

# Behaviour change and infrastructure beyond Covid-19

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Technical annex: scenario  
development methodology



# Scenario development methodology

**This annex sets out further details of the scenario development methodology which underpins the analysis on the impact of behaviour change due to Covid-19 on long term infrastructure demand.<sup>1,2</sup>**

The annex focuses on the process for developing qualitative scenarios including the core principles followed, and how key underlying trends that affect infrastructure demand were identified and packaged into scenarios. There are also full descriptions of the five scenarios, including overarching narratives and descriptions of the nature and intensity of the underlying trends.

In summary the Commission:

- took a scenario based approach to understanding the impacts of behaviour change following the Covid-19 pandemic on long term infrastructure demand, consistent with the first *National Infrastructure Assessment* and best practice
- used four principles to underpin scenarios which are plausible and coherent, and test a spread of possible futures
- developed five scenarios which test different intensities of underlying trends – working patterns, social wariness, dispersal from cities, and use of virtual tools for shopping and other activities.

## Background

### A scenario-based approach

The Commission has taken a scenario based approach to understanding the impacts of behaviour change following the Covid-19 pandemic on long term infrastructure demand. This is consistent with the Commission's first *National Infrastructure Assessment*, which took a scenario based approach to understanding the impact of key 'drivers' (population, economic growth, technology, environment and climate change) on future infrastructure supply and demand.<sup>3</sup> It is also consistent with international best practice in strategic infrastructure planning as set out in a report by the International Transport Forum at the OECD, which also helped to inform the Commission's first *National Infrastructure Assessment*.<sup>4</sup>

A scenario based approach to analysis of future infrastructure demand means policy and decision makers can prepare for a range of possible futures within a long term strategic framework, maintaining optionality and flexibility until it is clearer how things will settle. Taking strategic or financial decisions can be hard in an environment of uncertainty. Not deciding or postponing decisions – either to do more analysis or to wait until there is more certainty – is still a decision.<sup>5</sup>

Scenarios are a set of possible outcomes, including a narrative of how and why such outcomes would occur. The use of a scenario based approach is useful when uncertainties cannot be properly described with quantitative probability distributions. Using scenarios will not eliminate uncertainty. Scenarios instead help to map out, analyse and sometimes quantify very specific uncertainties that are important to help make decisions. They can clarify how possible outcomes would affect the criteria for making those decisions.<sup>6</sup>

## Core principles

The Commission adopted the following principles in developing scenarios of behaviour change.

- **The scenarios are based on a range of different behavioural responses, to help understand how behaviour and behaviour change can drive changes in infrastructure.** The different scenarios are fundamentally based around different plausible behavioural responses that could be expected following the pandemic. The associated infrastructure impacts of these responses should be understood as outputs, rather than defining the scenarios.
- **The scenarios cover a plausible range of future behaviour.** The scenarios do not seek to cover the full range of possible future behaviour however unlikely, nor have too narrow a focus on predicted future behaviour given the level of uncertainty. Instead a range of scenarios that are within plausible expectations of how behaviour may change based on evidence and theory are used.
- **The scenarios form coherent packages of futures, based on underlying interactions between behavioural trends.** There are many possible permutations of how various potential behavioural trends may develop. However, the trends are likely to interact with each other (e.g. working patterns and household location). Each scenario forms a coherent picture of a plausible future across all activity and properly considers both the direct and indirect interactions between behavioural patterns.
- **The scenarios help to estimate impacts on infrastructure demand, as well as enable more detailed modelling of sector demand.** The scenarios form a basis for quantitative modelling of future infrastructure demand across the key sectors. The scenarios enable high level quantitative implications to be directly drawn and form the basis of more in depth quantitative analysis.

## Developing the scenarios

### Identifying cross-cutting and sector trends

To develop the scenarios, the Commission identified twenty five potential behavioural trends that directly impact infrastructure demand. These were developed through a mixture of desk-based research, and engagement with internal sector experts within the Commission, external stakeholders and the expert panel.

