

Working towards a smoke-free England

A report prepared for Philip Morris Limited

November 2017



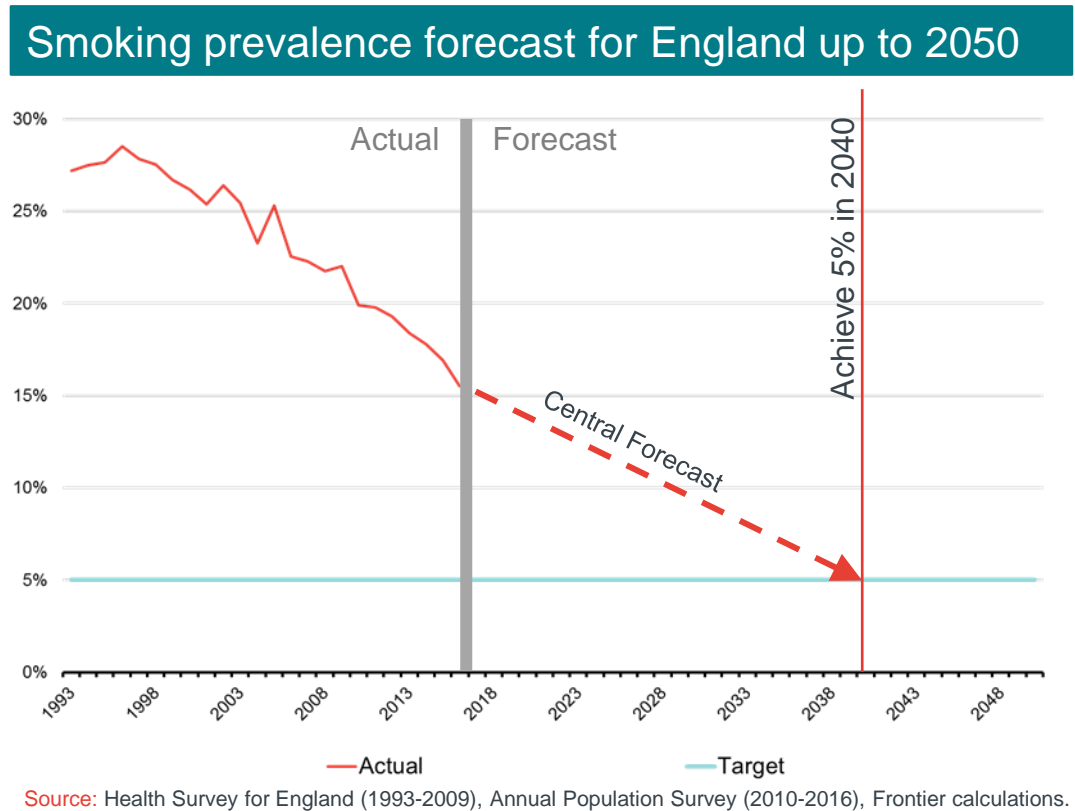
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Executive summary: Our central forecast estimates that the Government's smoke-free target will be met around 2040

- 1 Our central forecast is for the Government to meet its smoke-free target - to reduce smoking prevalence to **5%** or below of England's adult population - around **2040**. This forecast is based on a continuation of current above-inflation excise increases and known regulatory interventions.
- 2 If smoking then continued to decline at the same rate after 2040, it would reach **0%** in around **2051**.
- 3 Smoking is in long-run decline, but **since 2012 it has declined at more than twice the rate** seen between 1993 and 2011. Smokers switching to e-cigarettes appear to have made a material contribution to that recent trend.
- 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 **100,000** new vapers in 2017, compared with **800,000** in 2014.



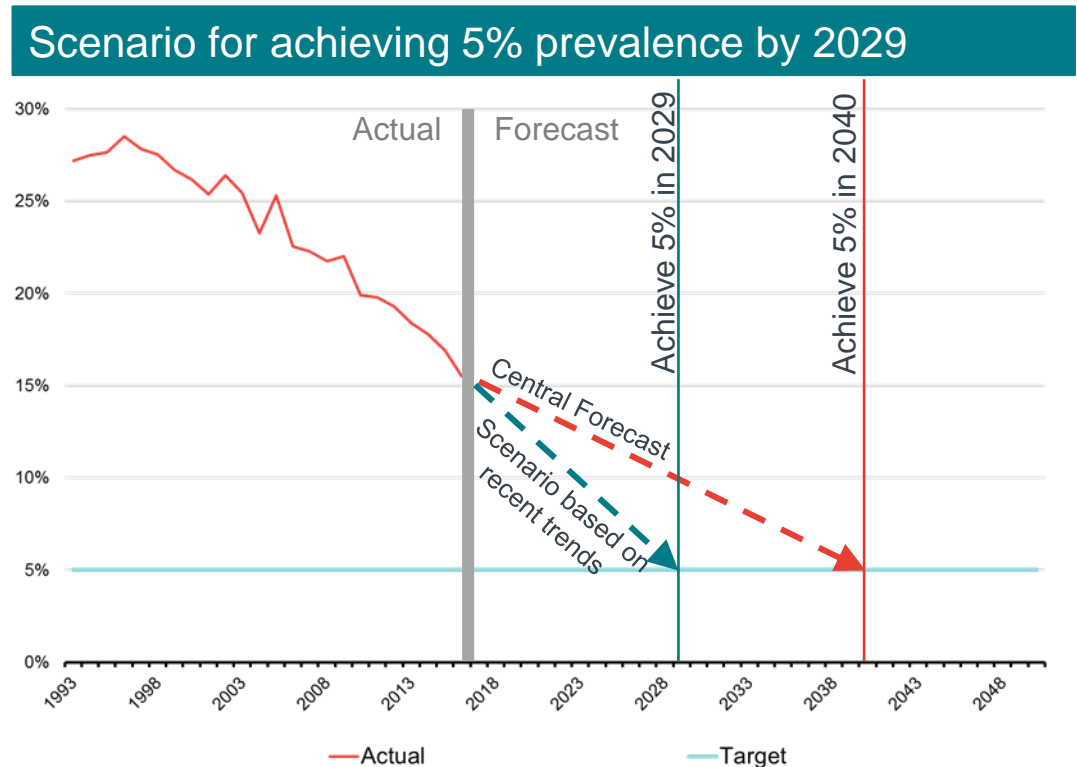
Executive summary: England could be smoke-free by 2029, but only if the recent faster falls in smoking prevalence can be sustained

5 The Government's target of reducing smoking to below **5%** could be met as soon as **2029** if the faster rate of decline since 2012 were maintained. If that trend continued further, smoking would be eliminated in England by **2035**.

6 Meeting this target by 2029 would require an additional **2.5 million** smokers to quit over and above those we already expect to quit in our central forecast. This is equivalent to around **210,000 extra quitters** each year.

7 **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 40,000 in 2016 from a peak of 100,000 in 2011; and/or
- Finding other new and effective ways to persuade smokers to quit.



Source: Health Survey for England (1993-2009) Annual Population Survey (2010-2016) Frontier calculations

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

The Government aims to reduce smoking to 12% of adults by the end of 2022. Longer term it seeks a 'smoke-free generation', defined as when smoking is reduced 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' (using the Government's definition), 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 recently published 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 analysis and our findings.

6.8 million

Number of smokers in England in 2016

Source: ONS (2016, 2017a), Frontier calculations

4.6 million

The number of smokers who need to quit today to meet the 'smoke-free generation' target now

Source: ONS (2016, 2017a), 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 products² 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 for a smoke-free generation

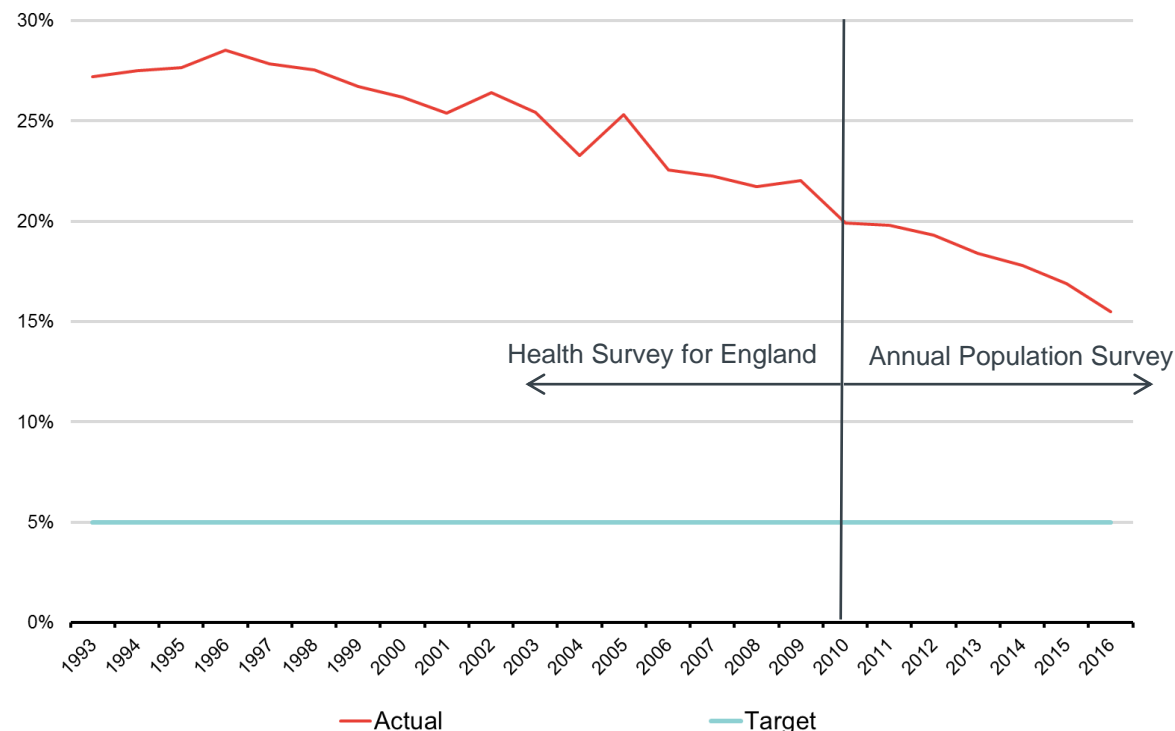
Smoking prevalence in England is in long-run decline. Although current prevalence remains at almost 1 in 7 adults, the fall in English smoking rates since 2000 has been faster than in Germany, France, Spain, Italy, and the OECD average.¹

The Government has recently 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.”²

For the purposes of this analysis, we examine progress towards a smoking prevalence rate of 5% or below, in line with the smoke-free generation ambition. 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.

