



Department for
Communities and
Local Government

Household Projections 2014-based: Methodological Report



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1. Introduction

The 2014-based projections have been updated to include the ONS 2014-based sub-national population projections published on 25th May 2016.

As with the previous projections, the methodology is split into two stages: Stage One produces summary household numbers based on long-term demographic trends and Stage Two gives a more detailed breakdown of household type.

The 2014-based projections include the following additional information compared to the 2012-based household projections:

- 2014-based sub-national population projections by sex and age that extend to 2039.
- Adjustments to the projections of the household representative rates in 2012 based on the LFS.

The methodology for the 2014-based household projections was based upon the 2012-based, 2011-based interim and 2008-based household projections. The household projections are compiled using a two stage process. Stage One produces the national and local projections for the total number of households by age group and relationship status group over the projection period. The total number of households in each local area form the basis of the control totals for Stage Two of the projection methodology which gives the detailed household type breakdown by age.

The Stage one household representative projections use a combination of two fitted trends through the available Census points (1971, 1981, 1991, 2001 and 2011). However, as with the 2012 based household projections, only partial information is available from the published Census 2011 data to derive household representative rates for 2011.

The Census 2011 uses a different definition of the household representative compared with the historic estimates of household formation used in the Stage One household projections methodology (Household Projections System, known as HOPS). This means that much of the published information on household representatives is not directly comparable with the HOPS derived estimates as the inconsistency produces different results by age, sex and status. The approach therefore was to use as much information as possible from the published Census 2011 data.

For Stage One household representative rates for 2011 have been derived at England level using the aggregate household representative rates by marital status from the 2011 Census, household population by age, sex and marital status from the Census 2011, data on household representative rates by age profile from the LFS and previous household projections. This enables the 2011 Census point to be added to the estimation process for Stage One. At local authority level, the household projections have been controlled to both the national projections and the aggregate household representative rate from the 2011 Census for each local authority. This approach means that the household projections are consistent with the available information on aggregate household representatives from the Census 2011.

This document goes into further detail of the household projections methodology, highlighting where and how changes have been made to the 2014-based projections.

2. Stage One

The methodology for the 2014-based projections follows that used for the 2012-based, 2011-based interim and 2008-based projections. Since the release of the 2012-based household projections, no further Census 2011 information has been included in the methodology. The updated data is limited to national and subnational population projections, 2013 mid-year population estimates and information on post Census 2011 household formation from the Labour Force Survey.

The household projections are compiled using a two stage process. Stage One produces the national and local projections for the total number of households by sex, age group and marital status group over the projection period. The total number of households in each local area form the basis of the control totals for Stage Two of the projection methodology which gives the detailed household type breakdown by age.

Stage One applies projected household membership rates to a projection of the private household population disaggregated by age, sex and marital status. The method uses a simplified three-way relationship categorisation to represent marital/cohabitational status. The categories are people in couples (including married couples who are living together and cohabiting couples); separated marrieds, divorced and widowed not in couples; and people not in couples (not cohabiting, never married). This is an aggregation of the detailed categories in the previous DCLG (Household Projections System, known as HOPS) model which captures the key household formation characteristics of the relationship status groups while retaining relative simplicity.

As in the 2012-based projections, the projection methodology for Stage One from the 2008-household projections has been maintained but adapted. The 2014-based projections includes information from the 2011 Census which together with data from the LFS has been used to update the estimates for the 2011 point that are then used in the household projections methodology at national level. The updated national projections are then used to control a set of projections for regions and local authorities that have been derived by applying projections of the household representative rates by sex, age and status to the 2014-based household population by sex, age and status. The regional and

local authority projection is then controlled to the 2011 Census aggregate household representative rate.

The projections methodology uses time-series modelling which weights together simple and dampened logistics trends. Cohort modelling is not used. The simplified time-series based projections are referred to as the Stage One projections to distinguish them from the detailed projections by household type described in Stage Two.

There are six key components to the household projections produced in Stage One each of which is given in detail below:

- a) Population projections
- b) Marital status composition
- c) Institutional population
- d) Household representative rates
- e) LFS adjustments
- f) Regional and local household projections

a. Population estimates and projections

Population estimates for local authorities in England for mid-2013 were published by ONS in June 2014 and have been used to produce household estimates for 2012 and 2013. The household estimates are produced as part of the 2014-based household projections.

Revised population estimates¹ for local authorities in England for mid-2002 to mid-2010 were published by ONS in May 2013 following the 2011 Census. The revised series provides a consistent time-series of population estimates to mid-2010 for each local authority in England. Mid-2011 (2011 Census-based)² population estimates for each local authority in England were published in September 2012. These mid-year estimates have

¹ <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-england-and-wales/mid-2002-to-mid-2010-revised--subnational-/index.html>

² <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-england-and-wales/mid-2011--2011-census-based-/index.html>

been included in the derivation of the household estimates for 2002 to 2011. The household estimates were originally produced as part of the 2012-based household projections and have been updated as part of the 2014-based household projections.

National and subnational populations are taken from the most recent 2014-based population projections published by ONS on 25th May 2016. For the 2014-based household projections, the 2014-based³ population projections are used by sex and five-year age band at both national and subnational levels.

The population projections are trend-based, making assumptions about future levels of fertility, mortality and migration based on levels observed over a five-year reference period. Therefore, they give an indication of what the future population, by age and sex structure, might be if recent trends continue, and take no account of policy or development aims in local authorities. The projections take as their starting point the 2014 mid-year population estimates released on 25 June 2015 and assume that recent trends continue. To model recent trends, data for the six preceding years are used, so in the case of the 2014-based projections, trends are based on data from the years 2009 to 2014. The projections are produced for 25 years, for each local authority by age and sex.

