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Cost-benefit analysis on full 5G – UK market summary

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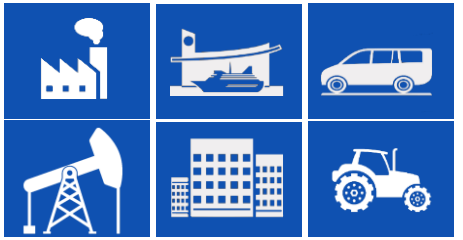
The study focused on evolution to standalone, virtualised 5G architectures to expand 5G uses with low-latency, ultra-reliable use cases, consistent with 'full 5G'

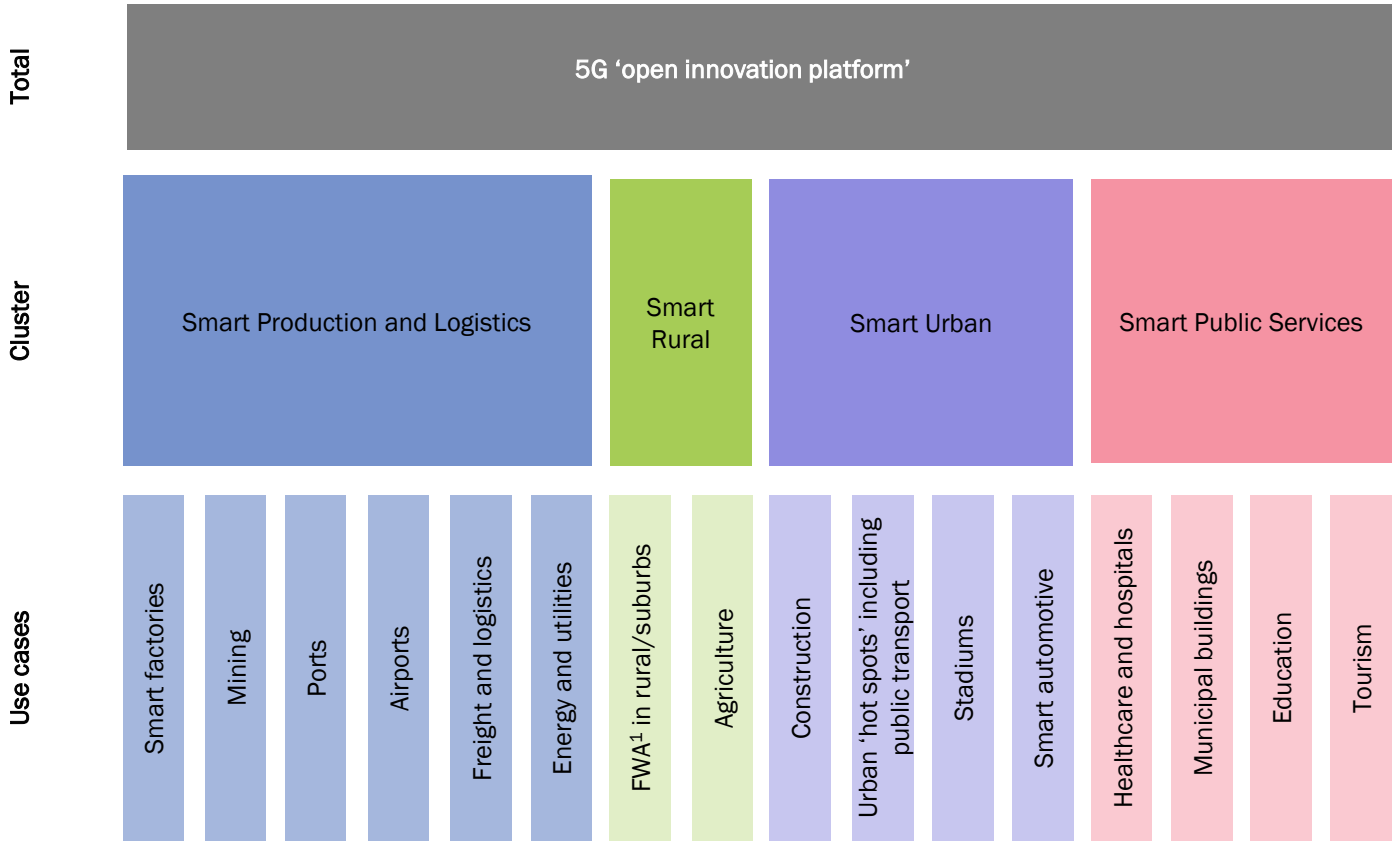
	4G/LTE and LTE-A	Initial 5G	Full 5G[1]
Devices	 User-friendly smartphones, and the development of the app market, significantly increased consumer data needs – some operators have launched 4G+ services to increase peak and average network speeds	 With initial 5G services focusing on the consumer market, devices are similar to the devices used in 4G+, including smartphones, tables and portable gaming devices – with pre-commercial showcases of ultra-reliable use cases	 Full 5G capabilities will significantly broaden the uses of 5G networks into multiple verticals with new applications enabled through end-to-end slicing (e.g. collaborative robots, automated machinery, autonomous transport) and new spectrum (incl. mmWave)
Types of usage (Data intensity ↓)	Email, Apps, Web browsing, Video streaming, VoIP, TV, Cloud robotics, Automation, Real-time video, AR/VR	Email, Apps, Web browsing, Video streaming, VoIP, TV, Cloud robotics, Automation, Real-time video, AR/VR	Email, Apps, Web browsing, Video streaming, VoIP, TV, Cloud robotics, Automation, Real-time video, AR/VR