Smoking prevalence in England 1993-2016



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2016), Frontier calculations.³

5% prevalence (or less)

Government's definition of a smoke-free generation

¹ OECD iLibrary, Health at a Glance 2015, Tobacco consumption among adults.

² Department of Health (2017).

³ We use Health Survey for England data for 1993-2009 and Annual Population Survey data from 2010 onwards. This is discussed further in Annex 2.

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

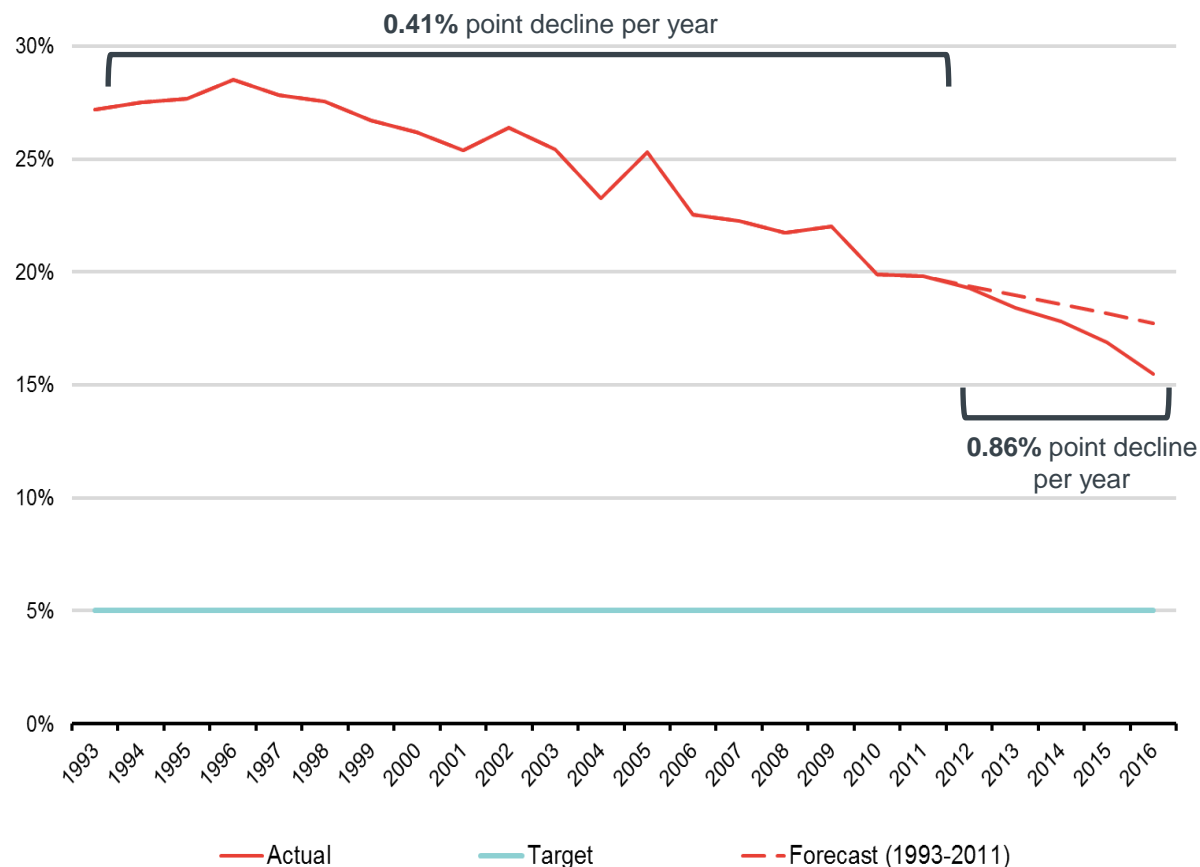
In recent years, smoking prevalence in England has fallen more quickly than the longer-term trend. This is shown in the chart to the right.

Average annual decline in smoking prevalence:

- 1993 - 2011: **0.41** percentage points.
- 2012 - 2016: **0.86** percentage points.

Between 2012 and 2016 the average annual decline in smoking prevalence was more than twice as fast as the earlier period.

Smoking prevalence in England 1993–2011 and 2012–2016



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2016), 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 2016 would have been **17.8%**.

Instead, smoking prevalence in 2016 was **15.5%**. This additional decline of more than 2 percentage points is equivalent to 980,000 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 (0.86 percentage points per year), prevalence in 2016 would have been **9.1%**, more than 6 percentage points lower. This would be equivalent to 2.8 million fewer smokers today.

A material part of the accelerated decline between 2012 and 2016 is likely to be due to the popularisation of e-cigarettes. This is because:

- E-cigarettes are an effective quitting aid, with 1.5 million ex-smokers in Great Britain having fully converted to e-cigarettes (ASH, 2017);¹ and
- Use of e-cigarettes has increased significantly between 2012 and 2016 (ASH, 2017).

These factors are discussed in more detail below.

17.8%

Prevalence in England in 2016 had trend decline between 1993 and 2011 continued from 2012

Source: Annual Population Survey (2017), Frontier calculations

15.5%

Actual prevalence observed in England in 2016

Source: Annual Population Survey (2017)

9.1%

Prevalence in England in 2016 if trend decline between 2012 and 2016 had begun in 1993

Source: Annual Population Survey (2017) Frontier Calculations

¹Some of the 1.5 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 as an aid to reduce cigarette consumption or give up smoking entirely:

- ASH (2017) shows that the most common reason amongst dual tobacco and e-cigarette users to take up e-cigarettes is to *reduce tobacco consumption*. The most common reason for take-up of e-cigarettes amongst ex-smokers is to *give up smoking tobacco entirely*. Additional detail is provided in Annex 3.

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

- 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.

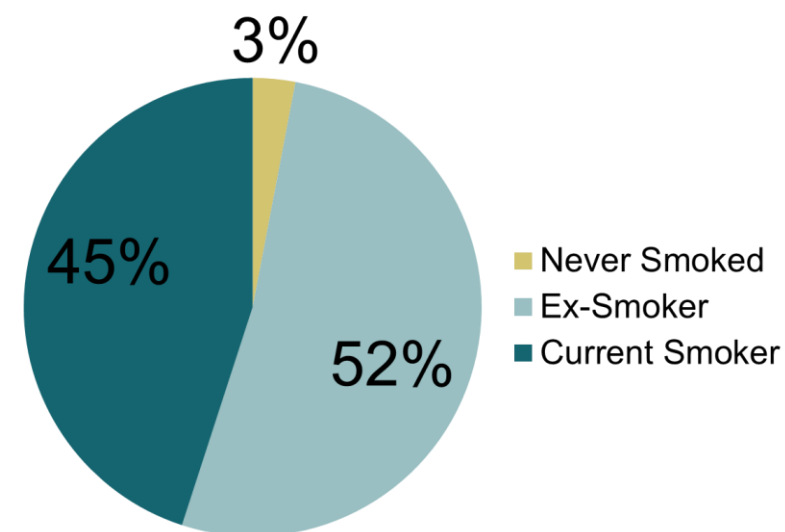
There is evidence that use of e-cigarettes can be associated with increased attempts to quit smoking, though not all studies show this:

- 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).
- 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

- **97%** of e-cigarette users ('vapers') in Great Britain are former or current smokers.
- Only **3%** 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** (see data on next slide).
- In 2017, for the first time, **the majority of current e-cigarette users in GB are ex-smokers (52%)**. Over **1.5 million** current e-cigarette users in GB have stopped smoking entirely.
- If all 1.5 million GB e-cigarette users were still smoking instead, prevalence would be **3.4 percentage points higher**. 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.

E-cigarette users by smoking status



Source: ASH (2017)

1.5 million

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

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

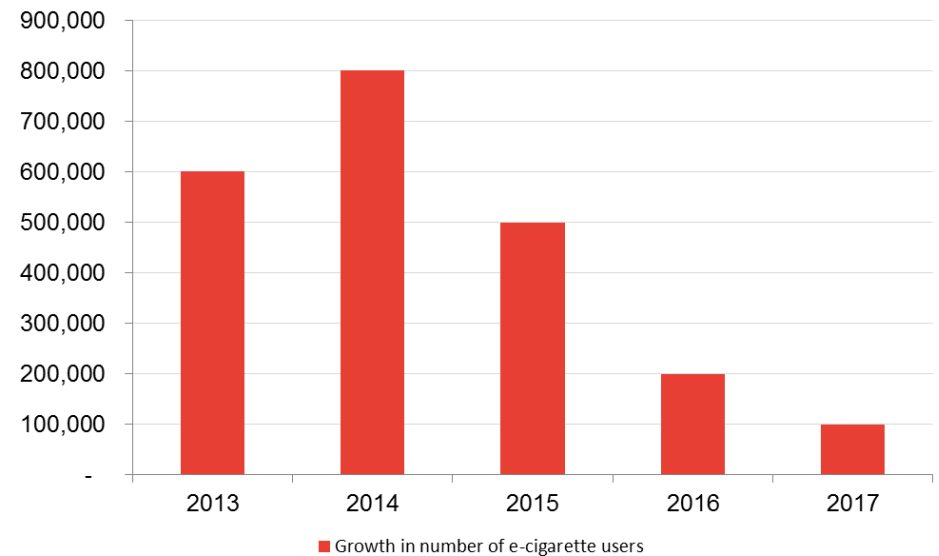
E-cigarette use has boomed but is now slowing down...

