Department for Digital, Culture, Media & Sport

Superfast Broadband Programme – State aid Evaluation Report 2020

Published: January 2021

Acknowledgements

The research reported here was funded by the Department for Digital, Culture, Media and Sport (DCMS). The research team have benefitted greatly from the support, guidance and information provided by DCMS staff. In particular, the Building Digital UK (BDUK) Benefits Realisation and Evaluation team (with special thanks to Konstantina Dimou, Tom Olley, Amit Bhopal, Sophie Coulman and Jamie Juniper) were vital to completion of this work. The coordination, support, provision of information and data and reviewing of research tools and findings was greatly appreciated.

The Superfast Broadband delivery team within BDUK were also essential to the delivery of this report. Their provision of information and facilitation of contact with local project leads enabled the team to complete the required research. Particular thanks are due to the Superfast Broadband Value for Money team for all their help and support with the financial analysis presented in this report. Thanks also to the BDUK State Aid team for the guidance provided on State Aid issues.

We are grateful to all the businesses, local project leads and telecommunications suppliers that have participated in this research. The insights and evidence provided were crucial to developing the evidence base for this report. We would also like to thank BDUK staff who facilitated contact between the research team and telecommunication providers.

Thanks are also due to the all the DCMS staff, the Evaluation team of DG COMP at the European Commission, and academic and telecommunications experts involved in peer reviewing this report. The inputs provided have helped to make this a much stronger piece of research.

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Glossary of key terms and acronyms

Category	Term / acronym	Meaning
Broadband / technology terminology	NGA	**Next Generation Access** – This refers to new or upgraded access networks that will allow substantial improvements in broadband speeds.[1] This includes Fibre to the Cabinet, Fibre to the Premises (Fibre to the Home), Wireless and Cable broadband connections.
	FTTP / FTTH	**Fibre to the Premises / Fibre to the Home** – This refers to an access network structure in which the optical fibre runs from the local exchange to the end user's living or office space.
	FTTC	**Fibre to the Cabinet** - An access network structure in which the optical fibre extends from the exchange to the cabinet. The street cabinet is usually located only a few hundred metres from the subscriber's premises. The remaining part of the access network from the cabinet to the customer is usually copper wire.
	Cable	Telecommunications infrastructure which utilises cable networks, such as Data Over Cable Service Interface Specification (DOCSIS-3) networks.
	Wireless	High-speed internet access where connections to the premises use radio signals rather than cables.
	GFAST	A type of connection which involves the deployment of additional fibre to a node that is very close to the premises to be served, normally located on a pole or in a chamber. The connection from the node to the premises retains the existing copper. This can achieve speeds up to four times faster than traditional FTTC connections.
	ADSL	**Asymmetric Digital Subscriber Line** - A technology used for sending data quickly over a conventional copper telephone line. It is used in current internet services with download speeds up to 24Mbps.
	SBB	**Standard broadband** - with download speeds of up to 30 Mbps.
	SFBB	**Superfast broadband** - download speeds from 30 Mbps up to 300 Mbps.
	UFBB	**Ultrafast broadband** - able to deliver download speeds equal or greater than 300 Mbps.
	LLU	**Local Loop Unbundling** - When communication providers can gain access to the network by placing their own equipment at the exchange. The communication providers then gain control of the line from the local exchange to the customer and the backhaul (the link between the local network and the global internet) runs from the local exchange to their core network.
	VULA	**Virtual Unbundling of the Local Loop** – an Openreach wholesale product used in the UK for the third party provision of superfast broadband services using VDSL (very high speed digital subscriber loop). It uses a single fibre based access infrastructure which is electronically unbundled and made

[1] The term was first used by the European Commission in 2010 to refer 'to upgrades to ADSL networks which had previously relied on end to end copper connections for the delivery of broadband services' – see para 11 of Commission recommendations

Category	Term / acronym	Meaning
		available to all providers on an equal and non-discriminatory basis.
Type of telecoms provider	ISP	**Internet Service Provider** – An organisation which provides households / businesses access to the internet. ISPs do not always own the infrastructure used to provide services, and can utilise the infrastructure owned by network providers to provide services.
	Network provider	Telecommunications providers which own infrastructure which is used to deliver internet services.
	Programme beneficiary	One of the five network providers that were awarded Superfast Broadband contracts.
	Alt-nets	**Alternative network** – Smaller network providers that are not reliant on the Openreach network.
Public sector organisations involved in delivery	BDUK	Building Digital UK.
	DCMS	Department for Digital, Culture, Media and Sport.
	Local Bodies	Local Authorities / devolved Governments responsible for delivering local Superfast Broadband Programme projects.
	NCC	**National Competency Centre** – an entity within BDUK which is responsible for ensuring the Superfast Broadband Programme complies with the European Commission State aid legislation.
Financial terms	IRR	**Internal Rate of Return** - a measure of an investment's expected future rate of return.
	WACC	**Weighted Average Cost of Capital** - the rate that a company is expected to pay on average to finance its assets.
	Capex	**Capital expenditure –** expenditure to buy/maintain/improve fixed assets.
	Opex	**Operational expenditure –** ongoing expenditure associated with delivering a product / running a business.
Economic and evaluation terms	Cost Benefit Analysis	A comparison of the monetary values of the costs and benefits of an intervention.
	Turnover	The amount of money generated by a business (value of sales).
	GVA	**Gross Value Added** – The additional value generated from economic activity (in monetary terms).
	Outcome	Outcomes are social or economic measures that could be affected by the programme (e.g. jobs, turnover, life satisfaction)
	Impact	Impacts are the effects on the outcome that are attributable to the programme over and above what would have occurred in the absence of the programme. Impacts occur over a longer time period.
	Benefit	A measurable improvement of a positive outcome (as perceived a by one or more stakeholders), which contributes towards one or more organisational objectives
	Efficiency	A measure of the extent to which a project, or policy's associated throughputs are increased
	Disagglomeration	A process by which companies or firms no longer need to be in close proximity to one another, and become more geographically dispersed.
	Opportunity Cost	The value of the best alternative use of resources or assets (the benefits foregone on alternatives courses of action when deploying resources or assets).
Superfast Broadband Programme terms	NBS	UK National Broadband Scheme (the Superfast Broadband Programme).
	Implementation Clawback	A mechanism to recover underspend. In the event of any underspend, the network provider was required to place

Category	Term / acronym	Meaning
		unused funds in an Investment Fund to help resource further schemes or extend the contract coverage to a greater number of premises than originally offered.
	Take-up clawback	If take-up proved to be higher than anticipated at the tendering stage, network providers were required to return a share of the excess revenues generated from additional take-up to the investment fund.
	OMR	**Open Market Review:** A process by which network providers outlined their existing broadband networks and their network roll out plans for the coming three years.
	'White' areas (postcodes)	Areas identified in the OMR process where there were no commercial plans to roll-out superfast broadband within three years.
	'Grey' areas (postcodes)	Areas identified in the OMR process where one provider was offering or expected to offer superfast broadband services within three years.
	'Black' areas (postcodes)	Areas identified in the OMR process where multiple providers were offering or expected to offer superfast broadband.
	SCT	**Speed and Coverage Template** - a list of premises or postcodes that were identified as 'white' in the OMR process and therefore eligible for subsidised infrastructure.
	PFM	**Project Financial Model –** a document which includes all of the financial information (build costs, expected take-up, WACC etc.), which is developed by programme beneficiaries at the start of the local project.
	C3 reports	A list of premises or postcodes where the Superfast Broadband Programme has provided upgraded connectivity.

1. Executive summary

Ipsos MORI and partners[2] were commissioned by the Building Digital UK (BDUK) directorate of the Department for Digital, Culture, Media and Sport (DCMS) in May 2019 to undertake the State aid evaluation of the UK National Broadband Scheme (the Superfast Broadband Programme). This document presents the final State aid evaluation report.

The Superfast Broadband Programme was announced in 2010 in response to concerns that the commercial deployment of superfast broadband infrastructure would fail to reach many parts of the UK. The Government established the programme to fund network providers to extend provision to areas where deployment was not commercially viable, on the expectation that doing so would result in economic, social and environmental benefits.

The scheme was initially backed by £530m of BDUK funding, with the aim of extending superfast coverage to 90 percent of UK premises by December 2016. These schemes were funded under the State aid judgement SA.33671 (2012/N).[3] This relates to Phase 1 and Phase 2 of the programme. Phase 3 of the Superfast Broadband Programme – the primary focus of this evaluation - was funded under a new State aid judgement covering contracts awarded between 2016 and 2018 (State aid SA. 40720 (2016/N)).[4] Contracts awarded under Phase 3 by mid-2020 involved £391m in public funding.

1.1 Evaluation aims and methodological approach

The aims and objectives of the State aid evaluation of the Superfast Broadband Programme are to provide evidence with respect to the seven key State aid evaluation questions, as set out in the National Broadband Scheme (NBS) evaluation plan. These questions are:

- Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?
- Question 2: To what extent has the target of the intervention taken-up Superfast Broadband connections and what speeds are available?
- Question 3: Has the aid had a significant incentive effect on the aid beneficiaries?
- Question 4: Has the aid had a material effect on the market position of the direct beneficiaries?
- Question 5: Is there evidence of changes to parameters of competition arising from the aid? (including third parties operating in the relevant intervention area(s))?
- Question 6: Is the gap funding model efficient compared to alternative schemes?
- Question 7: Did the aid lead to commercially sustainable networks?

The methodology used to undertake the State aid evaluation of the Superfast Broadband Programme follows the requirements set out in the UK National Broadband Scheme (NBS) evaluation plan[5] agreed between the European Commission and BDUK in 2016. Some changes to the agreed methodology have been made with the agreement of the European Commission, owing to the stage of delivery of the local projects within the Superfast Broadband Programme and the availability of the data foreseen to undertake the analysis.

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[2] Ipsos MORI's partners are: George Barrett, Richard George Feasey Plum Consulting and Simetrica.
[3] European Commission (2012) State aid SA.33671 (2012/N) – United Kingdom National Broadband scheme for the UK - Broadband Delivery UK
[4] European Commission (2016) SA. 40720 (2016/N) – National Broadband Scheme for the UK for 2016-2020
[5] Department for Digital, Culture, Media & Sport (2017) National Broadband Scheme Evaluation Plan (Redacted version). (Accessed in January 2020)

A summary of the methodological approach used for the evaluation is presented below:

- **Econometric analysis:** An assessment of the effects of Phase 3 contracts on superfast broadband coverage and take-up (Questions 1 and 2 of the State aid evaluation plan) was completed by implementing a series of econometric analysis that compared NGA, superfast and FTTP coverage and take-up in the areas benefitting from the programme to other postcodes that were eligible for subsidies but were not selected by network providers to benefit from broadband coverage delivered under Phase 3.

- **Modelling of expected Internal Rates of Return:** An assessment of the 'incentive effect' provided by the subsidies (Question 4 of the State aid evaluation plan) was completed by comparing the network provider's expected Internal Rate of Return (IRR) to their Weighted Average Cost of Capital (WACC).

- **Market share analysis:** An examination of the effect of the programme on the parameters of local competition was completed by exploring changes in the number of network providers active in the programme area, the technologies used to deliver broadband connections and their market shares between 2016 and 2020 (Question 4 and 5 of the State aid evaluation plan).

- **Cost benefit analysis:** A cost-benefit analysis of the programme was also completed to explore issues relating to the cost effectiveness of the Superfast Broadband Programme and the degree to which its costs were justified by its benefits. The analysis was completed in line with the principles of the HM Treasury Green Book[6] and were supported by a variety of econometric analyses examining the effect of subsidised coverage on businesses, workers, households and the public sector.

  The analyses followed a comparable methodology to prior evaluation studies exploring the economic impacts of the programme published in 2018[7]. However, the underlying data was only available at a higher level of geography (Output Area rather than postcode). The means that the impacts of the programme at the local level estimated in this report are lower than presented in previous studies. This is because the results based on data at the Output Area level are sensitive to displacement effects at the local level. For example, if improved broadband encourages firms to move small distances to take advantage of superior connectivity, this will have a positive effect on employment on the postcodes receiving enhanced coverage although there may be no overall change in employment at the level of the Output Area. For the purposes of the cost-benefit analysis, only productivity gains have considered a 'net impact' at the national level.

- **Supporting primary research:** The evaluation was supported by a programme of in-depth research with 40 Local Bodies that were involved in procuring contracts under the Superfast Broadband Programme and 16 telecommunications providers, a large-scale telephone survey of businesses (base 1,200) that were either located in areas where the network had been upgraded by the Superfast Broadband Programme in the years since 2016, or areas that were yet to receive superfast broadband coverage, and a series of 40 in-depth interviews with businesses in these areas.

[6] HM Treasury (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation.
[7] DCMS (2018) Economic and Public Value Impacts of the Superfast Broadband Programme

- **Availability of data sources:** The evaluation used a range of datasets covering different time periods:

  - Connected Nations, published by Ofcom, was used to measure the impact of the programme on superfast broadband coverage and take-up (State aid Evaluation questions 1 and 2). This gave annual data between 2012 and 2019 describing broadband availability and take-up in each postcode in the UK. The most recent data described broadband coverage in September 2019.

  - Data from ThinkBroadband was used to assess the effect of the programme on the market shares of network providers and NGA technology data. Data was obtained for the years 2016 and 2020.

  - Economic outcomes were measured using a variety of datasets. ONS Secure Research Service accessed data included the Business Structure Database (BSD) and the Annual Survey of Hours and Earnings (ASHE). These provided data up to and including 2018 at the time of analysis. Valuation Office Agency Rating List (VOA) data was also used with this data providing information on the rental value of commercial property in both 2010 and 2017. Claimant Count experimental data obtained from National Offender Management Information System (NOMIS) was utilised for unemployment outcomes and covered the years from 2013 to 2019.

  - Wellbeing effects were also explored and made use of both Land Registry Price Paid data and the Annual Population Survey (APS). Land Registry data covered the period from 2013 to 2019 for this analysis with the APS data covering the period between 2011 and 2019.

1.2 Key findings

This section provides a brief overview of the key findings from this report. These focus on the seven State aid evaluation questions, and the wider economic and social benefits of the programme.

Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?

Phase 3 contracts increased the number of premises passed by NGA services by 2,300 to 16,600 on postcodes benefitting from subsidised coverage by the end of September 2019 (with the weight of evidence to the lower end of this range). The share of the 79,100 premises upgraded by the end of September 2019 that would not have otherwise benefitted from NGA coverage is estimated at 3 to 21 percent.

Phase 3 contracts increased the number of premises with superfast coverage by 10,800 to 29,300, and the number of premises with FTTP coverage by 19,000 to 30,300. The additionality of superfast and FTTP coverage was correspondingly higher at 14 to 55 percent of premises receiving subsidised coverage. This indicates that some premises benefitting from subsidised upgrades would have otherwise received NGA coverage that did not deliver superfast speeds. There was also evidence that Phase 3 contracts delayed the availability of superfast coverage for some premises that would have otherwise received it earlier.

The findings were broadly consistent with more general analysis examining the impacts of the programme since delivery began in 2013. These findings indicated that the additionality of subsidised coverage peaks one year after premises are upgraded (at around 60 percent), before decaying at a rate of approximately 14 percent per annum. This implies that in many cases, the programme has worked to accelerate the availability of superfast broadband.

The results suggest that the processes used to identify the commercial plans of providers were not fully effective in establishing premises that would not benefit from commercial deployments in the near term. Several explanations for this emerged from the research. Network providers reported that their investment cycles were determined over relatively short time horizons (12 to 24 months). The absence of immediate commercial deployment plans did not necessarily imply that investment was considered economically unviable. Network providers sometimes could not provide Local Bodies with deployment plans of sufficient detail or certainty to be incorporated when the areas eligible for subsidies were determined. Finally, the definition of areas eligible for investment was based on a static view of network provider's plans, which subsequently evolved in response to regulatory innovation and growth in demand.

Question 2: To what extent has the target of the intervention been used and what speeds are available?

The findings indicated that Phase 3 contracts reduced the number of premises with superfast connections by 1.1 to 2.4 premises per postcode by September 2019. There was no conclusive evidence that subsidised coverage had a positive or negative effect on the average download speeds of connections by September 2019. This is likely a product of the short window of time that had elapsed for businesses and households to take-up, and the effect of the programme in delaying the availability of superfast for some premises that would have otherwise benefitted from commercial deployments. It is premature to draw conclusions on the impact of the programme on take-up, and analysis exploring the effects of the programme since it was launched in 2013 suggested it produced a broad range of positive impacts on take-up in the longer term.

The results did indicate that Phase 3 contracts increased the average upload speeds of connections (by 0.9Mbps to 3.9Mbps) and the maximum download speeds of connections by 6.2Mbps to 16.9Mbps. This may reflect the effect of FTTP delivery, which has enabled users to obtain higher capacity connections that may have otherwise been available.

Question 3: Has the aid had a significant incentive effect on the aid beneficiaries?

Based on projections provided by network providers at the tendering stage, the proposed network build under Phase 3 contracts was expected to either generate losses or to deliver positive rates of return (Internal Rate of Return or IRR) that were substantially lower than the cost of capital faced by the network provider - a loss of **[redacted]** per annum versus a Weighted Average Cost of Capital (WACC) of **[redacted]**. If it is assumed that profit maximising firms are only incentivised to implement projects where the IRR exceeds the WACC, then public subsidies would have been needed to create a sufficient economic incentive to deliver these investments.

The analysis suggested that network providers consistently underestimated take-up in the tendering process for Phases 1 and 2. The projections of take-up in Phase 3 of the programme also appear understated given that network providers will have learned the likely levels of demand from their experiences with Phase 1 and 2 contracts. This means beneficiaries may have understated revenue projections, increasing the apparent level of public funding needed to make the project economically viable. However, after updating projections in line with take-

up observed on Phase 1 and 2 contracts, the projected IRRs associated with Phase 3 projects without subsidy are not significantly higher than those expected at the tendering stage (a positive IRR of **[redacted]**). The projected IRRs of all Phase 3 contracts (without subsidy) are expected to be substantially lower than the WACC of the network provider.

The protections put in place by BDUK are likely to protect the public sector from the risk that it provided more than the minimum subsidy needed. Contracts have been designed such that network providers are required to return resources to the public sector if build costs are understated or if take-up proves higher than expected (leading to higher levels of profitability). While the provision of subsidies is expected to increase the IRRs on Phase 3 contracts to **[redacted]**, this falls to **[redacted]** once the activation of these contractual mechanisms is accounted for.

While the contracts have proven largely effective in containing subsidies to the minimum needed for the project to go forward, the public sector has incurred opportunity costs by tying resources up in the programme. BDUK may wish to consider whether seeking to contain these opportunity costs in future procurements could be justified.

Question 4: Has the aid had a material effect on the market position of the direct beneficiaries?

At a UK level, there has not been significant changes in the market share of programme beneficiaries in the broadband market between 2016 and 2020. Openreach dominates the market (even more so if Sky and TalkTalk are included in the Openreach market share, as these providers utilise the Openreach network), representing more than three quarters of the broadband market in both 2016 and 2020. The other beneficiaries of the Superfast Broadband Programme represented less than 0.5 percent of the market in both 2016 and 2020. A similar pattern is seen for the NGA market, with Openreach representing over 60 percent of the market in both 2016 and 2020, with the other programme beneficiaries representing less than 0.5 percent of the market.

In the areas where the Superfast Broadband Programme has been delivered, the programme appears to have had little impact on the market position of Openreach in either the overall broadband or NGA market, as Openreach maintains a dominant market position in both 2016 and 2020. However, the market share in both the overall broadband and NGA market for the smaller programme beneficiaries has increased between 2016 and 2020 in Phase 3 delivery areas which is not observed at a national level, suggesting the programme has positively affected the market share of the programme beneficiaries in these areas.

In areas where Openreach have delivered contracts, they have maintained their market share between 2016 and 2020 in both the overall broadband and NGA markets. However, in areas where the other, smaller programme beneficiaries have delivered contracts, the market share for Openreach has fallen (particularly in areas where Gigaclear have delivered contracts), with the market share of the other beneficiaries increasing. This suggests that the other beneficiaries are taking market share from Openreach in these areas.

Question 5: How far is there evidence of changes to parameters of competition arising from the aid?

At a UK level, the share of NGA broadband take-up as a proportion of total broadband take-up has increased markedly since 2016. NGA connections represented just over half of all broadband connections in 2016, but this has grown to over 70 percent of internet connections in 2020. Fibre to the Cabinet (FTTC) connections represented the largest proportion of NGA connections in both 2016 and 2020 (around a third of all broadband connections in 2016 and

just over a half in 2020). This pattern was also observed in areas benefitting from the Superfast Broadband Programme.

The average number of infrastructure providers operating on the postcodes benefitting from subsidised upgrades rose from 2.3 to 2.6 between 2012 and 2020, indicating the programme has helped promote greater competition in these areas. Although there has been an increase in the number of network providers offering services in Superfast Broadband Programme areas, most non-beneficiary network providers tended to provide services to only a small number of postcodes within the Superfast Broadband project areas. This suggests there has not been a large degree of overbuild.

The number of ISPs operating in Superfast Broadband Programme areas has increased between 2016 and 2020. There are a higher number of ISPs with customers in Phase 1 contract areas than Phase 2 and Phase 3. This would be expected, given that the Phase 1 areas were larger and more commercially viable. Additionally, all Phase 1 contracts were delivered by Openreach, and the qualitative findings suggested that at present no ISPs were utilising the subsidised networks built by programme beneficiaries other than Openreach.

Question 6: Is the gap funding model efficient compared to alternative schemes?

The gross public sector cost (i.e. before clawback) per additional covered premises over three years was £890 for Phase 3 contracts (in 2019 prices). However, the public sector savings from the clawback mechanism is expected to reduce the net cost per additional covered premises from £890 to £790 for Phase 3 contracts (though again, given the early stage of delivery, these estimates are highly uncertain).

A review of the literature suggests that there are no evaluations providing quantitative estimates of the cost-effectiveness of comparable initiatives in bringing forward broadband coverage. As such, it has not been possible to benchmark the scheme to explore issues relating to how far the programme design was optimal. However, a study for the European Commission does provide estimates of the projected cost per covered premises, and it appears that the cost per premises covered for the Superfast Broadband Programme is lower than the projected costs for comparable schemes in the EU.[8]

Question 7: Did the aid lead to commercially sustainable networks?

None of the 51 Phase 3 contracts currently listed on the Superfast Broadband management system have had services withdrawn by the network provider. This means that there have been no premises which have not been upgraded as a result of a beneficiary withdrawing from the programme.

However, a total of five contracts have been terminated. All of these contracts were awarded and terminated by the same Local Body and were awarded to the same beneficiary. These contracts were terminated by the Local Body, due to the inability of the beneficiary (and its supply chain) to deliver the network build outlined in their bids to the required quality within the specified timeframe of the contract. These contracts were not terminated due to the commercial viability of the contract.

Analysis of Phase 3 contracts shows that take-up is currently below the expected level of take-up at the start of the projects, and in some cases this is significantly lower than expectations.

[8] European Commission (2020) The role of State aid for the rapid deployment of broadband networks in the EU

However, the lower level of take-up is expected, given that the delivery of Phase 3 contracts is behind schedule. The beneficiaries did not raise any concerns about the long-term level of expected take-up in the qualitative interviews, suggesting that they expect the networks to be commercially sustainable.

The pre-delivery Average Revenue Per User was compared to the Average Operational Cost per User, which showed that all the beneficiaries expected their revenue to be higher than their Operational Cost. Actual revenues and operational costs per user are not monitored by BDUK and therefore it is not possible to assess any updated average costs and revenues for beneficiaries.

Wider economy effects

The present value of net public spending required to deliver the Superfast Broadband Programme over the lifetime of Phase 1, 2 and 3 contracts was estimated to be £815m in nominal terms. This is less than estimated total cost of the programme of £1.9bn, as there is expected to be a large amount of clawback generated from the beneficiaries delivering the programme.

The findings of the evaluation indicate that the programme has led to a range of economic and social benefits in the areas benefitting from subsidised coverage between 2012 and 2018. The key results included:

- **Local employment impacts:** Subsidised coverage was estimated to have increased employment in the areas benefitting from the programme by 0.6 percent, leading to the creation of 17,600 local jobs by the end of 2018.

- **Turnover:** Subsidised coverage also increased the turnover of firms located in the areas benefitting from the programme by almost 1.0 percent by 2018, increasing the annual turnover of local businesses by £1.9bn per annum.

- **Number of firms:** The evidence indicated that a share of these local economic impacts were driven by the relocation of firms to the programme area. The evidence indicated that subsidised coverage increased the number of businesses located in the areas benefitting by around 0.5 percent – suggesting the programme may have encouraged the relocation of economic activity to rural areas.

- **Turnover per worker:** There were also signals of efficiency gains - turnover per worker of firms in the areas benefitting rose by 0.4 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.7 percent by 2018, indicating that subsidised coverage has also raised the efficiency of firms. However, the strength of these gains appeared to decay with time because these firms employed more workers as time passed.

- **Wages:** The impacts of the programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by 0.7 percent in response to the upgrade. This gives greater confidence that the programme led to an increase in productivity.

- **Unemployment:** Local job creation also appeared to translate into reductions in unemployment, with the number of unemployed claimants falling by 32 for every 10,000 premises upgraded by 2018.

- **House prices:** The programme led to an increase in house prices (of between £1,700 and £3,500) suggesting that buyers valued the technology.

It is important to note that while most of these findings account for the possibility that businesses benefitting from the programme may have claimed market share from local competitors, they should not be interpreted as net economic impacts at the national level. At the national level, the programme is estimated to have resulted in:

- **Economic benefits:** The programme is estimated to have led to a cumulative total of £1.1bn in productivity gains between 2012 and 2019. This rises to between £1.6bn and £1.8bn over the 2012 to 2030 period.

- **Social benefits:** Based on its impacts on house prices between 2012 and 2019, the programme is estimated to have led to social benefits valued at between £0.7bn and £1.5bn.

The estimated Benefit to Cost Ratio (BCR) was £2.70 to £3.80 per £1 of net public sector spending based on its impacts between 2012 and 2019. Allowing for future economic benefits to 2030, the BCR is estimated to rise to £3.6 to £5.1 per £1 of net public sector spending.

Compliance

A sample of 15 project contracts were selected to evaluate the compliance of the programme with the State aid guidance. These project contracts were selected to represent different locations within the UK and contracts with each of the Phase 3 programme beneficiaries.

Across all the project contracts, there has been a high level of compliance with the State aid guidance. However, there are some gaps in the evidence provided for some projects. Given the other evidence that has been provided for these projects, it has been assessed that these are gaps in the evidence base, rather than evidence of non-compliance. The one area where there was evidence of a lack of compliance with European Commission Guidelines was around the timing of the Invitation to Tender (ITT) being issued, with this being more than a month after the public consultation exercise closed in most cases.

2. Introduction

Ipsos MORI and partners[9] were commissioned by the Building Digital UK (BDUK) directorate of the Department for Digital, Culture, Media and Sport (DCMS) in May 2019 to undertake the State aid evaluation of the UK National Broadband Scheme (the Superfast Broadband Programme). This document presents the final State aid evaluation report, examining the impacts of the programme between 2016 and 2020.

2.1 Superfast Broadband Programme

The Superfast Broadband Programme was announced in 2010 in response to concerns that the commercial deployment of superfast broadband infrastructure would fail to reach many parts of the UK. In June 2010 almost 3 million homes and businesses did not have access to broadband speeds of at least 2Mbps.[10] In June 2011 (the earliest data that is available), Superfast Broadband connections were available to 58 percent of premises in the UK.[11]

The Government established the programme to fund network providers to extend provision to areas where deployment was not commercially viable, on the expectation that doing so would result in economic, social and environmental benefits.

The scheme was initially backed by £530m of BDUK funding, with the aim of extending superfast coverage to 90 percent of UK premises by December 2016 (Phase 1). The programme was expanded in 2015, with a further £250m made available to extend coverage to 95 percent of premises by December 2017 (Phase 2). These schemes were funded under the State aid judgement SA.33671 (2012/N).[12]

Phase 3 of the Superfast Broadband Programme was funded under a new State aid judgement covering contracts awarded between 2016 and 2020 (State aid SA. 40720 (2016/N)).[13] Contracts awarded under Phase 3 by mid-2020 involved £391m in public funding. The scheme aims to provide superfast broadband coverage (or faster networks) in areas where availability remained below the 95 percent coverage target and extend superfast coverage beyond 95 percent where possible. This evaluation focuses primarily on contracts awarded under Phase 3 of the programme.

2.2 Evaluation aims and objectives

The aims and objectives of the State aid evaluation of the Superfast Broadband Programme are to provide evidence with respect to the seven key State aid evaluation questions, as set out in the National Broadband Scheme (NBS) evaluation plan:

- Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?
- Question 2: To what extent has the target of the intervention taken-up Superfast Broadband connections and what speeds are available?
- Question 3: Has the aid had a significant incentive effect on the aid beneficiaries?
- Question 4: Has the aid had a material effect on the market position of the direct beneficiaries?

[9] Ipsos MORI's partners are: George Barrett, Richard George Feasey Plum Consulting and Simetrica.
[10] Superfast Broadband Programme
[11] Ofcom (2011) Communications Infrastructure Report 2011: Fixed Broadband data
[12] European Commission (2012) State aid SA.33671 (2012/N) – United Kingdom National Broadband scheme for the UK - Broadband Delivery UK
[13] European Commission (2016) SA. 40720 (2016/N) – National Broadband Scheme for the UK for 2016-2020

- Question 5: Is there evidence of changes to parameters of competition arising from the aid? (including third parties operating in the relevant intervention area(s))?
- Question 6: Is the gap funding model efficient compared to alternative schemes?
- Question 7: Did the aid lead to commercially sustainable networks?

In addition to these seven key evaluation questions, the research has provided an assessment of compliance with the State aid judgement in the delivery of the programme (as required by the State aid evaluation plan). The evaluation also explores the overall benefits of the Superfast Broadband Programme to businesses, the public sector and households, as mentioned in section 3 of the State aid evaluation plan: BDUK will evaluate the wider outcomes and impacts of the programme, such as productivity, employment and public value; and undertake evaluations of the processes used to deploy the scheme.

2.3 Methodology

The methodology used to undertake the State aid evaluation of the Superfast Broadband Programme follows the requirements set out in the UK National Broadband Scheme (NBS) evaluation plan[14] agreed between the European Commission and BDUK in 2016. Some changes to the agreed methodology have been made with the agreement of the European Commission, owing to the stage of delivery of the local projects within the Superfast Broadband Programme and the availability of the data required to undertake the analysis foreseen. These limitations are set out in Section 2.4 of the report.

The methodology used is presented in detail in the Technical Annexes to this document, but a summary of the approach is detailed below:

- **Econometric analysis:** An assessment of the effects of Phase 3 contracts on NGA coverage and take-up (Questions 1 and 2 of the State aid evaluation plan) was completed by implementing a series of econometric analysis that compared areas benefitting from the programme to other postcodes that were eligible for subsidies. This was achieved by linking data on local broadband availability and take-up captured by Ofcom's regular Connected Nations report to management data compiled by BDUK describing the premises that were eligible for the programme. The underlying methodology was as robust as could be achieved within the constraints set by the design of the programme (achieving Level III on the Maryland Scientific Methods Scale). Full details of this analysis are set out in Technical Appendix 1.

- **Modelling of expected Internal Rates of Return:** An assessment of the 'incentive effect' provided by the subsidies was completed by comparing the network provider's expected Internal Rate of Return (IRR) to their Weighted Average Cost of Capital (WACC), before and after the award of subsidy. This analysis is motivated by the theoretical proposition that businesses in the private sector will maximise their profits if they implement all investment projects that generate expected returns that exceed their cost of capital. However, the rates of return earned on contracts awarded cannot be observed directly because revenues and operational costs will be realised in the long-term (i.e. over 15 to 20 years) and cannot be monitored directly by BDUK. To address this challenge, a modelling exercise was completed in which the financial models put forward by network providers as part of the tendering process were updated to account for changes in expected capital costs and observed take-up of the superfast services made available. The analysis covered 20 of 51 contracts awarded

[14] Department for Digital, Culture, Media & Sport (2017) National Broadband Scheme Evaluation Plan (Redacted version). (Accessed in January 2020)

under Phase 3 where the information needed to implement the modelling was available. Full details of this analysis are set out in Technical Appendix 2.

- **Market share analysis:** The effect of the programme on the parameters of local competition was explored by examining changes in the number of network providers active in the programme area and their market shares between 2016 and 2020. This was completed using network provider level data compiled independently by ThinkBroadband[15]. These analyses focused on changes over the period (in line with the methodology prescribed in the State aid evaluation plan) and achieve Level II on the Maryland Scientific Methods scale.

- **Cost benefit analysis:** A cost-benefit analysis of the programme was also completed to explore issues relating to the cost effectiveness of the Superfast Broadband Programme and the degree to which its costs were justified by its benefits. The analysis was completed in line with the guidance set out in the HM Treasury Green Book[16] and the approaches put forward for valuing economic and non-market impacts. The analysis was supported by a variety of econometric analyses examining the effect of subsidised coverage on businesses, workers, households and the public sector. These analyses employed a 'pipeline' design in which those areas benefitting from subsidised coverage in later years were compared to those benefitting in earlier years (again, achieving levels of robustness equivalent to Level III on the Maryland Scientific Method Methods Scale). Full details of this analysis are set out in Technical Appendix 3.

- **In-depth research with network providers and Local Bodies:** The evaluation was supported by a programme of in-depth research with 40 Local Bodies that were involved in procuring contracts under the Superfast Broadband Programme and 16 telecommunications providers (including all direct beneficiaries of the programme, network providers that tendered for but were not awarded contracts, network providers that did not tender for contracts, and internet service providers that could potentially make use of the infrastructure made available through the programme). The focus of the interviews was on understanding the mechanisms involved in producing the outcomes observed (including the role of processes adopted to manage the programme). Interviews were transcribed and analysed using the NVIVO qualitative analysis software package, with perspectives offered by the two groups triangulated against the key evaluation questions and, where possible, validated against the objective evidence available from monitoring information. Key findings were also validated in supplementary consultations with key BDUK officials responsible for the design and delivery of the programme.