Note: In July 2020, Vodafone was the first MNO in the UK to showcase standalone 5G technology. Some MNOs in other European countries have also confirmed standalone deployments in 2020 (e.g. Vodafone n several markets, Deutsche Telekom, Telenor and Elisa)

[1] Analysys Mason, Ericsson (https://www.ericsson.com/en/blog/2020/4/reducing-mobility-interruption-time-5g-networks) and Qualcomm (https://www.qualcomm.com/invention/5g/cellular-v2x)

As the basis for modelling, we developed a framework of full 5G as an 'open innovation platform' supporting clusters of cross-sector uses and environments

Overview of the 5G open innovation landscape considered in the study



Full 5G networks can support a wide range of possible innovations in different market and industrial sectors, which collectively can be considered as an overall 'open innovation platform'

It is useful to aggregate similar use cases into 'clusters' to align with different policy themes and provide results which can be more easily interpreted

The individual use cases form the foundations of the cost–benefit analysis, and provide structure for the various input assumptions and data sources.

[1] Fixed-wireless access

Source: Analysys Mason

Our cost–benefit approach compares the economic benefits to the additional costs of the new use cases via full 5G, beyond that of eMBB built on existing 4G networks

Overview of the cost–benefit modelling approach

- The study aims to compare the costs and benefits of new uses cases for 5G
- The study assesses the social, environmental and economic benefits of the clusters of use cases, with quantified estimates of economic benefit
  - the **quantitative** cost–benefit analysis conducted in the study considers the economic benefit of clusters (by considering the GDP of a sector which is connected to a particular use case and then an uplift due to improved productivity from having bespoke 5G connectivity) against the costs of delivering capacity/coverage for these different clusters
  - social and environmental benefits are considered on a **qualitative** basis
- The model considere the costs and benefits across all countries in Europe, separately modelling the costs and benefits for each
  - This summary focusses on results for the UK market

The reference case

- We consider several alternative deployments involving different spectrum, including localised deployment using mmWave, with modelling estimates for the UK market reflecting anticipated availability of spectrum in each band
- The modelling considers the costs additional to what would be incurred by an initial commercial roll-out of 5G enhanced mobile broadband (eMBB), which is already being commercially deployed in the UK[1]
- The study considers the additional costs for providing new use cases beyond eMBB, and these additional costs are compared against the benefits of those use cases