- The Smoking Toolkit Study (2017) has found that **5.5%** of adults in England currently use e-cigarettes. This corresponds to **2.4 million** English adults (18+). This is broadly consistent with ASH's (2017) estimate that **5.8%** of the adult population in Great Britain use e-cigarettes.
- ASH (2017) also shows the trend in e-cigarette usage 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** and has shown some signs of levelling off. In 2017 vaping grew by only 100,000.
- The majority of cigarette smokers (60%) in GB have tried e-cigarettes,¹ 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 annual 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' relative safety.²

Number of additional new e-cigarette users in Great Britain 2013-17



Annual growth in e-cigarette users

2013	86%
2015	24%
2017	4%

60%

Proportion of smokers who have tried e-cigarettes

Sources for all statistics above: ASH (2017)

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 2016. 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

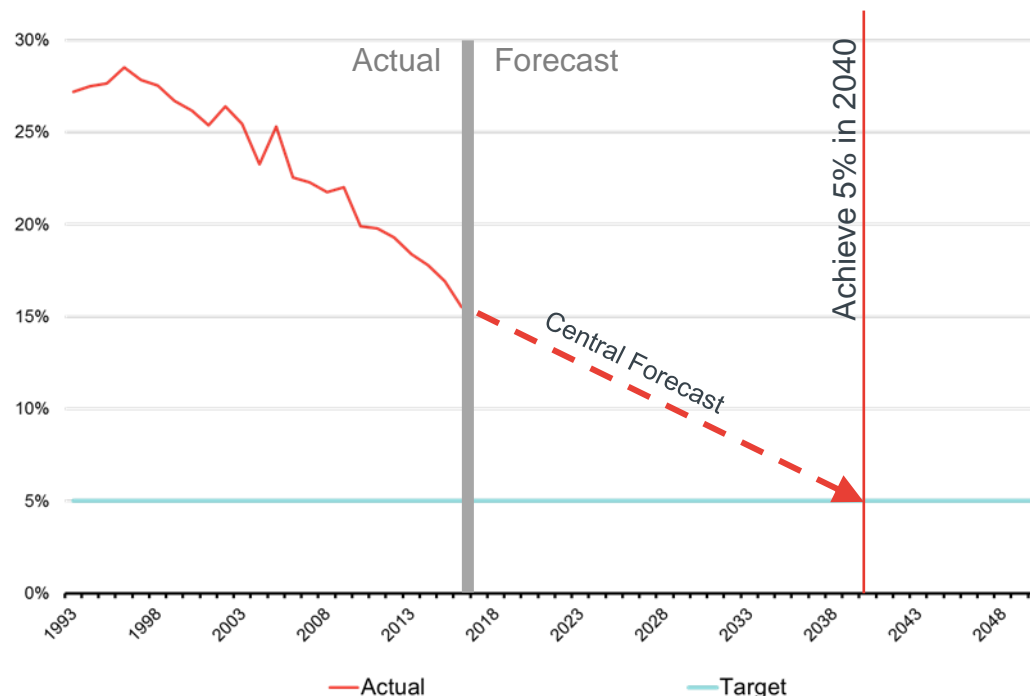
We adjusted this simple trend forecast to account for how the Government (where available) estimates smoking prevalence will be impacted by known or likely interventions in the coming years:

- 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 If prevalence then continued to decline at the same rate after 2040, smoking would reach 0% in around **2051**. 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 (2010-2016), Frontier calculations.

2040

Date by which prevalence of 5% may be achieved

2051

Date by which prevalence of 0% may be achieved if prevalence continues to fall at the same rate

¹ This can be seen in the chart. The solid red line depicts actual prevalence between 1993 and 2016. There are periods where the observed falls in prevalence are above average and others where they are below average.

² A recent PHE 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.

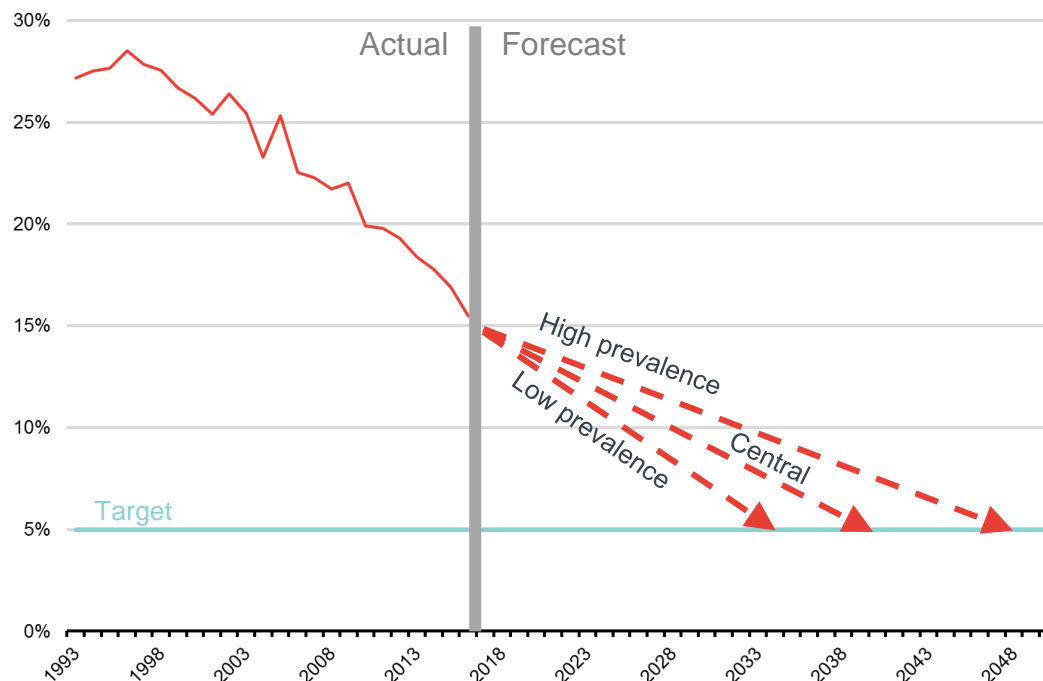
We have tested how our prevalence forecast changes under alternative policy impact assumptions

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 the 5% target 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 2016-50 – sensitivity analysis



Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2016), Frontier calculations.

Note: Scenario assumptions are detailed in Annex 4.

Forecast scenario:	Low	Central	High
Achieve 5% prevalence by:	2034	2040	2048
Achieve 0% prevalence by:	2044	2051	2060

If the trend since 2012 continued, England could be smoke-free by 2029, but it would need an additional 2.5 million people to quit smoking...

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.

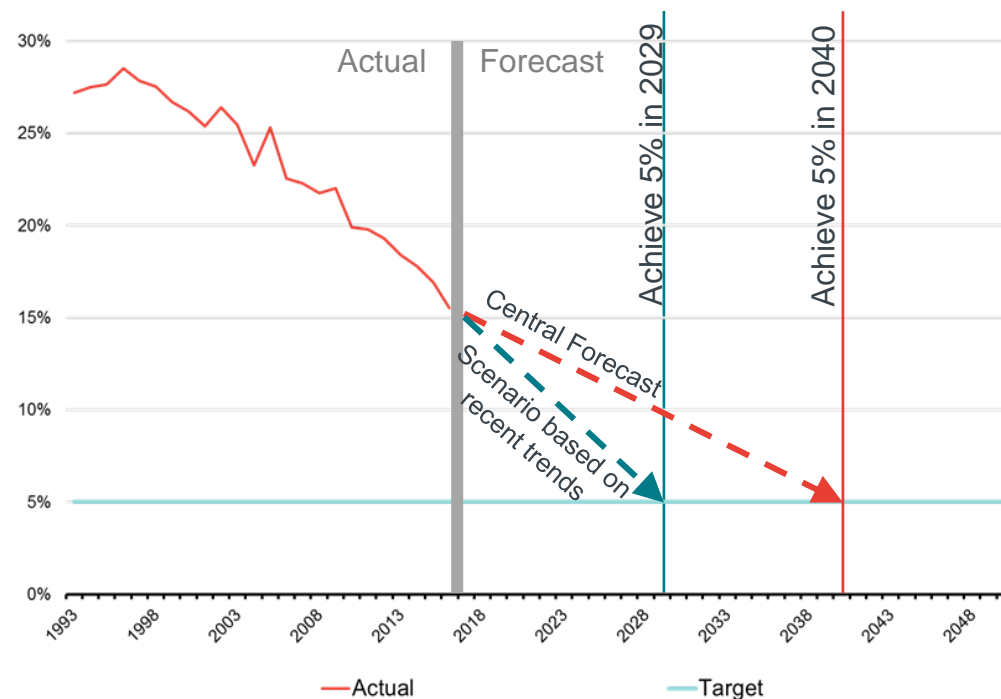
But if the faster trend decline since 2011 (0.86 percentage points per year) were sustained, a smoke-free England could be achieved much sooner – by 2029, 11 years ahead of our central forecast.

Put another way, reducing prevalence to 5% by 2029 requires **2.5 million more smokers to quit between 2018 and 2029** than our central forecast.¹

2.5 million is a very large gap. It is almost twice the **total reduction in smokers observed over the last 5 years**, and is more than the current total number of e-cigarette users who no longer smoke.

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 2029



Source: Health Survey for England (1993-2009) Annual Population Survey (2010-2016) Frontier calculations

2.5 million

Additional smokers required to quit by 2029 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.

