- If recent trends continue Richmond will be the first Lower tier Local Authority within London to reach the 5% target. This could occur in **2019**. In contrast we do not expect Lewisham to achieve smoke-free status until **2039**.
- 34% of London Local Authorities (Haringey, Islington, Newham, Tower Hamlets, Barking and Dagenham, Greenwich, Hounslow) will not reach 5% until **after 2040** if recent trends continue. Half of those will not reach 5% until after 2050.
- A higher proportion of London Local Authorities will not have reached 5% by 2040 than across the country as a whole.

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