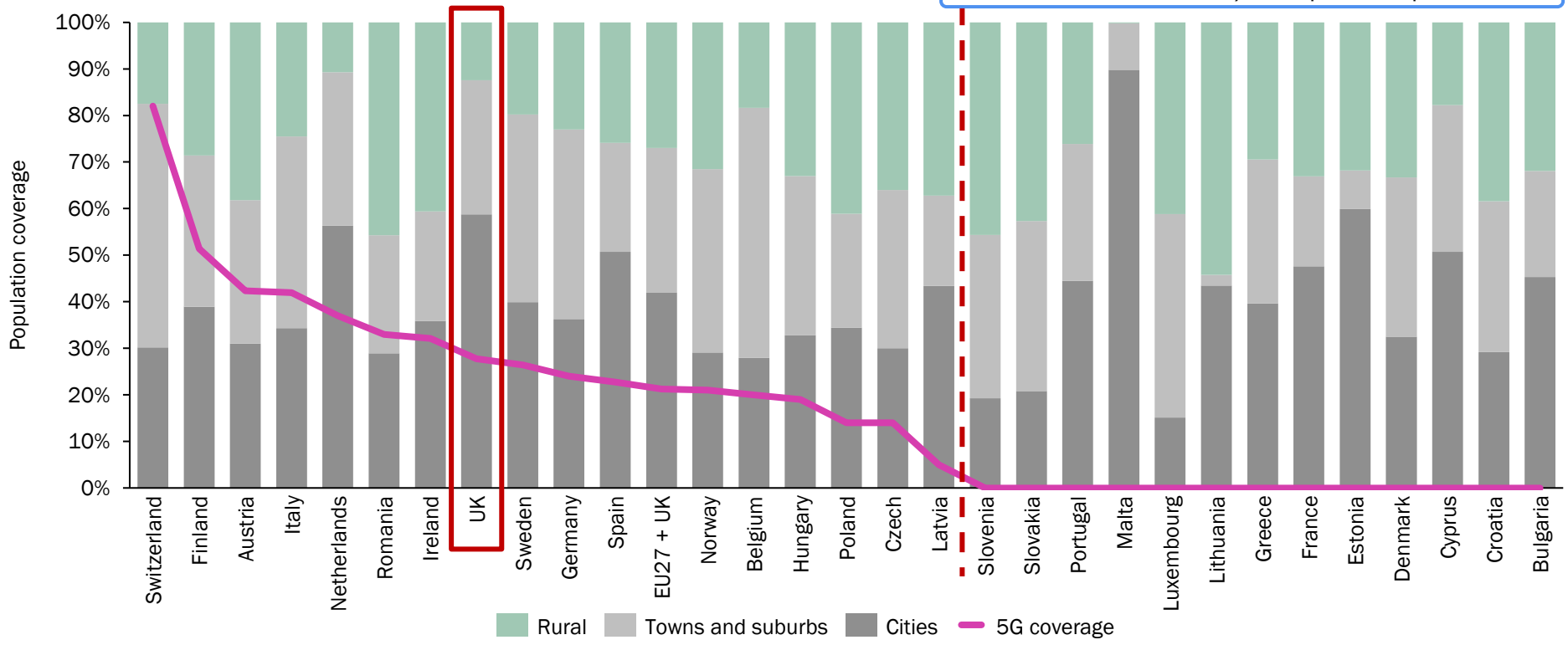
[1] As discussed subsequently, 5G is assumed to be deployed commercially on all existing sites by 2025 (via low-frequency spectrum), with higher-frequency 5G spectrum deployed on a subset of existing sites

Source: Analysys Mason

We have estimated 5G population coverage in the UK to be c.30% as of Q2 2020; this is around the average for European countries where 5G has been launched

5G coverage progress in Europe, Q2 2020, © GSMA Intelligence 2019/20

As per Ofcom's published data, full geographic coverage of 4G is not available in the UK but existing initiatives (e.g. Shared Rural Network) will improve this picture[1]



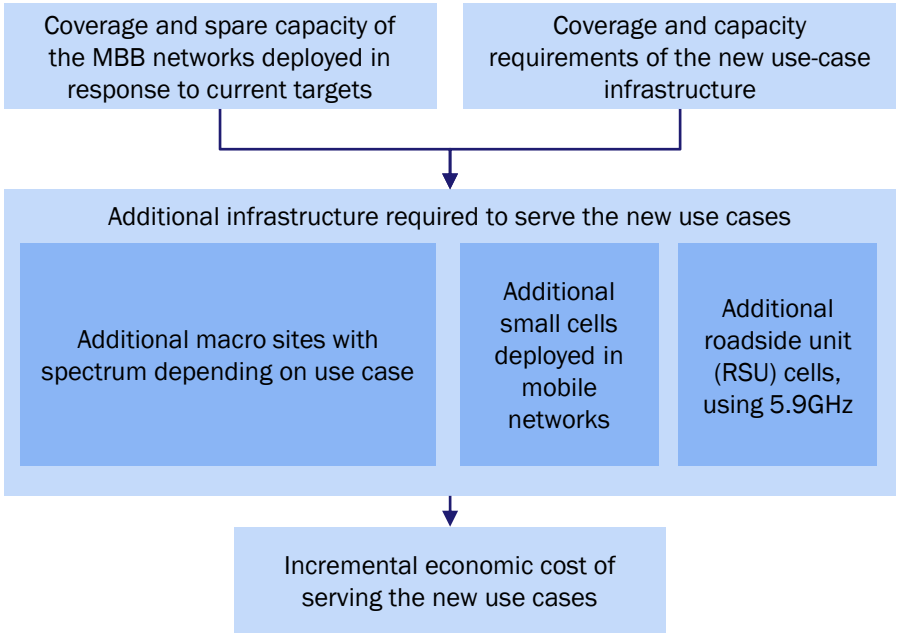
The chart above shows total 5G population coverage (pink line), overlaid on a classification of the population into geo-types. The chart does not indicate the split of 5G coverage (e.g. there may be some 5G coverage of rural areas); we have assumed MNOs generally roll out coverage in more densely populated areas first (i.e. in urban, then moving to suburban and then rural areas). A lack of 5G eMBB coverage in rural areas would impact the economic opportunities for full 5G in certain sectors (e.g. agriculture and FWA).