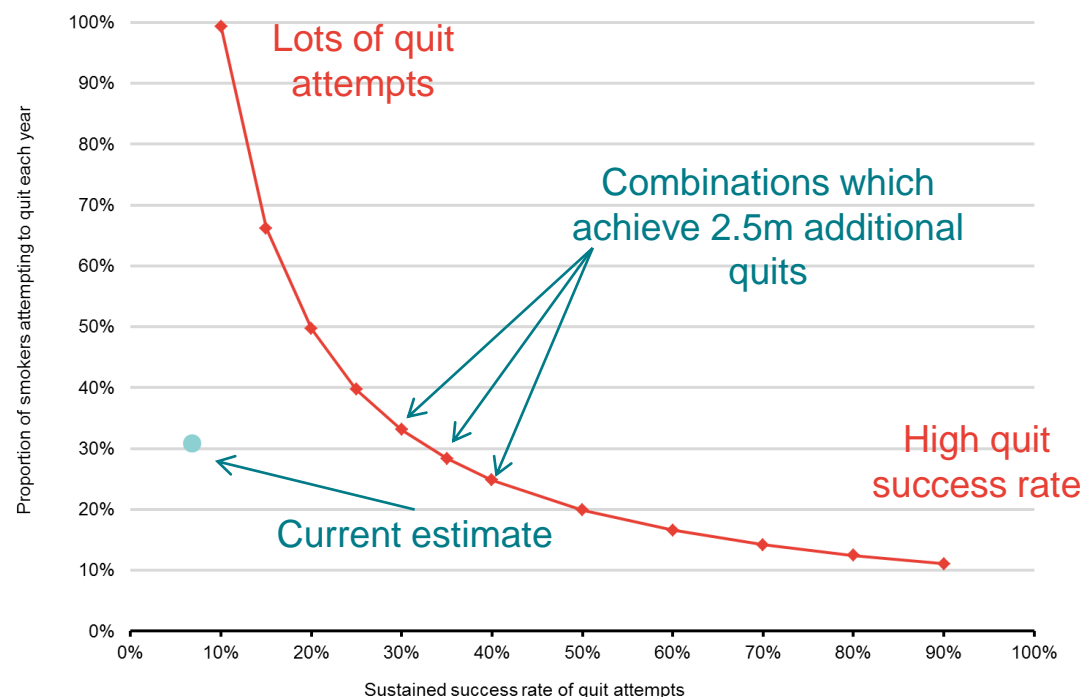
Around 30% of smokers attempt to quit each year. In the short term approximately 15 to 20% of these people succeed, either unaided or using a variety of quitting aids.¹ Longer term (6 to 12 months), average sustained quit success rates are lower, around 7%.²

Successfully reducing prevalence to 5% through **2.5 million more smokers quitting** could be achieved by either:

- **Higher quit success rate:** It would require a **sustained quit success rate of around 33%** assuming 30% of smokers attempt to quit each year (as currently).
- **Higher quit success rate *and* more quit attempts:** The chart to the right shows the different combinations of quit attempts and success rates which could achieve 2.5 million additional quits:
 - doubling the number of attempts to 60% of smokers, requires a sustained success rate to 16.5%; and
 - even with 100% of smokers attempting to quit each year, the sustained success rate would still need to be around 10%.

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

Quit attempts and quit success rates to achieve a 'smoke-free' England by 2029



Note: Estimate of current proportion of smokers attempting to quit each year is from the Smoking Toolkit Study (2017). Estimates of sustained success rate of quit attempts is based on aids used in most recent quit attempt also from the Smoking Toolkit Study (2017). 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 income 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 (2017). 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.

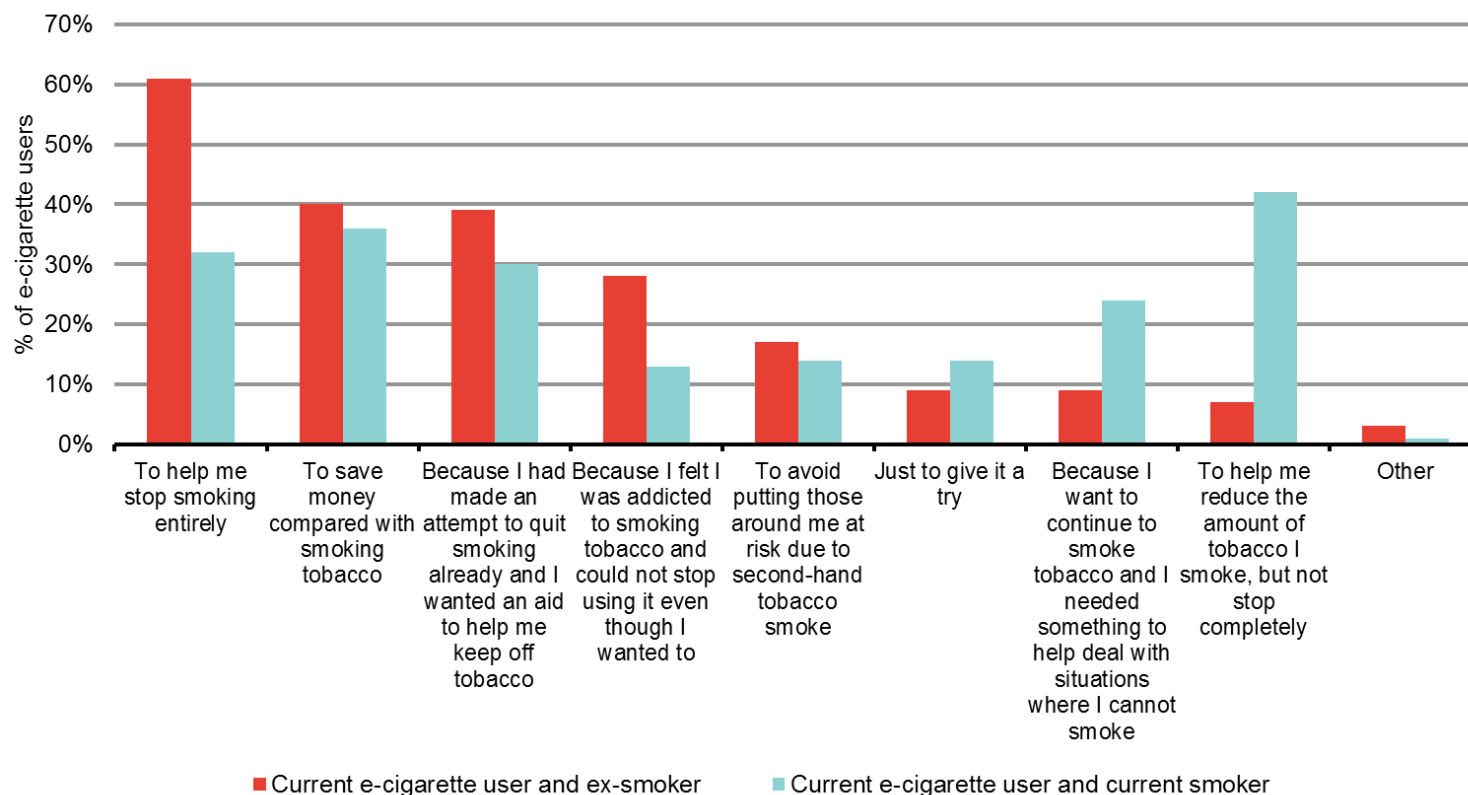
² Frontier calculations using West & Owen (2012), Hartmann-Boyce et al. (2016) and Smoking Toolkit Survey (2017).

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 products¹ to support greater reductions in smoking. This 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 9, 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



Source: ASH (2017)

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

² Gilchrist (2017).

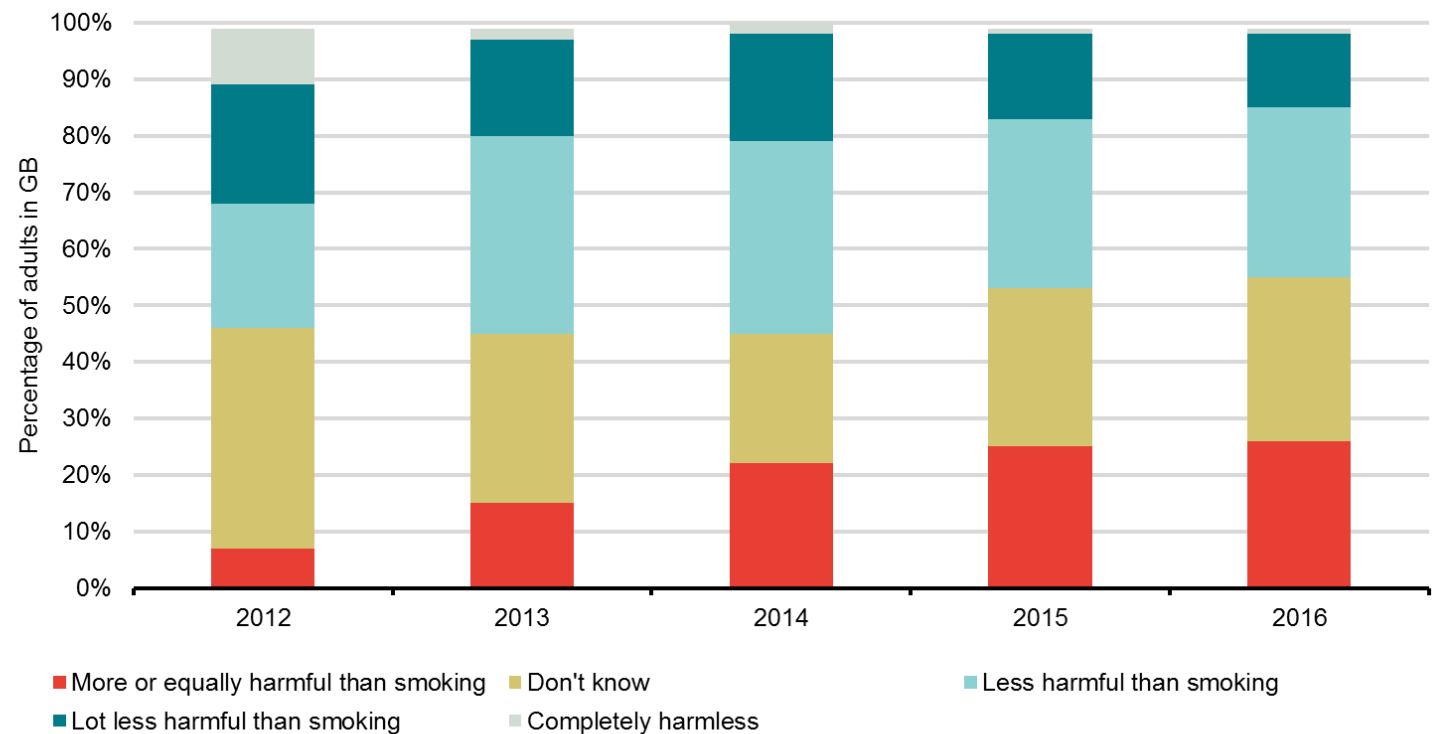
... although more work will need to be done to reassure the public about the relative risks of new products

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 (2017), currently only 13% of adults in Great Britain correctly identify that e-cigarettes are a lot less harmful than cigarettes. Over the last four years a growing proportion of the public fail to recognise that e-cigarettes are a lot less harmful than smoking (see chart).