For each trend, evidence and data was gathered on:

- the historic direction pre Covid-19
- the short term impact during the pandemic

- dependencies with other trends that affect infrastructure demand, as well as individual and social behaviours set out in behaviour change theory.

The trends are split into two groups – ‘cross-cutting’ and ‘sector’ trends. Cross-cutting trends are trends that are likely to affect multiple infrastructure sectors. Examples include:

- **office replaced by homeworking:** Increase in full-time remote working leads to reduction in need for office space and commuting across all locations (C02, see table 1)
- **social gathering:** Permanent reduction in public willingness to gather in social groups whether at home or elsewhere, as habits formed during the pandemic lead to a cultural shift in terms of leaving the house or organising crowded gatherings (C07).

Sector trends are specific to the infrastructure sectors within the Commission’s remit – Digital (D), Energy (S), Waste (S), Transport (T) and Water and wastewater (W). Flood risk, also in the Commission’s remit, is assumed not to be directly affected by changes in behaviour due to Covid-19. Examples of sector trends include:

- **domestic energy:** Increase of time spent at home leads to an increase of per capita domestic energy use (E01)
- **car uptake:** Increased use of cars, as a substitute for public transport and as a result of habits formed during the pandemic enduring (T02).

Table 1 provides the full list of these trends.

**Table 1: list of potential cross-cutting and sector trends**

Trend name	Example direction of change due to behaviour change
C01 Flexible working from home	Increased awareness and acceptance of remote working leads to permanently higher uptake of working from home on a part-time basis.
C02 Office replaced by home working	Increase in full-time remote working leads to reduction in need for office space and commuting across all locations.
C03 Workplaces in city centres	Employers take advantage of increased remote working to move office locations to places outside city centres, especially suburbs and outskirts.
C04 Workplaces in dominant regions	Employers take advantage of increased remote working to move away from ‘dominant’ regions towards other cities. Dominant regions are areas with the highest levels of employment growth in recent decades and high living costs (e.g. London).
C05 Urban population in city centres	People take advantage of increased remote working to move away from city centres towards suburban or scattered locations.
C06 Urban population in dominant regions	People take advantage of increased remote working to move away from ‘dominant’ regions towards other cities. Dominant regions are areas with the highest levels of employment growth in recent decades and high living costs (e.g. London).

Trend name	Example direction of change due to behaviour change
C07 Social gathering	Permanent reduction in public willingness to gather in social groups whether at home or elsewhere, as habits formed during the pandemic lead to a cultural shift in terms of leaving the house or organising crowded gatherings.
C08 Shift to online for shopping	Increased preference for shopping online, with reduction in visits to physical stores.
C09 Hospitality and entertainment	Changing attendance at cultural and social activities (regardless of location) including performance, dining, drinking and night-time economy, as a result of new habits and through ongoing perception of infection risk.
C10 Local suburban economic activity uptake	Increase in economic activity within a smaller radius from people's homes, particularly in suburban or outlying areas, as a substitute for city centre shopping and entertainment.
C11 Online and flexible education adoption	Parents that work flexibly enrol children to flexible schooling programmes and/or adults enrol for remote study University programmes or short courses, as they become more common through the prevalence of digital platforms.
C12 Business trips	Workers reduce the number of business trips they make as physical meetings become less essential and are replaced by virtual meetings.
C13 Overseas and air travel	People actively avoid confined spaces for extended periods of time, which leads to reduced overseas travel and development of internal tourism habits.
D01 Demand for internet capacity	Increased usage of digital services leads to increase in volume of data (download and upload), and demand for services offering higher levels of capacity.
E01 Domestic energy	Increase of time spent at home leads to an increase of per capita domestic energy use.
E02 Commercial energy	Decrease of time spent in office and decrease of hospitality consumption leads to a decrease of commercial energy consumption.
E03 Change in energy use pattern	Shift to working at home leads to change in patterns of energy use throughout the day.
S01 Business waste	Decrease of time spent in office and decrease of hospitality consumption leads to a decrease of business waste generated.
S02 Domestic waste	Increase of time spent at home leads to an increase of domestic waste generated.
T01 Public transport use	Ongoing reduction in attractiveness of public transport, as a result of habits formed during the pandemic and enduring perception of general risk of infection.
T02 Car uptake	Increased use of car, as a substitute for public transport and as a result of habits formed during the pandemic enduring.