The population of England is projected to grow at a slightly faster rate in the 2014-based projections than in the 2012-based projections. The higher projected growth rate is due to the change in assumptions made for the 2014-based projections, with the assumptions for net migration being higher and those for fertility and life expectancy being lower. The change in assumptions has an impact on the projected age profile of the population as shown in figure 1 below.

Overall the population of England is projected to be 0.9% higher than previously projected. Figure 1 shows that the largest change is for the 0-14 age group, with 2.1% more people in this age group by 2039 compared with the previous projections. In fact, all age groups have higher levels by 2039 compared with the previous projections with the exception of people aged 75 and over where the population is projected to be 138,000 lower than under

<http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2014basedprojections>

the 2012-based projections. The smallest change is for the 30-44 age band, with a difference of just 0.5% by 2039.

The changes to population by age group filter down to the sub-national population projections. It is the changes to population by age and sex at local authority level which will explain most changes to the household projections for local authorities.

Figure 1: Comparison of 2014-based population projections and 2012-based population projections
Changes in projected population by age compared with 2012-based projections, England

Age group	mid-2014		mid-2025		mid-2035		mid-2039	
	000s	%	000s	%	000s	%	000s	%
0-14	46	0.5	61	0.6	213	2.1	221	2.1
15 - 29	-28	-0.3	124	1.2	109	1.0	133	1.2
30 - 44	28	0.3	93	0.8	61	0.5	59	0.5
45 - 59	29	0.3	115	1.1	134	1.2	140	1.2
60 - 74	17	0.2	72	0.8	120	1.2	148	1.5
75 & over	-2	-0.1	-125	-2.0	-136	-1.8	-138	-1.6
All ages	89	0.2	339	0.6	502	0.8	563	0.9

Source: ONS

b. Marital Status Composition

The Census 2011 provided data on the structure of the household population by 5 year age band, sex and relationship status which have been included in the household projections methodology by controlling the estimates to the 2011 mid-year population estimates. This is consistent with the approach taken for the 2012-based household projections.

The 2008-based population projections by marital status for England & Wales were published on the 24 June 2010 by the ONS and incorporated into the household population projections for the 2014-based household projections. ONS have not produced updated marital status projections since. While the 2012-based household projections were being calculated the ONS were running a consultation on the future of the marital status projections. Since more recent marital status projections are unavailable, the

existing 2008-based marital status projections have therefore been controlled to the 2014-based population projections by age and sex across all geographic levels.

The marital status projections cover both legal marital status and (opposite-sex) cohabitation for the period to 2033. As the household formation behaviour of married and unmarried cohabiting couples is similar and distinct from the characteristics of other marital status groups, cohabiting as well as married couple households need to be identified. This means that the following marital status types are initially identified:

- Single - not cohabiting
- Married - not cohabiting
(other than with spouse, i.e. either living with spouse or living alone)
- Widowed - not cohabiting
- Divorced - not cohabiting
- Single - cohabiting
- Married - cohabiting (not with spouse)

Widowed - cohabiting

Divorced - cohabiting

The marital status projections are at national level only. Population estimates of resident population by single year of age, sex and legal marital status which ONS has updated to include marriages abroad are also included at the national level from 2002 to 2010. No official cohabiting population estimates which are consistent with the revised marital status estimates were available for this period. We have therefore produced estimates for the cohabiting population by marital status between 2002 and 2010 using trends in cohabitation shares of total marital status population as found in the marital status projections. Estimates of marital status in future years at subnational level are made by applying national/local differentials in marital status from the Census to projected marital status factors.

Population estimates from the eight marital status / relationship categories are aggregated to three broader groups. This has the advantages of presenting a smaller and hence simpler set of groupings to aid user understanding and to minimise the potential impacts of

errors in the projection data sets but which still captures the key features of household formation behaviour:

1. People who are part of a mixed-sex couple. This includes both married couples (where they live together) and cohabiting couples. This does not include people in same-sex couples;
2. Male and female separated, divorced or widowed (once married) people⁴;
3. Male and female single people who have never been married, and are not cohabiting (single as in not in a couple or separated, divorced or widowed; not necessarily a one-person household⁵);

c. Institutional Population

The household projections are based on the projected household population rather than the total population. The difference between the two is the population in communal establishments, also termed the 'institutional' population. This population comprises all people not living in private households. These include people living in nursing homes, halls of residence, military barracks and prisons.

Estimates of the institutional population by age, sex and marital status were available from the 2011 Census at England and local authority level. The institutional population estimates have been revised for the 2014-based projections to match the Census 2011 results by age, sex and marital status more closely. The resulting change in institutional population has a small impact on the estimates of households between 2002 and 2011. The changes to institutional population are small with the largest changes found in areas with the highest concentration of institutional population.

For the household projections, the assumption is made that the institutional population stays constant at 2011 levels by age, sex and marital status for the under 75s and that the share of the institutional population stays at 2011 levels by age, sex and relationship

⁴ Does not include previously cohabiting (not married) people who are now separated

⁵ This group, for example, will include single (never married) lone parents and people living in other multi-person households. It will also include those who previously cohabited although never married.

status for the over 75s. The rationale here is that ageing population will lead to greater level of population aged over 75 in residential care homes that would not be picked up if levels were held fixed, but holding the ratio fixed will.

The institutional population is subtracted from the total resident population projections by age, sex and marital status to leave the private household population, split by sex, age and marital status in the years required for household projections.

d. Household Representative Rates

The number of households is essentially the household population multiplied by the appropriate household representative rate. The household representative rate is the probability of anyone in a particular demographic group being classified as being a household representative and can take any value between 0 and 1.