Public perception of harm from e-cigarettes in Great Britain



Source: ASH (2017)

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

¹ McNeill et al. (2015)

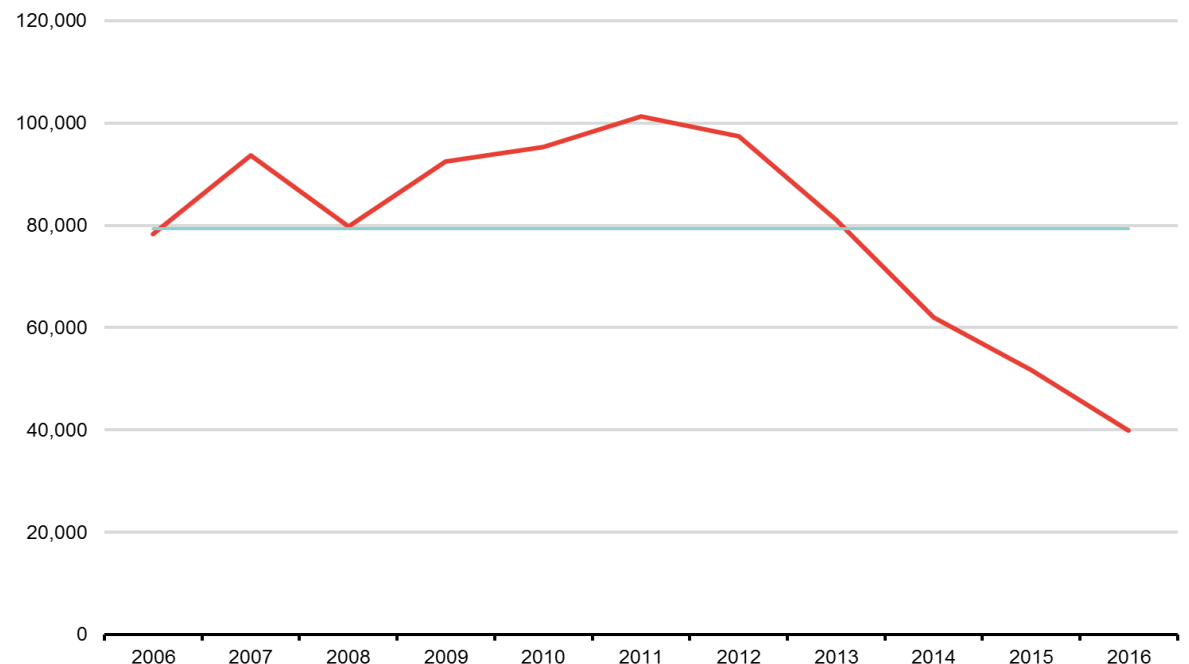
NHS Stop Smoking services are also an effective aid to smokers quitting, but the number of participants has declined in recent years

Helping 2.5 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 (2017) reports 4-week success rates for quit attempts of 49%. Although some of these quitters will return to smoking, we estimate that the long term quit success rate is around 12.3%.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 40,000 in 2016. The average for 2006 to 2016 was approximately 80,000 quits per year.²

Successful quits using NHS Stop Smoking services, England 2006-16



Source: NHS Digital (2017), Frontier analysis.

Percentage of all smokers who quit using NHS Stop Smoking services

2011	1.25%
2016	0.59%

Source: NHS Digital (2017), 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 40,000 per year.¹

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

- **Return to 2006-16 average (2x current levels):** If participation in NHS Stop Smoking services returns to the average observed between 2006 and 2016, this would achieve around 480,000 *additional* quits by 2029.²
- **Return to 2011 peak usage (2.5x current levels):** If participation returned to its peak level of 2011, achieving around 100,000 quits per year, this would deliver around 720,000 *additional* quits by 2029.
- **Expand to 2.5 times 2011 peak usage (over 6x current levels):** If NHS Stop Smoking services were increased to achieve around 250,000 quits per year (i.e. 2.5 times the 2011 peak), this would deliver an *additional* 2.5 million quits by 2029. 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 2029.

NHS Stop Smoking services quits, per year	Equivalent to	Additional quits relative to central forecast, per year	Total additional quits 2018 to 2029
40,000	2016 level	0	0
80,000	2006-16 average	40,000	~480,000
100,000	2011 peak	60,000	~720,000
250,000	2.5 x peak	210,000	~2.5 million

¹ See Annex 4 for more detail.

² Additional quits relative to Frontier’s central long-run forecast.

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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.

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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 2015.
- Sample size was 7,985 individuals in the most recent (2015) data.
- A respondent is classified as a smoker if they answer yes to: “Do you smoke cigarettes at all nowadays?”

Annual Population Survey

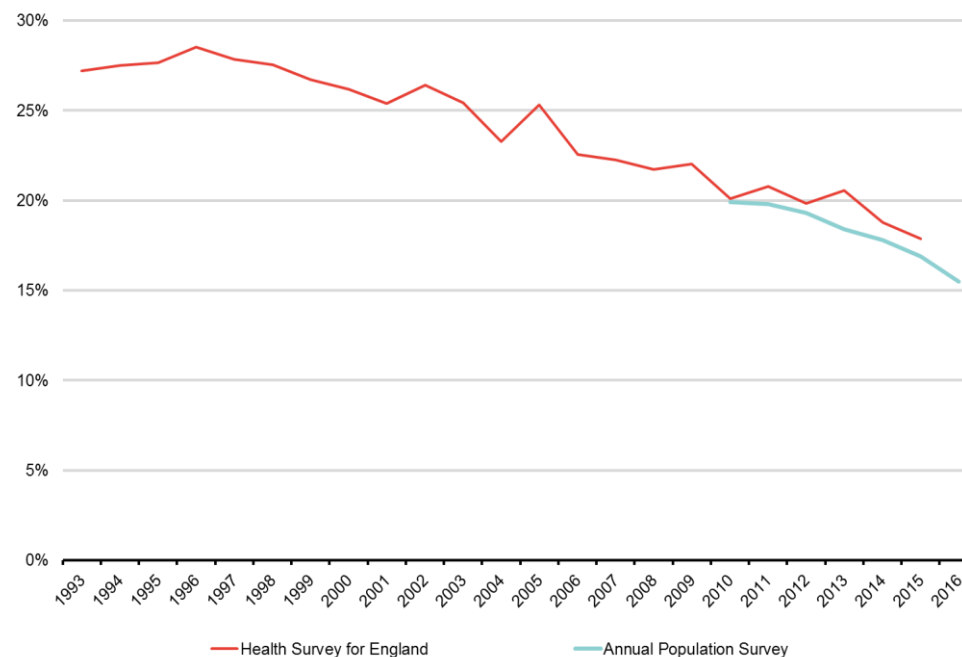
- Continuous household survey covering the UK collected by ONS.²
- Smoking prevalence data (for those aged 18+ in England) is available over the period 2010 to 2016.
- Sample size of 157,558 English individuals in the 2016 data.
- A respondent is classified as a smoker if they answer yes to: “Do you 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 2016 to produce a long time series (23 years). Trends are based on projecting forward the combined data series from 1993-2016.
- We prefer the APS prevalence estimates to the HSE estimates in later years, both because it has a larger sample size and contains 2016 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 1993-2016



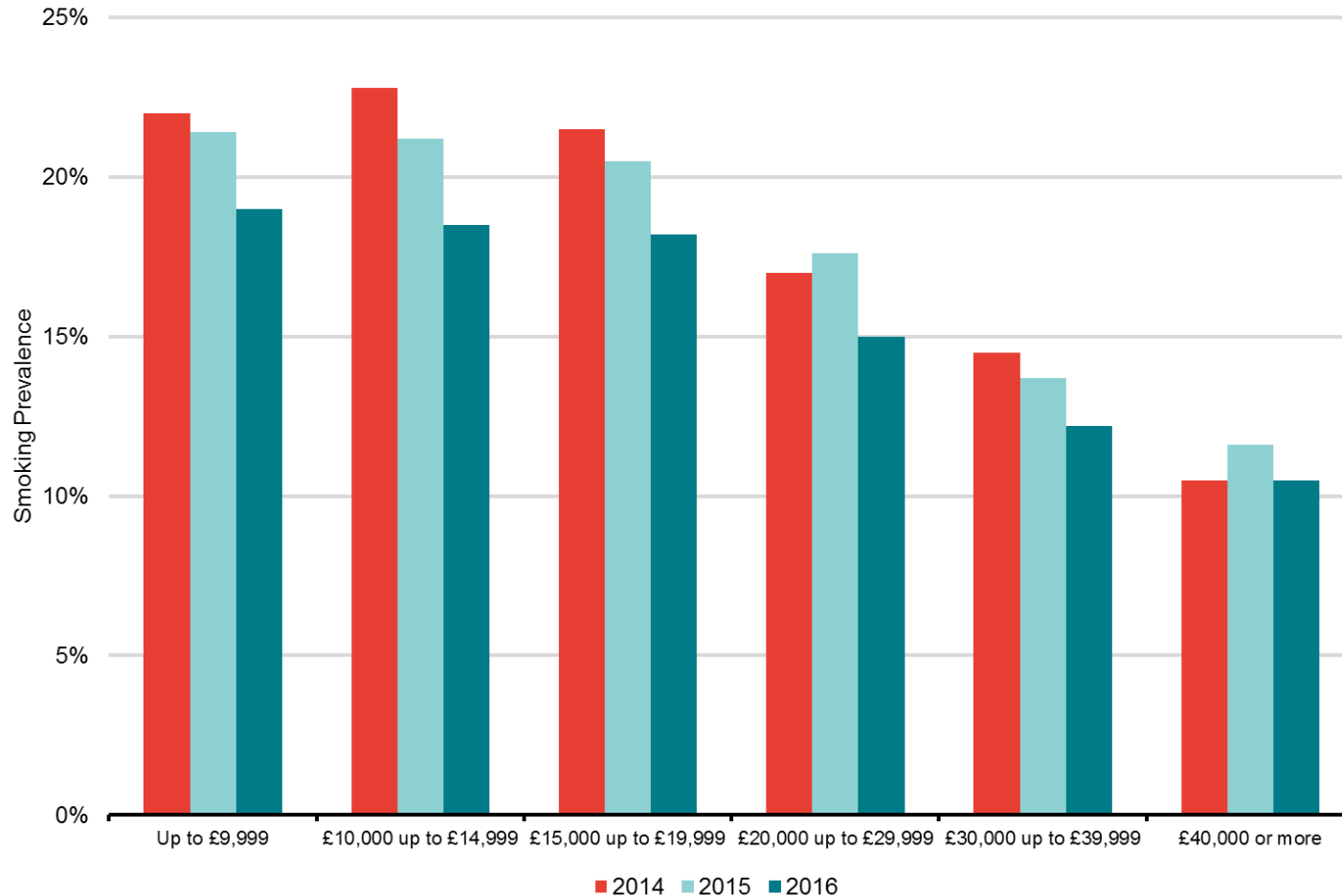
Source: Health Survey for England (1993-2009), Annual Population Survey (2010-2016),