- **Business surveys:** The evaluation also drew on the results of a large-scale telephone survey of businesses (base 1,200) that were either located in areas where the network had been upgraded by the Superfast Broadband Programme in the years since 2016, or were located on postcodes with planned upgrades that were yet to receive superfast broadband coverage. The achieved sample for the business survey included quotas for business size and sector, to ensure some control over the size and sector profiles of the businesses included in the survey rather than seeking to be strictly representative. The survey used an achieved sample of 1,200 rather than monitoring the response rates of a smaller population. The broader evaluation of the programme

15 ThinkBroadband is an independent organisation which collects information and data about internet coverage in the UK. It also runs an online 'speed test' function, where individuals can provide a limited amount of data about their broadband package and test the connection speed that they receive.
16 HM Treasury (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation.

involves an on-going survey of residential beneficiaries to understand its social impacts, which will be reported in future publications.

2.4 Outcome measures and time-frames for the evaluation

The following table provides an overview of the primary outcome measures for the evaluation, data sources, and the time-frame over which effects are considered (which varies across data sources).

Table 2.1: Outcome measures and time-frames for evaluation

State aid evaluation question	Outcome indicators	Source	Time frame
1. To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?	• Number of premises passed by NGA services • *Number of premises with superfast (30Mbps) coverage* • *Number of premises with Fibre-to-the-Premises coverage*	Connected Nations (Ofcom)	June 16 to September 19
2. To what extent has the target of the intervention been used and what speeds are available?	• Number of live NGA-delivered connections • *Number of premises connected to superfast (30Mbps) services* • Mean download speed of broadband connections • Mean upload speed of broadband connections	C3 reports, BDUK Connected Nations (Ofcom)	January 16 to September 19 June 2016 to September 2019
3. Has the aid had a significant incentive effect on the aid beneficiaries?	For each winning supplier: comparison of the supplier's expected Internal Rate of Return (with and without subsidy) versus their Weighted Average Cost of Capital	Modelling based on Project Financial Models (PFMs), observed costs (Finance Trackers), and reported take-up (C3 reports)	January 16 to September 19
4. Has the aid had a material effect on the market position of the direct beneficiaries?	For each winning supplier: • Supplier's market share of all active NGA lines within the relevant county/unitary local authority area(s) • The supplier's market share of all active NGA lines within the UK	Data provided by Thinkbroadband	2012 to 2020
5. Is there evidence of changes to parameters of competition arising from the aid? (Including third parties operating in the relevant intervention area(s))?	For each of the relevant county/unitary local authority area(s), and for the UK: • Take-up of NGA lines as a % of all broadband take-up • Market share (of take-up) for each NGA technology • Number of infrastructure providers offering NGA services	Data provided by Thinkbroadband	2012 to 2020

State aid evaluation question	Outcome indicators	Source	Time frame
6. Is the gap funding model efficient compared to alternative schemes?	Comparison against non-gap-funded UK and EU schemes in terms of: • Public funding per covered premises (using the maximum in-life coverage for closed schemes) • Public funding per live end user connection to the network (using the maximum in-life take-up for closed schemes) • Public funding per live end-user connection-years	The role of State aid for the rapid deployment of broadband networks in the EU (European Commission 2020)	N/A
7. Did the aid lead to commercially sustainable networks?	For each winning supplier, their actual versus original forecast: • Annual cashflow (before subsidy) • Take-up volumes • Average revenue per user • Average operational costs per user For the interventions funded by the 2016 NBS: • The number of projects, if any, from which services have been withdrawn (e.g. due to corporate insolvency, or project losses) • The number of premises covered by such projects, and the number of live connections for such projects • The % share of the overall 2016 NBS accounted for by such projects (in terms of number of projects, public funding, premises covered, take-up volumes)		

Outcome measures not originally included in the State aid evaluation plan have been italicised.

2.5 Limitations to the evaluation

There are some limitations to the evaluation that should be considered when interpreting the findings of the analysis. These are:

- **Progress with programme delivery:** At the time of the evaluation, many Phase 3 contracts were at comparatively early stages of delivery. Much of the data on which the evaluation is based was also only available to September 2019. Only 17 percent of the contracted number of premises to be upgraded were complete at this stage. This creates challenges in assessing the long-term additionality of the infrastructure upgrades, the effect of the programme on the market shares of beneficiaries, and the expected rate of return on the contracts awarded. To put the findings in medium-term context, the analyses were also completed for Phase 1 and 2 contracts to give a

programme level view on the issues of interest (updating previous analyses completed to understand the effect of the Superfast Broadband Programme on NGA coverage[17]).

- **Causality:** The programme was not delivered as a Randomised Control Trial and econometric methods have been used to establish estimates of the causal effects of the programme. These methods are based on comparisons between postcodes that benefitted from coverage subsidised by the programme and other postcodes that were eligible for investment but not chosen by network providers when developing their proposals to deliver the schemes. This creates the possibility that there are systematic differences between those areas benefitting from the programme and the comparison group that could bias findings. The commercial viability of network upgrades in areas benefitting from the programme could be expected to be higher than in eligible areas that did not.[18] While steps have been taken to mitigate this risk, the results may overstate the impact of the programme due to unobserved confounding factors.

- **COVID-19:** The data deployed in this analysis ran to mid-2019 and does not allow for an analysis of the impacts of the programme in relation to COVID-19. It is plausible that the programme enabled benefits such as remote working, the delivery of public services (e.g. General Practitioner consultations) on-line and increased local resilience through supporting social distancing arrangements. However, if COVID-19 has induced greater demand for superfast services amongst residential consumers, the rates of return earned on Superfast contracts will also be higher than when projected based on historic growth in take-up. This could make some upgrades commercially viable that previously were not (implying that additionality in the longer term was overstated). These issues will be considered in a future assessment of the programme, as part of the final round of evaluation.

- **Data availability:** The NBS evaluation plan agreed in 2016 identified data sources to be used to undertake the analysis plan set out in the document. However, as noted above, not all this data could be made available to the evaluation team. The data that was not available and the alternative data sources used are presented in the table below. These changes were communicated to the European Commission by the BDUK Benefits and Evaluation team in May and October 2020.

[17] DCMS (2018) Economic and Public Value Impacts of the Superfast Broadband Programme.

[18] It should be noted that the number of remaining postcodes where Superfast Broadband is not available is now quite small, as Superfast Broadband coverage was over 95% in the UK.

Table 2.2: Unavailable data sources and alternatives used

Intended data source	Alternative data source	Key differences
It was anticipated that the Ofcom would provide premises level data on NGA coverage between 2016 and 2020 (relevant to Q1 and Q2).	Ofcom Connected Nations report September 2019.	The data runs to September 2019 and is only available at postcode level. As such, the analyses have lower spatial resolution and cover a less extensive period than envisaged. However, as sample sizes are substantial, this does not limit the precision of statistical analyses.
Actual data on revenues and operational costs are needed to observe network providers actual rate of return, but are not monitored by BDUK (relevant to Q3 and Q7).	Modelling was completed by applying assumptions regarding operational costs and average revenue per user to take-up (which is monitored by BDUK). Not all the local projects in Phase 3 of the programme had all the required information to calculate the IRRs needed for the evaluation.	This approach assumes that operational costs and average revenues per user are static over time and align with the assumptions put forward by network providers in tenders. This has meant that it has not been possible to address some aspects of Q7 (i.e. annual cashflows and average revenues costs and costs per user) and rates of return are modelled rather than observed in relation to Q3.
Network provider level returns provided to Ofcom to compile the Connected Nations report could not be made available for this analysis due to commercial sensitivities. An attempt was made to request these returns from key network providers in the UK, though some significant network providers refused to co-operate with the request, leaving significant omissions in the resultant dataset. As such, the anticipated data to address Q4 and Q5 was not available.	ThinkBroadband network provider coverage data and Speed Test data	ThinkBroadband data is not collected or validated by the telecommunications regulator, Ofcom. Take-up data by ISP is collected from Speed Tests undertaken by consumers, rather than information collected by ISPs and submitted to Ofcom. This limits the robustness of the answers to Q4 and Q5, as consumers providing speed tests may not be representative of the broader population. Sample sizes were often small at the level of the individual contract area, limiting the degree to which results can be broken down at this level.
Management information about ISPs utilising upgraded networks (to establish how far network providers have made use of open access arrangements) has not been monitored (relevant to Q5)	ThinkBroadband Speed Test data	ISPs utilising the upgraded networks has been identified from the ISPs operating in Superfast Broadband Programme areas (the postcodes which the programme has built networks to). This is not a comprehensive list of ISPs operating in these areas, as it is based on speed tests completed.
It was anticipated that benchmarks would be available providing estimates of the value for money associated with alternative scheme designs (relevant to Q6).	No evaluations have examined the cost-effectiveness of other types of broadband programmes in bringing forward superfast broadband coverage. However, projected costs per premise information for schemes across Europe have been analysed.	The absence of benchmarks makes it challenging to provide answers to questions relating to whether the scheme design was optimal and whether alternative designs may have produced superior outcomes.

2.6 Structure of the report

The remaining sections of this report are structured as follows:

- Section 3 provides an overview of the Superfast Broadband Programme and the analytical framework deployed in the evaluation;
- Section 4 provides an overview of the delivery of the programme and the degree to which it has complied with the provisions of the State aid judgement
- Section 4 outlines the evidence of the effectiveness of the Superfast Broadband Programme;
- Section 5 details the evidence of the direct impacts of the Superfast Broadband Programme on the programme beneficiaries;
- Section 6 presents the evidence of the indirect impacts of the Superfast Broadband Programme on programme beneficiaries;
- Section 7 shows the wider economic effects of the Superfast Broadband Programme on businesses, public service providers and households; and
- Section 8 describes the evidence of the proportionality and appropriateness of the intervention.

3. Superfast Broadband Programme

This section provides an overview of the Superfast Broadband Programme. This includes a description of the aims and objectives of the programme, how it was delivered and an overview of the processes by which it was expected to produce its intended impacts on broadband coverage and take-up, and associated economic and social benefits. This serves as an analytical framework guiding the definition of the evaluation questions and the interpretation of results.

3.1 Policy Aims and Objectives

The first Ofcom Infrastructure report in November 2011 showed that 58 percent of UK households had access to Next Generation Access (NGA) broadband services capable of delivering superfast broadband speeds (download speeds exceeding 30Mbps). NGA technologies encompass the installation of fibre-optic networks to connect the telephone exchange to the cabinets serving customers (Fibre-to-the-Cabinet, FTTC) or to their premises (Fibre-to-the-Premises, FTTP), improvements to cable networks, and wireless technologies that allow customers to obtain broadband services without a cabled connection to the network.

At the time, private investment in the required infrastructure was expected to be constrained in less densely populated areas of the UK. The costs of investing in the fixed infrastructure needed to provide these services are usually substantial. Where population density is low, this will reduce commercial viability as the consumer base will be smaller and the costs of network build may be higher (e.g. if properties are more distant from the serving telephone exchange).

The Superfast Broadband Programme was announced in 2010 to respond to these concerns that superfast broadband would fail to reach many parts of the UK. On the expectation that extending superfast broadband coverage to these areas would produce economic, social and environmental benefits, the Government established the programme to provide £530m of public resources to fund further deployment with the aim of increasing coverage to 90 percent of UK premises by early 2016. The programme was extended in 2015, with a further £250m made available to extend coverage to 95 percent by the end of 2017.

The Superfast Broadband Programme was extended a second time under a new State aid approval covering the 2016 to 2020 period. Contracts awarded under this State aid scheme (commonly known as Phase 3) are the focus of this evaluation report. These projects had a greater focus on gigabit connectivity (download speeds of 1000Mbps) than those funded in prior phases, aligning with broader Government objectives to increase FTTP coverage in the UK. This third phase evolved from a series of pilots that sought to explore how coverage could be extended to reach more than 95 percent of UK premises.

3.2 Theory of Change

3.2.1 Direct effects on superfast broadband availability

The Superfast Broadband Programme aims to provide subsidies to network providers to extend superfast broadband infrastructure to areas that would not otherwise benefit from commercial deployments. Subsidising network providers involves a risk that they seek public funds for (deadweight) investments that they would have made anyway, enabling them to earn a higher rate of return. The impact of the programme on the number of premises covered by superfast broadband services will be limited if funds are allocated to commercially viable

schemes. The implementation of the programme incorporated several mechanisms to mitigate against these risks:

- **Allocation of subsidies:** Subsidies were allocated to Local Bodies based on BDUK's assessment of the gap funding[19] needed to upgrade each cabinet in the UK. In Phase 3, resources were allocated to achieve the greatest increase in coverage for the available resources. Several areas were deemed ineligible for BDUK support because existing commercial plans were already extensive.

- **Open Market Review (OMR) and public consultation:** Local Bodies were required to manage an OMR and public consultation process before they issued tenders. The first stage of this process involved requesting network providers to describe their commercial plans to roll-out basic and superfast broadband coverage over the next three years. This process classified premises into three groups:

  - **'White areas'** where there were no commercial plans to roll-out superfast broadband within three years.
  - **'Grey areas'** where one provider was offering or were expected to offer superfast broadband services within three years, and,
  - **'Black areas'** where multiple providers were offering or were expected to offer superfast broadband.

  This view of future superfast broadband availability was subject to a public consultation process, where the view was made available for comments for at least one month.

- **Tendering process:** Following the OMR and public consultation process, Local Bodies entered a tendering process to commission a network provider to deliver superfast coverage in the 'white' postcodes identified as eligible for subsidies. The tendering process in Phase 3 differed slightly from Phases 1 and 2. In the first two phases, a framework contract mainly was used to commission a network provider. In Phase 3, the tendering process involved an open procurement using an OJEU process. Local Bodies were also given the freedom to decide how to disaggregate the project – a single contract for the whole project or splitting the project geographically into multiple lots (allowing different network providers to bid for different lots).

- **Speed and Coverage Templates:** The view on the near term roll out of superfast broadband infrastructure obtained from the OMR was expressed in a Speed and Coverage Template (SCT) used in local tendering exercises by Local Bodies. The SCT provided a list of premises or postcodes that were identified as 'white' and eligible for subsidised infrastructure. Competing network providers completed the template by outlining which postcodes or premises they proposed to cover for the available funding (known as the 'build plan'). In this respect, the SCT is intended to limit scope for deadweight investments by restricting the target area for the programme to areas that would not otherwise benefit from commercial investments.

- **Project financial model:** In principle, a capital investment is commercially viable if the expected rate of return (IRR) is at least equal to the cost of capital faced by the investor. Network providers were required to provide a Project Financial Model (PFM) with their tender. This included estimates of the overall costs associated with delivering the project, take-up assumptions and expectations of future revenues and on-going operational costs. This model provided an estimate of the IRR associated with the

[19] The level of subsidy required to make the investment sufficiently profitable for the supplier.

project without subsidy, which could be compared with the network provider's Weighted Average Cost of Capital to determine the minimum level of subsidy needed to make the project commercially viable (i.e. a gap funding model).

- **Implementation clawback:** Protections against the risk that network providers overestimated their delivery costs were put in place by introducing a mechanism to recover underspend. The principle underlying contracts was that the network provider would fully invest its contracted funding. In the event of any underspend, the network provider was required to place unused funds in an Investment Fund to help resource further schemes or extend the contract to cover a greater number of premises than originally offered. Any unused public funding remained available for further investment.

- **Take-up clawback:** Further protections were introduced through 'take-up clawback' clauses in contracts. If take-up proved to be higher than anticipated at the tendering stage, network providers were required to return a share of the excess revenues to an Investment Fund which could be recycled to fund further coverage. Take-up clawback was capped so the amount returned to the public sector could not exceed the value of the subsidy awarded. The take-up clawback mechanism aimed to limit the extent to which network providers could earn excess returns on investments subsidised by the public sector.

3.2.2 Factors influencing additionality

While the programme involved actions to minimise the risk of deadweight losses associated with the contracts awarded, the following factors could influence the size of the impacts of the programme:

- **Information gathered through the OMR:** The level of additionality will be dependent on how far the OMR process was effective in accurately identifying 'white' postcodes where no commercial deployment of NGA networks was planned. If the OMR incorrectly identified 'black' or 'grey' areas as 'white' and eligible for subsidies, there is a danger that public funds are used to provide subsidised superfast infrastructure to areas that would otherwise have benefitted from commercial deployments. This could occur if the OMR process did not include the commercial plans of all relevant network providers or if network providers had incentives to understate their commercial plans. The OMR also provided a view of the commercial plans of network providers at a specific point in time, and the commercial viability of providing superfast coverage in rural areas may evolve with time. Growth in demand for superfast broadband services as well as technological and regulatory innovation may improve the expected profitability of investment sufficiently to make some premises or postcodes commercially viable after the OMR was completed.

- **Network provider behaviour during the tendering process:** As it is not possible to perfectly observe the commercial plans of infrastructure providers, the contractual mechanisms put in place give further protections against the risk that public sector resources are deployed to take forward schemes that were commercially viable. The implementation and take-up clawback mechanisms aimed to reduce how far network providers could exploit their superior information to overstate the gap funding requirement. The effectiveness of these mechanisms could be linked to the level of competition for the subsidies. Without competition, the network provider can transfer the risk of making unprofitable investments to the public sector by assuming low levels of take-up. This increases the apparent level of public funds required to make the project viable, with excess profits returned to the public sector only if the project was a

commercial success. This would be less attractive in the presence of competition, as it would reduce the value for money associated with the tender (increasing the likelihood the procurement was lost to a competitor).

3.2.3 Indirect impacts on the market

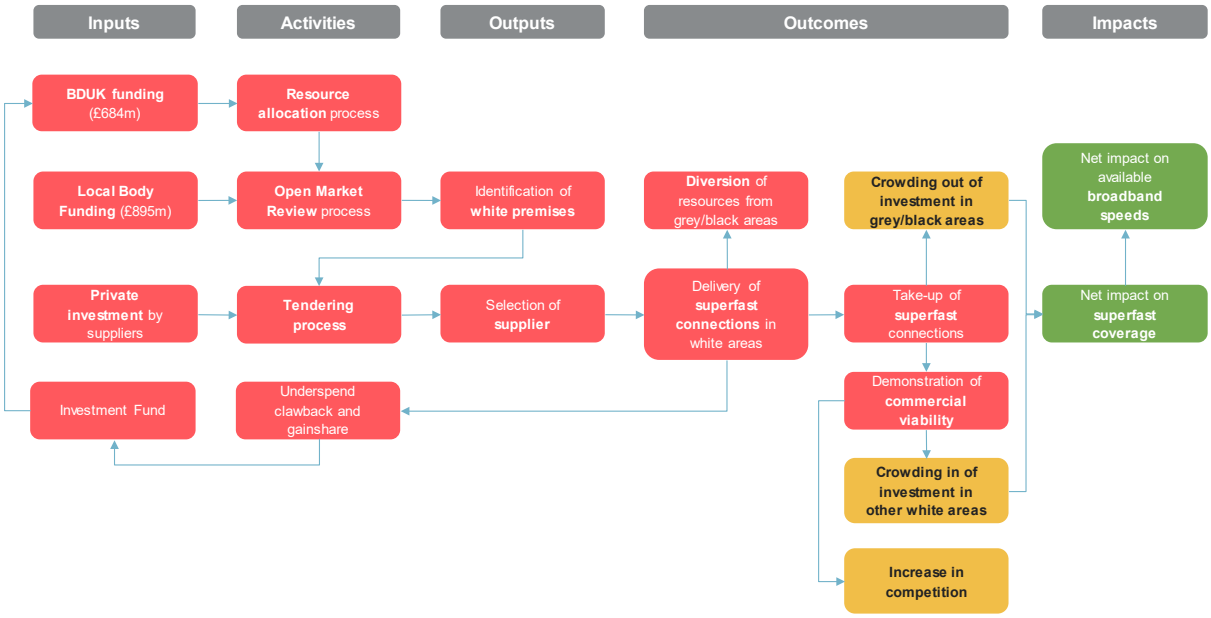
The processes used to deliver the programme may also be expected to have the following indirect impacts on local connectivity:

- **Crowding out:** The provision of subsidies for Superfast Broadband investment has the potential for two forms of 'crowding out':
  - **Discouragement effects:** The build plans of Phase 3 schemes were published, revealing the postcodes that would benefit from subsidised coverage. If network providers had plans to extend their networks to these areas that were not identified by the OMR process, the expected presence of subsidised competitors may reduce the profitability of those investments and, in some cases, lead to their abandonment.
  - **Price effects:** There may also have been negative impacts on 'grey' and 'black' areas if network providers faced capacity constraints – either in the labour market or in financial markets (for smaller network providers). If firms are not able to expand their overall capacity to deliver the programme investment, this may result in delays to, or abandonment of, parallel schemes. This risk is potentially greater for Phase 3 with these contracts entering delivery at a time when many network providers are beginning their commercial rollout of FTTP.
- **Crowding-in:** It is also possible that the programme helped demonstrate the commercial viability of infrastructure investment in the areas targeted, encouraging investments in other areas to maximise their returns. This would be visible in accelerated broadband coverage in 'white' areas that were not targeted by network providers. Successive announcements that the Government was providing further public subsidy could also have influenced network provider expectations, causing them to hold back investment expecting further funding to become available. Experiences with commercial deployments may also have demonstrated commercial viability.
- **Competition:** Finally, the programme may have led to changes in the parameters of competition and the market shares of infrastructure providers:
  - **Wholesale access requirements:** The programme was targeted at 'white' postcodes that could not sustain a single provider without subsidy and can be expected to create local monopolies. However, the programme required subsidised infrastructure providers to provide open and non-discriminatory wholesale access to physical infrastructure (ducts, poles, cabinets, masts), dark fibre, copper loop unbundling, and antenna on the subsidised portion of the network (with charges set with reference to benchmark wholesale market prices). These requirements could stimulate additional competition in both wholesale or retail markets.
  - **Overbuild:** Less directly, the nature of broadband technologies may have led to competitive distortions by increasing competition on 'grey' or 'black' postcodes. The cabinets upgraded to FTTC will serve multiple premises. Some of these premises will already have benefited from superfast coverage provided by competing infrastructure providers. Where the cabinet would not have been upgraded in the

absence of the programme, the entry of a subsidised competitor may have eroded the market shares and/or the profitability of incumbents.

The figure below presents a summary of the discussion above.

Figure 3.1: Connectivity impacts of the Superfast Broadband Programme



3.2.4 Economic and social benefits

As set out in the State aid evaluation plan, the Superfast Broadband Programme was expected to produce a variety of downstream benefits for businesses, workers, households, the public sector and the environment. These expected benefits have been mapped in the BDUK Benefit Framework as set out in the table below. This report does not cover all anticipated benefits of the programme – for example, environmental benefits have been considered out of scope due to lack of robust data. A comprehensive theory of change, setting out the causal process by which subsidised coverage is expected to produce these economic and social impacts is provided in Technical Appendix 3 (Cost-Benefit Analysis).

Table 3.1: BDUK Benefits Framework

Benefit type	Outcome / Impact	Covered in the evaluation?
Productivity Growth	Increased Business Productivity	X
	New Businesses Established	X
	Increased ICT Skills and Wider Educational Attainment	X
Employment	Employment (safeguarded or new)	X
Public Sector Efficiency	More Efficient Delivery and Increased Access to Public Services	X
	Cross-Government Learning for Large Procurement Programmes	X
Digital Divide	Reduced Digital Divide	X
Public Value	Improved Quality of Life and Wellbeing	X
Public Value	Consumer Savings	
Stimulating the Broadband Market	Stimulated Private Sector Partnerships and Investment	
	Market Failure Addressed Through Appropriate Intervention	X
	Increased Competition in the Market, Including Small Suppliers	X
	Innovation and Knowledge of New Technologies	
	Increased Community Capacity in Procuring Infrastructure	
Environmental	Reduced Impact on the Environment	

Source: BDUK (2015) Benefits Realisation Framework

3.3 Programme context

This section provides a brief overview of the broader context in which the Superfast Broadband Programme has been delivered.

3.3.1 Overview of broadband services

Based on the typology adopted by Ofcom, there are four types of fixed-line internet services available to customers in the UK.[20]

- Narrowband, having the capacity of a standard voice channel (64 Kbps);
- Standard broadband (SBB), with download speeds of up to 30 Mbps;
- Superfast broadband (SFBB), with download speeds from 30 Mbps up to 300 Mbps;
- Ultrafast broadband (UFBB), able to deliver download speeds equal or greater than 300 Mbps.

According to Ofcom's Wholesale Broadband Access Market Review, the main Internet Service Providers (ISPs) offered average speeds for their retail services spanning 17 Mbps to 300 Mbps in 2018.[21]

The 2018 Connected Nations[22] report illustrated that the UK Government target of 95 percent coverage of at least 24 Mbps by 2018 had been reached.[23] Furthermore, 94 percent of all UK premises had access to superfast broadband (30 Mbps), up from 91 percent in the prior year. Superfast coverage was the highest in England (94 percent), followed by Wales (93 percent), Scotland (92 percent), and Northern Ireland (89 percent). However, only 90 percent of UK

[20] Ofcom (2018). Wholesale Broadband Access Market Review 2018. Accessed on 5 November 2019.
[21] Ofcom (2018). Wholesale Broadband Access Market Review 2018. Accessed on 5 November 2019.
[22] Ofcom (2018). Connected Nations 2018 UK Report. Accessed on 5 November 2019.
[23] There is no single agreed upon definition of 'superfast broadband'. The UK Government considers superfast broadband as having download speeds of 24 Mbps, whilst Ofcom and the European Commission define superfast broadband as connections of at least 30 Mbps. For details, Hutton, Georgina, and Baker, Carl (2018). Briefing Paper CBP06643. Superfast broadband in the UK. Accessed on 5 November 2019.

Small and Medium Size Enterprises (SMEs) were covered by superfast broadband. The UK Government expects Superfast Broadband coverage to reach 97 percent by the end of 2020.

Ultrafast coverage has also increased. In 2018, access to speeds of 300 Mbps and above was available to 50 percent of premises, increasing from 36 percent in 2017.[24] Ultrafast was available to 51 percent of customers in England and 44 percent in Scotland. Coverage in Northern Ireland and Wales was lower, at 38 percent and 29 percent respectively. Nevertheless, two percent of UK premises in 2018 still did not have access to "decent" connection speeds[25] – a percentage that ranged from five percent in Northern Ireland to two percent in England.

3.3.2 Broadband providers

Ofcom analysis suggests that there are four main Internet Service Providers (ISPs) in the UK retail broadband market: BT (with a market share of 37 percent), Sky (23 percent), Virgin Media (20 percent), and TalkTalk (16 percent). In addition to these, there are regional network providers such as KCOM, or other fixed-line broadband network providers such as Vodafone, which together have a market share of approximately 4 percent.[26] Small network providers are also present in rural areas, and normally provide broadband services based on satellite or mobile technologies.[27]

BT has an incumbent position in the market as a result of being the former national network provider. Openreach, a wholly-owned subsidiary of BT, owns the largest copper-based telecom network in the UK covering nearly every premise, and an extensive fibre backbone network reaching around 91 percent of all premises.[28] Most competitors rely on access to the Openreach network via wholesale agreements to provide services to customers. Ofcom regulation requires Openreach to offer wholesale access to its networks where possible.

Sky is the second-largest operator in the UK retail market after BT and delivers services by utilising wholesale network access products and installing proprietary equipment in a number of exchanges – a process referred to as Local Loop Unbundling (LLU) and, more recently, through Virtual Unbundling of the Local Loop (VULA).[29] Another operator that has invested in unbundling Openreach's exchanges is TalkTalk, which provides services in the same way as Sky.

Virgin Media is the third-largest provider and the main competitor of Openreach in terms of broadband infrastructure, and in 2017 reached around 45 percent of all households.[30] Following recent fibre-coaxial network upgrades, most of the premises connected to Virgin Media's network are able to subscribe to services up to 300 Mbps.[31] Other providers include the vertically integrated Gigaclear and Hyperoptic, and CityFibre, which operate as infrastructure providers and have built FTTP networks in locations across the UK.

3.3.3 Regulation of the telecommunications market in the UK

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[24] Ofcom (2018). Connected Nations 2018 UK Report. Accessed on 5 November 2019.
[25] As per the Ofcom definition, "decent" connection speeds are of at least 10 Mbps and upload speeds of at least 1 Mbps.
[26] Frontier Economics (2018). Future Telecoms Infrastructure Review: Annex A. Accessed on 5 November 2019.
[27] Ofcom's (2018) Wholesale Access Market Review (page 4) indicated that broadband services via wireless, satellite, and mobile networks do not form part of the relevant market for an evaluation of fixed-line competition in the broadband market, thus operators relying on these technologies are outside the scope of this analysis.
[28] Ofcom (2018). Wholesale Broadband Access Market Review 2018. Accessed on 5 November 2019
[29] Ofcom (2018). Wholesale Broadband Access Market Review 2018. Accessed on 5 November 2019
[30] Frontier Economics (2018). Future Telecoms Infrastructure Review: Annex A. Accessed on 5 November 2019.
[31] Ofcom (2018). Connected Nations 2018 UK Report. Accessed on 5 November 2019.

EU regulation

Telecommunications markets in the EU were gradually opened to competition through a series of legislative measures beginning in 1998 and culminated ten years later with full liberalisation of services across the EU.[32] National Regulatory Authorities (NRAs) in Member States were established following the introduction of a new EU regulatory framework in 2002.[33]

The overarching regulatory framework for the electronic communications sector in Europe today is the European Electronic Communications Code (EECC).[34] This supersedes the Regulatory Framework for Telecommunications,[35] which was introduced in 2002 and modified in 2009. The EECC is currently being transposed in EU Member States and DCMS recently consulted on its implementation.[36] One of the provisions of this framework is a process to identify competition related market failures in the telecommunications market. This requires definition and analysis of relevant markets by National Regulatory Authorities (NRAs) under a procedure often known as 'Article 7.'[37] NRAs, such as Ofcom in the UK, are required to implement the market review process and where required by the presence of providers with significant market power (SMP), to impose suitable remedies to ensure compliance with the regulatory Framework. As part of this exercise, NRAs carry out nationwide consultations and consult with the relevant body in the European Commission on draft regulatory measures before they are adopted.[38]

Ofcom

Ofcom is the NRA in the UK and assumed its powers on 29 December 2003. Its competency spans telecommunications (fixed-line and mobile networks and services), postal services, TV and radio broadcasting, as well as the airwaves (radio spectrum) over which mobile, Wi-Fi and many other services operate.[39] It has concurrent powers under the UK Competition Act and cooperates with the European Commission's Directorate-General for Competition (DG COMP) to safeguard a level playing field in the telecoms market in the UK.[40]

Regulation of Openreach

Openreach Ltd is a fixed-line telecoms infrastructure company owned by BT Group, responsible for installation and maintenance across the UK's formerly national telecoms infrastructure. In 2006, Openreach was set up as a business division of BT that works on behalf of service providers (such as BT, Sky or TalkTalk) to maintain the local access network it covers and allows service providers to sell phone, broadband or TV services direct to customers using the network.

In 2016, after the Ofcom Digital Communications Review (DCR),[41] Ofcom announced that it required BT and Openreach to "legally separate" (i.e. set up Openreach as a subsidiary within BT Group). This was partly due to concerns that BT (through Openreach) could favour its own retail business over other Communications Providers (CPs) when making network investment decisions and in provision, operations and maintenance processes.[42] These decisions include

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[32] European Commission (2019). Overview. Telecommunications. Accessed on 14 November 2019.
[33] 3 Framework Directive 2002/21/EC and Access Directive 2002/19/EC.
[34] DIRECTIVE (EU) 2018/1972 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018.
[35] The Framework is based on the Framework Directive 2002/21/EC and the Better Regulation Directive 2009/140/EC
[36] Implementing the European Electronic Communications Code
[37] See further information
[38] European Commission (2019). Overview. Telecommunications. Accessed on 14 November 2019.
[39] Gov.uk (2019). Ofcom. Accessed on 14 November 2019.
[40] European Commission (2019). Overview. Telecommunications. Accessed on 14 November 2019.
[41] Ofcom. Digital Communications Review. Accessed on 14 November 2019.
[42] Ofcom (2016). Update on plans to reform Openreach. Accessed on 14 November 2019.

strategic decisions around fibre rollout measures, the cost of services to providers wishing to access the network, and eventual prices offered to consumers.[43]

In early 2017, BT Group agreed to the separation, and in July 2017 Ofcom established an Openreach Monitoring Unit to assess the legal separation in practice. In November 2018, Ofcom stated that they were "broadly satisfied" with the legal separation of Openreach from BT, if commitment from BT and Openreach on the following was maintained:

- Strengthening independent decision making;
- Improve industry engagement through customer consultations; and
- Openreach commitment to investing in faster, better broadband through full fibre (FTTP).[44]

Following an Ofcom statement in June 2019,[45] Openreach established a Physical Infrastructure Access (PIA) portfolio that allows retail service providers to share Openreach duct and pole infrastructure. PIA may only be used for public electronic communications services/network build. A retail supplier may access the network through the following:

- Buy a license to install a sub duct or cable within an access duct; and/or
- Buy a license to attach and maintain equipment on existing Openreach poles.[46]

Retail suppliers may also buy Points of Presence (PoPs) through Openreach's Access Locate product for the purposes of co-mingling equipment for other products, and/or through "pull-in" cables through Openreach infrastructure to a supplier's own PoP in the digital exchange (through a separate Cablelink product).[47]

[43] Ofcom (2018). New Ofcom rules to boost full-fibre broadband, 23 February 2018.
[44] Hutton, G. (2019). BT and Openreach House of Commons Briefing Paper, Number CP 7888, 11 January 2019.
[45] Ofcom (2019). Statement: Promoting competition and investment in fibre networks – review of the physical infrastructure and business connectivity markets. Accessed on 14 November 2019.
[46] It should be noted that the majority of third party services are provided using LLUA/VULA mechanism, rather than through PIA.
[47] Openreach (2019). Physical Infrastructure Access. Accessed on 5 November 2019.