A household representative is a person chosen for statistical reasons by virtue of age and/or sex as the representative of a household. The total number of projected households is equal to the sum of households represented by all age, sex and marital/relationship status types.

Note that the eldest male is taken as the household representative in the Stage One methodology. This is to preserve consistency with earlier Censuses.

The household representative rates can be represented algebraically for any year as:

$$HH_{total} = \sum_{a=0-4}^{85+} \sum_{s=m}^f \sum_{r=c}^s HRR_{a,s,r} \cdot HP_{a,s,r}$$

Where: HH is the number of households
HRR is the household representative rate
HP is the household population
a are age groups (0-4....85+)
s is male or female
r is marital/relationship status

e. Incorporating the Census 2011

The 2014-based projections used data from the 1971, 1981, 1991 and 2001 Censuses and partial information from the 2011 Census to project household representative rates by demographic group. Published data from the Census 2011 uses a different definition of the household representative than used in the household projections model. The Census 2001 and Census 2011 both identify household reference persons (HRP) based primarily on economic activity, whilst the household representatives in the household projections model is a person chosen for statistical reasons by virtue of age and/or sex as the representative of a household. By convention this is the oldest male on the Census form.

To produce household representative rates for 2011 by demographic group consistent with the previous Censuses requires detailed non-standard data from the Census. This data was commissioned by DCLG with the aim of producing a full set of household representative rates by sex, age and relationship status and included in the Stage One projection methodology. Work to incorporate the commissioned Census 2011 data into the projections raised a number of issues with the underlying data that need to be investigated further and as a result were not used in the 2012-based projections.

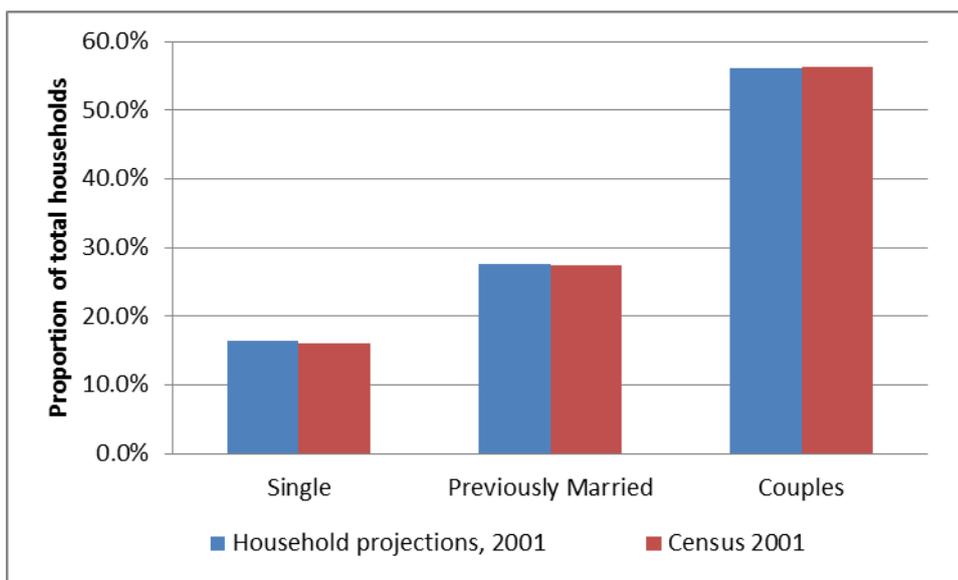
This update has used the estimates for 2011 generated for the 2012-based household projections which used as much information from the published Census 2011 data as possible at the England level. Further details on this approach are set out below.

The Census 2011 showed that the aggregate household representative rate (total households/ total adult population) was lower than the value suggested by the 2008-based projections. However no published information was available from the Census 2011 to split

this aggregate figure across age, sex and relationship status that was consistent with the data in the household projections model.

Analysis of the 2001 Census against the HOPS data for 2001 showed that the proportion of households represented across the three broad relationship status groups were comparable at the national level (Figure 2) but when these are further disaggregated by age/ and or sex then the data is inconsistent for couples and those previously married. It was therefore decided that in lieu of more detailed commissioned Census 2011 data, the household representative rates in 2011 could also be aligned to the aggregate status types from the Census 2011 and the rates by age and sex for singles.

Figure 2: Proportion of total households by relationship status, Census 2001 and DCLG household projections (HOPS).



Source: DCLG, ONS

Data for household representative persons was taken from the 2011 Census to infer how the changes in the representative rates for each relationship status changed between 2001 and 2011. Information was also taken from the Census 2011 data regarding the age profile of singles (since the definition of this category is broadly consistent with the HOPS definition). Further guidance on how this data was used is detailed below.

Aside from the (broad) age profile of singles, the published Census 2011 data cannot be used to derive the age profile of the household representatives in 2011. As a result (and consistent with the 2011 interim projections) LFS data has been used to inform the age

profile of household representatives in 2011. Analysis of the LFS suggests that there have been some steep falls in household representative rates for some age groups since the 2001 Census and the 2011 Census results – although not split by age – reinforce the trends observed in the LFS. It was therefore decided to use changes in the household representative rates by age-band from the LFS to estimate the changes that have occurred between the 2001 and 2011 Census. The LFS uses the same definition of household representatives as the household projections model.