Trend name	Example direction of change due to behaviour change
T03 Cycling uptake	Increased use of cycling as transport, due to increased localisation of trips, as a substitute for public transport and as a result of habits formed during the pandemic enduring.
T04 Walking uptake	Increased use of walking as transport, due to increased localisation of trips, as a substitute for public transport and as a result of habits formed during the pandemic enduring.
W01 Domestic water use	Increase of time spent at home leads to an increase of per capita water use.
W02 Commercial water use	Increase of time spent at home leads to a decrease in commercial water use.

## Underlying trends

Testing all possible permutations of cross cutting and sector trends is impractical as it would lead to a very large number of theoretical scenarios. The Commission therefore developed a shorter list of underlying trends that influence the longer list of cross-cutting and sector trends. These have been identified as the key drivers of behaviour change that affect a range of actors, primarily individuals, households and businesses.

The underlying trends are defined as follows:

- **working from home:** inclination of people and businesses (i.e. employers and employees) to adopt flexible working and/or homeworking
- **social wariness:** people being more cautious to participate in gatherings which involve being in close proximity to others
- **dispersal from cities:** inclination of people and businesses to locate in less densely populated areas, the opposite of the long term trend towards urbanisation and densification
- **use of virtual tools:** potential uptake of online and virtual activities in social, leisure, education, shopping and other activities.

These underlying trends are highly relevant to infrastructure demand, necessarily focusing on the impact on urban centres, transport and digital connectivity. However, these trends do not reflect the full scope of possible behaviour change.

## Scenario selection

The Commission's analysis considers five scenarios which provide a reasonable spread of possible outcomes and test different combinations of behaviour responses, in line with the principles set out above.

The scenarios are made up of plausible combinations and intensities (e.g. low, medium, high) of underlying trends. In developing the scenarios, the Commission considered how the underlying trends interact depending on their intensity. The theoretical number of scenarios is large because the combination of underlying trends can vary by intensity (low, medium and high) and variations within these (e.g. high homeworking could mean different combinations of flexible and homeworking among different occupations).

However, the interaction between underlying trends limits the number of plausible scenarios. For example:

- higher uptake of virtual tools is influenced and limited by the extent of social wariness and flexible or home working
- dispersal from cities is a function of the importance of cities and urban areas for living and working, as higher adoption of flexible and home working and higher social wariness could lead to a decline in the importance of cities, meaning households may decide to move to suburban or rural areas.

However, these interactions do not necessarily preclude scenarios where underlying trends may work together or in opposition, provided this is justified by the combination of trends as a whole and the accompanying narrative. A scenario based approach means testing different states of the world which may involve novel mixtures of underlying trends, especially in the absence of credible estimates or probability distributions of uncertainty.<sup>7</sup>

As such, the selected scenarios focus on the following:

- exploring scenarios with low and high intensities in the underlying trends
- using combinations of mixed intensities in the underlying trends to challenge assumptions about the relationships between workplaces and social wariness, and workplaces and population dispersal.

## **Underpinning assumptions**

To underpin the plausibility of these scenarios, two additional assumptions were made. These set a reasonable boundary for what might occur in all scenarios, which is less than the maximum conceivable change.