[1] By 2020, Ofcom's estimate is that at least one mobile network provides 4G coverage to 91% of the UK geography (9% of geography is in total not-spots). See https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-update-summer-2020/interactive-report

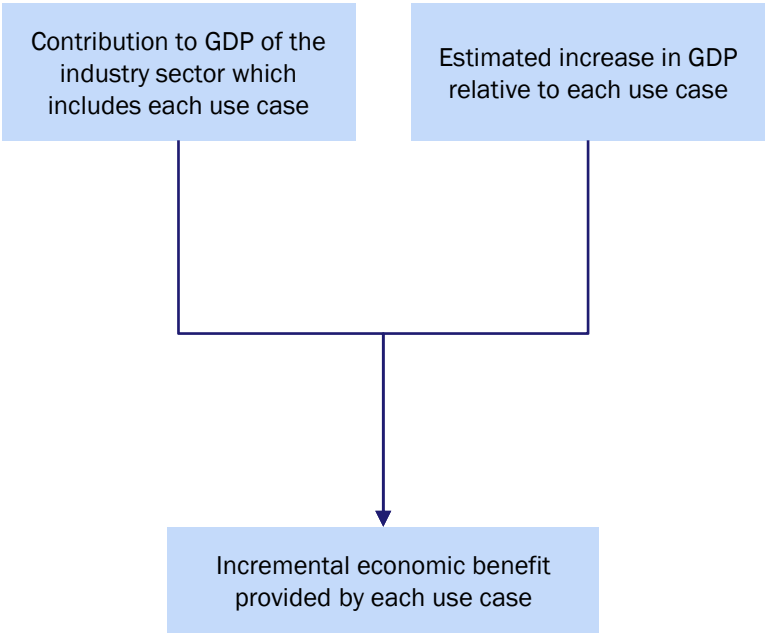
Source: Analysys Mason, Eurostat, GSMA Intelligence

To quantify the economic benefit, we built a model that estimates the additional network costs and economic benefits of many of the use cases per cluster