4. Programme Delivery

This section provides an overview of the delivery of the Superfast Broadband Programme over the period 2016 to 2019. This analysis draws predominantly on data collected by BDUK in the process of delivering the programme, and evidence from in-depth consultations with Local Bodies and network providers to explain the patterns observed. This section does not directly address the questions defined in the State aid evaluation plan and is provided to give context to the findings. It also provides an assessment of the degree to which the delivery of the programme has complied with the State aid legislation and guidance set out by the European Commission.

Key findings:

Fifty-one Phase 3 contracts were awarded to three network providers to make superfast broadband services available to 322,200 premises to superfast broadband services. These contracts covered 66,900 of 118,500 postcodes eligible for BDUK subsidies.

Network providers chose to direct subsidised investment in broadband to areas with low population density and levels of existing penetration of broadband technologies able to deliver superfast speeds (relative to the UK overall). These areas were characterised by features that would be likely to increase the cost of deployment.

Delivery of upgrades for Phase 3 of the programme began in 2018, and 79,100 premises received subsidised coverage by September 2019. This represents around 17 percent of the contracted premises to be upgraded. Delivery of Phase 3 was behind schedule. A range of explanations were put forward by stakeholders – including a need to rescope contracts at an early stage, the capacity of network providers and their suppliers, and stricter enforcement of requirements to complete a validated build plan before commencement of delivery.

4.1 Phase 3 target area

The Speed and Coverage Templates (SCTs) developed by Local Bodies before commencing the tendering process provides the list of the premises or postcodes that were eligible for BDUK investment. Postcodes were deemed eligible if they were not expected to benefit from commercial deployment of superfast broadband infrastructure over the next three years, as determined by the OMR and public consultation process ('white' postcodes, as described in Section 3).

A total of 63 Phase 3 SCTs were compiled for this analysis. These covered a total 157,900 postcodes in the UK[48], of which 118,500 were deemed eligible for investment. The spatial distribution of these postcodes is mapped in Figure 4.1 below. Details of these postcodes were linked to a variety of secondary datasets describing the baseline characteristics of local broadband networks in 2016. Postcodes eligible for investment through the programme differed in the following ways to postcodes across the UK (as shown in Table 4.1):

- **NGA and superfast coverage:** In 2016, 88 percent of postcodes in the UK received coverage from NGA broadband technologies. 77 percent of premises were able to access superfast (30Mbps) speeds. Both NGA and superfast coverage were

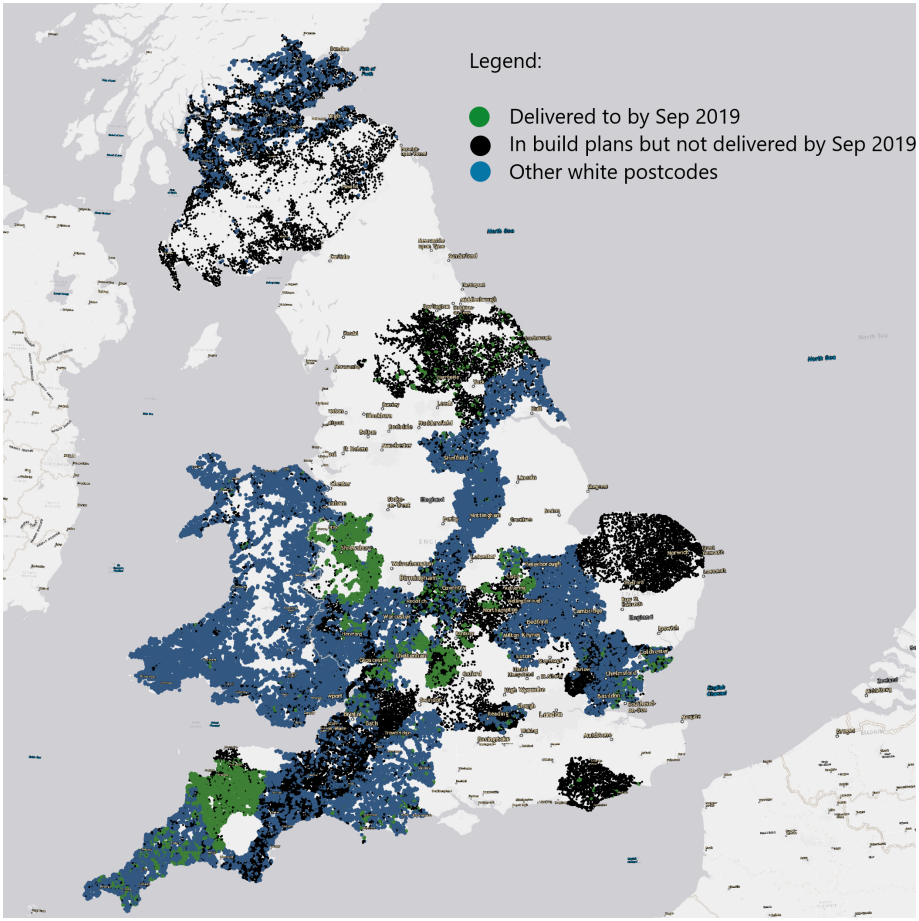
[48] The number of SCTs differs from the number of contracts as the tendering process was often divided into Lots in which a SCT was developed for each. However, in some cases, the same network provider was awarded multiple lots, resulting in a single contract.

substantially lower in the areas identified as eligible for the programme (29 percent Superfast Broadband coverage in areas that were included in Phase 3 build plans).

- **Network infrastructure:** Areas eligible for investment were characterised by features that would make it more challenging to bring forward NGA infrastructure on a commercial basis. Premises tended to be further from the exchange serving the building - more than 3,000m compared to an average of 2,400m across the UK overall. As the speed of broadband services provided using copper lines declines with distance, upgrading premises to superfast speeds involves greater costs by increasing the investment needed in fibre cables. The share of premises served by an exchange only line was also substantially higher (i.e. a line directly connected to the local exchange rather than passing through a cabinet). This would increase the cost of providing FTTC by requiring the installation of a new cabinet.

- **Demand density:** Population density (population per square kilometre) was substantially lower in areas eligible for investment than across the UK (less than half the national average). Local exchanges and cabinets also tended to serve smaller numbers of premises, and the unit cost of upgrading premises in the programme area to FTTC was estimated by BDUK at £324 in 2013 (relative to £179 across the UK). However, the areas eligible for BDUK investment were broadly equivalent to the rest of the UK in terms of local unemployment and employment rates and weekly earnings.

Figure 4.1: Map of Phase 3 postcodes in build plans, outside of build plans and premises upgraded by September 2019



Source: SCT templates, C3 Reports, Ipsos MORI analysis

Table 4.1 Characteristics of postcodes in Phase 3 build plans

Characteristic	Postcodes in Phase 3 build plans	Other 'white' postcodes	Ineligible/ other postcodes
Broadband availability and take-up in 2012			
% of postcodes with Next Generation Access, 2012	15.5	39.6	73.0
Average maximum download speed (Mbps) of connections, 2012	8.5	10.1	13.4
Average download speeds (Mbps) of connections, 2012	5.7	9.8	13.9
Broadband availability and take-up in 2016			
% of postcodes with Next Generation Access, 2016	72.9	79.8	96.1
% of postcodes with superfast (30Mbps) access, 2016	27.4	55.6	93.8
Number of premises with superfast connections 2016	1.7	5.2	8.1
Network characteristics in 2013			
Length of line from exchange to premises (m) 2013	3647	3081	2,161
Share of premises with exchange only lines (%) 2013	22.0	13.1	4.5
Delivery points at serving exchange 2013	6236	10874	17,566
Delivery points at serving cabinet 2013	247.0	303.5	380.2
% of postcodes in Virgin Media footprint 2013	0.8	14.8	48.3
Number of residential delivery points on the postcode 2013	11.5	15.1	19.6
Number of non-residential delivery points on the postcode 2013	1.0	1.1	0.7
Estimated cost to upgrade serving cabinet (£) 2013	67583	64585	61,711
Estimate upgrade cost per premises upgraded (£) 2013	332.1578	311.0	178.9
Area characteristics in 2013			
% of postcodes in rural areas 2013	80	55	14
Working age population (in Output Area), 2011	178	197	200
Population aged 65+ (in Output Area), 2011	58	56	50
Population density in OA (population per square km), 2011	666	1676	4,403
Premises density in OA (premises per square km) 2013	425	998	2,564
Gross weekly earnings in LA (£), 2013	503	542	518
Employment rate in LA (%), 2013	75	75.2	71
Unemployment rate in LA (%), 2013	6.4	7.2	8.2

Source: Connected Nations (Ofcom), BDUK modelling, Census 2011 (ONS), Annual Survey of Hours and Earnings (ONS), Annual Population Survey (ONS).

4.2 Phase 3 contracts

Fifty-one Phase 3 contracts were awarded to three network providers (34 to Openreach, 12 to Gigaclear, and four to Airband – a wireless provider) to upgrade 322,200 premises. These contracts covered 66,900 of the postcodes eligible for BDUK subsidies. Table 4.1 also describes the features of postcodes included by network providers in the build plans of Phase 3 contracts relative to other postcodes that were eligible for subsidised coverage:

- **Availability & coverage:** Superfast broadband penetration was lower in postcodes included in Phase 3 build plans than on other postcodes that were eligible for investment, in both 2012 and 2016. This is also reflected in measures of take-up, including the average and maximum speeds of connections and the number of superfast connections taken by consumers located on the postcode.

- **Network characteristics:** Areas in the build plans of Phase 3 contracts were also more likely to exhibit characteristics that would increase the costs of deployment. Premises included in the build plans of Phase 3 contracts were more likely to be served by exchange only lines, and were characterised by longer line lengths to the serving cabinet and exchange, and fewer delivery points per exchange/cabinet (i.e. lower demand density). BDUK modelling completed in 2013 also suggested that the estimated cost of upgrading the serving cabinet would be higher.

- **Area characteristics:** Postcodes included in the build plans of Phase 3 contracts were more likely to be rural in nature - 75 percent of postcodes designated (compared to 64 percent of postcodes eligible but not included in build plans). In addition, both population and premises density were lower in areas included in build plans. Employment and unemployment rates in the local authorities were very similar across groups, though average wages were lower in those areas included in Phase 3 build plans.

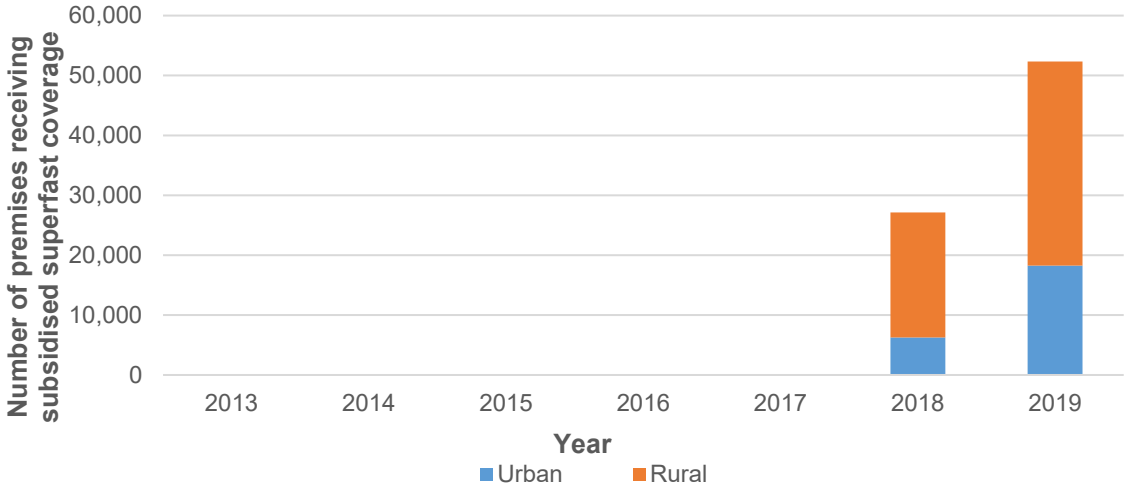
This indicates network providers selected premises that were costlier to upgrade and were characterised by a smaller customer base (the reverse of patterns observed for Phase 1 and Phase 2[49]). The areas excluded from build plans were characterised by relatively high levels of superfast broadband penetration and may have been characterised by small gaps in superfast broadband coverage. It may not have been cost effective to build out networks to fill these gaps in provision. Infrastructure providers may also have targeted communities with relatively low levels of existing penetration to maximise the size of the local markets that could be addressed.

4.3 Delivery of Phase 3 contracts

Delivery of upgrades began in 2018, as illustrated in Figure 4.2. Analysis of management data provided by BDUK showed that 79,100 premises received subsidised coverage by September 2019. This represents around 17 percent of the contracted premises to be upgraded and indicates that delivery of Phase 3 was behind schedule. While some contracts are not due to complete until 2024, 18 of the 51 contracts – accounting for 93,600 premises upgraded – were due to be completed by September 2019. A further ten contracts (accounting for a further 60,600 premises upgraded) were originally scheduled for completion by December 2019.

[49] BDUK (2018) Superfast Broadband Programme Evaluation: Annex A – Reducing the Digital Divide. (accessed August 2020).

Figure 4.2: Number of premises receiving superfast (30Mbps) subsidised coverage by September 2019, Phase 3



Source: C3 reports, Ipsos MORI analysis. Note that delivery has been assigned to the period covered by the relevant annual Connected Nations report and do not always cover a 12-month period.

Qualitative research with Local Bodies and network providers awarded contracts explored the factors driving these delays:

- **Change requests:** A key explanatory factor put forward was the need for formal requests for changes to contracts (as illustrated in Figure 4.3). This was often driven by a need to rescope[50] contracts to exclude areas that were incorrectly identified as eligible for BDUK subsidies during the OMR process (factors driving this are explored below). In general, the change requests were described as processes that take months to approve. In one case, a change request remained in discussion for up to three years. Providers generally considered that it took Local Bodies and BDUK a long time to agree and sign off change requests. However, two network providers did acknowledge that it could be time consuming to fully research and develop change requests, if it involved a lot of survey work or a lot of rescoping. This could take months to develop – though they also pointed out that it would take at least an equal amount of time to get the change requests signed off.

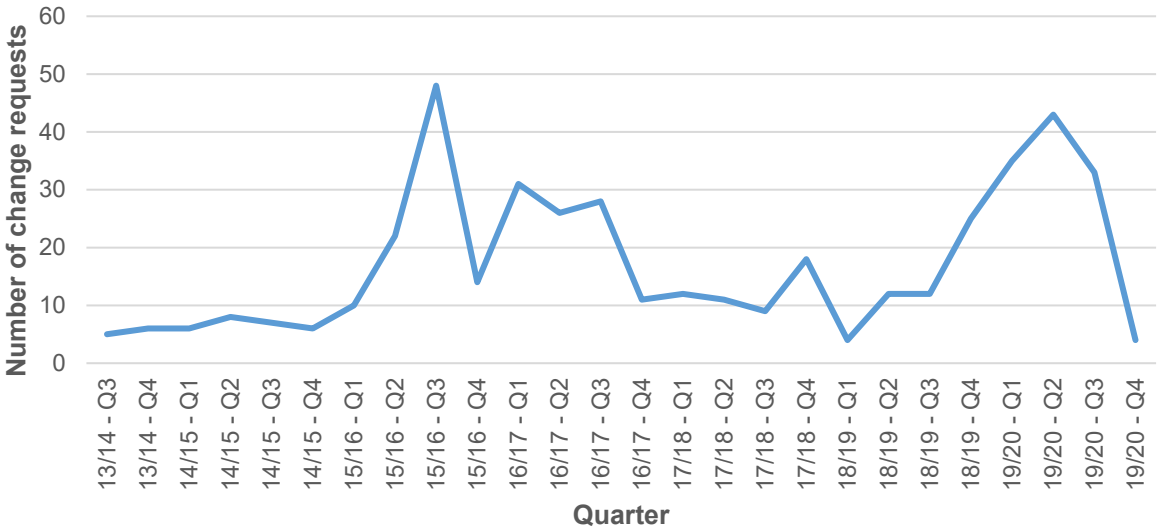
- **Capacity:** Interviews with Local Bodies highlighted a perception that there were some issues with a lack of capacity amongst providers throughout the programme. Civil engineering capacity was viewed to be limited with the contracts stretching sub-contractors delivering the infrastructure on the ground. Some interviewees saw this to be the result of the scale of delivery nationally, including a suggestion that some providers were prioritising commercial deployments at the expense of the delivery of the programme. Additionally, smaller network providers were not considered to have had the resource to expand in contract areas as quickly as anticipated and lacked the capacity to apply for wayleaves and other permissions, delaying delivery.

Some of these issues were acknowledged by the network providers. One stated that they had issues with new subcontractors, in terms of their capacity to deliver the work, the quality of the

[50] Rescoping a contract means changing the geographical area / the postcodes included in the delivery plan of the contract – by removing some areas / postcodes and adding new ones. This happens where areas / postcodes included in the delivery plan are subsequently found to be ineligible. Descoping a contract means removing a geographical area / postcodes from a contract.

work provided and their ability to manage contracts. However, capacity issues were not universally acknowledged – one large provider stated that there had not been significant issues with build capacity for the programme and attributed delays primarily to contractual issues and change requests.

Figure 4.3: Number of change requests logged, 2013 to 2019 (Phase 1, 2 and 3)



Source: BDUK management data.

- **Milestone Zero:** Contracts awarded through the programme included an initial milestone (Milestone 0), to validate the build plan. In Phase 3, this milestone was reportedly more strictly enforced, with providers required to complete validated build plan before any physical work on the contract could begin (in prior Phases, they reported being able to start physical work and amend the build plan on an ongoing basis). One provider stated that the enforcement of Milestone 0 in the contract had caused delivery issues, mainly the ability to complete build within the allotted contract length. This is because the validation of the build plan often took a long time.

4.1 Validation of compliance with State aid guidance

This sub section assesses the extent to which the Superfast Broadband Programme Phase 3 contracts have complied with the guidance set out in State aid SA. 40720 (2016/N). An evaluation framework was developed to assess the compliance of Superfast Broadband projects at three stages of project delivery, with 10 main evaluation questions. These stages and questions are set out in the table below:

Table 4.2: Validation evaluation framework

Stage of programme	Evaluation question
B0: Ready to commence Procurement; and B1: Ready to commence network provider engagement	Did local projects provide appropriate information and data to underpin public funding?
	Did local projects use appropriate mechanisms to engage with all relevant network providers?
	Did Local Bodies / NCC take appropriate steps to ensure the validity of OMR responses?
B2: Ready to procure	Did the local project follow EC guidelines during the Open Public Consultation (OPC) phase?
	Did local projects accurately account for responses received during the OPC phase?
	Did the local project follow EC guidelines about the geographic areas to be covered by the intervention?
	Did the local project follow EC guidelines when issuing the ITT?
C: Ready to contract	Were the bids assessed in a manner compliant with EC guidelines?
	Have the Local Bodies provided contracts which are State aid compliant?
	Approval of Change requests

In order to undertake the validation exercise, the following documents have been reviewed by the research team:

- The State aid decision letter for projects;
- The State aid application form prepared by the Local Body delivering the project and submitted to the National Competency Centre (NCC) to secure funding for the project;
- The State aid approval summary spreadsheet – prepared by the NCC to record evidence of how the local project complied with State aid guidance and legislation;
- The Invitation to Tender (ITT) prepared by BDUK to use in the OJEU process;
- The contract signed by the programme beneficiary, including the network provider solution section;
- The documentation and evidence collected by the NCC to assess whether the projects would pass the B0, B1, B2 and C checkpoints; and
- The database of change requests submitted to the NCC, recording the changes requested and how these were handled by the NCC.

A sample of 15 project contracts were selected to evaluate the compliance of the programme with the State aid guidance. These project contracts were selected to represent different locations within the UK and contracts with each of the Phase 3 programme beneficiaries.

Across all the project contracts, there has been a high level of compliance with the State aid guidance. However, there are some gaps in the evidence provided for some projects. Given the other evidence that has been provided for these projects, it has been assessed that these are gaps in the evidence base, rather than evidence of non-compliance. The one area where there was evidence of a lack of compliance with European Commission Guidelines was around the timing of the Invitation to Tender (ITT) being issued, with this being more than a month after the public consultation exercise closed in most cases.

4.1.1 Ready to commence: Procurement and network provider engagement

There was evidence that just over half of the sampled projects (eight projects) completed a determination of project design questionnaire that provided evidence of a local broadband plan as part of the submission of the State aid application form. This provided evidence that a local broadband plan had been developed and used to inform the design of the local project.

However, in the documentation for the remaining projects, there was no evidence of a local broadband plan. However, for all projects the NCC confirmed that the information provided in local broadband plan complied with the relevant legal basis from the European Commission, which suggests that there are local broadband plans that were reviewed by the NCC. It is most likely that these plans had been developed and sent to the NCC as part of applications for the Phase 1 and Phase 2 contracts, therefore Local Bodies did not include these again for their Phase 3 applications.

There was evidence that most of the projects had collected appropriate information to define the potential project intervention area. This information was collected through network provider engagement and the OMR process. Again, for the remaining projects there is no information in the evidence provided that the projects collected appropriate information, rather than confirmation that no or inappropriate information has been provided. Again, the NCC raised no concerns about the intervention area for these projects, which suggests that appropriate information has been provided but was not available to the evaluation team.

Most projects were able to provide evidence that a long list of relevant network providers had been invited to take part in the OMR process. This included all main network providers that were operating in their local area, as well as a longer list of potential network providers that could enter their local telecommunications market. The evidence assessed also showed that the projects had also followed up with network providers to encourage responses to the OMR process. This approach was assessed to be appropriate by the research team.

The projects provided evidence that they had received responses from the main network providers operating in their area. However, in some projects the network providers were not able to provide data at a premises level and only provided data at a postcode level, despite the projects asking for premises level data. Given that many network providers were unable to provide premise-level data, the NCC and the local project team decided that postcode level data would be acceptable for the projects and the NCC to robustly identify potential delivery areas.

Where relevant network providers had been invited to take part in the OMR process but had not submitted a response, the projects had not collected information (or the evidence had not been provided to the research team) as to why the network provider decided not to take part. Therefore, it is not possible to assess whether there were any systematic causes for non-responses across the programme. An analysis of network providers which provided coverage in 2016 in the 15 local areas covered in this exercise suggests that there were some providers which were active but did not provide a response to the OMR process. Some of the reasons why network providers did not take part in the OMR process were captured in the in-depth interviews with network providers, and these included small network providers not having the resources (either in terms of human resources or having the required technology to develop a response), and network providers being put off from submitting a response (for example previous responses to OMR processes being rejected).

The local project leads and the NCC were able to provide evidence that they had validated the OMR responses from network providers, to ensure that the responses were accurate and robust. This included excluding some responses from network providers where there were concerns that the submission was not accurate, comparing OMR responses to BDUK databases about coverage, and marking some postcodes as “under review” where the project and the NCC could not be certain of the designation of a postcode (for example due to a postcode being designated ‘white’ in this OMR exercise that had been designated as ‘grey’ in previous OMR processes). Where these changes have been made the changes were recorded in the evidence provided to the research team.

4.1.2 Ready to procure

All the projects analysed were able to provide evidence that they had undertaken a public consultation exercise, and most provided evidence that the exercise had been open for a month, in line with the European Commission guidelines. Most of the projects provided evidence that they had acknowledged the receipt of responses to the public consultation process, and explained how their responses had been used to inform the final intervention area. The projects also provided evidence as to how the responses had changed the intervention area (for example changing postcodes from 'white' to 'grey', or "under review"). However, not all responses to the public consultation resulted in changes to the intervention area. Where no action was taken, the projects did not provide evidence of the reasons why they decided not to amend the intervention area. However, the decision not to change the intervention area in line with the response to the public consultation was reviewed and confirmed by the NCC who raised no concerns to this.

In most cases the projects indicated that they had provided a response to all network providers that had submitted queries as part of the public consultation process, in line with European Commission guidance. Again, where this was not the case it has been assessed to be due to there being no evidence of a response being submitted, rather than evidence that no response was provided. Finally, in all cases there is evidence that the NCC reviewed the final intervention areas (following any changes made in the public consultation process) and were satisfied that the potential intervention area included only 'white' postcodes.

There appears to have been less compliance with the European Commission guidelines around the timing of issuing an ITT for the projects. This was supposed to be within a month of the closing of the OPC. However, most projects issued the ITT at least one month after the completion of the OPC process. No reasons were provided for this delay. Other than the delay in issuing the ITT, there is evidence that all projects followed European Commission guidance in issuing the ITTs, in terms of the information included in the ITT and that the tenders were open to all potential bidders. The NCC was aware of this issue, and although issuing guidance and encouraging local projects to meet this timeline, they had to respect that most projects did not have the resources in place to develop a procurement approach and issue an ITT within one month of the completion of the public consultation process.

4.1.3 Ready to contract

There was a high level of compliance at the ready to contract stage of the programme. All projects provided evidence that the assessments of bids received was technology neutral, in many cases providing the assessment criteria. Evidence was also provided that the successful bids included the required wholesale access agreements, confirmation that the solution needed to be NGA compliant and that the solution provided a step change. This information was validated by the NCC in all cases. All the projects and the NCC confirmed that the procurement was conducted in line with EU and UK public procurement rules and principles of equal treatment, non-discrimination, transparency and proportionality

Additionally, all of the contracts included the required references to wholesale access and pricing benchmarks, clawback mechanisms and the reporting and monitoring requirements. This is expected as BDUK issued a guide contract to all projects, and the projects assessed had all used this template (with some amendments, although not in the clauses that were assessed in this exercise.

5. Effectiveness

This section provides an assessment of the effectiveness of Phase 3 of the Superfast Broadband Programme in bringing forward NGA, superfast and FTTP coverage and its effects on speeds available and take-up. This section seeks to address the following questions set out in the State aid evaluation plan:

- Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?
- Question 2: To what extent has the target of the intervention been used and what speeds are available?

This section draws on an analysis of management data held by BDUK describing the delivery of the programme, econometric analyses exploring the net impacts of the programme on NGA and superfast coverage, and qualitative findings from research undertaken with Local Bodies, network providers and internet service providers. The findings of qualitative research were cross-referenced against available management information, secondary data sources where available and validated in consultation with officials within BDUK. Technical details of the econometric analysis are provided in Technical Appendix 1.

As delivery of Phase 3 contracts was at a comparatively early stage at the time of writing, additional analyses were completed looking at delivery of the overall programme to provide longer term insight into the effectiveness of the gap funding model adopted (covering both the 2012 to 2016 and 2016 to 2020 UK National Broadband Schemes).

Key findings:

Phase 3 contracts increased the number of premises passed by NGA services by 2,300 to 16,600 on postcodes benefitting from subsidised coverage by the end of September 2019 (with the weight of evidence to the lower end of this range). The share of the 79,100 premises upgraded by the end of September 2019 that would not have otherwise benefitted from NGA coverage is estimated at between 3 and 21 percent.

Phase 3 contracts increased the number of premises with superfast availability by 10,800 to 29,300, and the number of premises with FTTP coverage by 19,000 to 30,300. The additionality of superfast and FTTP coverage was correspondingly higher at between 14 and 55 percent of premises receiving subsidised coverage. This indicates that some premises benefitting from subsidised upgrades would have otherwise received from NGA coverage that did not deliver superfast speeds. There was also evidence that Phase 3 contracts delayed the availability of superfast coverage for some premises that would have otherwise received it earlier.

The findings were broadly consistent with more general analysis examining the impacts of the programme since delivery began in 2013. These findings indicated that the additionality of subsidised coverage peaks one year after premises are upgraded (at around 60 percent), before decaying at a rate of approximately 14 percent per annum. This implies that in many cases, the programme has worked to accelerate the availability of superfast broadband.

The results suggest that the processes used to identify the commercial plans of providers were not fully effective in establishing those premises that would not benefit from commercial deployments in the near term. Several explanations for this emerged from the research. Network providers reported that their investment cycles were determined over relatively short

time horizons (12 to 24 months). The absence of immediate commercial deployment plans did not necessarily imply that investment was considered economically unviable. Network providers sometimes could not provide Local Bodies with deployment plans of sufficient detail or certainty to be incorporated when areas eligible for subsidies were determined. Finally, the areas eligible for investment were selected based on a static view of network provider's plans, which have evolved in response to regulatory innovation and growth in demand.

The findings indicated that Phase 3 contracts reduced the number of premises with superfast connections by 1.1 to 2.4 premises per postcode by September 2019. There was no conclusive evidence that subsidised coverage had a positive or negative effect on the average download speeds of connections by September 2019. This is likely a product of the short window of time that had elapsed for businesses and households to take-up the services enabled, and the effect of the programme in delaying the availability of superfast for some premises that would have otherwise benefitted from commercial deployments. It is premature to draw conclusions on the impact of the programme on take-up, and an analysis exploring the effects of the programme since it was launched in 2013 suggested it produced a broad range of positive impacts on take-up in the longer term.

The results indicated that Phase 3 contracts increased the average upload speeds of connections (by 0.9Mbps to 3.9Mbps) and the maximum download speeds of connections by 6.2Mbps to 16.9Mbps. This may reflect the effect of FTTP delivery, which has enabled users to obtain higher capacity connections that may have otherwise been available.

5.1 Key outcomes

The following analyses examine how far the programme produced an increase in superfast broadband coverage and take-up over and above what may have occurred in its absence. The following table provides an overview of the outcome measures defined for these analyses. As highlighted in the introduction, a broader range of outcomes were included in the study than originally envisaged in the State aid evaluation plan while alternatives needed to be used for some outcomes:

- **Measures of broadband availability:** The primary measure of broadband availability defined in the State aid evaluation plan was the number of premises passed by NGA coverage. This describes the number of premises able to receive broadband services from a technology capable of delivering superfast speeds (30Mbps). However, not all premises served by NGA technologies will be able to receive superfast speeds. As the primary goal of the programme was to increase the number of premises with superfast coverage, this was included as a secondary outcome for the evaluation. The focus of the programme also shifted to gigabit capable technologies as policy evolved. FTTP availability was included as a secondary outcome measure to capture this shift.

- **Take-up:** The State aid evaluation plan defined the number of live NGA connections as a key measure of take-up for the evaluation. The key data source for this measure (Connected Nations) does not provide details of the number of premises with NGA connections. However, it does provide the number of premises with a superfast (30Mbps) connection. This measure was used in place of the number of live NGA connections.

Data for the following analyses were taken from the annual Connected Nations dataset published by Ofcom. A discussion of the limitations associated with this data is provided in Technical Appendix 1.

Table 5.1 Key outcomes (Questions 1 and 2)

Outcome	Description
Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?	
Number of premises passed by NGA services	The number of premises able to access broadband through NGA technologies – wireless, FTTC, FTTP and Wireless. This the primary outcome measure defined for the evaluation in the State aid evaluation plan agreed between DCMS and the European Commission.
Number of premises with superfast (30Mbps)	The number of premises able to access speeds of 30Mbps. NGA technologies can deliver superfast speeds but will not always do so. This measure aligns more closely with the objectives of the programme.
Number of premises with FTTP coverage	The number of premises able to receive broadband services through FTTP. Phase 3 of the programme prioritised technologies capable of delivering Gigabit per second speeds which has concentrated investment in FTTP delivery.
Question 2: To what extent has the target of the intervention been used and what speeds are available?	
Number of connections of 30Mbps or higher	The number of households or businesses taking up a 30Mbps connection is used as a proxy for the number of live NGA connections (the outcome measure defined in the State aid evaluation plan agreed between DCMS and the European Commission).
Average download speed of connections	The average download speed of connections is a secondary outcome measure describing the effect of the programme on actual speeds used by households and businesses.
Average upload speed of connections	The average upload speed of connections is a secondary outcome measure describing the effect of the programme on actual speeds used by households and businesses.

5.2 Changes in NGA and superfast coverage in the programme areas

The following figure provides an overview of changes in NGA, superfast and FTTP coverage in areas covered by the build plans of Phase 3 contracts (based on Connected Nations data):

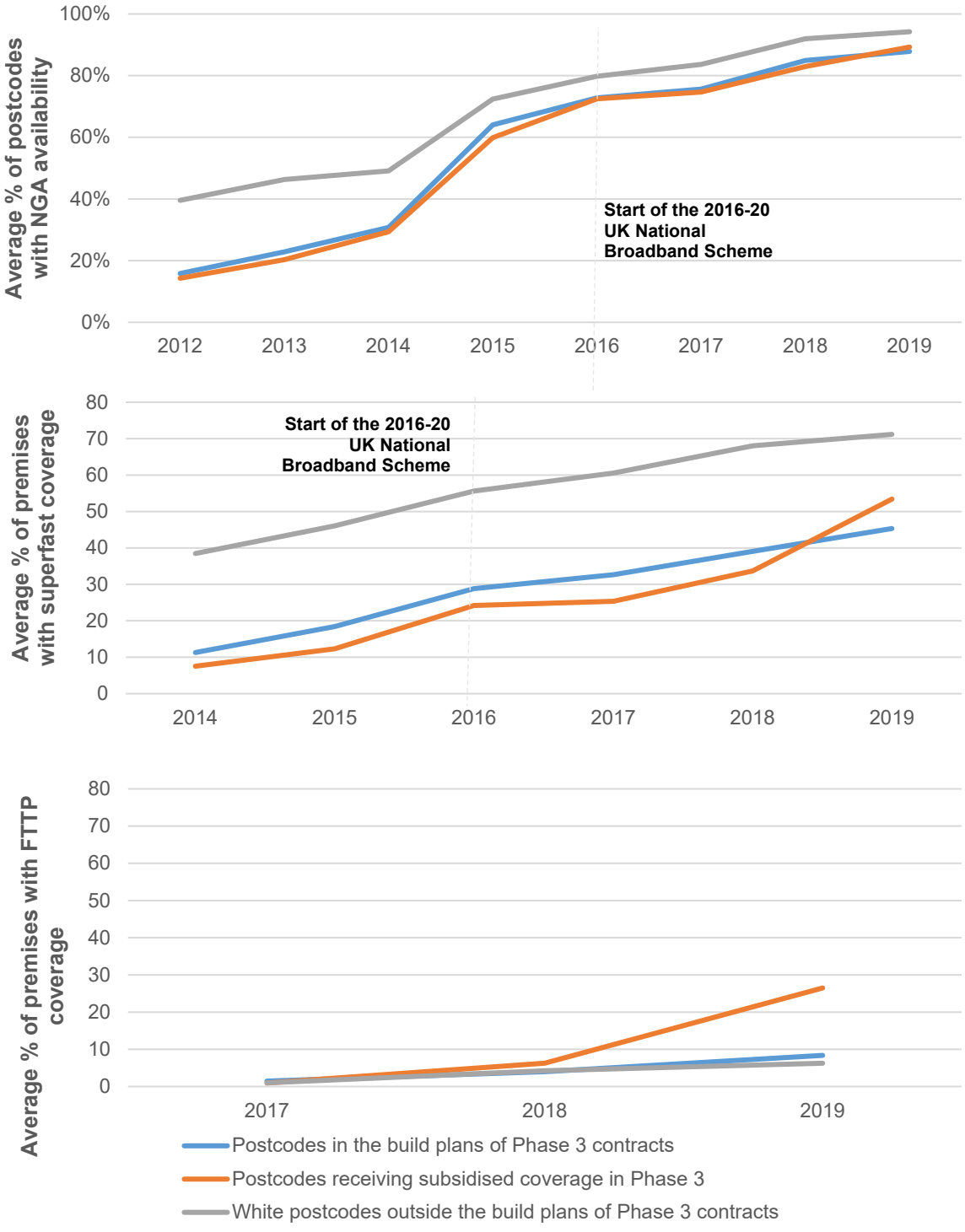
- **NGA coverage:** The percentage of premises on postcodes included in the build plans of Phase 3 contracts with NGA coverage rose from 73 percent to 88 percent between June 2016 and September 2019. NGA coverage rose at the same rate in areas receiving subsidised coverage by September 2019 and areas yet to be upgraded. It should be noted that this is based on a binary measure of NGA coverage[51] that is not sensitive to small changes in the share of premises with NGA coverage.