Unweighted LFS data was used and processed as follows:

1. The quarterly LFS household representative rate data by age (but not) sex are seasonally adjusted
2. The seasonally adjusted data are smoothed using a Henderson 9-point moving average
3. The smoothed quarterly LFS data are converted to annual series and are further smoothed using another Henderson 9-point moving average
4. The smoothed LFS household representative rates are spliced onto the 2001 Census data points.

The 2011 LFS based household representative rates by age were then applied to the household population by age to produce an initial estimate of households by age band. The total was then controlled to the 2011 Census aggregate household representative rate and the final 2011 household representative rates by age were then calculated. Household representative rates by age, sex and relationship status for 2011 were estimated using the following data:

- Census 2001-2011 change in household proportions by relationship status
- Census 2011, household population by age, sex and relationship status
- Census 2011, household representative rates for singles by sex and broad age band
- 2008-based household representative rate projections by age, sex and relationship status
- 2012-based household population projections by age, sex and relationship status

An iterative process was used to ensure that the estimated household representative rates meet the following criteria:

- Must take a value between 0 and 1.

- Consistent with the aggregate household representative rate from the Census 2011
- Consistent with the aggregate household representative rates by age derived from the LFS
- Consistent with the derived aggregate household representative rate by relationship status from the Census 2001.
- Consistent with the aggregate representative by broad age and sex for singles.

f. Projecting household representative rates

The procedure followed to project the household representative rates at the national level is consistent with the 2011-interim projections, with 5 observations to project forward but there remain issues that some of the Census points (particularly the 1991 Census) look to be quite strange.

The projections of the household representative rates use a combination of two fitted trends:

1. A simple logistics trend - a straight line fitted to $\ln (X_t / (1-X_t))$
2. A dampened logistics trends where an S-shaped curve is fitted to $\ln (X_t / (1-X_t))$

These functions were developed as part of the development for the Stage One [methodological review](#) to fit through the Census points as some of the trends are linear whilst others have a curve.

As with previous vintages of the projections, it is still not clear which of these is the most appropriate. The dampened trend provides a better fit for the Census data. But consideration has to be given to the extent to which data errors may have affected measured past trends and also to the fact that the data for 2011 by demographic type are estimates based on the trends by age from the LFS as well as some data from the 2011 Census. Further detail on concerns with some of the previous Census points (particularly 1991) is provided in the 2008-based methodology document.

Given the uncertainty, the alternative projections are weighted together using the following weights:

15 to 29 year olds: 80:20 weights for dampened / simple trend

30 year olds and over: 60:40 for dampened/ simple trend

The reason for the differential weights is that Labour Force Survey (LFS) data indicate declining aggregate household representative rates for the younger age groups and, consequently, there is evidence that it is more appropriate to give a bigger weight to the dampened trend in these cases.

g. LFS Adjustments

The LFS is a sample survey and as such subject to a margin of error but the data are far more up-to-date than the Census and some allowance for recent movements in the LFS are considered necessary. The LFS data has been incorporated into the England level projections for the 2012 period. The LFS data is seasonally adjusted and smoother as presented in the previous section. The smoothed LFS household representative rates are spliced onto the 2011 census data points.

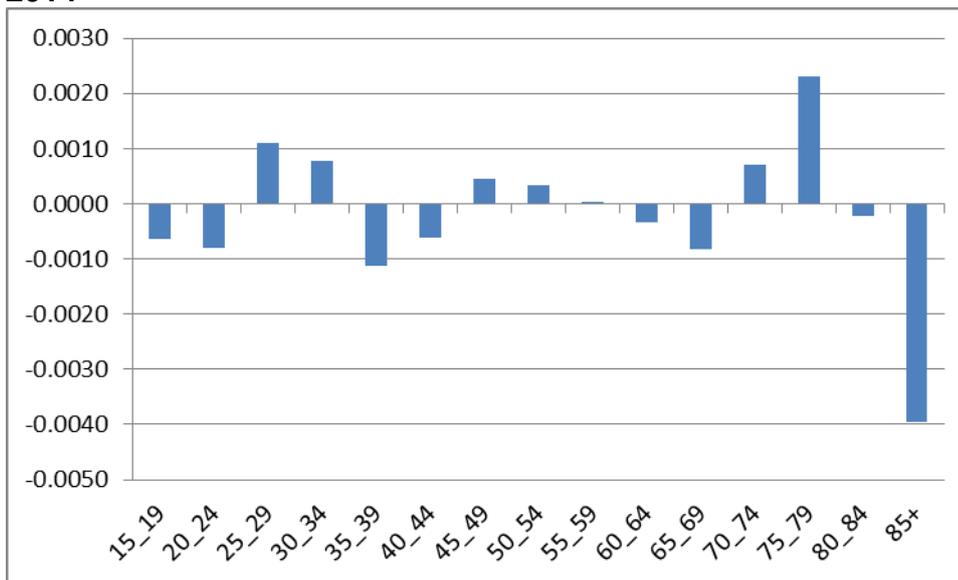
Adjustments are then made to all age and relationship status groups so that they move towards the smoothed LFS value with:

- a. The maximum weight of 50% to reflect uncertainty over accuracy and
- b. the LFS weight is linked to the time since the last census (the longer the time elapsed since the last census, the less time there is for household representative rates to get back on to trend).

For example in the 2014-based projections, the LFS data receives a 15% weight derived as the maximum weight (50%) multiplied by the time in years elapsed since the 2011 census divided by the maximum years between censuses (3/10). After 2014, the projections revert to the pre-LFS adjustment trends, reflecting the importance of retaining a view of long term trends. The post-2014 projections are not affected directly by the 2012 LFS adjustments.

The revisions, shown in Figure 5, are extremely small but the largest changes were to the household representative rates for males and females aged 75 to 79 and 85+.