¹ NHS Digital (2016).

² ONS (2017 A).

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

Smoking Prevalence by Income Group (ONS, 2017 C)



Source: ONS (2017 C) Opinions and Lifestyle Survey

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

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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) of the 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.
- 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.
- Hess et al (2016) also 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.

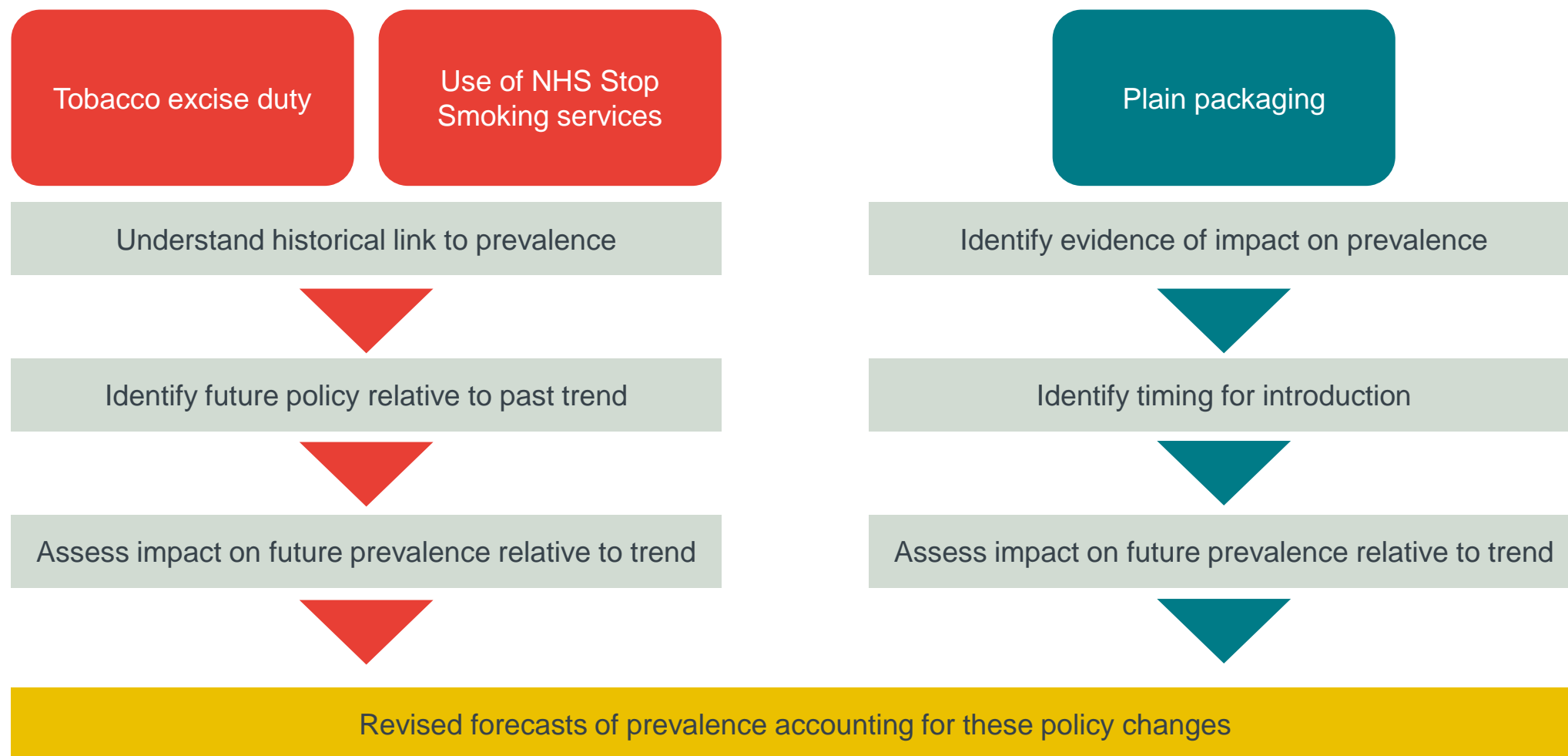


All the evidence suggests that the health risks posed by e-cigarettes are relatively small by comparison [with combustible cigarettes] but we must continue to study the long-term effects

PHE (2016)

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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

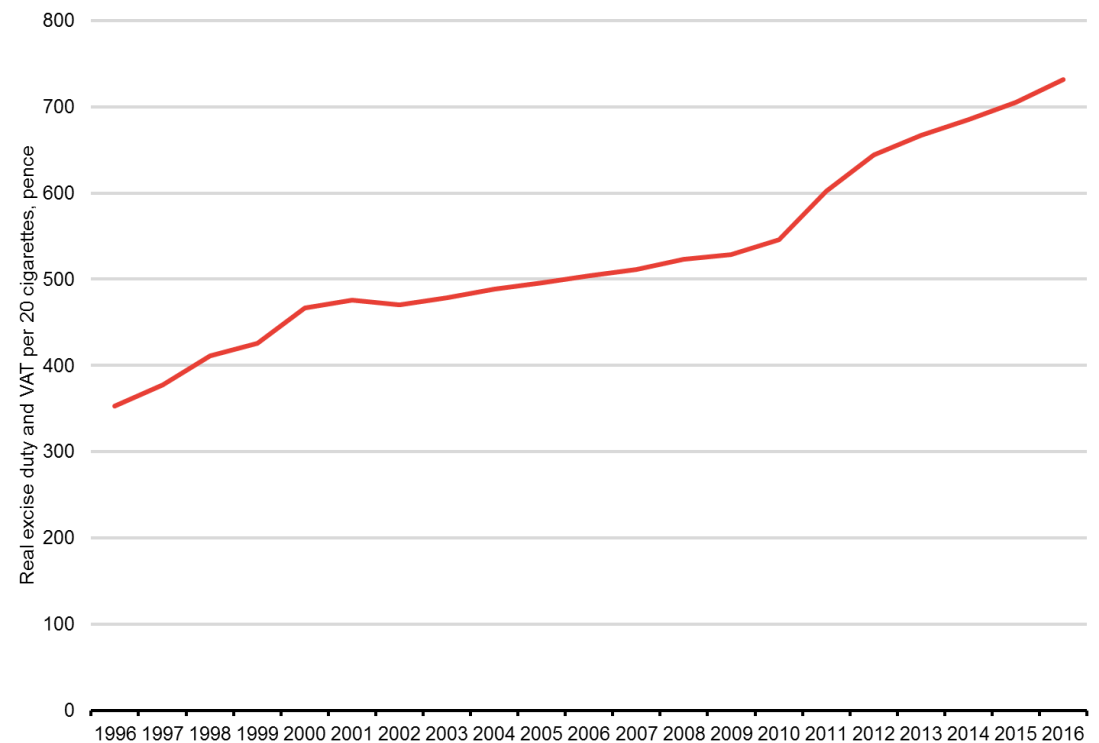
Modelling scenarios:

- 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 4.05% per year of total tax.³ Relative to the entire period this represents a slight increase in the growth rate of total tax (VAT and excise duty).
- 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 4.55% overall growth rates of total tax per year. Our high prevalence scenario assumes 3.55% overall growth rates of total tax per year.

Impact on prevalence by 2029:

- Central scenario: prevalence 0.2 percentage points lower than long-run trend.
- Low prevalence scenario: prevalence 0.4 percentage points lower than long-run trend.
- High prevalence scenario: prevalence 0.01 percentage points lower than long-run trend.