- **Superfast coverage:** The share of premises with superfast coverage rose at similar rates in areas covered by Phase 3 build plans and other 'white' postcodes between 2016 and September 2019 (from 27 to 45 percent and from 56 to 71 percent respectively). Superfast availability rose from 27 to 53 percent of premises in areas benefitting from subsidised upgrades by September 2019.

- **FTTP:** The proportion of premises with FTTP coverage rose from 1 to 26 percent between 2016 and 2019 in areas benefitting from subsidised coverage. FTTP coverage grew substantially less rapidly on 'white' postcodes that were not included in the build plans of Phase 3 contracts (1 to 6 percent of premises).

[51] A postcode was considered to have NGA coverage if more than 50 percent of the premises on the postcode were covered by NGA. This measure was adopted to facilitate comparability with the 2012 and 2013 Connected Nations reports, which gave a binary measure of whether NGA was available on the postcode.

Figure 5.1: Changes in Next Generation Access (NGA), superfast and FTTP coverage – areas in Phase 3 build plans and other 'white' postcodes, 2012 to 2019



Source: C3 reports, Ofcom Connected Nations, Ipsos MORI analysis. Data on FTTP coverage is only available from 2017.

5.3 Impacts on NGA, superfast and FTTP coverage

The analyses set out above suggest that the availability of superfast broadband services (though not NGA coverage) has increased more rapidly in the areas benefitting from subsidised coverage than other areas that were eligible for BDUK investment. This indicates

that the programme may have had a positive impact on broadband availability. However, as highlighted in Section 3, there is a possibility that these areas would have received superfast coverage in the absence of the programme.

A robust assessment of the impact of the Superfast Broadband Programme requires the selection of appropriate comparison group of postcodes or areas that did not receive BDUK investment, to enable an assessment of what may have happened in the absence of the programme. This is problematic for the following reasons:

- **Targeting at 'white' areas:** Investment was targeted at 'white' premises or postcodes where network providers claimed they had no plans to roll-out superfast broadband coverage. As such, 'grey' and 'black' premises or postcodes are unlikely to provide a suitable counterfactual as they had been deemed commercially viable, and more likely to have received superfast coverage in the absence of the programme. The inclusion of these areas in a comparison group would understate the impact of the programme. Drawing a comparison group from the population of postcodes that were deemed eligible for subsidised coverage in the OMRs but were not included in the build plans of Phase 3 schemes helps address this problem.

- **Supplier choice:** However, this latter approach could be problematic as network providers were largely free to choose which eligible premises would be targeted from those identified in the OMR. It may be reasonable to assume that network providers selected those locations that were most commercially viable to maximise their returns. In Phase 3, factors such as existing penetration of NGA networks and the presence of competitors appeared to be significant in network provider's prioritisation decisions. Eligible postcodes not included in the build plans of Phase 3 schemes can be expected to differ in systematic ways to those benefitting from subsidised upgrades, which could bias results. For example, premises in 'white' areas that did not benefit from BDUK investment may have been the hardest to upgrade profitably, and the least likely to have received superfast coverage in the absence of the programme.

As such, basic comparisons between areas benefitting from the programme and other eligible postcodes that did not benefit from the programme will likely overstate its impacts. Addressing these issues requires the selection of appropriate statistical methods that can accommodate for both observable and unobservable differences between these two groups of areas. Full details of the statistical analyses completed to explore the effects of the programme on NGA access are provided in Technical Appendix 1. The following sections provide a summary of the methodologies employed and the core results.

5.3.1 Methodology

An assessment of the impacts of Phase 3 contracts on NGA, superfast and FTTP coverage was completed using the methods defined in the State aid evaluation plan, using Connected Nations data between 2016 and 2019. These included:

- **Difference-in-differences:** The most straightforward approach adopted involved comparing changes in the NGA, superfast and FTTP coverage on postcodes that received subsidised coverage between 2016 and 2019 to postcodes that were eligible for but did not receive BDUK investment. This approach is robust to unobserved differences between the two groups of postcodes that do not change over time, although no attempt was made in these analyses to control for observed differences.

- **Matching:** The above approach did not control for observable differences between those postcodes that received upgrades and areas that were eligible for subsidies but were not included in the build plans of Phase 3 schemes. As highlighted above, there were systematic differences between the two groups of areas which could bias the findings of difference-in-difference models. To address this issue, postcodes receiving subsidised coverage by 2019 were matched with other eligible postcodes where they shared similar characteristics – such as historic superfast broadband penetration, population density, and features of local broadband networks. Difference-in-difference models were then applied to the matched samples to reach estimates of the impact of the programme.

- **Panel methods:** The analyses described above focused on overall changes in NGA and superfast coverage between 2016 and 2019. However, as annual data was available, it was also possible to better account for the timing of the upgrade and its effect on broadband availability by applying 'fixed effects' models. These models examined the relationship between broadband availability and the timing of subsidised upgrades. Like difference-in-difference models, these approaches are robust to unobserved differences between postcodes that do not change with the time. However, they were also adapted to account for unobserved 'shocks' affecting all areas (such as influential regulatory changes). Estimates of the impacts of the programme derived from these models can be considered the most robust.

- **Prediction based on the comparison group:** The final approach developed a statistical model to describe the evolution of NGA, superfast and FTTP coverage on eligible postcodes that were not included in the build plans of Phase 3 schemes between 2016 and 2019, based on the characteristics of the postcode. The model was then applied to postcodes that did receive subsidised coverage to predict how NGA, superfast and FTTP coverage would have changed had the programme not been funded. It should be noted that these models did not account for unobserved differences between the two groups of postcodes, and estimates of impact derived from these models can be considered the least robust.

The results of these analyses have the potential to be distorted by the delivery of parallel programmes seeking to increase superfast broadband availability. Data was obtained on the delivery of the Gigabit Connectivity Voucher Scheme and the fibre networks being deployed as part of Wave One of the Local Full Fibre Network programme to help control for the possibility that the analyses mistakenly attributed the effects of these parallel programmes to Phase 3 delivery. Qualitative research with Local Bodies also highlighted that there were also parallel schemes being delivered at the local level. Systematic data on the delivery of these schemes could not be obtained and it should be noted that the findings also do not account for all public support for the development of local broadband networks.

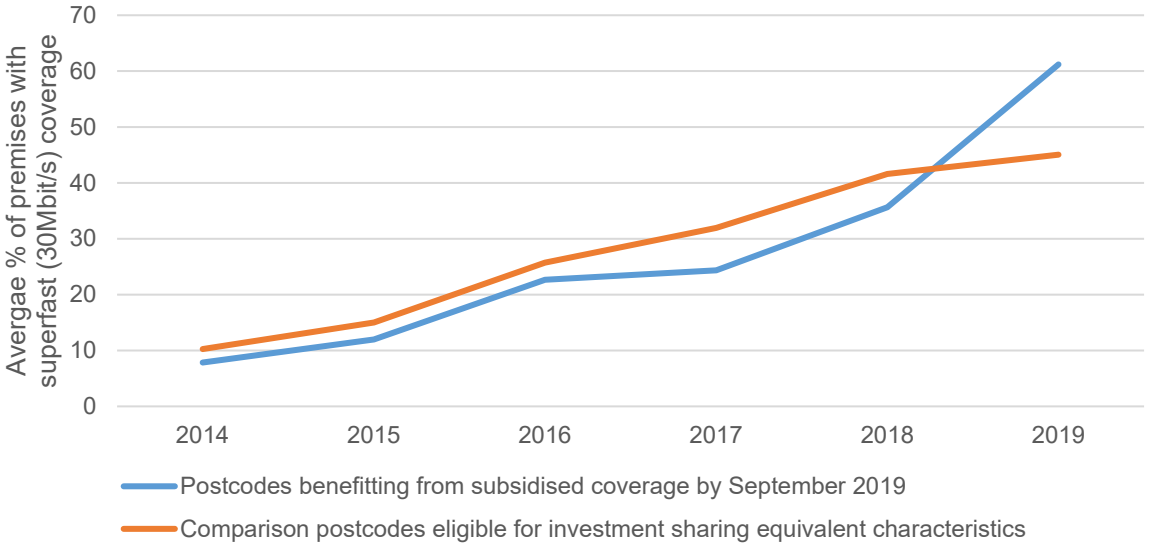
5.3.2 Impacts of Phase 3 contracts between June 2016 and September 2019

The results of the analysis indicated that the programme had a positive impact on NGA, superfast and FTTP availability in those postcodes benefitting from subsidised coverage by September 2019. However, the magnitude of these effects varied across the different approaches). This is illustrated in Figure 4.5 below which shows the increase in superfast broadband availability in postcodes benefitting from subsidised coverage and the matched sample of eligible postcodes that were excluded from Phase 3 build plans which shared similar characteristics:

- Superfast availability rose from 22 percent of premises in 2016 to just over 60 percent on postcodes that benefitted from subsidised upgrades by September 2019. Superfast availability rose in postcodes in the matched comparison group at a slower rate (from 25 percent to just over 45 percent).

- Most of this apparent impact on broadband availability occurred in the 2019 which aligns with the delivery profile of Phase 3 contracts. The figure also suggests the programme may have delayed the availability of superfast broadband services for some households that would have received coverage anyway. Growth in superfast availability was slower in areas benefitting from subsidised coverage between 2016 and 2018 (the period in which tendering exercises were being completed). This issue is explored in more depth below.

Figure 5.2: Evolution of superfast availability, postcodes receiving subsidised coverage by September 2019 and matched group of eligible postcodes, Phase 3



Source: Connected Nations, Ofcom, Ipsos MORI analysis

The statistical analyses provided estimates of the increase in share of premises benefitting from NGA, superfast and FTTP availability between 2016 and 2019 that could be attributed to the delivery of Phase 3 contracts. These estimates were applied to the number of premises on the postcodes benefitting from the programme to reach an estimate of the number of additional premises receiving subsidised coverage by September 2019. These results are summarised in Table 5.3 below:

On postcodes benefitting from subsidised coverage by September 2019, Phase 3 contracts were estimated to have increased the number of premises:

- Passed by NGA coverage by 2,300 to 16,600 (with the weight of results towards the lower end of this range, as illustrated in Figure 5.3).

- With superfast coverage (30Mbps) by 10,800 to 29,300.

- With FTTP coverage by 19,000 to 30,300.

The effect on superfast availability was larger than the effect on NGA availability. This indicates that a share of premises would have been passed by NGA coverage delivering sub-superfast speeds in the absence of the programme. The effect of the programme on FTTP availability was also larger than its effect on superfast availability – indicating that the priority given to gigabit speeds in tendering was effective in bringing forward full fibre networks. This may reflect the differing cost structures and payback periods of FTTC and FTTP, particularly if the latter involves more significant investment costs that cannot necessarily be recovered from the marginal increase in revenues.

Table 5.3 – Impacts of Phase 3 contracts on broadband availability by September 2019, postcodes benefitting from subsidised coverage

Measure of broadband availability	Estimated effect on availability by September 2019 (% of premises)		Increase in the number of premises with enhanced broadband availability	
	Min.	Max	Min.	Max
NGA availability	2.1	10.7	2,300	16,600
Superfast availability	9.9	25.2	10,800	29,300
FTTP availability	25.2	27.8	19,000	30,300

Source: Ipsos MORI analysis. The ranges show the low to high range implied by the statistical findings.

5.3.3 Implied additionality

The estimated number of additional premises benefitting from NGA, superfast and FTTP availability were compared to the total number of premises upgraded by the programme (79,100[52]) to provide an estimate of additionality (i.e. the share of premises upgraded that would not have received superfast coverage in the absence of the programme). The range of findings from the analysis are summarised in Figure 4.6, and suggest:

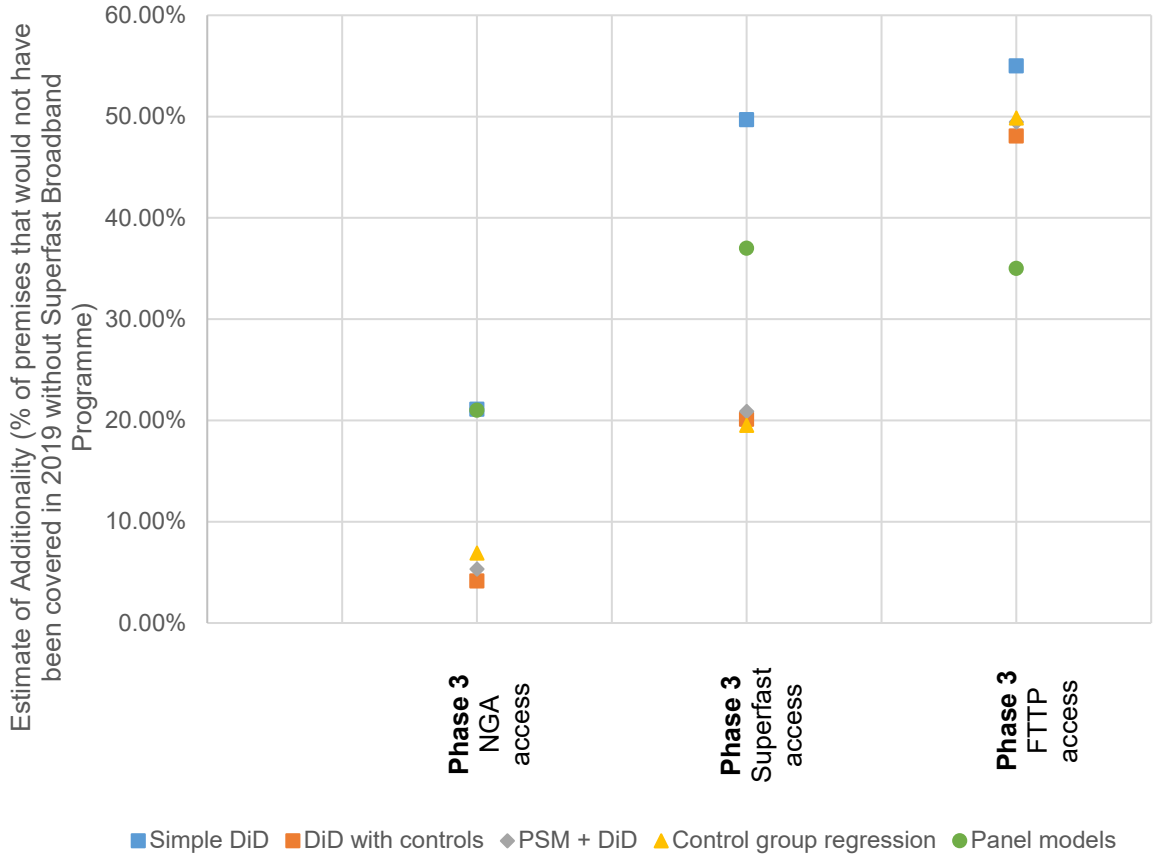
- Around 14 to 37 percent of premises upgraded to superfast (30Mbps) would not have received superfast coverage by 2019 in the absence of the programme. The more robust panel models pointed to estimated impacts towards the top end of this range. The additionality of FTTP coverage delivered through the programme was slightly higher and more consistent across different models (at 35 to 55 percent).

- The additionality of NGA coverage was lower at 3 to 21 percent of premises upgraded.

As highlighted below, these findings are consistent with results examining the impact of the programme overall. It should also be noted that additionality tends to peak around one year following the delivery of subsidised coverage (suggesting there may be lags in terms of the visibility of new coverage in the Connected Nations dataset). As this analysis focuses primarily on upgrades delivered in 2018 and 2019, it is likely that these results will understate the effects of the programme.

[52] 55,000 premises upgraded to FTTP.

Figure 5.3: Estimated share of premises upgraded that would not have otherwise received subsidised coverage by September 2019, Phase 3



Source: Ipsos MORI analysis

5.3.4 Effects on the whole Phase 3 target area

The analysis was repeated to examine the effect of the programme on all postcodes in the build plans of Phase 3 contracts (including the majority that had not yet received subsidised coverage by September 2019). Most of these results suggested that the programme had a negative effect on superfast availability by September 2019 - reducing the proportion of premises with superfast coverage by 3.2 to 10.3 percentage points. This is consistent with the observation above that the programme has delayed the delivery of superfast coverage for some households that would have benefitted from the programme anyway.

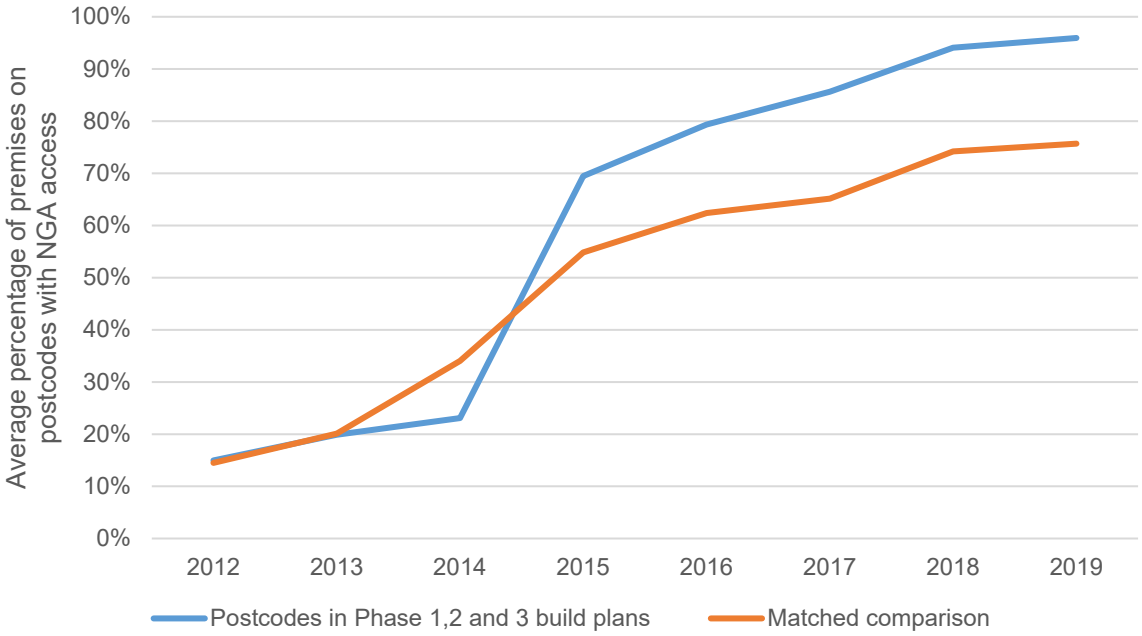
5.3.5 Impacts of Phase 1, 2 and 3 between 2012 and 2019

The delivery of Phase 3 contracts was at an early stage at the time of writing and it is premature to draw definitive conclusions on their long-term impacts. To provide a longer-term view on the impacts of the programme, similar analytical methods were applied to all contracts funded through the programme since delivery of Phase 1 began in 2013. As illustrated in Figure 5.4, the evolution of NGA coverage[53] in postcodes benefitting from the programme and other eligible postcodes has shown a broadly similar pattern to the effects of Phase 3 contracts

[53] Observations of superfast availability are not available from Connected Nations prior to 2014.

on superfast availability. There is an apparent delaying effect in the first year (in 2014), before a significant increase in coverage in the following years.

Figure 5.4: Evolution of NGA availability, postcodes receiving subsidised coverage by September 2019 and matched group of eligible postcodes



Source: Ipsos MORI analysis

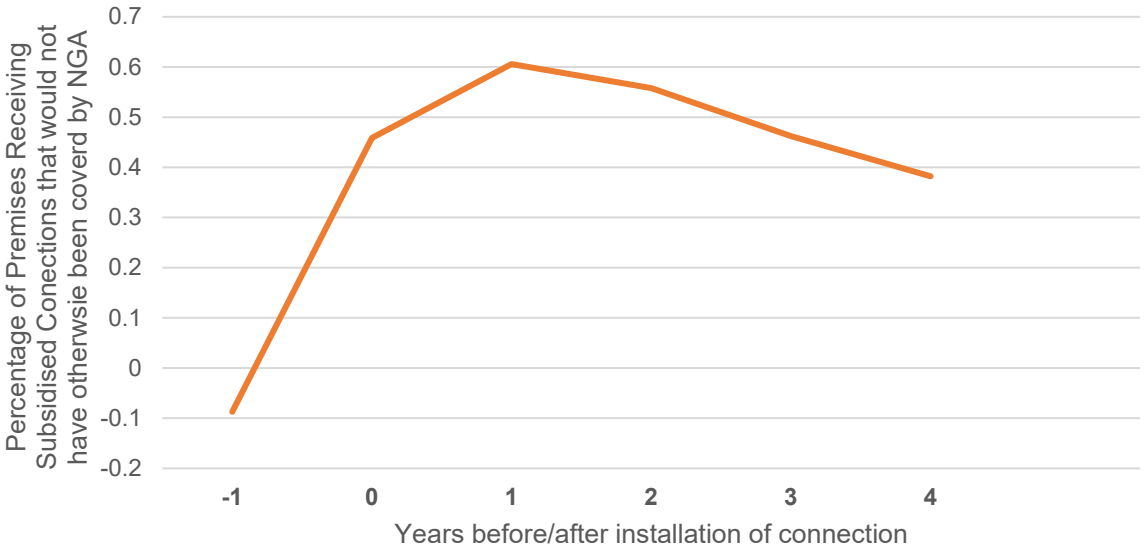
The longer time frame for these analyses supported an investigation into how the additionality of NGA coverage evolves with time. The figure below provides estimates of the additionality of subsidised coverage in the years before and after the upgrade and suggests:

- **Additionality:** Additionality peaks at just over 60 percent one year following the delivery of the upgrade. It is assumed that the increase in additionality is a result of lags between delivery of upgrades and the visibility of enhanced coverage in the Connected Nations dataset. If similar patterns hold for Phase 3 of the programme, this implies that the impacts reported above may be understated.

- **Decay over time:** The level of additionality decays from two years following the upgrade at a rate of around 14 percent per annum. This indicates that an important effect of the programme is to accelerate the availability of NGA coverage for some premises that would have otherwise received enhanced broadband coverage at a later stage.

- **Delaying effect:** Across the programme, subsidised coverage reduces superfast availability by 9 percent in the year before the upgrade. This suggests that a smaller share of premises receive enhanced broadband coverage later than they otherwise would have (and that there are some social costs attached to the programme).

Figure 5.5: Estimated additionality of NGA Coverage over time, Phase 1 to 3



Source: Ipsos MORI analysis; BDUK C3 reports & Ofcom Connected Nations

5.3.6 Factors driving additionality

The preceding sections indicate that the OMR and public consultation processes were not fully effective in identifying premises that would not benefit from commercial deployments (if it was, then estimated additionality would be in the region of 100 percent). The qualitative research with Local Bodies and network providers were used to identify the factors that may explain these findings:

- **Quality of data:** Local Bodies interviewees expressed some concerns with the quality of the information provided by providers as part of the OMR process. Responses provided by Openreach in Phase 1 were seen to have caused issues leading to some areas being included in the intervention zone that already had superfast, and areas being wrongly excluded in others. Premise level data was seen to be less inaccurate with limited numbers of providers aware of their network at such a level. Efforts to descope areas that were wrongly included were undertaken during project delivery, though this absorbed a significant amount of resource on the part of the Local Bodies. These issues were somewhat less prominent in Phases 2 and 3 as the data supplied was described as having improved 'substantially' albeit with the lack of suitably granular data issues still present.

- **Investment cycles:** Many network providers reported difficulty in providing data for the OMR, as their plans were not always set out for the next three years. This was the case for both smaller and larger providers. This could be because the providers did not have robust plans for future deployment for the next three years (for example being more responsive to customer demand), or their plans were not specified in sufficient detail to be included. One provider stated that they could only provide (or were only willing to provide) concrete roll-out plans for 12 months, and not the 36 months requested – and their less robust plans for months 13-36 were rejected by Local Bodies. This meant that some 'prospective' plans were supplied to Local Bodies that were ultimately rejected (and to the degree that these plans were brought forward in practice, this will reduce additionality).

- **Mismatch between length of contracts and OMR:** Another issue with the OMR process is that there was sometimes a mismatch between the time-period covered by the OMR (three years) and the time-period covered by the delivery contract (which could extend beyond the three-year period covered by the OMR). As issues of commercial viability are dynamic, the OMR could become outdated with network providers introducing new programmes of commercial deployment on postcodes that were previously identified as eligible.

- **Static nature of the OMR:** The static nature of the OMRs, completed at the outset of each phase, posed a barrier to its ability to provide an accurate reflection of commercial coverage in the views of many Local Bodies. Some of those interviewed pointed towards the delivery of infrastructure in 'white' areas by providers that responded to the OMR as evidence of this. Wireless network providers were seen to be most readily able to change plans at relatively short notice and can encroach upon 'white' areas. One Local Body proposed regular reviews of the landscape after the setting of the intervention area, to include consultation with providers, to remain informed of changes in commercial plans. The static nature of the OMR also raised issues where regulatory innovation – such as changes in Physical Infrastructure Access (PIA) agreement with Openreach, which reportedly made areas more distant from existing networks more commercially viable for providers.[54] This was not factored into their original OMR responses, which meant these were no longer the best representation of their roll out plans.

- **Realism of plans:** Local Bodies also faced challenges in establishing the realism of the delivery plans put forward in the OMR. In addition, several Local Bodies outlined some suspicions of 'gaming' by providers leading to an overstatement of commercial plans to discourage competition thus contributing to the issues above. These Local Bodies pointed to areas in their locality that were put under review following the OMR and referral to the NCC (marked as 'grey' and monitored) and have not been delivered through the commercial plans outlined in the OMR.

- **Wireless:** Wireless broadband providers had further problems with the OMR process. Many had their responses rejected by Local Bodies (all wireless providers that were consulted had experienced having their responses rejected). The most common reason was that the Local Bodies did not recognise their technology as suitable to provide superfast speeds (despite the wireless network providers claiming they provided substantial technical evidence to the contrary and extensive businesses case materials). Wireless providers felt that they had to provide more details (and incur a higher cost) to submit OMR responses than wired broadband providers.

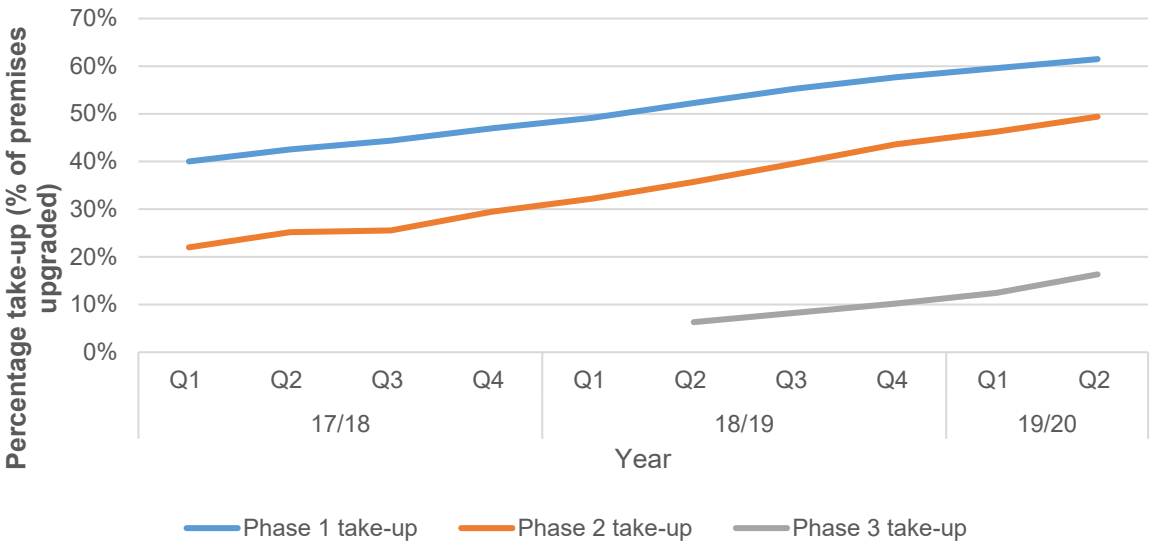
Despite concerns raised by the wireless providers, there are technical reasons why the Local Bodies took this approach, such as the placement of aerials, line of sight and number of premises on the network all affecting the ability of the network to deliver superfast speeds, and a lack of guarantees of the speed of service from Ofcom on wireless networks. Despite these concerns, a small number of programme contracts were awarded to wireless network providers.

[54] This relates to the Ofcom revision to Duct and Pole Access (DPA), which began in 216 and was adopted in 2018/19.

5.4 Take-up of NGA coverage

Take-up of subsidised coverage is monitored by BDUK (although the associated speeds of new connections are not). At the end of September 2019, a total of 15,400 connections had been made to newly upgraded services in Phase 3 contract areas. This was equivalent to 16 percent of the premises upgraded. As illustrated in the figure below, take-up of coverage made available through Phase 3 contracts has risen with time and growth in demand has broadly mirrored prior phases of the programme.

Figure 5.6: Reported take-up (%) of subsidised superfast connections to Q2 2019/20, Phase 1, 2 & 3



Source: Programme data (C3 reports); Ipsos MORI analysis.

Given the small share of planned delivery that had come forward at the time of writing and the relatively low rates of take-up reported by the end of Q3 2019/20, there was little evidence of material changes in take-up measures in the programme area relative to other postcodes eligible for investment:

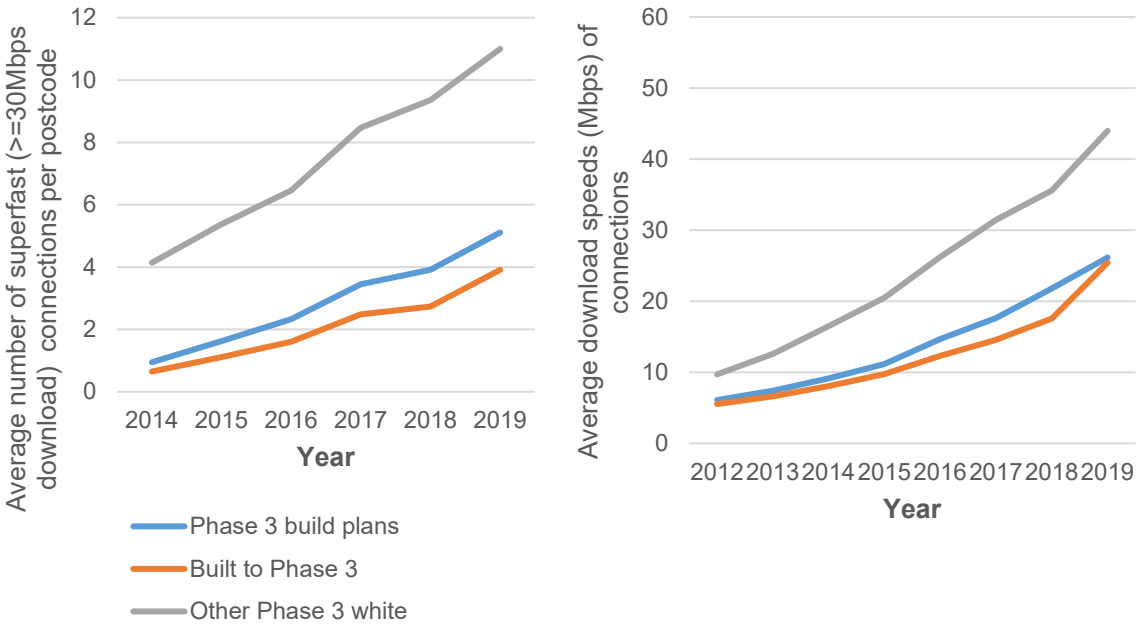
- **Number of superfast (30Mbps) connections:** The average number of superfast connections on postcodes in the build plans of Phase 3 schemes rose by 121 percent between 2016 to 2019 (from 2.3 to 5.1). Growth in the number of superfast connections rose slightly more rapidly (143 percent) on postcodes receiving subsidised coverage by 2019. However, demand for superfast connections also rose rapidly on other 'white' postcodes not included in the build plans of Phase 3 schemes (by 71 percent) over the same period.