Firstly, the extent of possible behaviour change is limited to a 'broader group' of actors (e.g. households, employees, employers) who have some or all of the necessary conditions to potentially adopt behaviour change(s). Of these, there is a sub-group who have the conditions in place to fully realise and maintain behaviour change long term. This is in line with the behaviour change theory and the impacts of Covid-19 to date set out in chapters one and two of the main report.<sup>8</sup>

Using working from home as an example:

- the broader group is defined as those that have been able to work consistently from home during the pandemic (i.e. not 100 per cent of all employers and employees), and is limited to certain types of occupations. The data shows that almost half of all UK employees doing at least some work at home in April 2020.<sup>9</sup> In March 2021, one year after the introduction of social distancing measures, 30 per cent of employees were working from home exclusively and 12 per cent occasionally.<sup>10</sup>

- the sub group are those would are able to fully realise flexible and homeworking, and are a sub set of the broader group (those who have worked from home during the pandemic). Various factors restrict higher uptake of flexible working and home working within the broader group (e.g. need for face-to-face interaction with people or processes, lack of buy-in from employers on benefits of flexible and homeworking).

Secondly, population mobility is not unlimited. Following the above, the modelling assumes that economic factors such as the cost of living (particularly property prices) and longer term trends towards urbanisation and densification will limit locational choices of households and businesses in future. It assumes that following a behaviour change these economic factors would adjust to a new steady-state (e.g. households moving to the suburbs and rural areas would push up demand and prices of property, but the opposite would also be true of more urban areas). This therefore acts as a limit on the extent dispersal from cities that would likely occur.

This is in addition to the broader group and sub-group concepts, which limits the number of households who would consider moving location due to changes in working patterns, although other households may consider moving location for reasons driven by other underlying trends. The Commission recognises there may be longer term policy changes that may relax this assumption to an extent (e.g. more housebuilding allowed in rural areas to meet permanently higher demand).

**Figure 1** (page ten) presents a logic chain that summarises the scenario development process outlined in this section of the annex.