UK cigarette excise duty and VAT: 1996-2016 (2016 prices)



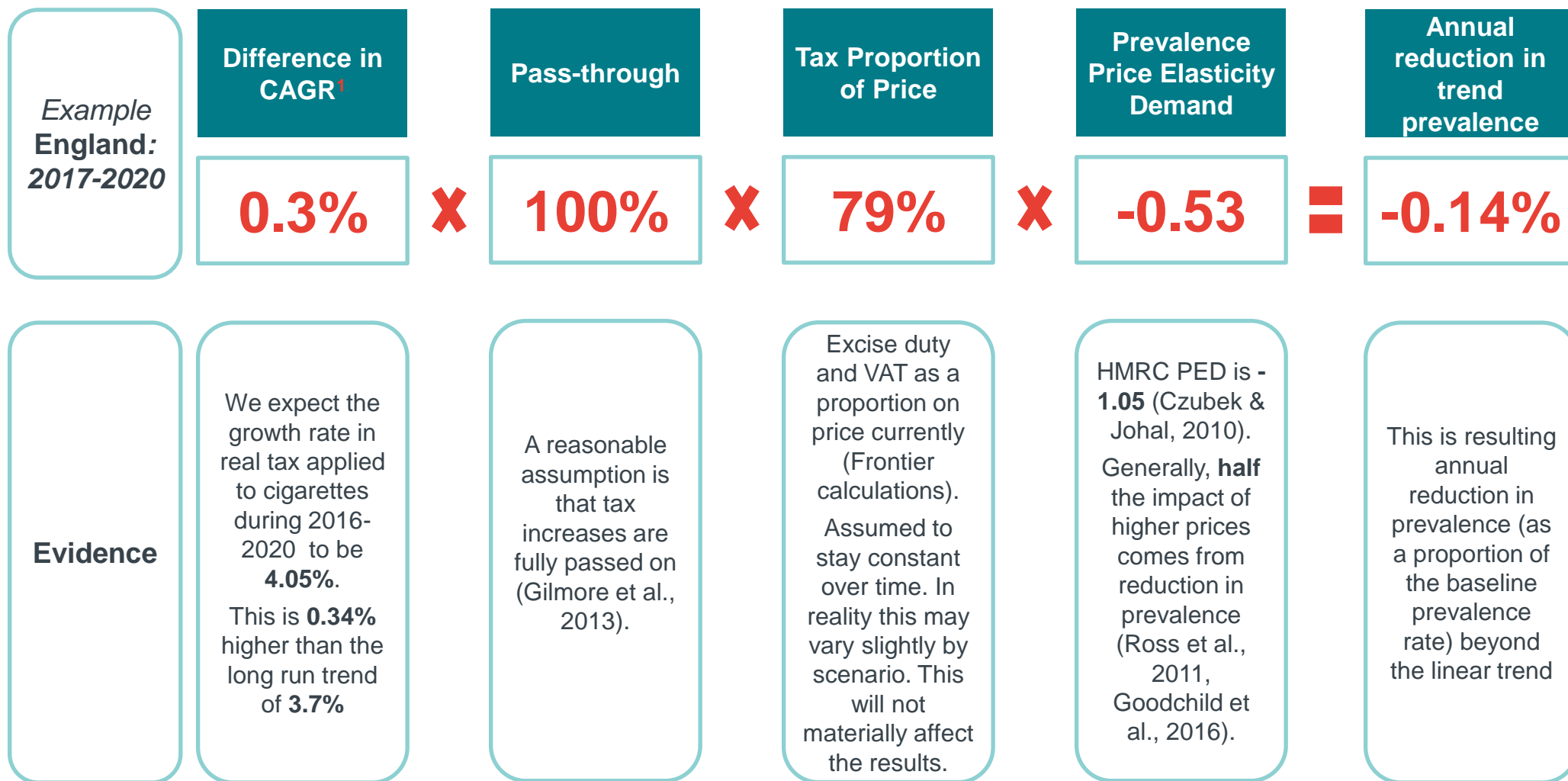
Source: IFS (2017), HMRC (2017), ONS (2017 B), Frontier calculations.

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 reduction in demand associated with an above-trend increase in price



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 spending has been relatively constant between 2011 and 2015.²
- 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 2016, falling to almost zero by 2025.
 - **Central scenario:** Use plateaus at 2016 levels (~40k successful quits).
 - **Low prevalence scenario:** Use increases back towards the average 2006-16 level, by 2025.

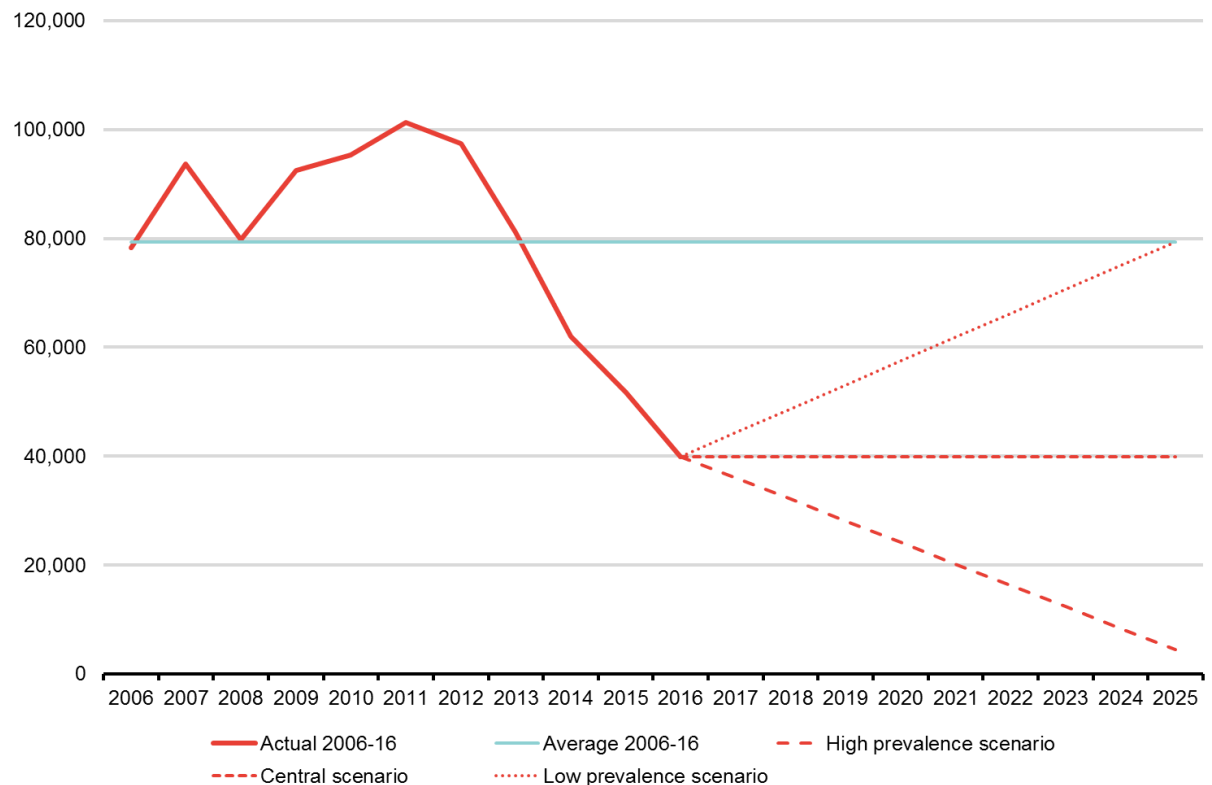
Impact on prevalence by 2029:

- High prevalence scenario: 1.8 percentage points higher than long-run trend
- Central scenario: prevalence 1.1 percentage points higher than long-run trend
- Low prevalence scenario: prevalence 0.4 percentage points higher than long-run trend

¹ NHS Digital (2017)

² NHS Digital (2017), Frontier calculations

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



Source: NHS Digital, 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.

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 0.8 percentage point impact on prevalence.

Modelling scenarios:

- High prevalence scenario: 0 percentage point reduction in prevalence relative to the long-run trend.
- Central scenario: 0.8 percentage point reduction in prevalence relative to the long-run trend.
- Low prevalence scenario: 2.3 percentage point reduction in prevalence relative to the long-run trend.

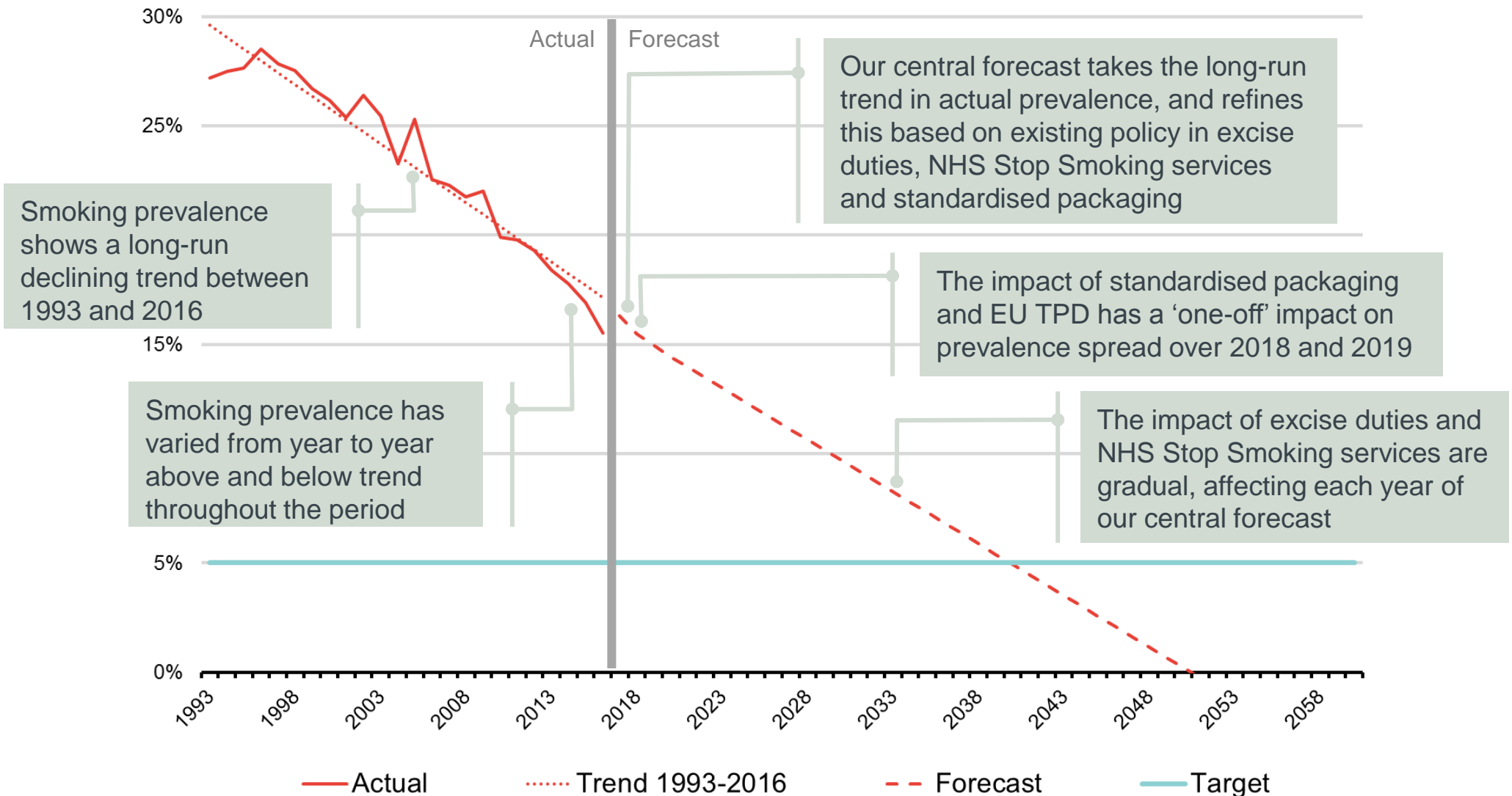
Additional note on calculations: The Department of Health (2015) Impact Assessment is based upon the following proportionate (rather than percentage point) impacts upon prevalence:

- 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 one-fifth of the impact of EU TPD (0.38%) is already observed in our latest (2016) prevalence figures (see paragraph 221 of the DH IA), but that the remainder of the EU TPD impact and all of the standardised packaging impact is observed from 2017 onwards. We multiply the remaining 5.32% by the latest prevalence figure, 15.5%, to estimate the remaining future impact at 0.82 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 (2010-2016), Frontier calculations.

References

Beard E, West R, Michie S, Brown J. (2016) Association between electronic cigarette use and changes in quit attempts, success of quit attempts, use of smoking cessation pharmacotherapy, and use of stop smoking services in England: time series analysis of population trends. *BMJ*: 354:14645

<http://www.bmj.com/content/bmj/354/bmj.i4645.full.pdf>

Brose LS, Hitchman SC, Brown J, West R, McNeill A. (2015) Is the use of electronic cigarettes while smoking associated with smoking cessation attempts, cessation and reduced cigarette consumption? A survey with a 1-year follow-up. *Addiction*: 110(7)

<https://www.ncbi.nlm.nih.gov/pubmed/25900312>

Bullen C, Howe C, Laugesen M, McRobbie H, Parag V, Williman J, Walker N. (2013) Electronic cigarettes for smoking cessation: a randomised controlled trial. *The Lancet* , 382:9905 , 1629 - 1637

[http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(13\)61842-5/fulltext](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)61842-5/fulltext)

Caponnetto P, Campagna D, Cibella F, Morjaria J, Caruso M, Russo C, Polosa R. (2014) Efficiency and Safety of an eElectronic cigarette (ECLAT) as Tobacco Cigarettes Substitute: A Prospective 12-Month Randomized Control Design Study. *PLOS ONE* 9(1)

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066317>

Czubek M, Johal S. (2010) Econometric Analysis of Cigarette Consumption in the UK. *HMRC*

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/331580/cig-consumption-uk.pdf

Department of Health (2015) Impact assessment opinion: Standardised packaging of tobacco products (Final)

<https://www.gov.uk/government/publications/impact-assessment-opinion-standardised-packaging-of-tobacco-products-final>

Department of Health (2017) Towards a smoke-free Generation: A Tobacco Control Plan for England

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/630217/Towards_a_Smoke_free_Generation_-_A_Tobacco_Control_Plan_for_England_2017-2022_2_.pdf

Gilchrist M. (2017) Heated Tobacco Technology: Science, Behaviour and Avoiding Unintended Consequences. *PMI Science Global Forum on Nicotine*

https://www.pmiscience.com/system/files/publications/gfn_2017_gilchrist_heated_tobacco_technology.pdf

References

Gilmore AB, Tavakoly B, Taylor G, Reed H. (2013) Understanding tobacco industry pricing strategy and whether it undermines tobacco policy: the example of the UK cigarette market. *Addiction: 108*

<https://www.ncbi.nlm.nih.gov/pubmed/23445255>

Glasser, Allison M. et al. (2017) Overview of Electronic Nicotine Delivery Systems: A Systematic Review *American Journal of Preventive Medicine 52(2)*

Goodchild M, Perucic A, Nargis N. (2016) Modelling the impact of raising tobacco taxes on public health and finance. *Bulletin of the World Health Organisation.*

<http://www.who.int/bulletin/volumes/94/4/15-164707/en/>

Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF, Hajek P. (2016) Electronic cigarettes for smoking cessation. *Cochrane Database of Systematic Reviews 2016, Issue 9.* http://www.cochrane.org/CD010216/TOBACCO_can-electronic-cigarettes-help-people-stop-smoking-and-are-they-safe-use-purpose

Hess IMR, Lachireddy K, Capon A. (2016) A systematic review of the health risks from passive exposure to electronic cigarette vapour. *Public Health Res Pract: 26(2)*

HMRC (2017) Excise Duty – Tobacco Duty rates

<https://www.gov.uk/government/publications/rates-and-allowances-excise-duty-tobacco-duty/excise-duty-tobacco-duty-rates>

HM Treasury (2017) Tax treatment of heated tobacco products

<https://www.gov.uk/government/consultations/tax-treatment-of-heated-tobacco-products/tax-treatment-of-heated-tobacco-products>

Hughes JR, Keely J, and Nuad S. (2004) Shape of the relapse curve and long-term abstinence among untreated smokers. *Addiction: 99(1)*

<https://www.ncbi.nlm.nih.gov/pubmed/14678060>

Hunt D, Knuchel-Takano A, Jaccard A, Bhimjiyani A, Retat L, Selvarajah C, Brown K, Webber L, Brown M. (2017) Modelling the implications of reducing smoking prevalence: the public health and economic benefits of achieving a 'tobacco-free' UK. *Tob Control 1-7*

<http://press.psprings.co.uk/tc/may/tc053507.pdf>

References

IFS (2017) Excise duties, tobacco (20 king-size cigarettes) <https://www.ifs.org.uk/uploads/publications/ff/excise.xlsx>

McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P. (2014) Electronic cigarettes for smoking cessation and reduction. *Cochrane Database of Systematic Reviews 2014, Issue 12*.
<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD010216.pub2/abstract>

McNeill A, Brose LS, Calder R, Hitchman SC, Hajek R, McRobbie H. (2015) E-cigarettes: an evidence update. A report commissioned by Public Health England
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457102/Ecigarettes_an_evidence_update_A_report_commissioned_by_Public_Health_England_FINAL.pdf

McNeill A, Gravely S, Hitchman SC, Bauld L, Hammond D, Hartmann-Boyce J (2017) Tobacco packaging design for reducing tobacco use (Review)
<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD011244.pub2/full>

NHS Digital (2016) Health Survey for England, 2015: Trend tables
<http://content.digital.nhs.uk/searchcatalogue?productid=23717&kwd=Smoking&sort=Relevance&size=10&page=1#top>

NHS Digital (2017) Statistics on NHS Stop Smoking Services in England [and previous versions]
<http://www.content.digital.nhs.uk/catalogue/PUB23213>

ONS (2017 A) Annual Population Survey: Smoking habits in the UK and its constituent countries
<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/qmis/annualpopulationsurveyapsqmi>

ONS (2017 B) Inflation and price indices
<https://www.ons.gov.uk/file?uri=/economy/inflationandpriceindices/datasets/consumerpriceinflation/current/consumerpriceinflationdetailedreferenceables.xls>

ONS (2017 C) Adult Smoking Habits in England
<https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/datasets/adultsmokinghabitsinengland>

References

ONS (2016) Population Estimates for UK, England and Wales, Scotland and Northern Ireland

<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland>

ONS (2015) Population Projections Data Files, England

<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/z3zippedpopulationprojectionsdatafilesengland>

Pasquereau, A, Guignard, R, Andler, R, and Nguyen-Thanh, V. (2017) Electronic cigarettes, quit attempts and smoking cessation: a 6-month follow-up. *Addiction (in press)*

<http://onlinelibrary.wiley.com/doi/10.1111/add.13869/abstract>

Pechey R, Spiegelhalter D, Marteau TM (2013) Impact of plain packaging of tobacco products on smoking in adults and children: an elicitation of international experts' estimates

<https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-13-18/open-peer-review>

Public Health England (2015) Health matters: smoking and quitting in England

<https://www.gov.uk/government/publications/health-matters-smoking-and-quitting-in-england/smoking-and-quitting-in-england>

Selbie, D. (2017) Our ambition for a smoke-free nation is in sight. *Public Health England*

<https://publichealthmatters.blog.gov.uk/2017/06/16/our-ambition-for-a-smoke-free-nation-is-in-sight/>

Royal College of Physicians (2016) Nicotine without smoke: Tobacco harm reduction. A report by the Tobacco Advisory Group of the Royal College of Physicians

<https://www.rcplondon.ac.uk/projects/outputs/nicotine-without-smoke-tobacco-harm-reduction-0>

Ross H, Blecher E, Yan L, Hyland A. (2011) DO cigarette prices motivate smokers to quit? New evidence from the ITC survey. *Addiction* 106(3)

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4439203/pdf/nihms678048.pdf>

Smoking Toolkit Study (2017) Electronic cigarettes in England – latest trends (2017 Q1)

<http://www.smokinginengland.info/sts-documents/>

References

West R, Owen L (2012) Estimates of 52-week continuous abstinence rates following selected smoking cessation interventions in England: Version 2
<http://www.smokinginengland.info/reports/>



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