- **Average download speeds:** The average download speeds of connections on postcodes included in the build plans of Phase 3 contracts rose from 14.7 Mbps to 26.2 Mbps between 2016 and 2019 (78 percent). Average download speeds rose more rapidly on postcodes receiving subsidised coverage by September 2019 (106 percent). However, growth in average download speeds was more rapid on postcodes that were not included in the build plans of Phase 3 schemes (115 percent) over the same period.

There were more marked differences in the maximum download speeds of connections (shown in the Figure below). Maximum download speeds on the postcodes included in the build plans of Phase 3 schemes rose at a similar rate to those on other 'white' postcodes.

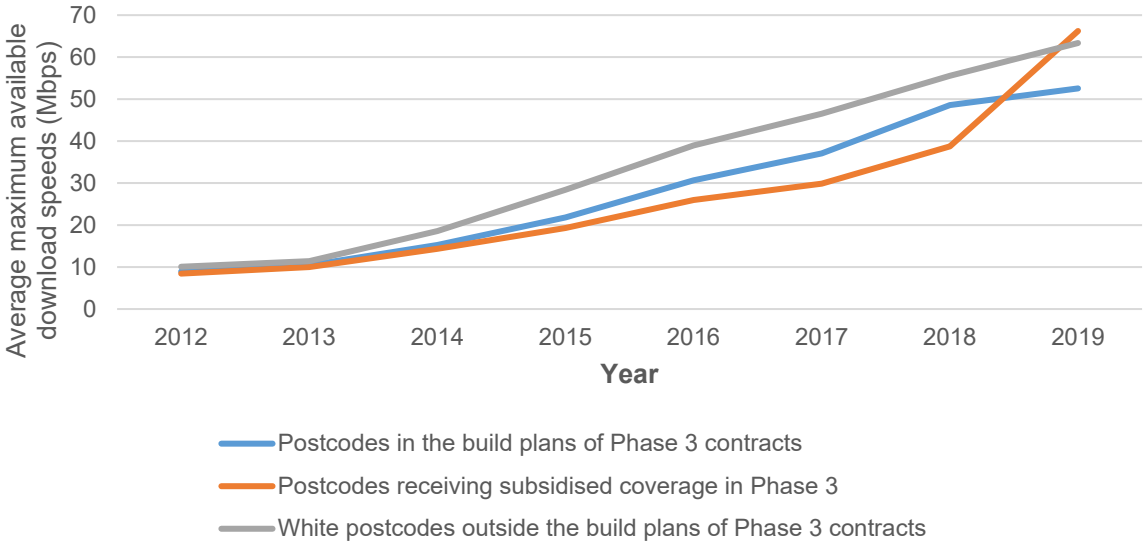
However, maximum download speeds rose most rapidly in those areas that had received subsidised coverage by September 2019 (reaching an average of 66 Mbps in September 2019). This evidence suggests that early adopters may be taking advantage of the faster speeds made available through FTTP (the availability of which was more widespread in these areas in 2019).

Figure 5.7: Number of superfast (30Mbps) connections and average download speeds of connections – areas in Phase 3 build plans and other 'white' postcodes, 2012 to 2019



Source: C3 reports, Ofcom Connected Nations, Ipsos MORI analysis.

Figure 5.8: Maximum download speeds of connections, areas in Phase 3 build plans and other 'white' postcodes, 2012 to 2019



Source: C3 reports, Ofcom Connected Nations, Ipsos MORI analysis.

5.4.1 Impacts on take-up

The statistical models described above were also applied to explore the effect of the programme on the take-up of superfast services - as visible in the number of premises with a live superfast connection (30Mbps or more), the average download speeds of connections, and the average upload speeds of connections. The results showed that:

- **Superfast connections:** The findings indicated that the programme led to a reduction in the number of premises with superfast connections (by 1.1 to 2.4 premises per postcode) by September 2019. This is likely explained by a combination of the effect of the programme in delaying the availability of superfast for some premises that would have otherwise benefitted from commercial deployments, and the limited time that had elapsed for businesses and households to take-up subsidised coverage by September 2019.

- **Average download speeds:** There was no conclusive evidence that the programme had a positive or negative effect on the average download speeds of connections by September 2019. The findings ranged from an effect of reducing average download speeds by 2.1Mbps to increasing download speeds by 2.2Mbps.

- **Maximum download speeds and upload speeds:** The results indicated that the programme increased the average upload speeds of connections (by 0.9Mbps to 3.9Mbps) and the maximum download speeds of connections by 6.2Mbps to 16.9Mbps. It is assumed that this reflects the effect of FTTP delivery, which has enabled some users to obtain higher capacity connections that may have been available from FTTC or other NGA technologies.

It is premature to draw any conclusions in relation to the impact of the programme on take-up. Take-up of superfast broadband services increases with time and the analysis of the long-term effects of the programme set out in Technical Appendix 1 highlights that, in the long-run, the programme has had positive effects on a wide range of take-up measures. As such, it will be important to revisit this analysis once more time has elapsed.

Table 5.4: Impacts of Phase 3 contracts on broadband take-up by September 2019, postcodes benefitting from subsidised coverage

Measure of broadband take-up	Estimated effect by September 2019 (% of premises)	
	Low	High
Average number of premises with connections with download speed of 30Mbps +	-2.4	-1.1
Average download speed of connections (Mbps)	-2.1	2.2
Average upload speed of connections (Mbps)	0.9	3.9
Maximum download speed of connections	6.2	16.9

Source: Ipsos MORI analysis

6. Direct impacts on aid beneficiaries

This section of the report provides evidence to answer the third and fourth State aid evaluation questions as set out in the NBS evaluation plan:

- Question 3: Has the aid had a significant incentive effect on the aid beneficiaries?
- Question 4: Has the aid had a material effect on the market position of the direct beneficiaries?

The evidence set out in this section is based on modelling of the expected profitability of contracts awarded under Phase 3 based – as far as possible – on observed costs and take-up. Full details of this modelling are provided in Technical Appendix 2, **[redacted]**. This section also provides evidence on the market share of those awarded contracts under Phase 3, based on data compiled by ThinkBroadband. Where relevant, additional information is provided from the qualitative interviews to help contextualise and interpret results.

Key findings:

Based on projections provided by network providers at the tendering stage, the proposed network build under Phase 3 contracts was expected either to generate losses or to deliver positive rates of return (Internal Rate of Return or IRR) that were substantially lower than the cost of capital faced by the network provider - a loss of **[redacted]** per annum versus a Weighted Average Cost of Capital (WACC) of **[redacted]**. If it is assumed that profit maximising firms are only incentivised to implement projects where the IRR exceeds the WACC, then public subsidies would have been needed to create a sufficient economic incentive to deliver these investments.

Network providers consistently underestimated take-up in the tendering process and projections for Phase 3 appear understated given experiences with Phase 1 and 2 contracts. This will have understated revenue projections and the IRRs (increasing the public funding required to make the project economically viable). However, after updating projections in line with take-up observed on Phase 1 and 2 contracts, the expected IRRs associated with Phase 3 projects without subsidy are not significantly higher than those expected at the tendering stage (moving to positive IRR of **[redacted]**). The projected IRRs of all Phase 3 contracts are expected to be substantially lower than WACC of the network provider.

The protections put in place by BDUK are likely to protect the public sector from the risk that it provided more than the minimum subsidy needed. Contracts have been designed in such a way that network providers are required to return resources to the public sector if build costs are understated or if take-up proves higher than expected (leading to higher levels of profitability). While the provision of subsidies is expected to increase the IRRs on Phase 3 contracts to a **[redacted]** return, this falls to **[redacted]** once the activation of these contractual mechanisms is accounted for.

While the contracts have proven largely effective in containing subsidies to the minimum needed for the project to go forward, the public sector has incurred opportunity costs by tying resources up in the programme. BDUK may wish to consider whether seeking to contain these opportunity costs in future procurements could be justified.

When examining the market position of the programme beneficiaries, it can be seen that there has not been significant changes in the market share of programme beneficiaries in the broadband market between 2016 and 2020, with Openreach dominating the market, with more than three quarters of the total broadband market and over 60 percent of the Next Generation

Access (NGA) market in both 2016 and 2020. The other programme beneficiaries cumulatively make up less than 0.5 percent of the total broadband and NGA markets.

In the areas where the Superfast Broadband Programme has been delivered, the programme appears to have had little impact on the market position of Openreach in either the overall broadband or NGA market as Openreach maintains a dominant market position in both 2016 and 2020. However, the market share in both the overall broadband and NGA market for the smaller programme beneficiaries has increased between 2016 and 2020 in Phase 3 delivery areas which is not observed at a national level, suggesting the programme has positively affected the market share of the programme beneficiaries in these areas.

In areas where Openreach have delivered contracts, they have maintained their market share between 2016 and 2020 in both the overall broadband and NGA markets. However, in areas where the other, smaller programme beneficiaries have delivered contracts, the market share for Openreach has fallen (particularly in areas where Gigaclear have delivered contracts), with the market share of the other beneficiaries increasing. This suggests that the other beneficiaries are taking market share from Openreach in these areas.

6.1 Incentive effect of the State aid on programme beneficiaries

This section examines the strength of the incentive effect of State aid provided by the Superfast Broadband Programme. The aim of the analysis is to explore whether public subsidies were needed to provide an incentive to network providers to extend superfast networks to the areas targeted by the programme.

The motivation for this analysis stems from the results of classical economic theory that suggests the private sector will maximise profits by implementing all projects that generate a rate of return that at least equal their cost of capital. The rationale for the programme is underpinned by an assumption that there are some areas of the UK where investments in superfast broadband infrastructure will not generate a rate of return that exceeds the cost of capital. These investments would not be commercially viable, leaving some areas at risk of being excluded from superfast broadband coverage (producing a 'digital divide'). The programme seeks to provide the minimum subsidy that would be required to make these investments commercially viable (i.e. the subsidy that would equalise the expected returns associated with the investment and the cost of capital faced by the network provider).

However, it is not feasible for the public sector to perfectly observe the expected costs and revenues associated with potential investments in superfast coverage before it awards subsidies. Network providers also have an incentive to seek subsidies for investments that would have been commercially viable in the absence of public support to maximise profitability and minimise risk exposure. The design of the programme anticipates this risk through the implementation of an Open Market Review process designed to encourage network providers to reveal their investment plans and to ensure that subsidies are directed towards premises that would not be covered by commercial deployments. The contracts are also designed to protect the public sector from the risk that the subsidy exceeds the minimum needed for the project to go forward (for example, if costs prove less significant than originally expected or if revenues exceed original expectations).

This section examines the effectiveness of these arrangements by comparing the expected rate of return on the contracts awarded (the Internal Rate of Return[55] or IRR) to the network

[55] The discount rate that sets the present value of an income stream to zero.

providers' Weighted Average Cost of Capital (WACC)[56]. As highlighted in the State aid evaluation plan, if the actual IRR earned on the investments made exceeds the WACC before the subsidy was awarded, this would call into question the strength of the incentive effect provided by the subsidies. It should be noted that this may not hold true where there are market failures (e.g. a dominant supplier with market power may not be incentivised to implement an investment project if it earns a marginal rate of return).

6.1.1 Competition for Phase 3 contracts

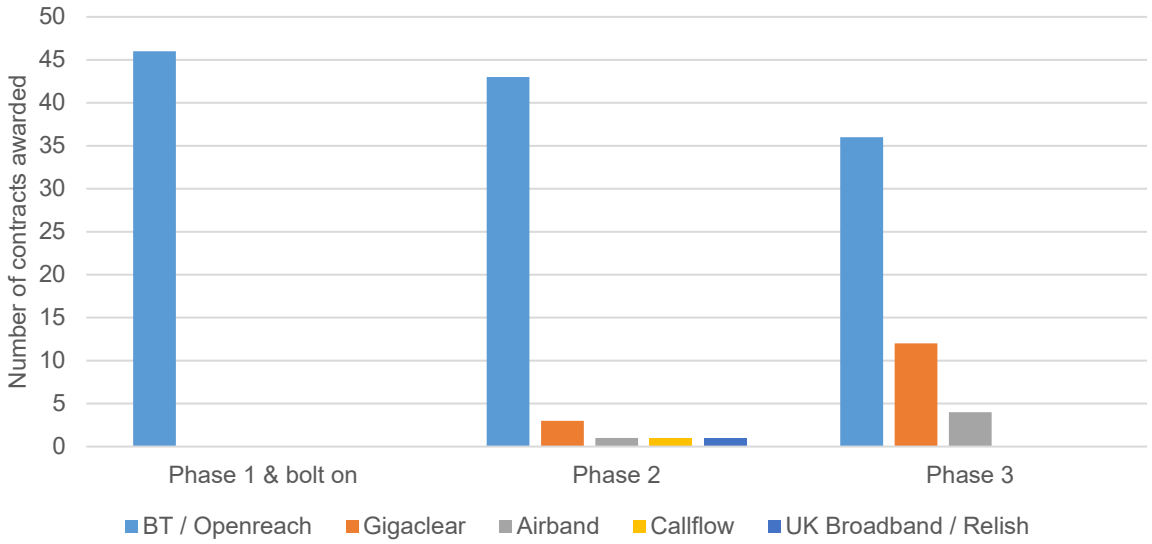
The programme is based on a gap funding model that aims to provide the minimum level of subsidy required to make the project commercially viable. The level of gap funding to be provided is determined by the set of assumptions put forward by the tenderer in terms of the build cost, take-up, average revenue per user and operational costs. The tenderer can potentially use this process to transfer risk to the public sector by either assuming low levels of future take-up or overstating expected build costs – which will increase the level of gap funding required to make the project viable. This strategy is less feasible in the presence of competition, as it will reduce the value for money associated with the tender and increase the probability of not being awarded the contract.

In Phases 1 and 2, Local Bodies predominantly used the BDUK framework to procure the providers' services to deliver the infrastructure. This approach restricted the number of possible bidders to two (one of which did not engage for any tenders). In Phase 3, as required by the State aid judgement under which the programme was approved, procurements published through the OJEU were used by Local Bodies to target specific areas and/or clusters with the ability to target faster connection speeds, but the main benefits were expected to come from increased competition.

Data was not available on the number of bids received in response to the OJEU procurements to evaluate its effectiveness directly in generating larger numbers of bids. However, Local Bodies consulted highlighted a good degree of engagement from providers to Phase 3 procurement exercises with several bodies receiving five or six Expressions of Interest (EOIs). These translated into fewer responses to the full tender (between one and three). Nevertheless, there was a more even distribution of network providers awarded contracts, with Openreach being awarded just over two thirds of the contracts (69 percent), and Gigaclear being awarded a significant number of contracts (12 contracts, 23 percent).

[56] For the purposes of this analysis, an average comparison between IRR and the network provider WACC has been made. A comparison to the marginal cost of capital would be preferable approach and may therefore produce different results from average rates.

Figure 6.1: Number of contracts awarded by beneficiary and Phase of programme



Source: Cora Management Information, June 2020

The table below provides a breakdown of funding for contracts awarded under Phase 1, 2 and 3 of the programme by source of funding. This table illustrates that the subsidy required as a percentage of the total cost of the project has remained constant over the three Phases of the programme (with the share of costs funded by the network provider rising from 24 percent in Phase 1 to over 27 percent in Phase 3). However, investment in postcodes covered by Phase 3 contracts should – in principle - have been less commercially viable than those covered by Phase 1. This could be taken as a signal that greater competition has helped to keep the gap funding requirement constant over time, above other possible explanations (such as the development of new methods or increased skills / knowledge of the beneficiary workforce).

Table 6.1: Superfast Broadband Programme expenditure by phase

	Phase 1 (contracts awarded 2012 – 2014)	**Phase 2 (contract awarded 2013 – 2016)**	**Phase 3 (contracts awarded after 2017)**
Average premises	95,405	16,952	6,197
Average contract value (£m)	£35.0	£13.8	£12.3
Funding source:			
BDUK funding	29%	26%	12%
Local Body funding	31%	22%	37%
ERDF / Defra funding	12%	1%	12%
Supplier CAPEX	24%	25%	27%
Supplier OPEX	0%	5%	4%
Funding generated from take-up clawback	3%	10%	5%
Funding generated from underspend	0%	11%	3%

Source: Cora Management Information, June 2020

Lotting[57] was also used in some areas to try to encourage further competition but views on its effectiveness were mixed with some areas forgoing this entirely given a lack of feasible geographic splits of the target areas. Where this approach was used, some Local Bodies thought it may have marginally increased the number of responses. In general, smaller providers engaged in the study highlighted a preference for smaller lots, though there was an acceptance that the lots needed to be of a suitable size to make them worthwhile bidding for. Additionally, the lots needed to be of a suitable size to ensure the management burden to Local Bodies and providers was appropriate (it is more difficult to manage many small contracts than one large one). Smaller providers also stated that they would be more able to bid for contracts following dividing up some of the areas (into lots).

However, when the ITTs came out, there were still restrictions on which organisations could apply (turnover of applicants and other qualification criteria). This restricted the level of competition that was possible, but again providers generally understood that there needed to be some restrictions to provide reassurance that the publicly funded networks would be completed.

6.1.2 Methodology for modelling future IRRs

The aim of the analysis is to compare the IRRs earned in practice by network providers against their cost of capital. However, this involves several challenges:

- **Data availability:** Network providers have a contractual obligation to provide BDUK with information on the actual costs of the network build and the share of premises upgraded that have been connected. However, network providers are not required to provide information on on-going operational costs or revenues earned (partly due to challenges in attributing operational costs to the infrastructure). As such, it is not possible to observe the profitability of the contracts awarded directly.

- **Time horizons:** The IRR associated with the network build is determined over long time horizons (i.e. fifteen to twenty years depending on the Phase). Due to the early stage of implementation for a large proportion of Phase 3 contracts, information on final build costs are not yet available and there are few quarters of reported information on take-up to provide meaningful comparisons against expectations.

The following general methodology was adopted in light of these constraints:

- **Phase 1 and 2:** A modelling exercise was completed to project the costs, revenues and IRR associated with Phase 1 and 2 contracts. The build costs – and any implementation clawback - associated with these contracts were either known (where the contract was complete) or revised expectations were available from BDUK where the project was at an advanced stage. Observations of take-up were available for an extensive period, though not for the fifteen-year period over which the IRR was originally calculated. A projection of future take-up was developed by projecting past trends forwards. Estimates of revenues, operational costs and take-up clawback were derived by applying assumptions provided by the network provider in their original PFM relation to the average revenue and operational cost per user to this revised take-up projection. These revised estimates of expected costs and revenues were used to provide an update to the expected IRR on the project.

[57] Lotting is a process by which the local body divides their broadband project into multiple contracts (lots) rather than one single contract

- **Phase 3:** There was limited data available on the costs and take-up of most Phase 3 contracts owing to their comparatively early stage of implementation. Projections of the build costs associated with these contracts were developed by scaling initial expectations in light of changes in the number of premises to be upgraded. Information on actual take-up was generally insufficient to develop a projection by extrapolating past trends into the future, so an assumption was adopted that take-up would broadly follow patterns observed and projected for Phases 1 and 2.

A comprehensive overview of the methodology and data sources used is included in the Technical Appendix 2. However, the following limitations should be borne in mind:

- **Take-up:** Estimates of revenues, operational costs and take-up clawback are driven by a projection of future take-up. This projection is based on an extrapolation of past trends and actual take-up may be higher or lower than projected in practice. Deviations from these projections will have complex effects on the IRRs presented in the following sections. For example, while higher take-up than projected would imply higher revenues and higher IRRs, the network provider may need to return a higher share of the subsidy received to the public sector via the take-up clawback mechanism than expected.

- **Modelling of revenues:** The modelling of future revenues is based on price schedules put forward by the network provider in its PFM submitted as part of the tendering process. The analysis assumes that these prices are both accurate and are constant over the duration of the period. Additionally, the average revenue per user is based on the share of customers taking up FTTC and FTTP technologies assumed by the network provider in the documents submitted with its tender. In practice, prices may vary over time. For example, increased competition may place downward pressure on prices (resulting in lower revenues and lower IRRs than estimated in the following analyses). If demand for more expensive packages is higher than expected, this will result in higher revenues and higher IRRs than estimated. This cannot realistically be addressed in any future iterations of the evaluation unless BDUK were to begin monitoring the revenues earned by network providers on connections made to subsidised infrastructure.

- **Operational costs:** The modelling of operational costs was based on the forecast of operational costs provided by the network provider in the documents submitted with its tender, divided by the forecast number of customers, to provide an estimate of the operational cost per user. If actual operating costs per connection differ from these assumptions – for example, due to technological change – then the IRRs will be higher or lower than presented below.

- **Customer upgrades:** The analyses do not account for any revenues foregone by network providers as a result of any customers upgrading from existing packages. As such, the IRRs presented below will be systematically overstated (and the significance of this issue is unknown).

- **Internal focus:** The IRRs focus on the revenues earned and costs incurred by the network provider with the primary objective of establishing whether the network provider had an economic incentive to deliver the network build without a subsidy. However, it should be noted that there will likely be displacement of customers, revenues and profits from other network providers. While this issue does not affect the IRRs, the rates of return presented will not mirror the social rate of return.

6.1.3 Internal Rates of Return at the tendering stage

The expected rate of return on the contracts before and after subsidy are provided in the Project Financial Model completed by network providers as part of the tendering process. At the baseline, network provider projections suggested that:

- **Commercial viability without subsidy:** On average, Phase 3 contracts were expected to be loss making without a subsidy (delivering an IRR of **[redacted]**). There was substantial variation at the individual contract level, although no project was expected to deliver an IRR that exceeded the network provider's WACC (**[redacted]**). The expected profitability of investments proposed by network providers facing a higher cost of capital were broadly in line with those put forward by the dominant supplier which faced a lower cost of capital (a weighted average of **[redacted]** respectively). **[Redacted]**.

- **Commercial viability with subsidy:** The expected IRR associated with the contracts with subsidies averaged **[redacted]** per annum. This was lower than the average network provider's WACC (**[redacted])**. It is possible that the network providers saw residual value in the network build at the end of project lifetime. Additionally, delivery of the network build may have conferred other advantages to the network provider that are not captured by these analyses, such as reducing the marginal costs of deployment to adjacent areas.

- **Comparison with Phase 1 and 2:** The expected profitability of Phase 3 contracts without subsidy was expected to be higher than those associated with Phase 1 and 2 contracts, meaning that they would require a lower level of public support to make them economically viable. As illustrated below, this was driven primarily by more optimistic take-up assumptions adopted by network providers in tenders. This could have been driven by the higher levels of competition involved, which may have limited scope for network providers to use less optimistic take-up assumptions to transfer risk to the public sector. Alternatively, network providers may have seen relatively greater opportunities to develop local monopoly advantage in Phase 3, resulting in higher take-up. This is considered less plausible given that observed take-up on earlier Phases was substantially higher than anticipated.

6.1.4 Expected and actual costs

At the tendering stage, the expected costs associated with the network build (for the contracts in the scope of this analysis) were estimated by network providers to be approximately £169m. Based on information on actual costs to date:

- **Costs to date:** Network providers had incurred costs of £101m in delivering the network build based on information available at the time of writing.

- **Forecast future costs:** Across the portfolio, the future costs associated with the network build were expected to be £66m.

- **Expected versus forecast:** At the portfolio level, the forecast costs are broadly in line with expected costs and have little effect on the IRRs presented below. While there is variation at the contract level, this variance is primarily driven by differences in the contracted number of premises to be upgraded and any changes that have subsequently been agreed with the local body. The results do not factor in any possible differences in the expected and actual efficiency of the network build, and to the degree

that these are significant, the estimated IRRs presented below will be overstated or understated.

Table 6.2: Modelled build costs for Phase 3 contracts

	Baseline build capex (PFM)	Actual build capex (Finance Tracker)	Additional modelled build capex	Total predicted build capex
Total costs	£168,865,826	£101,179,650	£66,555,338	£167,734,988

Source: Ipsos MORI analysis

6.1.5 Actual and predicted take-up

The take-up level represents the number of premises connected. It is a significant component of the analysis as it influences both the level of revenues earned by providers, operational costs, as well as subsidies to be returned to the public sector via the take-up clawback mechanism. There was little data available on the observed take-up of superfast services enabled by contracts delivered under Phase 3. However, there is extensive information on the take-up of coverage brought forward Phase 1 and Phase 2 that was used to inform expectations.

Figure 6.2 below shows the profile of expected take-up (as a percentage of premises passed) for Phase 1 and 2 contracts as set out in documents submitted by tenderers. This is compared to actual take-up as monitored by BDUK. The figures illustrate that actual take-up substantially exceeded expected take-up in both Phases 1 and 2 of the programme:

- **Phase 1:** In the long-run (ten years after the completion of the project), take-up was predicted to **[redacted]** of the premises passed. In practice, actual take-up exceeded this level in the third year of the contract and continued to increase to almost **[redacted]** by 2019/20.

- **Phase 2:** Expected take-up was predicted by network providers to **[redacted]** for Phase 2 contracts. Given that network providers had learned from Phase 1, some questions could be raised about the credibility of these expectations (i.e. observed take-up on Phase 1 contracts had already broadly reached this level at the time Phase 2 contracts were awarded). In practice, actual take-up of Phase 2 rose more quickly than for Phase 1 contracts and had reached **[redacted]** by 2019/20.

To model the expected rates of return on Phase 1 and 2 contracts, a generalised logistic function was used to forecast take-up beyond the point of latest available data in both phases, capped at a maximum value of 85 percent. This is in line with the assumption that the maximum take-up level is around 85 percent across the UK.[58]

Figure 6.2: Predicted and actual take-up levels rates for Phase 1 and 2 contracts

[redacted]

Figure 6.3 below shows the profile of average take-up (as a percentage of premises passed) for Phase 3 contracts:

[58] This capping was deemed appropriate through discussions with BDUK and with reference to Ofcom's Connected Nations 2018 report indicating average take-up of 85% across the UK. No time factor has been applied to decrease the assumed 15% of premises which do not take-up superfast broadband over time. Ofcom (2018). *Connected Nations 2018.*.

- **Expected take-up:** On average, network providers expected take-up to reach **[redacted]** in the long-term. This is higher than assumed for Phase 1 and 2 contracts, and increased the expected IRRs on Phase 3 contracts. However, there are questions around the plausibility of these assumptions given that take-up on Phase 1 and 2 contracts had already exceeded this value at the time many of these contracts were awarded.

- **Actual take-up:** There was limited data available on actual take-up of coverage brought forward under Phase 3 (shown in a solid blue line in the following figure). Take-up did lag expectations, but this is primarily driven by delays in delivery of the scheme rather than lower than expected demand for superfast services. However, as the associated revenues will be realised at later stages than originally expected, these delays will have the effect of reducing the IRR associated with the investments.

- **Projected take-up**: Owing to the limited data available on the take-up, it has been assumed that future take-up patterns will mirror the growth in demand observed for Phase 1 and 2 contracts (the dashed curve is based on the average of Phase 1 and 2). This is a source of additional uncertainty (particularly as most delivery is FTTP rather than FTTC) and will require revisiting in any future evaluation.

Figure 6.3: Actual and projected take-up of coverage brought forward under Phase 3

[redacted]

6.1.6 Expected and forecast revenue and operational costs

The take-up projection was used to estimate expected revenues and operational costs (based on the average revenue per user assumptions put forward by the tenderer and the estimated operational cost per user inferred from their financial projections). Figure 6.4 below presents the modelled revenue against the network provider predictions at the tendering stage. Total revenue across the Phase 3 portfolio is estimated to be in the region of **[redacted]**. The figure also highlights the effect of delays in the early years of the contract. **[redacted]**.

Figure 6.4: Network provider predictions of revenue against modelled data

[redacted]

Similarly, Figure 6.5 below presents modelled operating costs. Modelled operating costs in Phase 3 include network and wholesale connection opex, deployment closure costs, ongoing contractual reporting, wholesale cessation costs and wholesale migration costs. The analysis suggests that the level of operating costs is forecast to **[redacted].**

Figure 6.5: Baseline operating cost projections against modelled revenue for Phase 3 contracts (in scope)

[redacted]

6.1.7 Internal Rates of Return based on projected take-up, revenues and operational costs

Based on the updated revenue and cost projections set out in the preceding sections, the modelling indicated that:

- **Commercial viability without subsidy:** Although projected take-up is higher than assumed by network providers at the tendering stage, the IRR associated with the projects without subsidy are not significantly higher (moving from a **[redacted]** per annum loss to positive annual rate of return of **[redacted]**). This can be explained by the delays early in the contract, resulting in revenues being recognised later than originally expected. In all cases, the IRRs associated with the projects were expected to be substantially lower than WACC of the network provider (**[redacted]**[59]). Arguably, a subsidy would have been needed in all cases to create a sufficient economic incentive to deliver the scheme.

- **Commercial viability with subsidy:** The provision of subsidies increases the average IRR associated with the contracts to **[redacted]**. This exceeds the network providers WACC (**[redacted]**) and in 12 of the 20 cases the network provider would be expected to earn excess returns without the application of implementation and take-up clawback. However, it should be noted that the size of these excess returns is substantially smaller (on average) than those associated with Phase 1 and 2 contracts. Again, this provides a signal that the more competitive environment for Phase 3 contracts may have limited scope for network providers to transfer risk to the public sector.

[59] **[Redacted]**

6.1.8 Internal rates of return after implementation and take-up clawback

Estimates of clawback were developed based on predicted underspend associated with the network build and predicted take-up levels and involve substantial uncertainties. However, the modelling shows that the Phase 3 contracts could be expected to generate **[redacted]** of implementation clawback. Additionally, contracts were only expected to trigger small amounts of take-up clawback (with **[redacted]** of take-up clawback expected across the portfolio in the seven years after the physical work of each contract has been completed). This is again explained by the delays associated with the delivery of Phase 3 contracts. While take-up is projected to exceed original expectations, this is not expected to occur until relatively late on in the lifetime of the project (often beyond the final review point that takes place seven years into the contract).

Overall, the analysis suggests that the clawback mechanism may prove effective in limiting any excess returns that might be earned by network providers. Across the portfolio, the clawback mechanisms are expected to reduce the IRR associated with the contracts (on average) to **[redacted]** – broadly in line with ex-ante expectations (**[redacted]**). Additionally, at the individual contract level, only one is expected to deliver a rate of return that exceeds the WACC of the network provider (**[redacted]**).

6.1.9 Summary of results

The estimated Internal Rates of Return associated with Phase 3 (and Phase 1 and 2 contracts, for comparison) are summarised in Table 6.3. These can be compared to the network providers WACC of **[redacted]** percent. The key findings from this analysis indicate:

- **Commercial viability without subsidy at the tendering stage:** Based on projections provided by network providers at the tendering stage, the proposed network build under Phase 3 contracts was expected either to generate losses or to deliver positive rates of return that were substantially lower than the cost of capital faced by the network provider (a loss of **[redacted]** per annum versus a WACC of **[redacted]**).

- **Commercial viability without subsidy adjusted for take-up**: Take-up projections appear understated given network providers would have had information on take-up on Phase 1 and 2 contracts. This will have fed through to understated revenue projections and rates of return, increasing the level of gap funding required from the public notionally required to make the project economically viable. However, after updating projections in line with take-up observed on Phase 1 and 2 contracts, the expected IRRs associated with Phase 3 projects without subsidy are not significantly higher than those expected at the tendering stage (moving from **[redacted]** per annum loss to positive annual rate of return of **[redacted]**). In all cases, the IRRs associated with the projects were expected to be substantially lower than WACC of the network provider. Arguably, a subsidy would have been needed in all cases to create a sufficient economic incentive to deliver these contracts.

- **Effectiveness of contractual mechanisms:** The protections put in place by BDUK are likely to protect the public sector from the risk that it provided more than the minimum subsidy needed. Contracts have been designed in such a way that network providers are required to return resources to the public sector if build costs are understated or if take-up proves higher than expected (leading to higher levels of profitability). While the provision of subsidies is expected to increase the IRR on Phase 3 contracts to **[redacted]**, this falls to **[redacted],** once the activation of these contractual mechanisms is accounted for.

- **Opportunity costs:** While the contracts have proven largely effective in containing subsidies to the minimum needed for the project to go forward, the public sector has incurred opportunity costs by tying resources up in the programme. BDUK may wish to consider whether seeking to contain these opportunity costs in future procurements could be justified. The evidence in this analysis indicates that increased levels of competition (in Phase 3 of the programme) limit the extent to which network providers can transfer risk to the public sector (as doing so results in less competitive tenders). However, other options could include using the information on the tail end of the distribution of observed take-up rates across Phase 1, 2 and 3 contracts to set a maximum level of subsidy to be offered as part of a given procurement. This may still allow network providers to understate profitability by adjusting revenues via price schedules (though if BDUK are able to monitor revenues earned on connections as well as volumes of customers, this may limit scope to do so).

- **Future competition:** The results of these analysis also do not factor the possibility that the network providers' market share and any excess profits are eroded by the entry of competitors via the open access arrangements required by the programme. This could only be realistically assessed if BDUK was able to monitor revenues earned by network providers alongside customer volumes (as this would help explore issues in relation to both market share and prices). It should be noted that this issue is likely to be more significant for vertically integrated operators that act as both wholesalers and retailers.

- **Scope for inefficiencies:** Clearly, there is also scope for inefficiencies arising from the leakage of subsidies into wages or other operating costs. These will not be visible in the analysis of rates of return and could not be captured in this analysis, but if this occurs it would reduce the value for money of the programme.

Table 6.3: Internal Rates of Return - Phase 1, 2 and 3 contracts

[Redacted].