Calculation of the cost of providing the new use cases



Calculation of the benefits of new uses cases



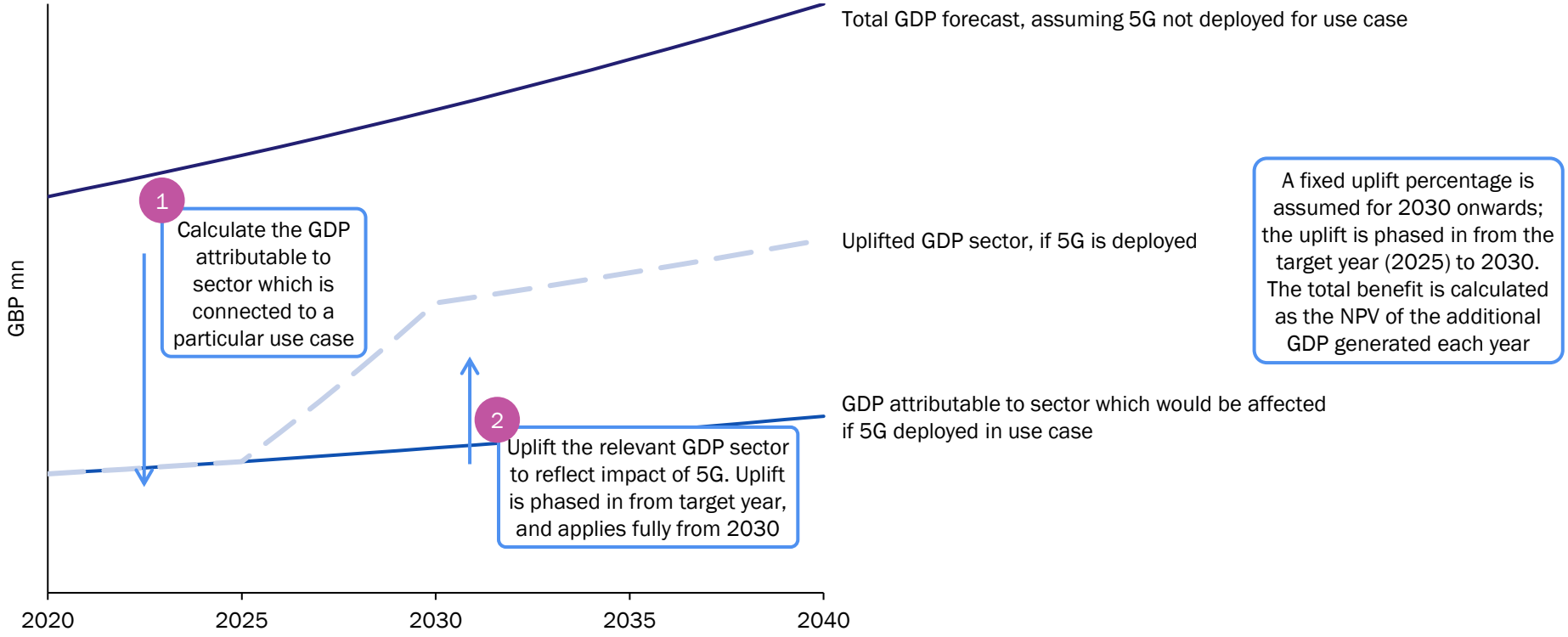
The costs and benefits associated with the new use cases are calculated with reference to the 5G MBB networks assumed to be deployed as at 2025. Costs and benefits considered in the study are incremental to 5G MBB (costs and benefits associated with 5G MBB are not considered).

Characteristics of 5G MBB networks in 2025 assumed in the base case		
5G coverage from existing low and lower-mid-band spectrum (e.g. 700MHz–2.6GHz)	Additional 5G capacity from mid-band spectrum (e.g. 3.5GHz)	Further 5G capacity from high-band spectrum (e.g. mmWave)
Deployment on up to 100% of sites assumed in base case	Deployment on all urban and suburban sites assumed in base case	Captured in use-case analysis

Source: Analysys Mason

Economic benefit is calculated by estimating (1) the GDP of the sector which is connected to a particular use case, and (2) the uplift to sector GDP if 5G is deployed

GDP forecast: two-step process for calculating economic benefit of deploying 5G in a particular use case



In some cases an alternative process is used (FWA and urban hotspots), or no economic benefit is modelled (healthcare and hospitals, smart automotive, and stadiums). See the following slide for details of each use case

Note: GDP forecasts up to 2024 are from the IMF's World Economic Outlook Database. As of June 2020, this GDP data takes account of the impact of the COVID-19 pandemic on an individual country level. Beyond 2024, a growth rate has been applied that is equal to the pre-COVID forecast CAGR between 2019 and 2024).