Figure 5: Impact of the LFS adjustment on household representative rates by age in 2014



Source: DCLG

The overall impact is small and reduced the projected number of households in 2039 by 3,000 or 0.01 per cent compared to what would have been produced using the unadjusted household representative rates.

h. Regional and local projections

The Stage One household projections model uses a top-down approach with projections first produced at England level, then regional level and then finally local authority district level.

At the England level the process imposed the change in household representative rate by age in the LFS between 2002 and 2011 on to the 2011 Census point and incorporated other information from the Census 2011 as outlined above.

At the regional and local level the LFS data does not provide estimates which are considered robust enough to use the same approach as used at the national level. In consultation with the Steering Group when producing the 2011-based projections it was decided to control the 2008-based regional household representative rates to both the England 2011-based projections and to the Census 2011 aggregate household representative rate for each area. The same process was then repeated for the local authority areas, controlling the local household representative rates to the regional

household representative rates and the Census 2011 aggregate household representative rate. The same approach has been used for subsequent household projections, however the national, regional and local rates have been controlled to the aggregate Census 2011 household representative rates based on the adult household population. The 2011-based projections controlled to the total aggregate household representative rate (total household representatives/ total household population).

The process was to apply the regional 2008-based household rate to the regional 2014-based household population projection (and household population estimates between 2002 and 2013) by age, sex and marital status to produce a first cut set of Stage One household estimates and projections. The regional totals by age, sex and marital status were then controlled to the England totals by age, sex and marital status and the aggregate household representative rate by region from the 2011 Census to produce a final set of Stage One household projections by region. The process was then repeated at local authority level.

The regional and local controlling procedure adjusts the household projections so that there is consistency across spatial levels and in the age/ sex/ marital/relationship status composition of the population as given in the ONS resident population projections. Priority has been given to ensure internal consistency within a given area before consistency across demographic type at regional and national level. The controlling process ensured that the data is consistent across local authority level and demographic types to England totals by demographic type.

3. Stage Two

Summary

Stage 1 Household Projections provide household numbers by marital status and age. Trends in household formation by these groupings are derived from the '10 yearly' population censuses since 1971.

Stage 2 Household Projections provide household numbers by type (one person, couple, with/without dependent, multi-person) and age. Trends in household formation are based on the 2001 and 2011 Censuses.

The Stage 2 projections are constrained to the national and local authority total household numbers in the Stage 1 projections.

Stage 2 Household Types

The 'Household Projection' classification differs from the current standard ONS Census outputs. Commissioned Census tables were used to provide the best comparable information from the 1991 and 2001 Censuses. Previous Stage 2 projections used a '17 type' aggregation of households. This was not possible since the calculation of classification (which differs from the standard Census outputs classification) cannot be applied to the 2011 Census in a way that is consistent with the 2001 Census for all household types. A simplified '8 type' classification (B) (see table below) was agreed with ONS as the best for projecting trends, given the available data. The table also shows how the households are aggregated from the more complex classifications.

Numbers of household by the 8 types were derived from commissioned census tables: C1092 (2001 Census) and BD0105 (2011 Census).

Household Type Aggregations

	Aggregation (A) – Summary Categories	Aggregation
A1	One person (a person living alone who shares neither housekeeping nor a living room with anyone else)	B1,B2
A2	Couple and no other adult (a household which contains one family and no others, comprising of a married or cohabiting couple without dependent children)	B3
A3	Couple and one or more other adult (a household which contains one or more married or cohabiting couple families with one or more other adults present).	B4
A4	Households with dependent children	B5,B6,B7
A5	Other (other multi person)	B8
	Aggregation (B) '8 types' (6 + male and female one person) - 2012-based household	

	projections	
B1	One person households: male	C1
B2	One person female	C2
B3	One family and no others : Couple households : No dependent children	C3
B4	A couple and one or more other adults : No dependent children (2)	C10
B5	Households with one dependent child	CC4,C7,C11,C14
B6	Households with two dependent children	C5,C8,C12,C15
B7	Households with three or more dependent children	C6,C9.C13,C16
B8	Other households with two or more adults	C17
	Aggregation (C) '17 types': 2008 and 2011-based household projections	
C1	One person male	
C2	One person female	
C3	One family and no others : Couple households : No dependent children	
C4	One family and no others : Couple households : With one dependent child (1)	
C5	One family and no others : Couple households : With two dependent children (1)	
C6	One family and no others : Couple households : With three or more dependent children (1)	
C7	One family and no others : Lone parent households : With one dependent child (1)	
C8	One family and no others : Lone parent households : With two dependent children (1)	
C9	One family and no others : Lone parent households : With three or more dependent children (1)	
C10	A couple and one or more other adults : No dependent children (2)	
C11	A couple and one or more other adults : With one dependent child (2)	
C12	A couple and one or more other adults : With two dependent children (2)	
C13	A couple and one or more other adults : With three or more dependent children (2)	
C14	A lone parent and one or more other adults : With one dependent child (2)	
C15	A lone parent and one or more other adults : With two dependent children (2)	
C16	A lone parent and one or more other adults : With three or more dependent children (2)	
C17	Other households with two or more adults	
	(1) Households with dependent children and no non-dependent children. (2) In these categories, the other adults may include another couple and/or another lone parent and/ or a non-dependent child.	

Aligning definitional differences between Stage 1 and Stage 2

Stage 2 combines data with two different definitions of the household representative:

- The existing DCLG/ HOPS definition which is used in the Stage One projections – the oldest male then the oldest female if there is no male:
- The Census definition (introduced for the 2001 Census) – the eldest economically active person then the oldest inactive person if there is no economically active person.