6.2 Effects on market position of direct beneficiaries

The previous section suggests that the contracts developed by BDUK have broadly contained the risk that network providers earned excess returns on infrastructure subsidised by the public sector (though noting that at this stage, these findings are speculative owing to the early stage of the delivery of the programme). This section examines the degree to which those network providers benefitting from the programme have gained a material advantage over competitors. This assessment is based on descriptive analysis of changes in the market share of each network provider awarded contracts through the programme, based on speed test data provided by ThinkBroadband. The analysis here describes the market position at a national level, a Phase 3 programme level and a combination of all Phase 3 contracts delivered by the same beneficiary. This analysis differs slightly from that outlined in the State aid evaluation plan of analysing the market position at a local authority level and the contract level. The change in the analysis was to identify the impact of Phase 3 contracts on the market position rather than the impact of the programme as a whole, which the analysis at a local authority level would show. Additionally, the sample sizes available from the ThinkBroadband data would not support a robust analysis of beneficiary market position at the individual contract level. As this analysis is based on speed test data, there are some potential irregularities in the data, which are highlighted in Section 2 of the report. These should be taken into account when interpreting these findings – particularly at the smaller geographic levels.

ThinkBroadband is an independent organisation which collects information and data about internet coverage in the UK. It also runs an online 'speed test' function, where individuals can provide a limited amount of data about their broadband package and test the connection speed that they receive. The information provided and collected through individuals completing a speed test has been compiled into a dataset. It should be noted that the speed test data does not include all ISPs offering services in an area, or the number of ISPs with customers in each area. It measures the number of ISPs where customers have completed speed tests. Therefore, there could be inaccuracies in this data. Additionally, there are a number of contracts with low numbers of speed tests completed, therefore the analysis for these areas lacks robustness.

To assess the market position of each beneficiary of the programme, the ISPs which utilised each beneficiary was mapped. This information was collected from a web search of the ISP's website, the Openreach website (which lists ISPs which utilise their wholesale products) and the ThinkBroadband website. A complete list of ISPs included in the dataset and the network providers they have been mapped to is included in Annex A.

6.2.1 UK market shares of network providers

The market share for network providers has been estimated from the proportion of speed tests completed for ISPs which were mapped to the network provider. The market share of all NGA connections (FTTC, FTTP, cable, wireless and satellite connections) for network providers has been estimated by the proportion of speed tests completed for ISPs which were mapped to the network provider that utilised these technologies.

- **Openreach:** At a UK level, connections supplied through the Openreach network dominate the market, with around 40 percent of take-up in all years being made through the Openreach network. This percentage increases if the Sky and TalkTalk networks are included as being provided through the Openreach network (as these networks utilise the Openreach network) to between 70 and 80 percent. Openreach has a less dominant position in relation to NGA connections, although its market share rises from 61 to 67 percent (including connections through Sky and TalkTalk).

- **Other network providers:** Other network providers awarded Superfast Broadband contracts represent a very small proportion of the broadband market – cumulatively less than one percent of the total broadband market in 2020 (see Table 6.4 below). Between 2016 and 2020, the market share of total broadband connections for the beneficiaries got smaller, driven by a decrease of the market share for Openreach (via Sky and TalkTalk). The smaller network providers also account for a very small proportion of the NGA broadband market – less than one percent of the market in 2020.

Table 6.4: Share of the total broadband market, Superfast Broadband beneficiaries

	Total broadband connections		NGA connections	
Network provider	**2016**	**2020**	**2016**	**2020**
Openreach	38.6%	39.6%	35.5%	37.0%
Openreach (plus Sky and TalkTalk)	78.1%	75.2%	60.5%	67.2%
Airband	0.0%	0.1%	0.1%	0.1%
Gigaclear	0.1%	0.2%	0.2%	0.3%
Callflow	0.0%	0.0%	0.0%	0.0%
UK Broadband / Relish	0.0%	0.0%	0.0%	0.0%
Total programme participants	**78.3%**	**75.5%**	**60.8%**	**67.6%**
Virgin Media	19.9%	17.1%	36.9%	23.3%

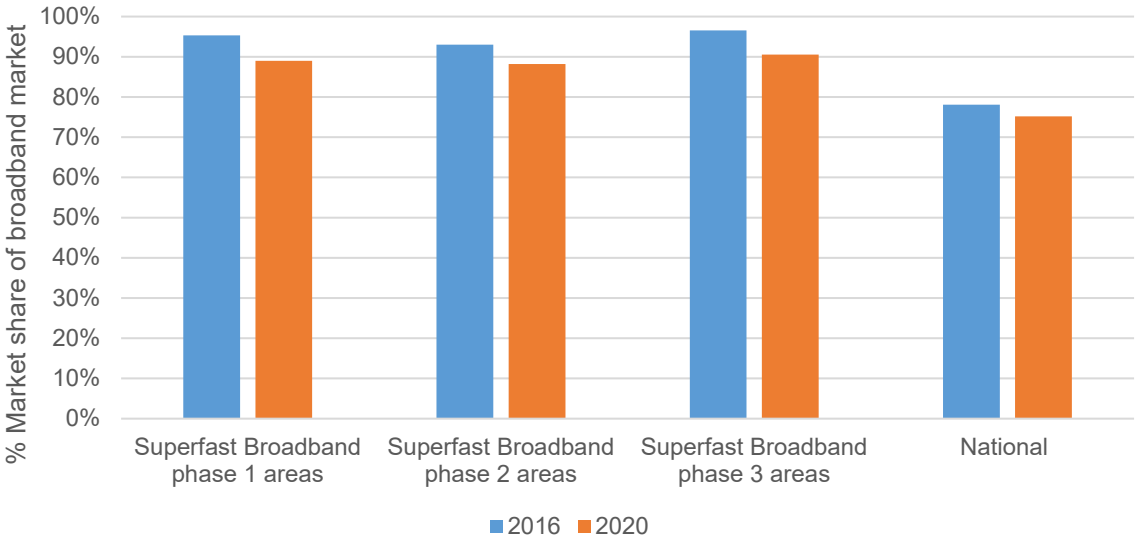
Source: ThinkBroadband speed test data

6.2.2 Overall market shares across Superfast Broadband contract areas

The market share of the broadband market for the network providers across the areas that the Superfast Broadband Programme has or is currently operating was analysed using the same approach. This approach was taken instead of examining the impact at a Local Authority level as at the Local Authority level it would not be possible to distinguish the impact of contracts awarded in different phases of the programme.

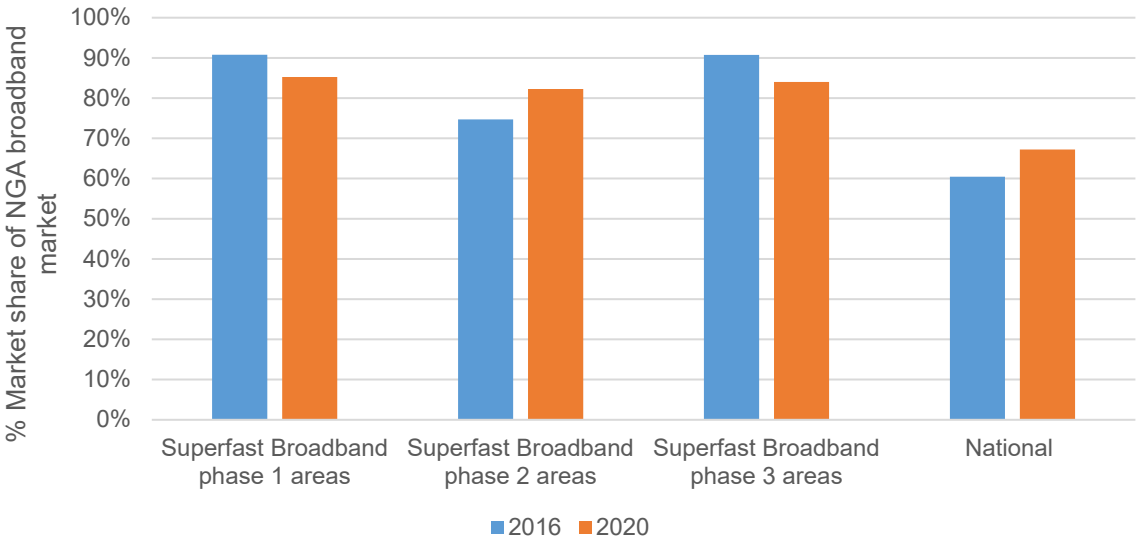
The market share for Openreach (including Sky and TalkTalk) across all these areas declined between 2016 and 2020, from around 95 to 90 percent of all connections. While this is higher than the national average (between 70 and 80 percent), the decline in market share aligns with national trends. In terms of NGA connections, while Openreach's national market share increased between 2016 and 2020, it fell in Phase 1 and Phase 3 contract areas while rising in Phase 2 contract areas (see Figures below).

Figure 6.6: Total broadband market share for Openreach (including Sky and TalkTalk) in Superfast Broadband delivery areas and nationally



Source: ThinkBroadband speed test data

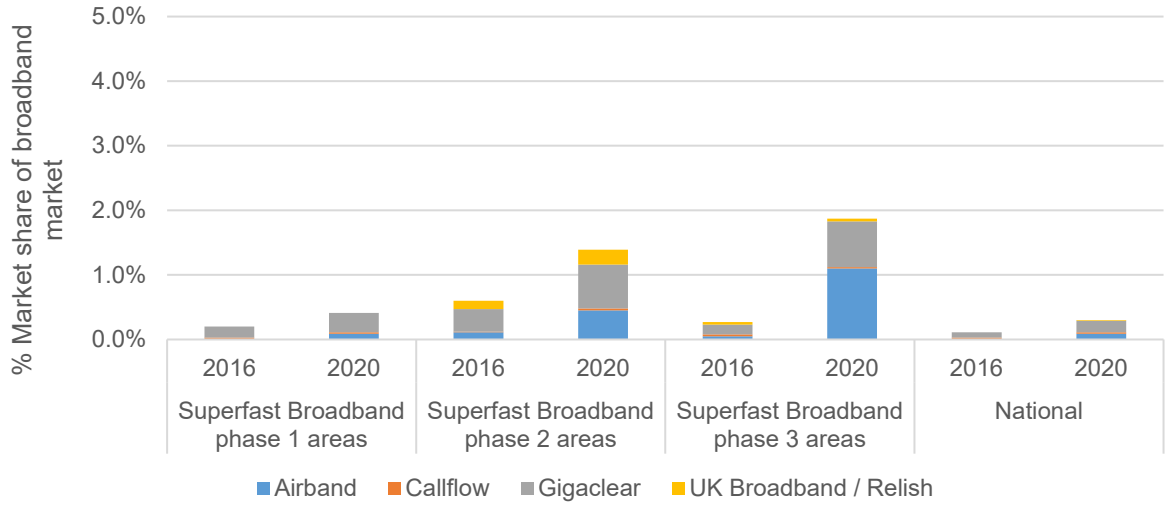
Figure 6.7 – NGA broadband market share for Openreach (including Sky and TalkTalk) in Superfast Broadband delivery areas and nationally



Source: ThinkBroadband speed test data

The market share for all broadband connections for all other network providers awarded contracts through the Superfast Broadband Programme is presented in the figure below. This shows that the market share of these network providers rose faster between 2016 and 2020 in contract areas than nationally. Airband and Gigaclear – who have been awarded more contracts – saw larger increases in market share in the Superfast Broadband delivery areas than Callflow and UK Broadband / Relish. Similar patterns are seen in terms of their share of NGA connections. However, the overall market share of these network providers is not significant in local or national terms (less than two percent of total broadband connections and less than 4 percent of NGA connections).

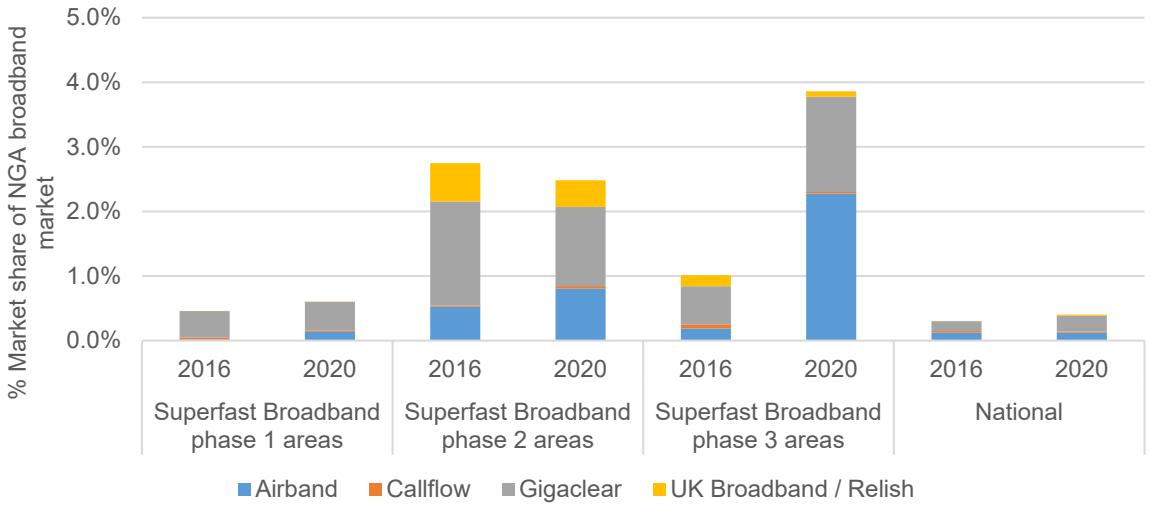
Figure 6.8: Total broadband market share for all other Superfast Broadband Programme beneficiaries in Superfast Broadband delivery areas and nationally[60]



Source: ThinkBroadband speed test data

NOTE: The scale of the market share in the figure is from 0 to 5 percent of the total market – caution when comparing to figure 6.6

Figure 6.9 – NGA broadband market share for all other Superfast Broadband Programme beneficiaries in Superfast Broadband delivery areas and nationally[61]



Source: ThinkBroadband speed test data

NOTE: The scale of the market share in the figure is from 0 to 5 percent of the total market – caution when comparing to figure 6.7

[60] It should be noted that these market shares are based on relatively small sample sizes, and this should be taken into account when interpreting these findings.
[61] Ibid.

6.2.3 Market shares within Superfast Broadband contract areas

Further analysis was completed to look at changes in market share in the specific contract areas in which beneficiaries were operating (aggregated across all contract areas due to the small sample sizes available for individual areas). More details of the sample sizes in each project area is provided in Annex A. This analysis showed:

- **Openreach:** In Phase 3 contract areas where Openreach deliver the project, the market share of Openreach declined between 2016 and 2020 for both NGA connections and total broadband connections. As Openreach's national market share of NGA connections rose over this period, this does not suggest that Openreach acquired a substantial competitive advantage as a result of the aid it received from the Superfast Broadband Programme.

- **Gigaclear:** In areas where Gigaclear deliver the Phase 3 local project, its market share of total broadband connections rose from 7 percent to 25 percent between 2016 and 2020, while its share of NGA connections rose from 18 to 34 percent. This increase in market share appears to have been taken from Openreach (including Sky and TalkTalk) – whose market share of total broadband connections fell from 90 to 74 percent over the period, and whose share of NGA connections fell from 75 to 57 percent.

- **Wireless providers:** This pattern is repeated for areas where wireless providers have been contracted to deliver Superfast Broadband projects. The market share of total connections taken by wireless providers rose from 1 to 11 percent between 2016 and 2020, while their share of NGA connections rose from 3 to 23 percent. Again, this appears to have been achieved at the expense of the Openreach – which saw its market share of total broadband connections decline from 95 percent in 2016 to 81 percent in 2020 in these areas, while its share of NGA connections fell from 83 to 65 percent over the same period.

7. Indirect impacts

This section presents the evidence collected and analysed to answer State aid evaluation question 5 – i.e. how far is there evidence of changes to parameters of competition arising from the aid (including third parties operating in the relevant intervention areas)? As set out in the State aid evaluation plan, this question is addressed by examining the following parameters of competition: changes in NGA take-up as a proportion of total take-up; the share of take-up by NGA technology; the number of network providers offering NGA services; and the number of unique Internet Service Providers making use of the open access made available.[62]

Key findings

At a UK level, the share of NGA broadband take-up as a proportion of total broadband take-up has increased markedly since 2016. NGA connections represented just over half of all broadband connections in 2016, but this has grown to over 70 percent of internet connections in 2020. Fibre to the Cabinet (FTTC) connections represented the largest proportion of NGA connections in both 2016 and 2020 (around a third of broadband connections in 2016 and just over a half in 2020). This pattern was also observed in areas the Superfast Broadband Programme has delivered to, with an increase in NGA take-up in Phase 3 contract areas of over 20 percentage points between 2016 and 2020.

The average number of infrastructure providers operating on the postcodes benefitting from subsidised upgrades rose from 2.3 to 2.6 between 2012 and 2020, indicating the programme may have helped promote greater competition in these areas. Although there has been an increase in the number of network providers offering services in Superfast Broadband Programme areas, most non-beneficiary network providers tended to provide services to only a small number of postcodes within the Superfast Broadband project areas in 2020, as was the case in 2016. This suggests there has not been a large degree of overbuild.

The number of Internet Service Providers (ISPs) operating in Superfast Broadband Programme areas has increased between 2016 and 2020. There are a higher number of ISPs with customers in Phase 1 contract areas than Phase 2 and Phase 3. This would be expected, given that the Phase 1 areas were larger and more commercially viable, and more time has lapsed since project completion. Additionally, all Phase 1 contracts were delivered by Openreach, and the qualitative findings suggested that at present no ISPs were utilising the subsidised networks built by programme beneficiaries other than Openreach.

7.1 Parameters assessed and approach

The table below describes the analytical approach that has been used to provide evidence to answer the State aid evaluation question.

[62] As noted in Section 2, due to data restrictions it was not possible to assess the number of ISPs utilising the networks through the Open Access Agreements, as this data has not been collected. Therefore, this report explores the number of ISPs operating in the areas the programme has delivered to as a proxy of this indicator.

Table 7.1: Analysis used to provide answers to the State aid evaluation questions

Analysis	Evaluation question
Analysis of broadband take-up by technology. The market share of seven different types of broadband connection has been calculated. These are FTTP, FTTC, GFast, Cable, Fixed wireless / satellite connections, ADSL and other connections.	Question 5: • Take-up of NGA lines as a % of all broadband take-up
The market share by type of technology. Analysed at three levels: a UK national level; for all areas where the Superfast Broadband Programme has been delivered (portfolio level); and at an individual contract level. The market share has been calculated for each of these for 2016 and 2020.	Question 5: • Market share (of take-up) for each NGA technology
The number of network providers operating in the areas that the Superfast Broadband Programme has been delivered. The statistical analyses described in Section 4 were also extended to examine how far the programme had a causal effect on the number of network providers active in the programme area.	Question 5: • Number of infrastructure providers offering NGA services
The number of ISPs operating in an area. The number of ISPs operating has been estimated at a national, for all areas where the Superfast Broadband Programme has been delivered (portfolio level) and individual contract level for 2016 and 2020. It should be noted that the speed test data does not include all ISPs offering services in an area, or the number of ISPs with customers in each area. It measures the number of ISPs where customers have completed speed tests. Therefore, there could be inaccuracies in this data.[63] Additionally, there are a number of contracts with low numbers of speed tests completed, therefore the analysis for these areas lacks robustness.	Question 5: • *Number of unique operators making use of the open access made available under the 2016 NBS*[64]

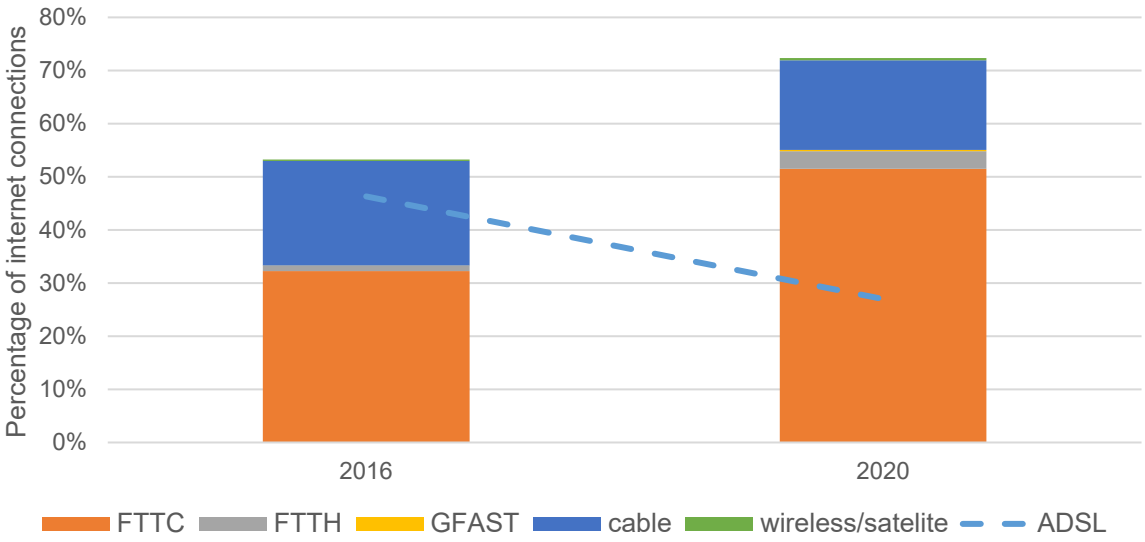
7.2 Take-up of NGA lines as a percentage of all broadband take-up and Market share for each NGA technology

At a UK level, the share of NGA broadband take-up as a proportion of total broadband take-up has increased markedly since 2016. The figure below shows that take-up of NGA connections represented just over half of all broadband connections in 2016, but this has grown to over 70 percent of internet connections in 2020. FTTC connections represented the largest proportion of NGA connections in both 2016 and 2020 (around a third of broadband connections in 2016 and just over a half in 2020). FTTP and wireless connections represented under five percent of the broadband market in 2020 and under two percent in 2016.

[63] It is not possible to estimate the degree to which the data may be inaccurate. However, the data is likely to become less accurate when analysing smaller geographic areas, and this should be taken account of when interpreting the results.

[64] Data has not been collected which shows the number of unique ISPs which have accessed networks through the open access made available under the 2016 NBS. Therefore, a proxy measure of the number of ISPs providing services in the areas where the Phase 3 contracts have been delivered has been analysed.

Figure 7.1: UK broadband take-up by technology type



Source: ThinkBroadband speed test data

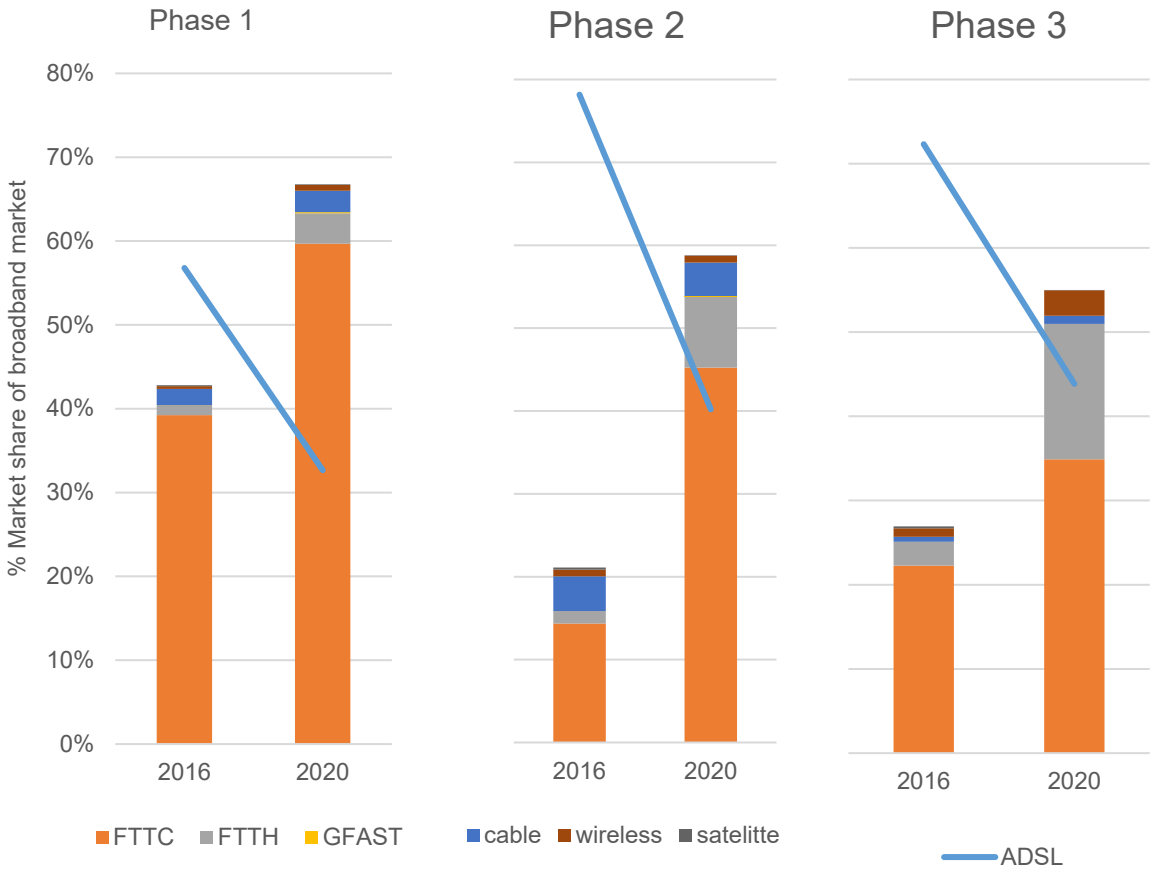
This analysis was undertaken separately for the delivery areas for Phases 1, 2 and 3 of the Superfast Broadband Programme as illustrated in the figure below. This found that between 2016 and 2020, there was an increase in NGA take-up in Phase 3 contract areas of nearly 30 percentage points. However, this lags the increase in NGA take-up in Phase 2 contract areas of 38 percentage points. This would be expected, as Phase 3 contracts are still being delivered, and consumers in these areas may not have the opportunity to take-up new NGA connections as of 2020. Additionally, as illustrated in Section 5, Phase 3 contracts did not have a positive impact on the number of superfast connections by September 2019. As such, it is unlikely that the programme has yet caused consumers to switch from ADSL to NGA in Phase 3 areas.

As with the national pattern, FTTC is the dominant technology for NGA connections, representing around one third of total broadband connections in 2016 and over half of broadband connections in 2020 in areas upgraded by the Superfast Broadband Programme areas.

FTTP and wireless connections are slightly more prevalent in Superfast Broadband delivery areas than nationally, representing 5.5 percent of connections in the delivery areas in 2020, and over 16 percent in Phase 3 contract areas. This would be expected as FTTP connections are being delivered by the Superfast Broadband Programme, particularly in Phase 3 contracts (with FTTP in Phase 3 areas representing more than three times the market share of Phase 1 areas). Local Bodies and network providers explained during qualitative interviews that the aim of the projects that they tendered for (particularly in Phase 1 and Phase 2 of the Superfast Broadband Programme) was to provide the maximum volume of Superfast Broadband coverage (in terms of number of premises upgraded) for the lowest possible price. In Phase 1 and Phase 2, the most economical mechanism of delivering Superfast Broadband speeds was

mainly through FTTC technologies.[65] Additionally, the open nature of the competitions for Phase 3 contracts allowed smaller network providers to offer different technological solutions to Local Bodies.

Figure 7.2: Broadband take-up by technology type in Superfast Broadband delivery areas by Phase of delivery (% of connections)



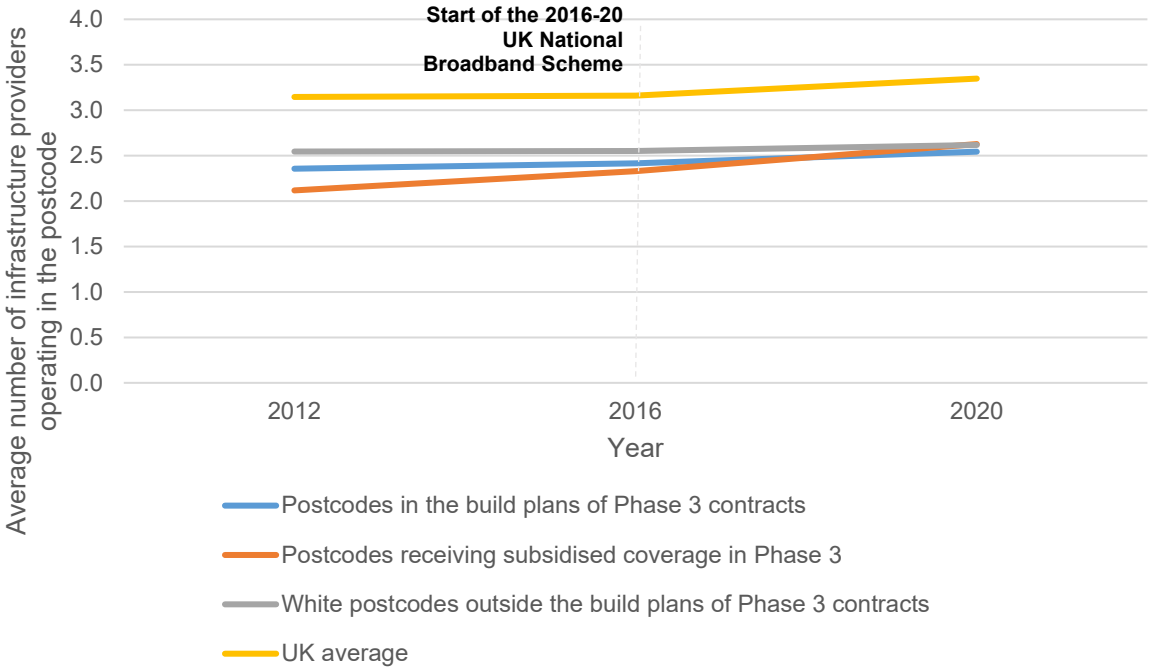
Source: ThinkBroadband speed test data

7.3 Number of infrastructure providers offering NGA services

The figure below shows the change in the number of network providers[66] operating in postcodes that were eligible for subsidies under Phase 3 contracts between 2016 and 2020. In 2016, the average number of infrastructure providers operating in the areas covered by Phase 3 build plans was lower than in other areas that were eligible for Superfast Broadband support (but did not receive any). The average number of infrastructure providers operating on the postcodes benefitting from subsidised upgrades rose from 2.3 to 2.6 between 2012 and 2020, whilst the average number in other areas that were eligible for support (but did not receive any) rose from 2.5 to 2.6. This may indicate that the programme has helped promote greater competition in these areas, although as discussed in below, the coverage of non-beneficiary network providers in the upgraded areas is thought to be relatively low.

[65] Wireless technologies could also be used in some areas to provide Superfast Broadband connection speeds economically. However, in Phase 1 no wireless providers were able to tender for contracts, and some Local Bodies were confident that wireless solutions could deliver superfast speeds to the entire target population (doubts about the technological capabilities).
[66] Data included network providers owning and operating their own networks (not including ISPs) regardless of whether or not they provided a superfast network.

Figure 7.3: Changes in the average number of infrastructure providers operating in areas in Phase 3 build plans and other 'white' postcodes, 2012 to 2020



Source: C3 reports, ThinkBroadband coverage dataset, Ipsos MORI analysis.

There were a large number of network providers offering services in Superfast Broadband areas in 2020, and this has increased since 2016. For all Phase 3 contract areas combined, there were 30 network providers offering services in these areas, compared to 13 in 2016. These numbers are lower than in Phase 1 and Phase 2 contract areas (44 network providers in Phase 1 areas in 2020 and 38 in Phase 2).

However, most non-beneficiary network providers tended to provide services to only a small number of postcodes within the Superfast Broadband project areas. Non-beneficiaries had a maximum coverage of nine percent of the delivery areas in Phase 1 contracts, 12 percent in Phase 2 contracts and three percent in Phase 3 contracts (all Virgin Media), and below three percent for all other network providers in all phases (with the highest levels of coverage among wireless network providers). This suggests there is not a large degree of overbuild in Superfast Broadband Programme areas.

This finding was reinforced during the qualitative interviews with network providers. Some non-beneficiaries (particularly small wireless network providers) stated that they would try to avoid building Superfast Broadband networks to the areas that were receiving subsidised coverage. This was because they felt that it would not be commercially viable to have superfast broadband networks in these areas.

However, other non-beneficiaries were more confident in their ability to compete with subsidised networks, and although they would not actively pursue building networks in areas that were being upgraded by the programme, they would not alter plans they had already developed to roll out networks to areas that subsequently received Superfast Broadband

Programme support.[67] This was because they were confident of maintaining their customers due to brand loyalty and quality of service provision. Additionally, one large network provider stated that some non-beneficiaries were rolling out new networks in programme delivery areas that had been classified as not being upgraded in the OMR process (and that the non-beneficiary had not claimed to be delivering to in the OMR process). This is possible, as there were challenges relating to the OMR process and network providers' ability to provide accurate information for the OMR (see previous section).

Therefore, it was expected that the programme areas have seen an increase in the number of network providers operating in the delivery areas, but equally it is expected that these other network providers only cover the Superfast Broadband Programme delivery areas at the fringes. It also demonstrates that there is no evidence that the programme crowded out infrastructure investment, in aggregate, in Phase 3 areas, although the current value Phase 3 investments is modest.