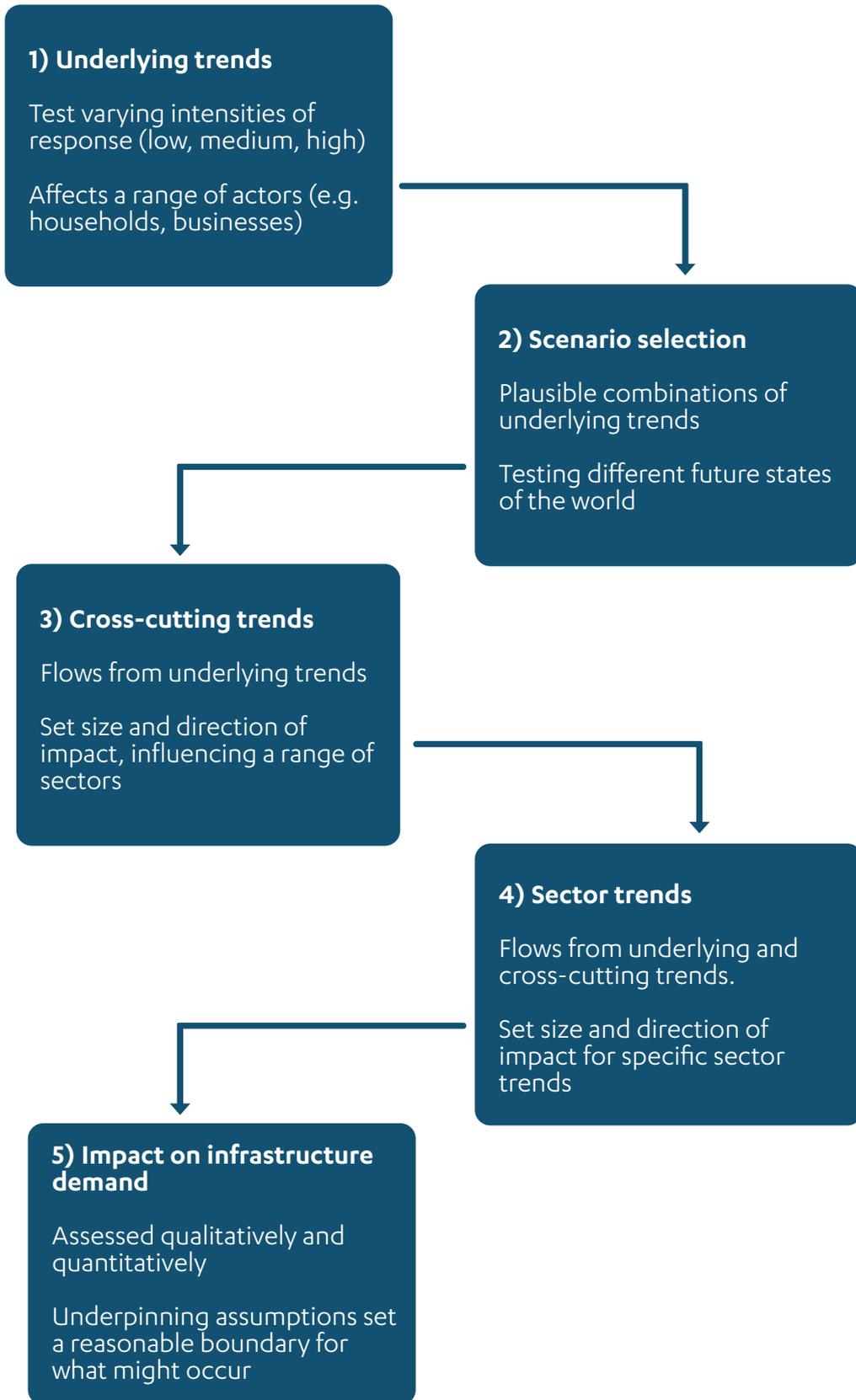
## Qualitative scenario descriptions

This section sets out the full descriptions of the five scenarios:

1. Reversion and reaction
2. A more flexible future
3. Low social contact urban living
4. Social Cities
5. Virtual local reality.

For each scenario, there is a description of the overarching narrative, and a description of the intensity and nature of each underlying trend. These are presented on pages 11 to 15, with each scenario presented on a standalone page for presentational purposes.

Figure 1: scenario development logic chain



## Scenario 1: Reversion and reaction

The world reverts to a state similar to 2019, but there is also a reaction to the significant restrictions on everyday life experienced under Covid-19. People realise that activities such as homeworking or online entertainment are not as effective or fulfilling as ones that involve physical presence among other people. For example, there is only a limited adoption of flexible working and working from home.

Underlying trend	Intensity and description
<b>Working from home</b>	<b>Low.</b> Office-based working is maintained for people and businesses but with a very limited increase in flexible working and homeworking compared to before. This also includes a slight increase in the adoption of virtual events or conferences with third parties.
<b>Social wariness</b>	<b>Low.</b> People are generally happy to be in large gatherings in most contexts (indoor and outdoor). Behaviours developed during the pandemic, such as reduced willingness to use public transport, are not maintained.
<b>Dispersal from cities</b>	<b>Low.</b> Centralisation continues in line with permanent but limited increases in flexible and home working. People still desire to be close to urban centres for access to workplaces and amenities. London and other major cities continue to be important hubs for people to work and socialise.
<b>Use of virtual tools</b>	<b>Low.</b> Existing trends, such as online shopping, do not continue the same trajectory as before the pandemic. Instead, they peak in 2019 as there is a premium on being with others or having face to face contact in response to the significant restrictions on socialising during the pandemic.

## Scenario 2: A more flexible future

Flexible working is adopted within a sub group of employers and employees (i.e. where it is practical and feasible to do so). This is a result of people’s preference for a more flexible lifestyle, that still involves a significant amount of social engagement. City centres continue to be important hubs for people to work and socialise, however increased flexible working somewhat flattens the distribution of public transport use across the working day and week. Both urban and suburban areas continue to be key areas for living.