The approach taken to 'accommodate' the different definitions was as follows:

- The 2001 distribution of households by 'Stage 2' types were aligned with the definitions in the 2001 Census by calculating the 2001 Census distribution of households by age and by 'couples' and 'non-couples'. This distribution was applied to the Stage 1 household estimates by couples and non-couples to derive the Stage 2 control totals. The 2001 Stage 2 household numbers by type were adjusted to be consistent with the control totals.
- The above process was repeated using '2011' data.
- The Stage 1 household totals remained the overall control total.

Stage 2 Projection Methodology

Stage 2 uses 2001 and 2011 Census data from commissioned tables aggregated into 8 household types (Aggregation B). The numbers of household reference persons and the household population for each grouping are used to derive the proportions of persons 'heading' and 'not heading' households. Trends in these rates are projected forward using a two-point exponential method.

Stage 2 works from the bottom up by projecting household numbers first at local authority level. These projections are, however, constrained to the Stage 1 totals.

The initial Stage 2 local authority level household projections are calculated by applying headship rates to the household population projections by age band to give an estimate of the number of heads of household for each household type and age band. These initial projections are then constrained to the 'Stage 1' household numbers.

The initial (unconstrained) Stage 2 projections are subject to the following checks and adjustments. These adjustments do not affect the total households projected within each local authority which is constrained to the Stage 1 projections. Any adjustments change the distribution across the household types.

- The **minimum number of adults** required to 'fill' the projected households is not greater than the projected private adult household population. This check is run successively at local authority, regional and national level.
- The **minimum number of dependent children** 'implied' by the projected household types does not exceed the numbers dependent children in the population projections. The 'implied' number of dependent children from the household projections is compared with the number of dependent children calculated from the population projections for each local authority. The number of households with children was adjusted, for each local authority, so that the ratio of the number of

independent children in the population projection to the number implied by the household projections is constant over the projection period. A ratio is used in the absence of information on the distribution of the number of children in households with three or more dependent children. The ratio assumes the distribution remains the same as the estimates for 2011. Without this adjustment the results would tend to underestimate the number of households with dependent children as a result of underestimating the number of households with 3 or more dependent children

4. Sensitivity testing and variants

Sensitivity testing

To help users, sensitivity tests have been performed by applying the 2014-based assumption of household formation to the 2012-based household population projections, which were used for the 2012-based household projections. A further sensitivity test has been performed by applying the 2012-based assumptions of household formation to the 2014-based household population projections. These sensitivity tests were run at local authority level to help users understand the impact of the changes to the population projections and the changes in household formation on the household projections. The results of the sensitivity tests for local authorities are available in live tables 429a and 429b.

Table 1: Sensitivity analysis results and 2014-based and 2012-based household projections

Projection	Variable	2012	2037	Total Change (000s)	Average Change (000s)	Percentage Change
2014-based Household Projections	Households (000s)	22306	27650	5343	214	24.0%
	Household population (000s)	52536	61472	8936	357	17.0%
	Average Household Size	2.36	2.22			
2014-based Household Projections using 2012-based population (Live Table 429a)	Households (000s)	22306	27534	5228	209	23.4%
	Household population (000s)	52536	60913	8377	335	15.9%
	Average Household Size	2.36	2.21			
2014-based household population and 2012-based household formation (Live Table 429b)	Households (000s)	22305	27664	5359	214	24.0%
	Household population (000s)	52536	61472	8936	357	17.0%
	Average Household Size	2.36	2.22			
2012-based household projections	Households (000s)	22305	27548	5244	210	23.5%
	Household population (000s)	52536	60913	8377	335	15.9%
	Average Household Size	2.36	2.21			

Variant projections

Variant household projections have been run alongside the main projection. These variant projections use the Office for National Statistics variant national population projections which demonstrate the effect of assumptions regarding fertility, life expectancy and net migration on future levels of population. The population variants are available at England level. Applying the household formation rates from the household projections to the variant population projections gave a broad indication of the sensitivity of the household projections to demographic assumptions at national level. Five variant projections have been run:

- High fertility
- High life expectancy
- High net migration
- Low net migration
- Zero net migration

Table 2: Variant household projections, based on variant 2014-based national population projections, England				
<i>Thousands</i>		Assumptions in population (England)	Number of Households in 2039	Average annual increase 2014-2039
	Principal	(a)	28,004	210
Fertility				
Long term average number of children per woman	High	2.10	28,026	211
Life expectancy				
Expectation of life at birth at 2037, years	High	Males: 86.2 Females: 88.9	28,456	228
Net migration				
	High	233,000	28,831	243
Long term annual migration	Low	108,000	27,177	177
	Zero Net	0	26,069	133

(a) Long-term principal assumptions in England 2014-based population projections

Fertility: Average number of children per woman: 1.90

Life expectancy: Expectancy of life at birth in 2039

Male: 84.4 Female 87.2

Long term annual net migration: +170,500

5. Uncertainty in the projections

As with any set of projections, the household projections are subject to error if any of the components – household population, relationship status or household representative rate – are wrong. Projections become increasingly uncertain the further they are carried forward due to the inherent uncertainty of demographic behaviour. This is particularly so for smaller geographical areas and detailed age, sex and type breakdowns.