Table 7.2: Coverage on non-beneficiaries in Superfast Broadband delivery areas, 2020

Network provider	Phase 1	Phase 2	Phase 3
Virgin	9.28%	12.11%	3.62%
Vfast wireless	2.68%	0.74%	0.00%
Kijoma wireless	1.39%	1.06%	0.51%
Boundless wireless	0.71%	0.96%	0.50%
Solway comms wireless	1.41%	0.74%	0.16%
Greenco wireless	0.83%	1.72%	0.00%
Truespeed wireless	0.21%	0.00%	0.72%
Gigafast FTTP	0.22%	0.08%	0.22%
Hyperoptic FTTP	0.14%	0.11%	0.04%
Glide FTTP	0.11%	0.31%	0.37%

Source: ThinkBroadband coverage dataset

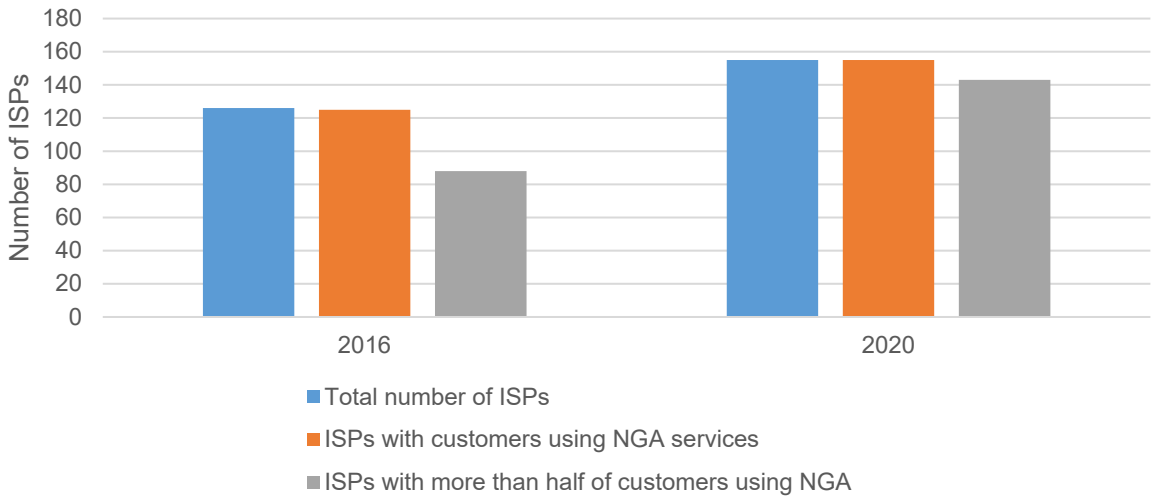
7.4 Number of unique operators offering services in Phase 3 contract areas

The number of ISPs with customers in the UK (proxied as the number of ISPs where customers have completed a speed test on the ThinkBroadband website) has increased over time. In 2020, over 150 ISPs had customers in the UK (see figure below).[68]

In both 2016 and 2020, nearly all ISPs provided NGA services to at least one customer in the UK (only one ISP did not have an NGA customer in the dataset in 2016, and all ISPs had at least one customer receiving NGA services in 2020). However, there were changes between 2016 and 2020 in the proportion of customers which were utilising NGA connections between ISPs. In 2016, around 70 percent of ISPs had over half of their customer base using NGA connections – in 2020 this had grown to 92 percent of ISPs.

[67] This point relates to both network providers that are currently competing with the beneficiaries in programme delivery areas, and network providers that intend to compete with the beneficiaries in these areas in the future, but have not rolled out their plans as yet.
[68] This includes both ISPs which own their network (for example Virgin Media) and ISPS which utilise wholesale network products.

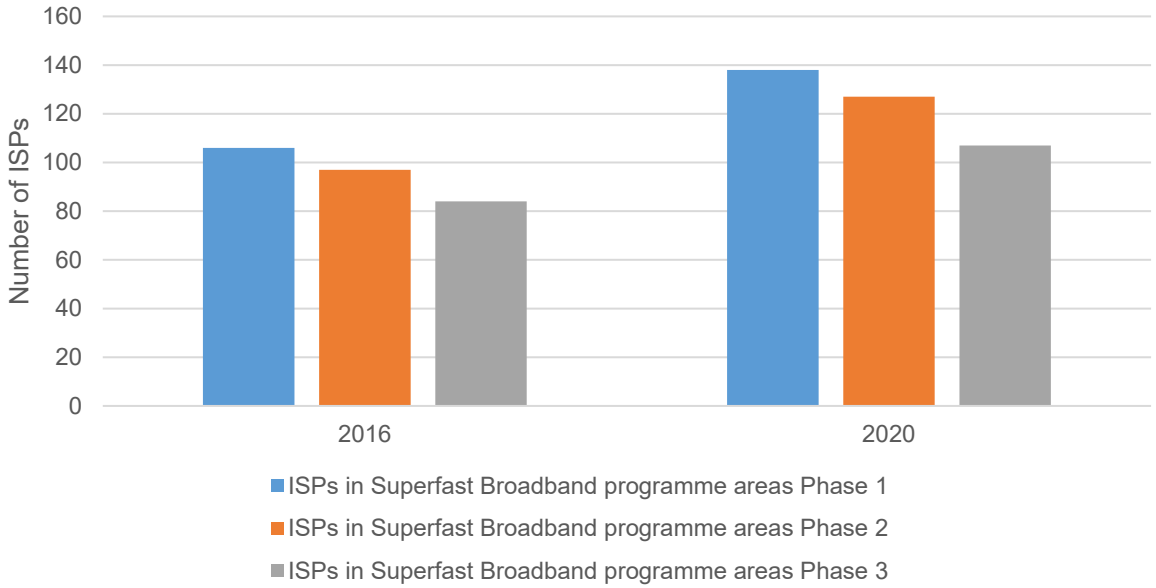
Figure 7.7: Number of ISPs offering services in the UK, 2016 and 2020



Source: ThinkBroadband speed test data

A similar pattern to that seen nationally is observed in the Superfast Broadband delivery areas. There has been an increase in the number of ISPs with customers between 2016 and 2020. When comparing between phases, it can be seen that there are a higher number of ISPs with customers in Phase 1 contract areas than Phase 2 and Phase 3. This would be expected, as Phase 1 contracts covered a larger number of premises and in more economically viable areas, providing a larger market for different ISPs to access.

Figure 7.8: Number of ISPs offering services in the Superfast Broadband delivery areas by Phase, 2016 and 2020



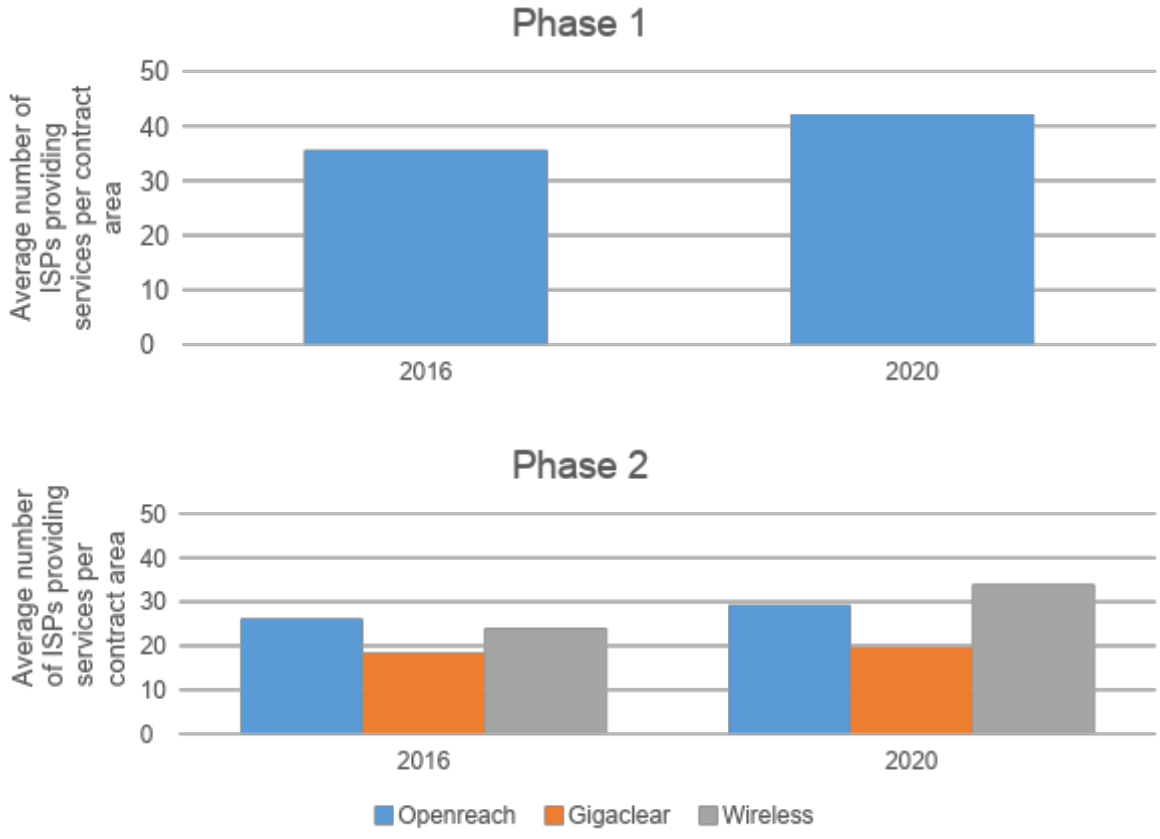
Source: ThinkBroadband speed test data

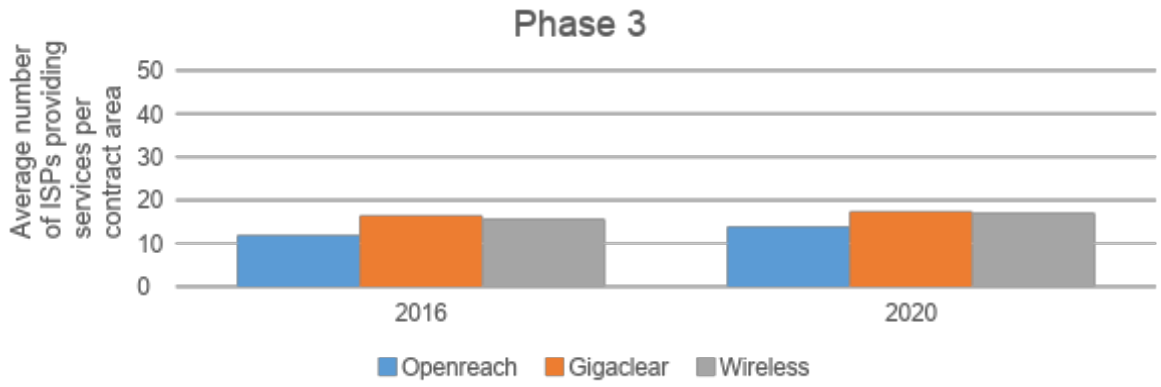
Interviews with the programme beneficiaries suggest that most of the ISPs offering services in the Superfast Broadband Programme delivery areas will be utilising the Openreach network.

Other beneficiary interviews suggested that although there were wholesale access requirements in place on the networks they had built as part of the programme, these had not been utilised yet by other ISPs. One of the main reasons cited for this was that these beneficiaries do not have a large number of existing ISPs which utilise any of their networks (outside the ones constructed for the Superfast Broadband Programme) so do not have an existing customer base for their new networks. They anticipate that as their business matures and other ISPs start using their wider network that ISPs will also begin to utilise the networks built through the programme. As all of Phase 1 contracts were delivered by Openreach, it would be expected that these contract areas had the highest number of ISPs operating in the area.

The qualitative findings on use of Superfast Broadband Programme networks by ISPs is reinforced by an analysis of the data by beneficiary. Particularly in Phase 1 and Phase 2, the number of ISPs providing services in an area is higher in areas where Openreach have delivered the contract than in areas where Gigaclear have delivered contracts. In Phase 3, this pattern is less clear cut but, as noted, there are currently fewer ISPs offering services in Phase 3 areas than in Phase 1 and 2 contract areas.

Figure 7.9: Average number of ISPs offering services in the Superfast Broadband project areas by Phase and beneficiary, 2016 and 2020




Phase 3
Average number of ISPs providing services per contract area
50
40
30
20
10
0
2016
2020
Openreach
Gigaclear
Wireless

8. Wider Economy Effects

This section of the report summarises the results of a series of econometric analyses exploring the economic and social impacts of the programme, and provides an overall cost-benefit analysis of the Superfast Broadband Programme. Full details of these analyses are provided in Technical Appendix 3. As Phase 3 of the programme was at an early stage of delivery, and its economic and social benefits had not been realised, this section focuses on the costs and benefits of the whole programme (Phases 1, 2 and 3).

Estimates of the impacts of the programme have been obtained by linking records of the delivery of the programme to a wide range of administrative and secondary data sources providing annual data on a variety of economic and social impacts of interest (e.g. the productivity of firms located in the areas served by the programme). Statistical analyses focused on comparisons between individuals, firms or properties that benefitted from the programme at different points in time, with those receiving coverage used as a counterfactual for those benefitting earlier.

Key findings:

Lifetime costs (2012 to 2030)
The present value of net public spending required to deliver the Superfast Broadband Programme over the lifetime of Phase 1, 2 and 3 contracts (i.e. from 2012 onwards) was estimated to be £815m in nominal terms. This is less than estimated total cost of the programme of £1.9bn, as there is expected to be a large amount of clawback generated from the beneficiaries delivering the programme.

Local economic and social impacts between 2012 and 2018
The findings of the evaluation indicate that the Superfast Broadband Programme led to a range of economic and social impacts in the areas benefitting from subsidised coverage between 2012 and 2018 (i.e. over and above what may have happened in the absence of the programme). The key results included:

- **Local employment impacts:** Subsidised coverage was estimated to have increased employment in the areas benefitting from the programme by 0.6 percent, leading to the creation of 17,600 local jobs by the end of 2018.

- **Turnover:** Subsidised coverage also increased the turnover of firms located in the areas benefitting from the programme by almost 1.0 percent by 2018, increasing the annual turnover of local businesses by £1.9bn per annum.

- **Number of firms:** The evidence indicated that a share of these local economic impacts was driven by the relocation of firms to the programme area. The evidence indicated that subsidised coverage increased the number of businesses located in the areas benefitting by around 0.5 percent – suggesting the programme may have encouraged the 'disagglomeration' of economic activity to rural areas.

- **Turnover per worker:** There were also signals of efficiency gains - turnover per worker of firms in the areas benefitting rose by 0.4 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.7 percent by 2018, indicating that subsidised coverage has also raised the efficiency of firms. However, the strength of these gains appeared to

decay with time – while subsidised coverage had a stable effect on turnover, impacts on employment increased with time.

- **Wages:** The impacts of the programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by 0.7 percent in response to the upgrade. This gives greater confidence that the programme led to an increase in productivity.

- **Unemployment:** Local job creation also appeared to translate into reductions in unemployment, with the number of unemployed claimants falling by 32 for every 10,000 premises upgraded.

- **House prices:** The programme led to an increase in house prices (of between £1,700 and £3,500) suggesting that buyers valued the technology.

National economic and social benefits between 2012 and 2019, and to 2030

The findings above describe the effect of the programme on the areas that benefitted from subsidised coverage. However, these results do not account for possible negative effects in areas that did not benefit from the programme. For example, as the programme encouraged firms to move to the areas benefitting from enhanced broadband coverage, there will have been offsetting loss of jobs in the areas from which those firms relocated. Allowing for these types of offsetting effects, at the national level, the programme is estimated to have resulted in:

- **Economic benefits:** The programme is estimated to have led to £1.1bn in productivity gains between 2012 and 2019. This rises to an estimate of £1.6bn to £1.8bn over the period from 2012 to 2030.

- **Social benefits:** Based on its impacts on house prices between 2012 and 2019, the programme is estimated to have led to social benefits valued at between £0.7bn and £1.5bn.

The estimated Benefit to Cost Ratio (BCR) was between £2.70 and £3.80 per £1 of net public sector spending based on its impacts between 2012 and 2019. Allowing for future economic benefits to 2030, the BCR is estimated to rise to between £3.6 and £5.1 per £1 of net public sector spending.

8.1 Costs

BDUK monitoring data gave details of 144 contracts that had been signed as part of the Superfast Broadband Programme across Phase 1, 2 and 3 of the programme. The gross value of the public funding associated with these contracts was £1.9bn at the point of award (in nominal terms), providing funding for the capital costs associated with upgrading network infrastructure in the programme area. However, as indicated, the clawback mechanisms integrated in the contracts required network providers to return resources to the public sector through the clawback mechanisms.

The value of clawback will not be known until the contracts have been fully wound down seven years post completion. The modelling described in Section 6 was used to develop estimates of the lifetime net public costs (i.e. net of implementation and take-up clawback). Details of this analysis is set out in Technical Appendix 2, but a summary is provided in the following table. This illustrates:

- **Gross public spending:** The value of expected public spending of the lifetime of these contracts was estimated at £743m in 2019 prices (£634m in present value terms) based on data available in June 2020.

- **Net public spending:** However, after accounting for implementation and take-up clawback, it was estimated that the net cost of the contracts to the public sector was £334m (in 2019 prices). A large share of the difference was accounted for by the level of take-up clawback associated with Phase 1 contracts, which were projected to be delivered at a net cost to the public sector of £60m against forecast public spending of £304m (in 2019 prices, £87m in present value terms).

- **Time costs:** As highlighted in Section 5, the clawback mechanisms employed in the delivery are expected to be highly effective in returning resources to the public sector. For example, of the 28 contracts modelled under Phase 1, 12 were expected to be delivered at no nominal cost to the public sector. However, a significant share of the costs is driven by the opportunity cost of temporarily tying up public sector resources in the programme. While the nominal net expected cost of the 28 Phase 1 contracts modelled was £34m, the present value of these expected costs (in real terms) was £86.9m. This implies that around 60 percent of the costs of these projects will be in the form of inflation (i.e. future payments will be received in nominal terms and will be worth less in real terms in future years) and social preference for consumption today versus consumption in the future. These time costs will partly be offset by interest payments made to BDUK that could only be accounted for in the modelling of projects that had been completed.

For 28 of the 34 unmodelled contracts **[redacted]** under Phases 1 and 2, BDUK had prepared forecasts of future implementation and take-up clawback which were used as the basis for estimating the expected costs to the public sector. These forecasts are based on lower long-run take-up than assumed in the modelling described in Section 6, and may understate the levels of take-up clawback that may ultimately be returned to the public sector. For Phase 3 contracts (where delivery was at very early stages), **[redacted]**, no adjustment was made for possible future implementation and take-up clawback. As such, the overall estimated net cost of the programme (£832m in present value terms, in 2019 prices), is likely to be overstated.

There is a substantial difference between the gross value of public spending associated with the contracts awarded (£1.9bn) and forecast public spending before clawback (£1.7bn in 2019 prices and £1.5bn in nominal terms). This is largely driven by underspending on Phase 1 contracts. The gross value of the public spending associated with contracts at the point they were awarded was £1.2bn. However, final claims were only made for £689m of public funding.

Table 8.1: Expected net public sector costs (£m, 2019 prices)

Phase	Number of contracts	Forecast public funding (£m)		Forecast underspend clawback (£m)		Forecast take-up clawback (£m)		Net cost to the public sector (£m)	
		Nom.	PV	Nom.	PV	Nom.	PV	Nom.	PV
Modelled contracts									
Phase 1	28	303.9	277.0	-34.1	-30.0	-210.0	-160.1	59.9	86.9
Phase 2	31	340.2	279.7	-11.1	-8.4	-126.7	-89.2	202.4	182.1
Phase 3	20	98.9	77.4	-21.8	-17.2	-5.0	-3.2	72.1	57.0
Total	**79**	**743.1**	**634.1**	**-66.9**	**-55.6**	**-341.7**	**-252.5**	**334.4**	**326.0**
Unmodeled contracts									
Phase 1	17	700.7	654.7	-80.0	-63.3	-338.1	-248.5	282.6	342.9
Phase 2	17	135.9	116.1	0.0	0.0	-34.0	-23.9	102.0	92.2
Phase 3	31	88.4	71.1	0.0	0.0	0.0	0.0	88.4	71.1
Total	**65**	**925.0**	**842.0**	**-80.0**	**-63.3**	**-372.1**	**-272.4**	**472.9**	**506.2**
Overall programme									
Phase 1	45	1004.7	931.7	-114.1	-93.3	-548.2	-408.6	342.4	429.8
Phase 2	48	476.1	395.8	-11.1	-8.4	-160.7	-113.1	304.3	274.3
Phase 3	51	187.3	148.5	-21.8	-17.2	-5.0	-3.2	160.5	128.1
Total	**144**	**1,668.1**	**1,476.1**	**-147.0**	**-119.0**	**-713.9**	**-524.9**	**807.2**	**832.2**

Source: Ipsos MORI analysis; CORA; BDUK

This analysis focuses on delivery of the programme to March 2019. While Phase 1 and 2 of the programme were largely complete at this stage, Phase 3 contracts were at relatively early stages of delivery (around 79,100 premises had been upgraded under Phase 3 contracts (around 17 percent of the 322,242 contracted). This was factored into the analysis by adjusting down the net costs of Phase 3 in proportion to the share of contracted delivery completed by this stage. This gave a total cost for the programme of £727m. This does not include administrative costs incurred by BDUK and the Local Bodies in their management of the programme because these costs were not monitored on a systematic basis.

Table 8.2: Expected net public sector costs (£m, 2019 prices) of delivery to March 2019

Contract phase	Net cost to the public sector, net of clawback (£m present value)	% of contracted premises delivered	Costs included in the analysis
Phase 1	429.8	~100	429.8
Phase 2	280.7	~100	274.3
Phase 3	128.1	17	22.6
Overall	**838.6**		**726.7**

Source: Ipsos MORI analysis; CORA; BDUK

8.2 Additionality

The results set out in the subsection 8.1 explore the impacts of subsidised coverage. However, the results do not factor in the likelihood that much of this coverage may well have been achieved through commercial deployments in the absence of the programme. As noted, estimates of the additionality of the coverage funded through the programme are described in Section 5 and set out in full in Technical Appendix 1, which examined the share of the premises

involved that would not have been upgraded in the absence of the programme (and how this evolved with time). These findings suggested that:

- **Evolution over time:** The level of additionality is estimated to peak in the year after the premises were upgraded at 61 percent. Additionality decayed between the second and fourth year following the upgrade at a rate of 14 percent per annum. These patterns were broadly stable over Phase 1, 2 and 3 of the programme. This is consistent with a view that the programme substantially accelerated the deployment of superfast connectivity. However, in the absence of the programme, rising demand and take-up as well as regulatory innovation would have led to greater commercial viability over time. This would have induced commercial deployments in many areas in the longer term in the absence of the programme.

- **Projected additionality:** A high to low range for the future additionality of the programme was developed on the following basis:

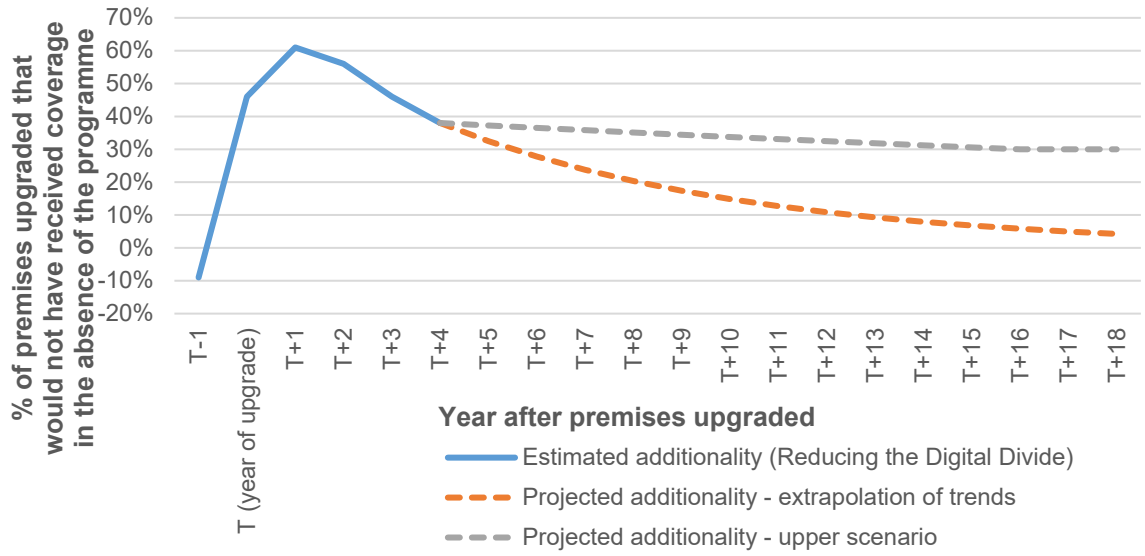
  - **Extrapolation of trends:** A lower bound scenario was developed by extrapolating the trends implied by the results over the duration of the appraisal period. This implied a higher rate of decay (14 percent per annum) and the rate of additionality fell to 4 percent over 14 years. This would capture scenarios in which unforeseen technological innovations enable the hardest to reach premises to be served profitably.

  - **Future telecoms infrastructure review:** A projection of past trends may produce an overly pessimistic view of future additionality. The Future Telecoms Infrastructure Review was prepared on the basis that the final 10 percent of premises (3m of 30.5m in the UK) would never receive commercial investment in full fibre connectivity. This assumption was used to explore the sensitivity of results to a more optimistic view of additionality in the long-run as follows. In 2019, Ofcom's Connected Nations report suggests that 95 percent of premises received superfast coverage. This is equivalent to 29m premises and implies that around 1.5m of the 'last 10 percent' received superfast coverage by 2019. By 2019, 5.3m premises had received subsidised coverage – implying that just under 30 percent would never receive commercial deployments. In this scenario, this share is treated as a notional limit for additionality and the rate of additionality is assumed to decay from 38 percent to 30 percent over 14 years (a rate of decay of 2.0 percent per annum). As this assumption is based on the viability of FTTP rather than FTTC infrastructure, this scenario will likely overstate the long-run additionality associated with the investments (and has been developed primarily to probe the stability of the core findings to alternative assumptions).

- **Delaying effect:** The evidence also suggested that nine percent of premises upgraded would have otherwise received superfast coverage one year earlier in the absence of the programme (see Section 5). This is consistent with evidence from the qualitative research with network providers that suggested that the OMR process could lead to some postcodes being marked as eligible for investment where commercial deployment plans were insufficiently developed or certain. The likelihood that a subsidised competitor would emerge would discourage investment in these areas. This delaying effect will have negative economic and social costs in the short-term and this is modelled using a negative value for additionality in the year prior to the upgrade.

The figure below displays the assumed additionality profile over time.

Figure 8.1: Additionality profile over time



Source: Ipsos MORI analysis

Technical Appendix 3 tabulates the estimated number of additional premises passed based on this additionality profile. The gross number of premises passed is based on BDUK's Broadband Performance Indicator[69] for the period 2012/13 to 2017/18. Delivery for 2018/19 is taken from BDUK's Table of Local Broadband Projects. Under the two additionality scenarios, the number of additional premises upgraded are largely equivalent by 2018/19 but diverge by 2029/30 (giving a long-term range for the number of additional premises upgraded of 500,000 to 1.7m).

8.3 Economic impacts

8.3.1 Local economic impacts between 2013 and 2018

A series of econometric analyses linking records of the postcodes benefitting from subsidised coverage to a variety of administrative and secondary datasets were used to explore the local economic impacts of the programme. These results are set out in detail in Technical Appendix 3 and provide estimates of the effect of the programme on the areas that have benefitted from subsidised coverage. It is important to note that while most of these findings account for the possibility that businesses benefitting from the programme may have claimed market share from local competitors, **they should not be interpreted as net economic impacts at the national level**. The key results included:

- **Local employment impacts:** Subsidised coverage was estimated to have increased employment in the areas benefitting from the programme by 0.6 percent, leading to the creation of 17,600 local jobs by the end 2018.

- **Turnover:** Subsidised coverage also increased the turnover of firms located in the areas benefitting from the programme by almost 1.0 percent by 2018, increasing the annual turnover of local businesses by £1.9bn per annum.

[69] Broadband Performance Indicators Accessed November 2020

- **Number of firms:** The evidence indicated that a share of these local economic impacts was driven by the relocation of firms to the programme area. The evidence indicated that subsidised coverage increased the number of businesses located in the areas benefitting by around 0.5 percent – suggesting the programme may have encouraged the 'disagglomeration' of economic activity to rural areas.

- **Turnover per worker:** There were also signals of efficiency gains - turnover per worker of firms in the areas benefitting rose by 0.4 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.7 percent by 2018, indicating that subsidised coverage has also raised the efficiency of firms. However, the strength of these gains appeared to decay with time – while subsidised coverage had a stable effect on turnover, impacts on employment increased with time.

- **Wages:** The impacts of the programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by 0.7 percent in response to the upgrade. This gives greater confidence that the programme led to an increase in productivity.

- **Unemployment:** Local job creation also appeared to translate into reduced unemployment, with the number of unemployed claimants falling by 32 for every 10,000 premises upgraded.

8.3.2 Mechanisms of impact

The ways in which the Superfast Broadband Programme supported businesses to upgrade their broadband connection and how this helped businesses generate the economic benefits described above was explored in a quantitative survey of 1,200 businesses and qualitative interviews with 40 businesses. This found that:

- The Superfast Broadband Programme had allowed businesses to upgrade their internet connection, with nearly half of businesses now reported using fibre connections (either FTTP or FTTC connections) in areas where the Superfast Broadband Programme had delivered improved connectivity compared to 30 percent in comparator areas. This increased the connection speeds that businesses were able to receive, but just as importantly for businesses it improved the reliability of their connection (meaning their connection was less likely to 'drop out' or become unavailable).

- The most commonly reported perceived impact of improved connections were enhanced customer services (72 percent), utilising the Internet of Things (55 percent), cloud-based computing (51 percent) and promoting flexible working (50 percent). Fewer businesses reported introducing new goods or services or opening up new markets. This suggests that the benefits of the subsidised coverage may have arisen primarily through enhanced operational efficiency.

- Examples of this operational efficiency were explored in the qualitative interviews, and included:

  - **Transferring documents:** Businesses described the difficulties they had transferring large documents between employees, customers and clients, with a lack of confidence that documents would be shared and long upload times being

required (both to upload files to a server, cloud computing or via email). One company stated that they used to have to build in "upload times" into their project timelines, to ensure that deadlines could be met. With the improved connections, the time required to share documents was reduced, meaning that staff did not have to spend as long facilitating the sharing of documents and freeing time to spend on other tasks.

- **Using online administrative systems:** Businesses reported a reluctance to use online systems with their previous internet connection, such as online accountancy, sales or website management services. This was because of a lack of confidence that their connection speed (and reliability) would enable them to use these services. With the faster internet connections, some businesses have started to use these systems. Additionally, while many businesses reported using cloud computing with their previous internet connection, some switched from having servers on their premises (or rented elsewhere) to using cloud based storage. The businesses that reported using cloud based storage with their previous internet connection stated that it was inefficient, but had improved since they upgraded their internet connection. Finally, a small number of businesses reported switching from an existing business line for their telephone system to having a phone system run through their internet connection. This tended to reduce their overhead costs (or at least be cost neutral). Businesses that had utilised an internet based phone system reported that it would have been difficult to do this on their previous connection due to a lack of reliability in their connection (meaning that their phone system would also be unavailable).

- **Reduced travel times and expense:** Businesses reported that the improved speed and reliability meant that there was a reduction in travel times and expense. This was because their previous connections were too slow or unreliable to undertake specific tasks. For example, one business owner reported having to travel to public facilities in a city rather than using a connection where the business was based because it was too slow to undertake the tasks required. Other businesses reported that they would have to go to visit clients to resolve tasks that can now be resolved remotely (such as IT support) because of the poor connection speed they could access at their business address.

- Although few businesses reported introducing completely new services, some businesses did state that they had introduced new ways of working or offers to customers. These included being able to video conference, either internally or externally with customers. Previously their poor internet connection speed prevented video conferencing. Some other businesses reported being able to offer remote IT support to customers, which meant that they spent fewer man hours resolving problems (as travel time was reduced) but also allowed them to support multiple clients at the same time, thus increasing their efficiency.

- Businesses also reported that the improved connectivity had a positive impact on the volume of training they provide. This is because employees can access online training facilities or attend virtual conferences. The online training modules were reported to be less expensive than classroom based learning (in some cases free with software packages the businesses had purchased) while maintaining a high level of quality. This, coupled with reduced travel costs for training and conferences (both in terms of travel cost and time – meaning workers could be at their desk instead of travelling to and from training) meant training budgets could extend to include more training hours per year.

8.3.3 National economic benefits

In line with the HM Treasury Green Book, it is assumed that the local economic impact of the programme will largely be neutralised by offsetting effects elsewhere in the economy (displacement). While businesses located in areas receiving subsidised coverage have expanded their sales, this will have come at the expense of loss of market share for competing firms (who may be located locally or elsewhere in the UK).

The findings also suggested that relocation of economic activity was an important driver of the effects observed and assuming these activities would have otherwise been relocated elsewhere in the UK it is likely that much of the job creation impacts described above would have been realised in other locations. Even if firms expanded without directly displacing the activities of domestic based competitors, increased demand for workers and other inputs can be expected to have placed additional pressure on prices, resulting in reductions in output and employment elsewhere.

As such – and in line with the principles of the HM Treasury Green Book - only the effects of the programme in terms of raising productivity are considered to qualify as economic benefits at the national level. The evaluation provided a range of results to indicate that the programme has supported improvements in productivity – including raising the turnover of per worker and wages of employees of firms located in areas benefiting from subsidised coverage. The effect of the programme was also visible in commercial rental values – which rose by 1.8 percent in response to the upgrade.

GVA based measure of economic benefit

An increase in productivity will increase overall economic output (GVA) as resources are used more efficiently. However, it is important to note that turnover per worker at the local level may rise both because firms become more efficient, and because more productive firms relocate to the area (a displacement effect that would not lead to improvements in productivity at the national level). To address this issue, the economic benefits of the programme have been estimated based on its effects on firms that did not relocate (i.e. spatially stable firms) over the period of interest, as follows:

- **Short-term impact on turnover per premises upgraded:** The short-term impact of the programme on the turnover per worker of spatially stable firms was estimated at 0.01 percent per premises upgraded in the Output Area (based on results covering the 2016 to 2018 period). The average turnover per worker of spatially stable firms benefitting from the programme was approximately £106,000. This implies that turnover per worker rose by just under £12 for each premise upgraded across spatially stable units. The average level of employment amongst spatially stable firms in Output Areas supported by the programme was almost 37 employees per output area. This gives a total effect on turnover driven by apparent efficiency gains of £450 per premises upgraded (per annum).