Underlying trend	Intensity and description
<b>Working from home</b>	<b>Medium.</b> Flexible working is adopted within a sub-group of employers and employees. The vast majority of employees are expected to come into the office a few days a week (1-2 days). Virtual events or conferences with third parties become increasingly common as well.
<b>Social wariness</b>	<b>Low.</b> People are mostly happy to gather in large groups in most contexts, both indoors and outdoors. While public transport use is lower, people are no longer as reluctant to use it as during the pandemic.
<b>Dispersal from cities</b>	<b>High.</b> Due to flexible working, there is higher demand for suburbanisation; however, people still maintain proximity to city centres to access workplaces and amenities. Some households that are able to (and in the sub-group) will relocate within the same city region but move further away from the city centre.
<b>Use of virtual tools</b>	<b>Medium.</b> Existing trends, such as online shopping, accelerate. Due to increased flexible working, there is also an increase in virtual activities in other domains, such as education and other public services, leisure, and social. This is counteracted by low social wariness, causing people to maintain face to face contact with others.

### Scenario 3: Low social contact urban living

Office-based working bounces back, with a modest increase in flexible working. This is a result of employers' perception of office presence as a more productive way to work, combined with establishing the right measures for their employees' safety. However, social wariness is permanently higher with certain habits formed during the pandemic sticking, and as a result, there is a greater uptake of virtual activities across all domains.

Underlying trend	Intensity and description
<b>Working from home</b>	<b>Low.</b> Office-based working is maintained, but with a modest increase in flexible working within a small sub-group of employers and employees compared to before. Higher social wariness means some changes are made to the office so that employees feel comfortable and safe coming into the office as frequently as they did pre-pandemic (e.g. end to hotdesking, better ventilation, use of active travel). Offices offer a separation between home and work life, which was largely absent during the pandemic. There is also a modest increase in the adoption of virtual events or conferences with third parties.
<b>Social wariness</b>	<b>High.</b> Social wariness is permanently higher with certain habits formed during the pandemic sticking. With respect to travel behaviours, people avoid public transport in favour of driving and other modes (e.g. active travel) where possible and avoid public transport during peak times. If people do use public transport, they will usually wear face masks. People also reduce socialising – particularly large indoors gatherings. Where necessary, people significantly prefer outdoor settings over indoor ones for certain activities.
<b>Dispersal from cities</b>	<b>Low.</b> Centralisation continues in line with permanent but modest increase in flexible working. People still desire to be close to urban centres for access to workplaces and amenities.
<b>Use of virtual tools</b>	<b>High.</b> Existing trends, such as online shopping accelerate. Permanently higher social wariness spills over into an increase of virtual activities in other domains, such as social, leisure, education and public services. People avoid face to face contact with others except with a trusted circle of family and friends.

## Scenario 4: Social Cities

Homeworking is adopted at a high level among employers and employees who are practically able to do so. Employers benefit from cost savings from less office space, and employees prefer a homeworking lifestyle. However, although the demand to change location by households (in the sub group that are able to) may increase, the ability to do so is too constrained by economic factors to be realised for all but a very small minority. In addition, people prefer to be socially active and are not anxious about large gatherings, which means central urban areas and other hubs are still important places for leisure and socialising. This leads to noticeable changes to city centres and other office hubs, with changing travel patterns (e.g. flattening the distribution of public transport use across the working day and week). The decline in permanent office space is somewhat offset by growth in other amenities/uses.