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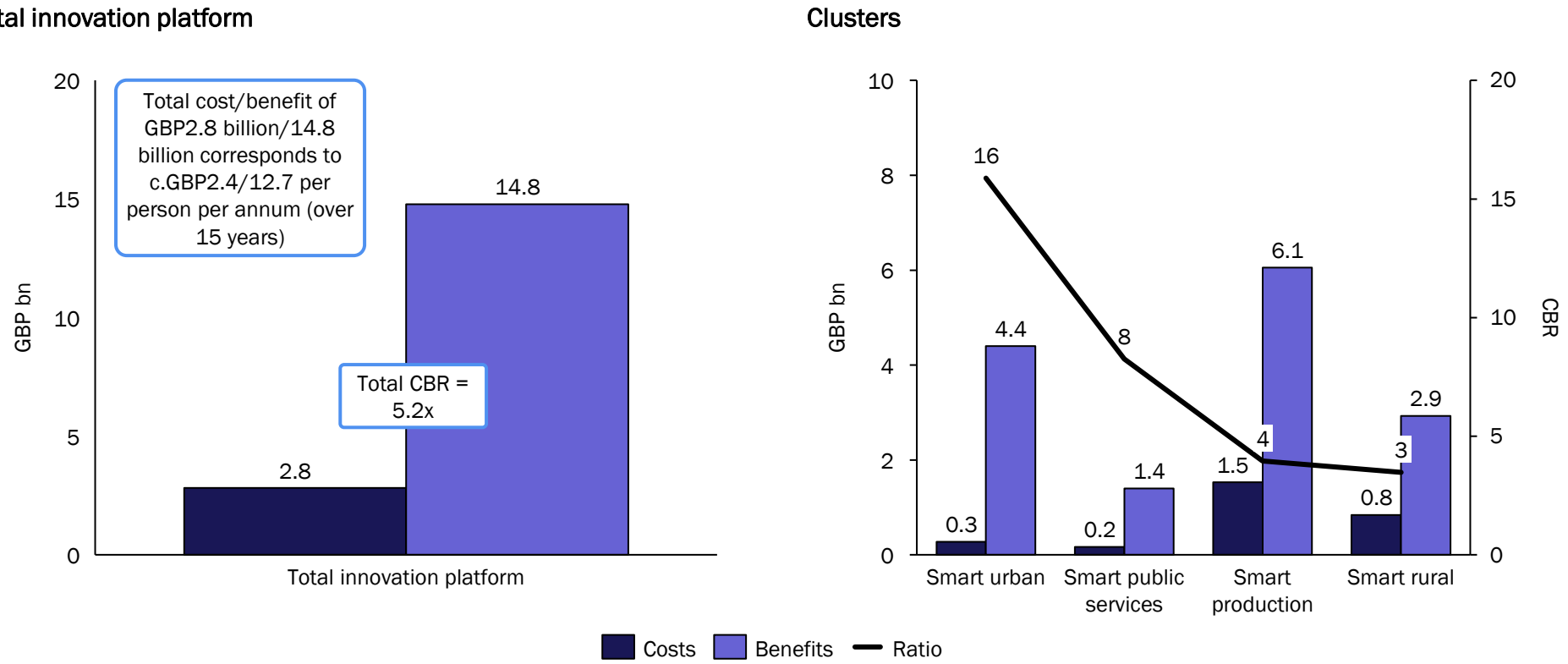
As a total ‘open innovation platform’, full 5G networks in the UK can deliver c.GBP15 billion benefit, at c.GBP3 billion cost (5.2x ratio additional benefit vs cost)

5G upgrade cost, benefit and cost–benefit ratio (CBR), Europe



The benefits and costs shown here are in addition to the benefits leveraged from the initial 5G eMBB network investments in the UK – the benefits and costs shown here are for the expansion of 5G networks to ‘full 5G’ capability in accordance with our open innovation platform concept

Source: Analysys Mason

Many 5G use cases will be delivered by MNOs commercially: where commercial investment is not viable, public subsides can help

5G use case and whether public funding is needed

Use case	Requires public funding
Smart factories	No
Mining	No
Ports	No
Airports	No
Freight and logistics	No
Energy and utilities	No
FWA	Yes[1]
Agriculture	Partly[2]
Construction	No
Urban hotspots including public transport	Partly[3]
Stadiums	No
Smart automotive	Yes
Healthcare and hospitals	Yes
Municipal buildings	Yes
Education	Yes
Tourism	Yes

- Many of the use cases we have considered as part of our full 5G assessment are expected to be deployed commercially by UK MNOs, within the coverage areas of their nationwide networks, once fully rolled out
- In hard-to-reach locations and deployment where the business case is challenging, use cases that are more likely to require public funding are shown in the table on the left
  - Estimated public funding needs are included in the charts on the next slide

[1] Commercially deployed 5G FWA is assumed as part of initial 5G deployment (i.e. our base case), but here we specifically consider additional targeted investment (primarily non-commercial FWA deployments in isolated or remote areas).