The results from the Census 2011 showed that the 2008-based projections were overestimating the rate of household formation and support the evidence from the Labour Force Survey that household representative rates for some (particularly younger) age groups have fallen markedly since the 2001 Census. However, it has not been possible to include detailed data on Stage One household representative from the Census 2011. By imposing the change in household representative rates by age from the LFS onto the aggregate Census points in 2011 we are assuming that the aggregate trends observed in the LFS by age are correct. It is possible that the trends by age group were different to those observed in the LFS but at this stage it is not possible to quantify the differences. The changes in household representative rates between 2001 and 2011 have an impact on the projections of household representative rates, so if the decline in the household rate for a given age band has not been as great (or indeed greater) as suggested by the LFS then the projected growth rate would have been stronger than originally projected and vice versa.

The 2014-based household projections use the 2008-based marital status projections which have not been updated with the results from the 2011 Census. It is unlikely that updated marital status projections will be available in the future. The trends in marital status impact the projections of future household formation. However the scale of this impact has not been quantified as part of this update. The Stage One projections are designed to capture long-term trends in household formation and projections of these long-term trends are used to control the Stage Two projections by age and type. The projections for Stage Two do not depend on relationship status so the key factor here is to understand the sensitivity of the Stage One household projections to changes in relationship status.

There could also be cohort effects that are ignored by the current methodology. Recent falls in household representative rates for younger age groups may carry forward through a cohort process into older age groups in future years. If there is evidence in the future from the Census and the LFS of cohort effects then it would be necessary to consider whether introducing cohort effects into the model would improve the household projections – especially given the additional complexity and data requirements that this approach would entail.

6. Properties of the System

- The household representative rate method used to produce the projections has a number of basic characteristics that tend to shape the projections:
- All other things being equal, the higher the adult population the higher the number of households. Similarly, higher adult population growth means higher household number growth;
- For a given population, the number of households will be determined by the age, sex and marital status composition of the population;
- Household representative rates tend to be higher the higher the age band (figure 6 and figure 7);
- Because of the convention that the male is the household representative in couple households the household representative rates for males will be close to one for older age groups and zero for females.
- Singles' (never married) household representative rates tend to be below previously married rates for both sex and all age groups. The male and female under 30's singles household representative rates tend to be lower than the others and reflect a higher degree of living at home and sharing.
- Household representative rates for those aged between 40-44 to 65-69 tend to trend upwards over time though the scope of household representative rates that are already close to one is obviously more limited than those that are low.
- Household representative rates for male couples in younger age groups (35-39 and below) show gradual decline over time.
- Household representative rates for younger (35-39 and below) male singles and previously married tend to be flat over time.
- Household representative rates for younger females (25-29 and below) tend to be flat over time, whilst rates for single females aged 30-39 are rising over time.
- Socio-demographic events can have a marked impact on the number of households given the size of the population. These include the increase in marriage and divorce rates and the ageing of the population both of which will tend to increase household numbers relative to population.

Figure 6: Male Household Representative Rates in England (2014), 2014-based and 2012-based household projections

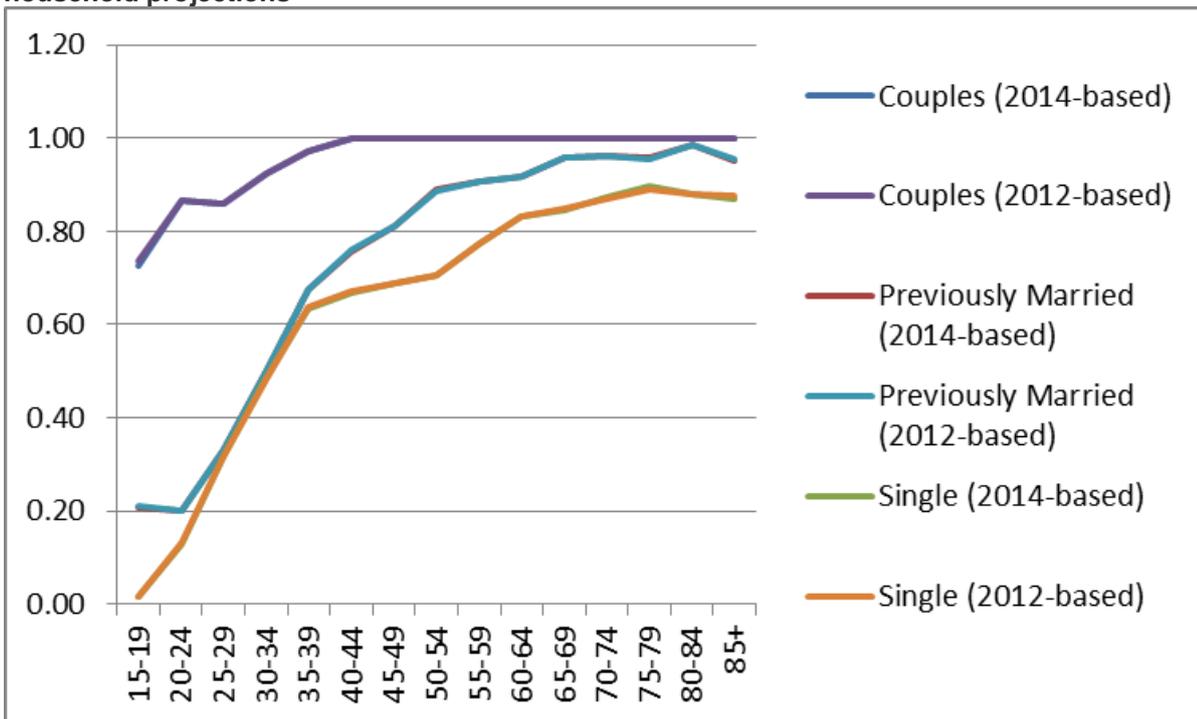
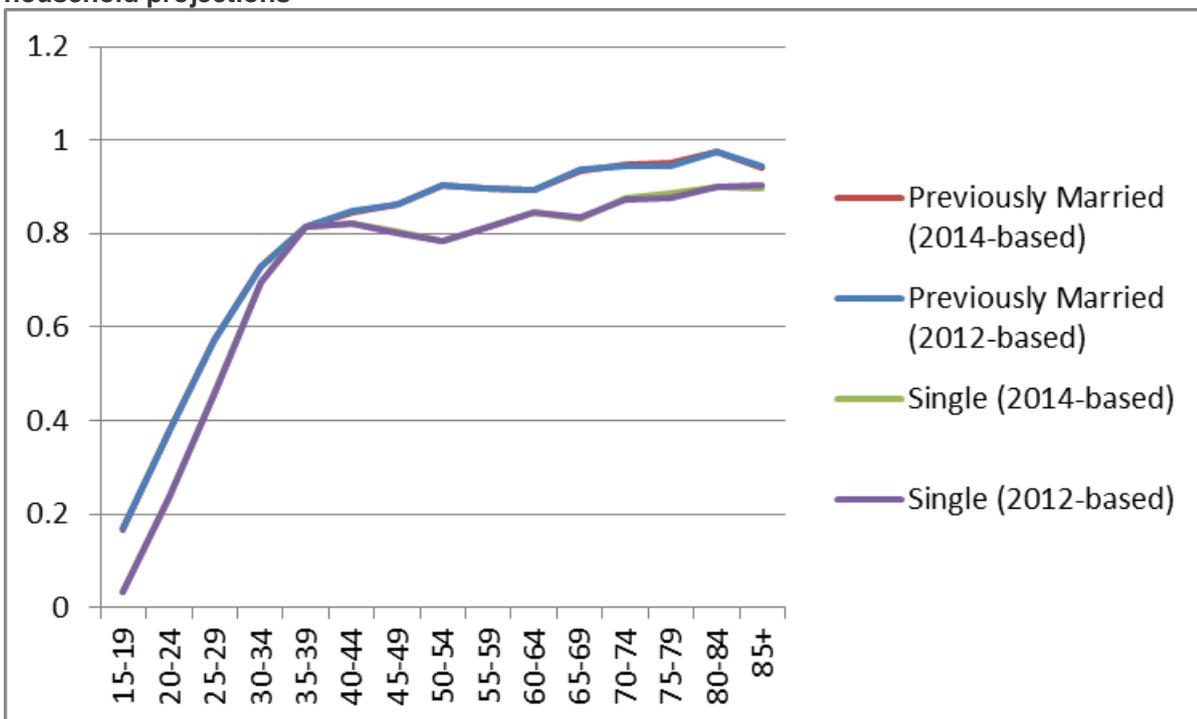