Underlying trend	Intensity and description
<b>Working from home</b>	<b>High.</b> When certain conditions are met, a sub-group of employers and employees prefer and are practically able to work from home or remotely, in general. These businesses significantly reduce their office space as virtually all meetings and work events are done online. Businesses may maintain a touch-down office presence, or hire space, for important meetings and social events.
<b>Social wariness</b>	<b>Low.</b> People are generally happy to be in large gatherings in most contexts, both indoor and outdoor. While public transport use is lower, people are no longer reluctant to use it compared to during the pandemic.
<b>Dispersal from cities</b>	<b>Low.</b> There is an increase in demand from households (part of the sub-group) who wish to change location due to permanent homeworking. However, the ability to do so is too constrained by economic factors, so the extent of household movement is extremely limited. In addition, there is a continued desire to be close to urban centres for socialising and amenities. The net effect is that there is noticeable impact on city centres from the decline in permanent office space which is somewhat offset by growth in other amenities/uses. Local amenities also grow more important due to permanently higher homeworking.
<b>Use of virtual tools</b>	<b>Medium.</b> Existing trends, such as online shopping, accelerate. There is still a premium on face to face contact with others for social events, but successful transition to virtual working spills over into an increase of virtual activities in other domains, such as social, leisure, education and other public services.

## Scenario 5: Virtual local reality

Homeworking is adopted at a high level among employers and employees who are practically able to do so (i.e. those in the sub-group). Employers benefit from cost savings from less office space, and employees prefer a homeworking lifestyle. However, social wariness is permanently higher with certain habits formed during the pandemic sticking. People radically alter how they live (and to a smaller extent where), and significantly reduce travel as a result.

Underlying trend	Intensity and description
<b>Working from home</b>	<b>High.</b> Homeworking is adopted at a high level among employers and employees who are practically able to do so (i.e. those in the sub-group). These businesses significantly reduce their office space as virtually all meetings and work events are done online. Businesses may maintain a touchdown office presence, or hire space, for important meetings and social events.
<b>Social wariness</b>	<b>High.</b> People maintain heightened wariness of large gatherings indoor and smaller settings such as pubs and public transport (which is largely avoided in favour of other modes such as cars and active travel), but are more comfortable in outdoor settings.
<b>Dispersal from cities</b>	<b>High.</b> There is high demand from households (mostly in the sub-group) to live away from city centres in the suburbs and rural areas (suburbanisation) or re locate to other city regions (regionalisation). Economic factors constrain the amount of population movement that is realised, as does the supply of housing in areas where it is typically scarce (e.g. rural). However, there is still a noticeable impact on city centres nonetheless due to a decline in their importance for working and socialising. Certain local amenities will grow significantly in importance as a result (local greenspaces, local shops such as supermarkets, takeaway restaurants and cafes) while others are likely to decline (sit-in pubs and restaurants, stores where products can be purchased online). Activities for which there are no online alternatives, such as haircuts, become more common in local areas than city centres.
<b>Use of virtual tools</b>	<b>High.</b> Virtual activities are embraced highly across all domains. People avoid face-to-face contact with others except with a trusted circle of family and friends.

## Endnotes

- 1 National Infrastructure Commission (2021), [Behaviour change and infrastructure beyond Covid-19](#)
- 2 Steer (2021), [Infrastructure Demand Quantitative Analysis for Scenarios of Behaviour Change](#)
- 3 National Infrastructure Commission (2015), [Congestion, Capacity, Carbon: priorities for national infrastructure - Modelling Annex](#)
- 4 International Transport Forum (2016), [Strategic Infrastructure Planning: International Best Practice](#)
- 5 International Transport Forum (2016), [Strategic Infrastructure Planning: International Best Practice](#)
- 6 International Transport Forum (2016), [Strategic Infrastructure Planning: International Best Practice](#)
- 7 International Transport Forum (2016), [Strategic Infrastructure Planning: International Best Practice](#)
- 8 National Infrastructure Commission (2021), [Behaviour change and infrastructure beyond Covid-19](#)
- 9 Office for National Statistics (2020), [Coronavirus and homeworking in the UK](#)
- 10 Office for National Statistics (2021), [Coronavirus and the social impacts on Great Britain](#)

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