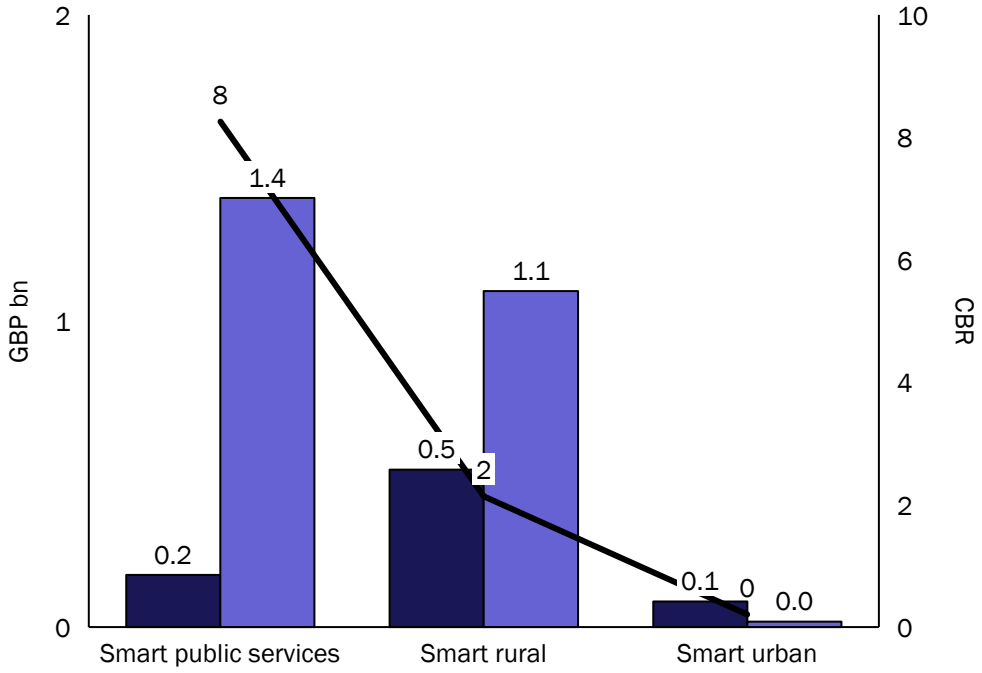
[2] We assume that the agricultural use case would be delivered commercially if the agricultural environment is within the coverage area of our modelled MBB networks. However, we assume that public subsidy would be required for agricultural environments outside the coverage area of our modelled MBB networks.

[3] The urban hotspots use case is assumed to include provision of connectivity for public transport in urban areas (e.g. real time passenger and other travel/tourist information). The public-transport portion of the cost associated with this use case (estimated to be around 10%) would require public sector procurement and funding.

Source: Analysys Mason

For the use cases where public subsidy is needed, we estimate that over GBP2.5 billion of benefit can be delivered in the UK for less than GBP800 million funding

Benefits and costs of public funding within modelled clusters



- There are additional use cases within some of the clusters modelled that will require public funding (specifically healthcare and hospitals, smart automotive) which we have not modelled economic benefit (and benefits for these are not included in the chart)
- We note the UK Shared Rural Network (SRN) will invest GBP500 million of public funds to build mobile infrastructure in current 'total not-spots' (i.e. locations uncovered by any MNO network currently)
  - There will be some overlap between our GBP800 million calculation and the GBP500 million already being invested in the SRN, since the location and number of new sites to be built as part of the SRN is not yet known.

Source: Analysys Mason

In terms of expected economic benefit from full 5G, the UK generally ranks highly vs. other European countries in each of the clusters modelled

Top 15 countries ranked by total benefit

Smart Production

Country	Costs (EUR bn)	Benefits (EUR bn)
Germany	3.2	23.5
Poland	1.8	6.7
France	1.3	6.4
UK	1.5	6.1
Italy	2.2	5.0
Switzerland	0.4	4.5
Spain	1.7	4.0
Ireland	0.2	2.9
Netherlands	0.5	2.4
Finland	0.5	2.3
Romania	0.9	2.3
Sweden	0.5	2.3
Austria	0.4	2.2
Czechia	0.7	2.1
Belgium	0.3	1.7

Smart Rural

Country	Costs (EUR bn)	Benefits (EUR bn)
Germany	1.3	8.0
France	1.6	7.3
Italy	3.3	6.3
Spain	1.2	5.7
Austria	1.2	5.5
Poland	1.8	5.1
Finland	1.1	3.3
Netherlands	0.1	3.1
UK	0.8	2.9
Romania	0.6	2.5
Czechia	0.4	2.1
Switzerland	0.1	2.0
Hungary	0.3	1.5
Sweden	0.5	1.5
Greece	0.4	1.4

Smart Urban

Country	Costs (EUR bn)	Benefits (EUR bn)
Germany	0.6	7.2
UK	0.3	4.4
France	0.4	2.6
Switzerland	0.1	2.5
Austria	0.1	1.5
Spain	0.3	1.5
Poland	0.3	1.4
Romania	0.2	1.3
Sweden	0.3	1.0
Netherlands	0.1	1.0
Denmark	0.1	0.9
Italy	0.4	0.9
Norway	0.1	0.8
Finland	0.2	0.7
Belgium	0.1	0.6