Figure 7: Female Household Representative Rates in England (2014), 2014-based and 2012-based household projections



7. Glossary

Average Household Size – The average household size is the average number of people within a private household (including children). It is calculated by dividing the household population by the number of households for a given geography and/or age group.

Communal Population – The communal population (also known as the institutional population) includes all people not living in private households; such as medical establishments (for example hospital, sheltered housing, and care homes), educational establishments (schools and university), military, religious and detention facilities, and those living in temporary accommodation.

Dependent Child – A dependent child is a person in a household aged 15 and below or aged between 16-18, single, still in full-time education and living with parent(s)/guardian(s).

Headship Rate – The proportion of individuals in a specific group considered the head of household. The variables defining each group are; geography, age group, sex and household type. The formula differs from the household representative rate as it uses the variable of household type, rather than relationship status.

Household – The definition of a household in the 2011 Census was:

‘one person living alone; or a group of people (not necessarily related) living at the same address who share cooking facilities and share a living room or sitting room or dining area’.

This was a change from the 2001 Census to take into account social changes and modern living arrangements. Previously the 2001 definition was:

‘one person living alone or a group of people (not necessarily related) living at the same address with common housekeeping – that is, sharing either a living room or sitting room or at least one meal a day’.

This change was not considered significant enough to realign the data to the old definition.

Household Formation Rate – This is the same as the headship rate and household representative rate.

Household Population – The household population is the total population after the communal population has been removed.

Household Reference Person – The Household Reference Person (previously known as Head of Household or Household Representative) is the individual that is taken to represent the household for statistical purposes. The definition of the household reference person has changed over time from being the eldest male within a household to the eldest economically active person within a household.

Stage One household projections have historically used the eldest male definition.

Stage Two household projections use the current Census definition of eldest economically active person in the household as the household reference person.

More detail is provided in the article [*Defining a Household Representative Person*](#) by Jean Martin.

Household Representative Rate – The household representative rate is the probability of a person from a specific demographic group (based on geography, age group sex and relationship status) being considered the household reference person. The value of the household representative rate will be between 0 and 1. The formula differs from the headship rate as it uses the variable of relationship status, rather than household type.

Household Type – The Household Type (also known as the Household Composition) classifies each household by the number of adults and children living within it and the nature of those relationships. It is divided into five categories, of which there are 17 sub-categories, depending on the number of dependent children within a household.

Living Arrangements – The living arrangements variable in the 2011 Census is divided into two categories and seven sub-categories. These are initially divided on the whether the household representative person is living in a couple in the household, before subdividing into further marital status definitions. These were considered consistent with previous household projections, which categorised the Stage On demographic groups into; single, married (or co-habiting) and previously married.

Other Households – This is a household type within Stage Two of the household projections. This category is of multi-person households and will contain the majority of adults living in house shares.

Total Population – The total population is all usually resident population in the UK based upon their local authority residence, whatever their nationality.