Smart Public Services

Country	Costs (EUR bn)	Benefits (EUR bn)
Germany	0.3	2.1
France	0.6	1.8
UK	0.2	1.4
Italy	0.1	0.8
Spain	0.2	0.8
Netherlands	0.0	0.6
Switzerland	0.0	0.5
Sweden	0.0	0.4
Poland	0.1	0.4
Belgium	0.0	0.3
Norway	0.0	0.3
Denmark	0.0	0.2
Austria	0.0	0.2
Finland	0.0	0.2
Romania	0.1	0.2

While we can account for country-specific differences using high-level modelling inputs (GDP per capita, sectoral GDP, sites, traffic, number of use-case location etc.), specific dynamics in individual countries (e.g. level of digitisation in certain sectors of the economy) have not been captured. Modelling inputs have not been available for all countries (in which case European averages have been used). Individual country results should therefore be treated with caution

Source: Analysys Mason

The UK ranks third vs. other European countries in terms of total expected economic benefit from full 5G across all clusters

All countries ranked by total benefit across total innovation platform (i.e. all clusters)

Country	Costs (EUR bn)	Benefits (EUR bn)
Germany	5.5	40.7
France	3.8	18.1
UK	2.8	14.8
Poland	4.0	13.5
Italy	6.1	13.1
Spain	3.4	11.9
Switzerland	0.6	9.5
Austria	1.8	9.4
Netherlands	0.7	7.1
Finland	1.8	6.5
Romania	1.8	6.3
Sweden	1.2	5.2
Czechia	1.2	4.6
Denmark	0.5	4.2
Ireland	0.5	4.0

Country	Costs (EUR bn)	Benefits (EUR bn)
Norway	0.9	3.4
Belgium	0.4	3.0
Hungary	0.8	2.9
Bulgaria	0.9	2.4
Greece	0.9	2.4
Portugal	1.0	2.0
Slovakia	0.6	1.3
Croatia	0.4	1.0
Lithuania	0.4	0.8
Latvia	0.2	0.6
Slovenia	0.2	0.6
Estonia	0.2	0.6
Cyprus	0.1	0.3
Luxembourg	0.1	0.3
Malta	0.0	0.1

While we can account for country-specific differences using high-level modelling inputs (GDP per capita, sectoral GDP, sites, traffic, number of use-case location etc.), specific dynamics in individual countries (e.g. level of digitisation in certain sectors of the economy) have not been captured. Modelling inputs have not been available for all countries (in which case European averages have been used). Individual country results should therefore be treated with caution

Source: Analysys Mason

In conclusion, our modelling supports UK 5G policies being targeted at promoting 5G use in UK industrial settings, and improved 5G rural coverage (including FWA)

Continuing to accelerate 5G rollout for consumer use will be important up to 2025, including making the remaining 5G spectrum available in the UK, and renewed focus post COVID on reducing barriers to deployment. In addition, we identify specific policies to promote cross-sector 5G use, in priority order below

Increasing rollout of 5G including completion of 700MHz and 3.6-3.8GHz auction plus 26GHz licensing

Priority order		Recommended policies / focus
1	Smart production and logistics	▪ Put the appropriate policies in place to ensure large industrial players in the UK can deploy 5G public or private solutions and continue to promote use of 5G for these use cases via 5G CREATE ▪ A priority might be putting measures in place to encourage UK industries to be primary drivers of further 5G rollout
2	Smart rural	▪ Continued partnership between UK MNOs and Government to make 5G rural coverage deployment feasible via SRN and related projects in the UK nations and regions (e.g. Scottish Government 4G in-fil) to provide connectivity for rural communities, rural industry and rural transport routes, which will benefit rural industries including the agriculture sector ▪ Ensure 5G FWA is considered equitably as part of solutions for next-generation access broadband services
3	Smart urban	▪ Trial 5G-based AI solutions in UK cities (e.g. 5G infrastructure for transport, logistics, smart estates, stadiums) ▪ Aim to bring mmWave bands such as 26GHz into use in the UK by 2025 ▪ As per smart production and logistics, a priority might be measures to encourage 5G usage by local authorities to be a primary driver of further 5G rollout
4	Smart public services	▪ Ensure public authorities can make specific 5G investments (e.g. in next-generation connectivity plans and funding), such as for facilities management, provision of public services, maintenance of public spaces ▪ Continue to promote 5G cost reduction /l lowering barriers to deployment