- **Short-term impact on GVA per premises upgraded.** It was assumed that firms did not change the shares of labour and other inputs used in production in response to the subsidised coverage, and the effect on turnover per worker can be interpreted as an improvement in productivity. Applying the average GVA as a percentage of turnover

across the UK as whole over the 2008 to 2018 period (31 percent)[70], this gives an effect on GVA per premises upgraded of £140 (per annum).

- **Persistence:** The results of the evaluation suggested that the estimated effect on turnover per worker per premises upgraded fell from 0.011 percent at the end of 2016 to 0.009 percent at the end of 2018 (a rate of decay of 13.2 percent per annum). The average age of these upgrades was 1.8 years at the end of March 2016 and 3.8 years at the end of March 2018. It is assumed that the short-term effect of the programme persists for the first two years following the upgrade, and thereafter decays at a rate of 13 percent per annum.

These results were applied to the profile of additional premises upgraded set out in the subsection 8.2. Summary results covering the 2011/12 to 2018/19 period (benefits to date) and the 2011/12 to 2029/30 period (including projected benefits) are set out in the table below. The present value of GVA benefits (with a baseline of 2012/13) are estimated at £1.1bn by 2018/19 and between £1.6bn and £1.8bn by 2029/30.

This approach may understate the economic benefits of the programme. If spatially stable firms displace sales from less productive firms, then there will also be benefits associated with the transfer of output from less to more productive producers which are not captured in this analysis. The programme is also assumed not to lead to productivity gains for relocating firms (as the quality of their broadband access prior to the relocation is unknown). Additionally, the relocation of firms to the programme area may also produce agglomeration economies (e.g. resulting from knowledge spill-overs arising from greater opportunities for face to face interaction and collaboration) that could only be partly captured in the econometric analysis. However, it should be noted that these relocations will be accompanied by disagglomeration elsewhere and these effects may neutralise each other at the national level.

Table 8.3 – Additional GVA resulting from productivity gains (£m, 2019 prices)

Period	Undiscounted (£m)	Discounted (£m)
Productivity gains 2011/12 to 2018/19 (£m)	1243.1 – 1245.1	1,078.8 – 1,080.4
Productivity gains 2011/12 to 2029/30 (£m)	1972.9 – 2275.0	1,609.9 – 1,810.8

Source: Ipsos MORI analysis.

Unemployment impacts

The results of the evaluation suggested that for every 10,000 premises upgraded there was a corresponding on-going reduction in the number of unemployed claimants of 32.1 claimants. The extent to which these effects might be understood as net economic benefits will be linked to how far the programme drew individuals out of (or helped them avoid) extended periods of involuntary worklessness in which they were not productively deployed (rather than short-term episodes of unemployment[71]).

The data available did not permit an analysis of the effects of the programme on long-term unemployment directly as claimant counts at the local level do not provide information on the duration of claims. However, the prior evaluation of the programme (using different data series[72]) suggested that for every individual taken out of unemployment by the programme,

[70] Source: Annual Business Survey, ONS. Ten year average of GVA as a percentage of turnover used to avoid bias from annual fluctuations in GVA to turnover ratio.
[71] Though some of these episodes will have otherwise evolved into long-term unemployment.
[72] DCMS (2018) Economic and Public Value of the Superfast Broadband Programme.

0.29 individuals were taken out of long-term employment. Assuming this applies to the results obtained in this study, it is estimated that for every 10,000 premises upgraded, the number of long-term claimants fell by 9.2.

Assuming the effects on long-term unemployment represent the effect of the programme on the overall productive capacity of the economy, and valuing the output produced by those individuals at £15,480 per annum[73], it is estimated that these effects could have led to an additional £125m in national economic output (GVA) by 2019 (in present value terms). This effect is estimated to rise to between £237m to £306m in the longer term (though to the extent this is driven by relocation of economic activity, there may have been corresponding increases in long-term unemployment elsewhere).

Table 8.4 – Additional GVA resulting from reductions in long-term unemployment (£m, 2019 prices)

Period	Undiscounted (£m)	Discounted (£m)
GVA from the reduction in long-term unemployment 2011/12 to 2018/19 (£m)	144.5 – 144.9	124.9 – 125.2
GVA from the reduction in long-term unemployment 2011/12 to 2029/30 (£m)	303.5 – 409.9	237.1 – 305.9

Source: Ipsos MORI analysis.

8.4 Social benefits

8.4.1 Evidence of social benefits

The analysis also extended to exploring the social benefits of the programme. These effects may arise directly from their consumption of superfast broadband services or indirectly (e.g. by enabling greater remote working, reducing commuting times and/or improving the quality or efficiency of public services). These types of well-being or utility benefits for individuals are more challenging to explore because they can be directly quantified or monetised in the same way as the economic impacts described in the preceding section. A range of complementary approaches were adopted to explore the value of the programmes to consumers and households using econometric methods (again, set out in full in Technical Appendix 3):

- **House prices:** The first approach was to explore the effect of the programme on house prices (a "revealed preference" approach). The underlying assumption is that if households place a value on superfast connectivity, this will be reflected in an increase in what they are willing to pay to obtain access to the scarce asset. The price premium paid for houses with superfast connectivity should therefore represent the present value of the future net benefit they expect to gain from access to faster internet services. The findings of the study suggested that the programme led to an increase in house prices (of 0.6 to 1.2 percent, or £1,700 to £3,500) suggesting that buyers valued the technology. These estimates also compare to the results of a previous study estimating the per household benefit of upgrading rural areas of the UK to FTTC of £3,145 (based on an analysis of the impact of upgrading local exchanges to ADSL during the 2000 to 2010 period)[74].

- **Subjective well-being:** A second approach was adopted examining the impacts of the programme on self-reported levels of subjective well-being (a "stated preference"

[73] It is assumed that the productivity of the average worker avoiding long-term unemployment due to the programme is lower than the national average, and here we have assumed that workers would gross annual pay at the 25th percentile of all workers (based on the 2017 Annual Survey of Hours and Earnings). Economic benefits have been valued on the basis of wages in line with the DfT Transport Appraisal Guidance module on employment effects.
[74] Gabriel Ahlfeldt (2014) Speed 2.0 Evaluating Access to Universal Digital Highways

approach, which was used in the previous evaluation of the programme). However, the findings provided mixed evidence as to how far there was an overall impact on the subjective well-being of residents. Modelling of the effect of the programme on subjective well-being showed no significant effects on the total population, although there was evidence of variable effects across age groups – with positive effects on those aged 65 and above and neutral or negative effects on other age groups. It should be noted that these analyses focused on changes in the well-being of those living in properties before and after the upgrade (and could be distorted by migration patterns).

- **Public services:** These issues were explored further by examining the effects of the programme on local education and health services. While not providing direct measures of well-being, these analyses provided supplementary evidence of some of the potential drivers of the social impacts of the programme, as well as exploring its public sector benefits. The results of the evaluation also provided some signals of possible disbenefits associated with superfast broadband coverage in rural areas. There was evidence that the programme had stimulated migration to the areas benefitting from subsidised coverage. For example, the number of patients registered with GP surgeries increased by 3.2 to 5.9 percent on average in response to the upgrade, and there were some suggestions that the number of pupils in schools benefitting from subsidised coverage increased. Migration may have altered the composition of local populations and could partly explain the mixed results on overall subjective well-being – for example, if those migrating to the programme area came largely from urban areas (as residents of urban areas typically report lower levels of well-being).[75] Increased population growth appears to have placed pressure on some public services which could offset positive well-being effects arising from consumption of faster broadband services. For example, increased numbers of patients registered with primary care providers did not come with an equivalent increase in capacity, and subsidised coverage appears to have reduced satisfaction with continuity care, ability to obtain appointments, and their overall satisfaction with their GP surgery.

The mixed nature of the evidence suggests that the social impacts of the programme are complex and further research is needed to understand these effects in more depth. More research is being completed as part of the broader evaluation programme to address these gaps in understanding. This includes a face-to-face survey of households benefitting from subsidised coverage and analysis of the Oxford Internet Survey (OXIS) being undertaken by BDUK.

8.4.2 Valuation of social impacts

The social benefits of the programme were valued using the house price gains estimated through the econometric analysis. This 'revealed preference' is considered more robust than the available alternatives as it is based on observed market prices. However, the mixed findings create some challenges in interpreting the impact of the programme on house prices, and the following approach was adopted:

- **Scope of welfare gains:** The effect of the programme on house prices reflects the valuation of the marginal buyer, whose preferences may differ in substantial ways to the broader population benefitting from subsidised coverage. As noted, there was mixed evidence as to how far the subjective well-being of residents increased in response to the programme. As such, it can be anticipated that the general population do not value access to superfast broadband services as highly as those purchasing

[75] There is potential endogeneity in the model, in that house price growth could be influenced by local planning policies, which may also influence the choice of postcodes in be included in a local project by the programme beneficiary.

properties. To mitigate against the risk of overstating the value of the social benefits brought about by the programme, it was assumed that effect on house prices reflected the welfare benefits accruing to the population of households that moved to the programme area rather than all residential premises receiving subsidised coverage. This implicitly assumes that other residents derived no value from improved superfast broadband infrastructure or that the benefits they derive are offset by other factors (such as increased congestion or reductions in social cohesion). As such, the findings below should be considered a 'lower bound' to the value of social benefits arising from the programme.

- **Valuation:** To reach an estimate of the welfare gains, the estimated house price premium of £1,700 to £3,500 was applied to the number of houses sold in the programme area after the premises was upgraded (813,500). This gave a gross value of the price uplift of £1.4bn to £2.9bn.

- **Expectations:** An assumption was applied that consumers had reasonably formed expectations regarding the likelihood that homes would receive superfast coverage in the future. As such, the impact of the programme on house prices is interpreted as the present value of the total welfare gains associated with having access to superfast coverage immediately (and possibly other relevant features of the home, such as proximity to newly relocated employers) as opposed to coverage at some uncertain point in time in the future.

- **Additionality:** Flowing from this, the gross value of the price uplift was adjusted in light of short-term additionality (an average of 54 percent up to two years following the upgrade) to reflect the possibility that the premises would have otherwise received subsidised coverage in the absence of the programme at the time of purchase. However, the value of the price uplift was not adjusted further in the long-term as it was assumed that the possibility that the property would have received superfast coverage in the future was factored into willingness to pay. As such, the present value of welfare benefits to 2019 and to 2030 are equivalent (and estimated at £741m to £1.5bn).

- **Net effects:** To the extent that house prices were driven by migration induced by the programme, these may not represent net benefits as there may be offsetting effects elsewhere. Additionally, there is a possibility that the house price uplift may be linked to the programme's effects in attracting additional economic activity to the area (in which case, there may be an element of double counting with the economic benefits).

The following table provides a summary of the results.

.

Table 8.5: Land value uplift arising from impacts on house prices (£m, 2019 prices)

Period	Low house price premium	High price premium
Land value uplift (£m, present value)	741.9	1,536.8

Source: Ipsos MORI analysis; CORA; BDUK

8.5 Benefits to cost ratio

Drawing on the results above, low and high estimates of the Benefit to Cost Ratio (BCR) associated with the programme are developed using the estimates of the net cost of the programme set out in subsection 8.1. This gives a range for the BCR as follows:

- **Benefits from 2012 to 2019:** The short-term BCR (based on benefits to date) is estimated at between £2.7 and £3.8 per £1 of net lifetime public sector costs. This exceeds the hurdle rate of return normally applied in the appraisal of public sector programmes and suggests that the programme has already delivered a strong rate of return.

- **Benefits from 2012 to 2030:** In the long-run (allowing for future economic benefits), the BCR is estimated to rise to £3.6 to £5.1 per £1 of net public sector spending.

- **Sensitivity:** It should also be noted that investment in the programme can also be justified on the long-term economic benefits alone. Excluding the welfare effects inferred from house prices (which are less certain), the BCR is estimated to range from £2.5 (low future additionality) to £2.8 (high future additionality). The narrow nature of this range indicates that the benefit to cost ratio is not heavily dependent on the assumptions made regarding future additionality.

It is important to note that the modelling of the future benefits do not attempt to incorporate the possible effects of COVID-19 or the departure of the UK from the European Union (as the magnitude and direction of these effects are largely unknown at this stage). As these events are likely to have a transformative effect on the UK economy, projections of the future benefits of the programme should be treated as indicative.

Table 8.6: Benefit to Cost Ratios, 2012 to 2019 and 2012 to 2030

	2012 to 2019		**2012 to 2030**	
	High additionality / house price effects	**Low additionality / house price effects**	**Low additionality / house price effects**	**High additionality / house price effects**
Benefits				
Productivity gains (£m)	1,079	1,080	1,610	1,811
Long-term unemployment (£m)	125	125	237	306
House prices (£m)	742	1,537	742	1,537
Total	**1,946**	**2,742**	**2,589**	**3,697**
Costs				
Lifetime cost	727	727	727	727
Benefit to cost ratio	**2.7**	**3.8**	**3.6**	**5.1**

Source: Ipsos MORI analysis

9 Proportionality and appropriateness

This section addresses the final questions defined in the State aid evaluation plan:

- Question 6: Is the gap funding model efficient compared to alternative schemes?
- Question 7: Did the aid lead to commercially sustainable networks?

The analyses in this section focus on the unit cost of delivery associated bringing forward the programme (in gross and net terms) and the degree to which the networks brought forward have proven commercially sustainable.

However, as highlighted in the introduction, some aspects of the analyses envisaged in the State aid evaluation plan have proven infeasible due to data availability. Firstly, a review of the literature suggests that there are few evaluations from other EU countries providing ex-post quantitative estimates of the cost-effectiveness of comparable initiatives in bringing forward broadband coverage. As such, it has not been possible to robustly benchmark the scheme to explore issues relating to how far the programme design was optimal. Secondly, actual revenues and operational costs per user are not monitored by BDUK and consideration of those aspects of commercial sustainability are limited to the assumptions put forward by network providers in their tenders.

Key findings:

At the point of agreeing contracts to deliver the Superfast Broadband Programme local projects, the expected gross public sector costs per covered premises was £342 for the Superfast Broadband Programme, although there was significant variation across the various phases. Phase 1 had the lowest gross public sector cost per premises passed of £266. Phase 3 had the highest public sector cost per premises at over £1,216. This is expected given the proportion of full fibre build expected in Phase 3 delivery which was expected to come at a higher cost and the comparative commercial viability of the premises being upgraded. However, for premises covered so far by Phase 3 projects (to March 2019), the current expected cost per premises passed was £500, significantly less than the original expected costs.

The expected public sector costs factoring in the savings from the clawback mechanisms was also estimated, and is expected to reduce the net cost per additional covered premises from £890 to £790 for Phase 3 contracts (though, again, given the early stage of delivery, these estimates are highly uncertain).

Whilst an attempt has been made to compare the costs per connection for the programme to comparative schemes, there is little evidence on comparable interventions. There are very few studies that have sought to examine the cost-effectiveness of broadband programmes, and one study attempts to estimate the projected cost per premises passed for different EU schemes. This showed that in general, the Superfast Broadband Programme had a lower cost per premises passed than the expected cost for most other EU schemes. The lack of evaluation evidence (ex-post) may in part be because of a relative lack of public programmes on the same scale as the Superfast Broadband Programme and a consequent lack of published evaluative work. This means it is difficult to form conclusions as to the effectiveness of the gap funding model, although it does appear that the cost per premises covered for the Superfast Broadband Programme is lower than the projected costs for comparable schemes in the EU.

The commercial sustainability of the networks funded by the Superfast Broadband Programme have been assessed by examining current and expected take-up of connections and a comparison of the average operational cost per unit and the average revenue per unit of the network.

The expected take-up of connections was expected to be between 36 percent and 86 percent, and this is expected to be achieved by between 2019/20 and 2032/33. Actual take-up is currently below the expected level of take-up at the start of the projects, and in some cases is significantly lower than expectations. However, the lower level of take-up is expected, given that the delivery of Phase 3 contracts is behind schedule (see Section 4 of the report). Additionally, no network providers indicated in their interviews that they did not expect take-up to reach the expected levels in the future.

The estimated quarterly Average Revenue Per Unit is higher than the quarterly Average Operational Cost per Unit for programme beneficiaries. This suggests that the beneficiaries will still expect the networks to be sustainable in the long run.

9.1 Gap funding model efficiency

This section provides answers to the State aid evaluation question 6: Is the gap funding model efficient compared to alternative schemes? It provides the key State aid evaluation metrics of the public funding per covered premises and a comparison of these values against comparator schemes. It has not been possible to provide the metric of public funding per live end user connection-years due to a lack of available data.

9.1.1 Initial expected public sector cost per covered premises

Data on the costs of delivering the Superfast Broadband Programme have been drawn from BDUK monitoring data and the outputs of the modelling exercise described in Section 6 (and used in Section 8 to support the cost-benefit analysis). A total of £1.9bn of public sector funding was committed across Phase 1, 2 and 3 contracts with a total of 5.5 million contracted premises passed. This equates to an ex-ante gross public sector cost per premises covered of £342. There was significant variation across the various phases. Phase 1 had the lowest gross public sector cost per premises passed of £266. Phase 3 had the highest public sector cost per premises at over £1,216. This is expected given the proportion of FTTP build expected in Phase 3 delivery which was expected to come at a higher cost.

Table 9.1: Contracted cost per premises passed by Phase

Contract phase	Contracted public sector cost[76] (£m)	Contracted premises passed	Gross public subsidy per gross premises passed (£)
Phase 1	1,169.1	4,388,618	266.39
Phase 2	332.6	830,654	400.39
Phase 3	391.9	322,242	1,216.29
Overall	1,893.6	5,541,514	341.72

Source: Ipsos MORI analysis; CORA; BDUK

[76] In nominal terms, not in present value terms. Taken from CORA management extract

9.1.2 Current expected (actual) public sector cost per covered premises

The table below provides estimates of the current expected public funding per covered premise by March 2019 (following the approach outlined in Section 8). As highlighted, current expectations of public spending (before implementation and take-up clawback) differ significantly to the contracted costs outlined above (primarily driven by underspend on Phase 1 contracts). The expected gross public spend per premises passed was lower overall at £280 (rather than £342) and the expected gross public spend per covered premises in Phase 3 fell from £1,216 to just above £497 (primarily due to expected underspend, though note that these projections are highly uncertain at this stage).

Factoring in the likelihood that some of those premises passed to date would otherwise have received coverage through commercial deployments, the table below also includes the estimated number of additional covered premises. This applies estimated additionality over the first three years following delivery (to align with the period covered by the OMR process) of 56 percent. The gross public sector cost (i.e. before clawback) per additional covered premises over three years was £500 (in 2019 prices).

Table 9.2: Expected gross cost per premises and additional premises passed

Contract phase	Expected public sector cost (£m)	Premises passed by March 2019	Additional covered premises to date	Expected Gross public subsidy per gross covered premises (£)	Expected Gross public subsidy per additional covered premises (£)
Phase 3 to date	25.5	51,285	28,720	500	890
Overall	**1476.1**	**5,268,398**	**2,950,303**	**280**	**500**

Source: Ipsos MORI analysis; CORA; BDUK. 2019 prices.

9.1.3 Net public sector cost per additional covered premises over three years

The table below outlines the expected public sector costs factoring in the savings from the clawback mechanisms. This is expected to reduce the net cost per additional covered premises from £890 to £790 for Phase 3 contracts (though, again, given the early stage of delivery, these estimates are highly uncertain).

Table 9.3: Net public sector cost per additional covered premises

Contract phase	Net public sector cost (£m)	Additional covered premises	Net public subsidy per additional covered premises (£)
Phase 1	429.8	2,818,651	150
Phase 2	274.3	500,273	550
Phase 3	22.6	28,720	790
Overall	726.7	3,353,638	220

Source: Ipsos MORI analysis; BDUK

9.1.4 Benchmarking

Whilst an attempt has been made to compare the costs per connection outlined for the programme above, there remains little evidence on comparable interventions. There are very few studies that have sought to examine the cost-effectiveness of broadband programmes in

the EU ex-post. This may in part be because of a relative lack of public programmes on the same scale as the Superfast Programme and a consequent lack of published evaluative work. However, there are some examples where the expected unit cost of premises passed has been estimated. It should be noted that these are projected public sector costs per gross premises passed, rather than observed costs. The estimated costs are:[77, 78]

- In Austria, the cost per premises passed was approximately £1,900 and £3,600 across two projects.
- In Germany, projects estimated the average of cost per premises passed was between £1,100 and £9,300.
- In Finland, the projected cost per premises passed was estimated to be between £1,300 and £5,800 across three projects.
- In Hungary there are multiple projects, and the average cost per premises passed was estimated to be between £200 and £660
- In Ireland, the estimated cost per premises passed was £4,900.
- In Italy, several projects estimated that the cost per premises passed was between £230 and £330.
- In Portugal there are several projects and the estimated cost per premises passed was estimated to be between £220 to £810.

These show that in most countries, the average cost per premises upgraded is higher than the cost observed in the Superfast Broadband Programme.

A recent study evaluating parts of the SuperConnected Cities Programme (SCCP)[79] in the UK did include a cost benefit analysis of the Connection Voucher Scheme element of that programme. This made vouchers up to a value of £3,000 available to small to medium sized businesses (SMEs) to put towards upgrading their internet connection. To be granted, the connection would need to provide at least superfast speeds but was technology agnostic. The study found the average cost of subsidised connections through this programme was £1,400, although this also varied substantially by technology type (ranging from £1,100 for FTTC connections to £2,800 for Fixed Wireless / Microwave connections). The cost per installation was estimated at £1,400, though each installation led to a further 4.7 additional connections per postcode. This equated to an estimated cost per additional connection of £290. However, this is not directly comparable to the figures above as it focuses on the cost of connections rather than the cost of coverage.

9.2 Commercial sustainability of networks

The NBS evaluation plan sets out the key indicators to be assessed to draw conclusions about whether the Superfast Broadband Programme has led to the development of commercially sustainable networks. These included an assessment of the actual versus original forecast annual cashflow (before subsidy)[80], take-up volumes, average revenue per user, average operational costs per user for each winning network provider.

9.2.1 Withdrawn contracts

[77] European Commission (2020) The role of State aid for the rapid deployment of broadband networks in the EU.

[78] Values converted from € to £ using exchange rates from xe.com

[79] Superconnected Cities Programme

[80] It has not been possible to evaluate this indicator due to a lack of data

The evaluation plan also envisaged an assessment of the number of projects, if any, from which services have been withdrawn (e.g. due to corporate insolvency, or project losses), the number of premises covered by such projects, and the number of live connections for such projects, and percentage share of the overall 2016 NBS accounted for by such projects (in terms of number of projects, public funding, premises covered, take-up volumes).

For the interventions which have been funded under State aid SA. 40720 (2016/N), of the 51 contracts currently listed on the Superfast Broadband management system, none have had services withdrawn by the network provider. This means that there have been no premises which have not been upgraded as a result of a beneficiary withdrawing from the programme.

However, a total of five contracts which were awarded under State aid SA. 40720 (2016/N) have been terminated. All of these contracts were awarded and terminated by the same Local Body and were awarded to the same beneficiary. These contracts were terminated by the Local Body, rather than the beneficiary. The reason for the termination was the inability of the beneficiary (and its supply chain) to deliver the network build outlined in their bids to the required quality within the specified timeframe of the contract.

As mentioned in Section 2 of the report, the Superfast Broadband Programme has not collected data on the number of ISPs utilising the networks that have been funded by the programme. Therefore, it has not been possible to complete the assessment of commercially sustainable networks as set out in the NBS evaluation plan. Additionally, as Phase 3 contracts have not been completed at the time of the evaluation, the beneficiaries are not yet at the post subsidy stage, meaning it is difficult to assess their position pre and post subsidy. The cash flow by contract has been assessed in Section 5 of this report (as part of the assessment of the impact on direct beneficiaries).

9.2.2 Actual vs expected take-up

The expected levels of take-up of Superfast connections by end users was included in beneficiaries' PFM submission, and included take-up by quarter and by technology type. The level and speed of take-up varied by contract, beneficiary and connection type. A summary of the expected take-up of Phase 3 contracts is provided in the table below. This shows that the beneficiaries are expecting take-up of connections through their networks of between 36 percent and 86 percent, and are expecting to reach these levels of take-up by between 2019/20 and 2032/33.

Table 9.4: Expected take-up by beneficiary and technology type for Phase 3 contracts

[redacted]

The expected level of take-up presented in the PFMs by the beneficiaries was compared to the reported level of take-up by the beneficiaries to the Superfast Broadband Programme in June 2020. This comparison is presented in the table below. This shows that take-up is currently below the expected level of take-up at the start of the projects, and in some cases is significantly lower than expectations. However, the lower level of take-up is expected, given that the delivery of Phase 3 contracts is behind schedule (see Section 4 of the report).

In the qualitative interviews, the beneficiaries were asked about their forecasted level of take-up and whether they expected this to be achieved. No beneficiary responded that they expected take-up to be significantly below their forecasted level. Additionally, the evidence from Phase 1 and Phase 2 contracts on take-up (see Technical Appendix 3) suggests that

take-up for Phase 3 contracts will continue to rise in the future and that the expected levels of take-up will be observed or more probably exceeded in the Phase 3 contract areas.

Table 9.5 – Actual versus expected take-up by beneficiary and technology type, June 2020

[redacted]

9.2.3 Original forecast average revenue / cost per user[81]

Beneficiaries reported the Average Revenue Price per Unit (ARPU) in the PFM. On average, the ARPU for FTTC is £22.21 and for FTTP is £46.94 across the Phase 3 portfolio. The total average operational cost over the lifetime of the programme is highlighted in the table below, alongside an average quarterly operational cost.[82] This has been calculated by dividing the operational cost provided by the beneficiaries in their PFM by the expected level of take-up. It can be seen that the estimated quarterly ARPU is higher than the quarterly Average Operational Cost per Unit, suggesting that the beneficiaries will still expect the networks to be sustainable in the long run.

Table 9.6: Expected Average Operational Cost per User and Average Revenue per Unit for Phase 3 contracts prior to delivery

[redacted]

[81] Due to the early stages of delivery of most of the Phase 3 contracts, and a lack of data, it is not possible to estimate the actual average revenue and actual average cost per connection at the moment.

[82] It should be noted that the operational cost does not include the capital expenditure required to construct the network.

10 State aid conclusions

This section provides a brief overview of the key findings from this report. These focus on the seven State aid evaluation questions, and the wider economic and social benefits of the programme.

Question 1: To what extent has the aid resulted in increased access to an NGA network being deployed in 'white' NGA areas?

Phase 3 contracts increased the number of premises passed by NGA services by 2,300 to 16,600 on postcodes benefitting from subsidised coverage by the end of September 2019 (with the weight of evidence to the lower end of this range). The share of the 79,100 premises upgraded by the end of September 2019 that would not have otherwise benefitted from NGA coverage is estimated at 3 to 21 percent.

Phase 3 contracts increased the number of premises with superfast coverage by 10,800 to 29,300, and the number of premises with FTTP coverage by 19,000 to 30,300. The additionality of superfast and FTTP coverage was correspondingly higher at 14 to 55 percent of premises receiving subsidised coverage. This indicates that some premises benefitting from subsidised upgrades would have otherwise received NGA coverage that did not deliver superfast speeds. There was also evidence that Phase 3 contracts delayed the availability of superfast coverage for some premises that would have otherwise received it earlier.

The findings were broadly consistent with more general analysis examining the impacts of the programme since delivery began in 2013. These findings indicated that the additionality of subsidised coverage peaks one year after premises are upgraded (at around 60 percent), before decaying at a rate of approximately 14 percent per annum. This implies that in many cases, the programme has worked to accelerate the availability of superfast broadband.

The results suggest that the processes used to identify the commercial plans of providers were not fully effective in establishing premises that would not benefit from commercial deployments in the near term. Several explanations for this emerged from the research. Network providers reported that their investment cycles were determined over relatively short time horizons (12 to 24 months). The absence of immediate commercial deployment plans did not necessarily imply that investment was considered economically unviable. Network providers sometimes could not provide Local Bodies with deployment plans of sufficient detail or certainty to be incorporated when the areas eligible for subsidies were determined. Finally, the definition of areas eligible for investment was based on a static view of network provider's plans, which subsequently evolved in response to regulatory innovation and growth in demand.

Question 2: To what extent has the target of the intervention been used and what speeds are available?

The findings indicated that Phase 3 contracts reduced the number of premises with superfast connections by 1.1 to 2.4 premises per postcode by September 2019. There was no conclusive evidence that subsidised coverage had a positive or negative effect on the average download speeds of connections by September 2019. This is likely a product of the short window of time that had elapsed for businesses and households to take-up, and the effect of the programme in delaying the availability of superfast for some premises that would have otherwise benefitted from commercial deployments. It is premature to draw conclusions on the impact of the programme on take-up, and analysis exploring the effects of the programme since it was launched in 2013 suggested it produced a broad range of positive impacts on take-up in the longer term.

The results did indicate that Phase 3 contracts increased the average upload speeds of connections (by 0.9Mbps to 3.9Mbps) and the maximum download speeds of connections by 6.2Mbps to 16.9Mbps. This may reflect the effect of FTTP delivery, which has enabled users to obtain higher capacity connections that may have otherwise been available.

Question 3: Has the aid had a significant incentive effect on the aid beneficiaries?

Based on projections provided by network providers at the tendering stage, the proposed network build under Phase 3 contracts was expected to either generate losses or to deliver positive rates of return (Internal Rate of Return or IRR) that were substantially lower than the cost of capital faced by the network provider - a loss of **[redacted]** per annum versus a Weighted Average Cost of Capital (WACC) of **[redacted]**. If it is assumed that profit maximising firms are only incentivised to implement projects where the IRR exceeds the WACC, then public subsidies would have been needed to create a sufficient economic incentive to deliver these investments.

The analysis suggested that network providers consistently underestimated take-up in the tendering process for Phases 1 and 2. The projections of take-up in Phase 3 of the programme also appear understated given that network providers will have learned the likely levels of demand from their experiences with Phase 1 and 2 contracts. This means beneficiaries may have understated revenue projections, increasing the apparent level of public funding needed to make the project economically viable. However, after updating projections in line with take-up observed on Phase 1 and 2 contracts, the projected IRRs associated with Phase 3 projects without subsidy are not significantly higher than those expected at the tendering stage (a positive IRR of **[redacted]**). The projected IRRs of all Phase 3 contracts (without subsidy) are expected to be substantially lower than the WACC of the network provider.

The protections put in place by BDUK are likely to protect the public sector from the risk that it provided more than the minimum subsidy needed. Contracts have been designed such that network providers are required to return resources to the public sector if build costs are understated or if take-up proves higher than expected (leading to higher levels of profitability). While the provision of subsidies is expected to increase the IRRs on Phase 3 contracts to **[redacted]**, this falls to **[redacted]** once the activation of these contractual mechanisms is accounted for.

While the contracts have proven largely effective in containing subsidies to the minimum needed for the project to go forward, the public sector has incurred opportunity costs by tying resources up in the programme. BDUK may wish to consider whether seeking to contain these opportunity costs in future procurements could be justified.

Question 4: Has the aid had a material effect on the market position of the direct beneficiaries?

At a UK level, there has not been significant changes in the market share of programme beneficiaries in the broadband market between 2016 and 2020. Openreach dominates the market (even more so if Sky and TalkTalk are included in the Openreach market share, as these providers utilise the Openreach network), representing more than three quarters of the broadband market in both 2016 and 2020. The other beneficiaries of the Superfast Broadband Programme represented less than 0.5 percent of the market in both 2016 and 2020. A similar pattern is seen for the NGA market, with Openreach representing over 60 percent of the market in both 2016 and 2020, with the other programme beneficiaries representing less than 0.5 percent of the market.

In the areas where the Superfast Broadband Programme has been delivered, the programme appears to have had little impact on the market position of Openreach in either the overall broadband or NGA market, as Openreach maintains a dominant market position in both 2016 and 2020. However, the market share in both the overall broadband and NGA market for the smaller programme beneficiaries has increased between 2016 and 2020 in Phase 3 delivery areas which is not observed at a national level, suggesting the programme has positively affected the market share of the programme beneficiaries in these areas.

In areas where Openreach have delivered contracts, they have maintained their market share between 2016 and 2020 in both the overall broadband and NGA markets. However, in areas where the other, smaller programme beneficiaries have delivered contracts, the market share for Openreach has fallen (particularly in areas where Gigaclear have delivered contracts), with the market share of the other beneficiaries increasing. This suggests that the other beneficiaries are taking market share from Openreach in these areas.

Question 5: How far is there evidence of changes to parameters of competition arising from the aid?

At a UK level, the share of NGA broadband take-up as a proportion of total broadband take-up has increased markedly since 2016. NGA connections represented just over half of all broadband connections in 2016, but this has grown to over 70 percent of internet connections in 2020. Fibre to the Cabinet (FTTC) connections represented the largest proportion of NGA connections in both 2016 and 2020 (around a third of all broadband connections in 2016 and just over a half in 2020). This pattern was also observed in areas benefitting from the Superfast Broadband Programme.

The average number of infrastructure providers operating on the postcodes benefitting from subsidised upgrades rose from 2.3 to 2.6 between 2012 and 2020, indicating the programme has helped promote greater competition in these areas. Although there has been an increase in the number of network providers offering services in Superfast Broadband Programme areas, most non-beneficiary network providers tended to provide services to only a small number of postcodes within the Superfast Broadband project areas. This suggests there has not been a large degree of overbuild.

The number of ISPs operating in Superfast Broadband Programme areas has increased between 2016 and 2020. There are a higher number of ISPs with customers in Phase 1 contract areas than Phase 2 and Phase 3. This would be expected, given that the Phase 1 areas were larger and more commercially viable. Additionally, all Phase 1 contracts were delivered by Openreach, and the qualitative findings suggested that at present no ISPs were utilising the subsidised networks built by programme beneficiaries other than Openreach.

Question 6: Is the gap funding model efficient compared to alternative schemes?

The gross public sector cost (i.e. before clawback) per additional covered premises over three years was £890 for Phase 3 contracts (in 2019 prices). However, the public sector savings from the clawback mechanism is expected to reduce the net cost per additional covered premises from £890 to £790 for Phase 3 contracts (though again, given the early stage of delivery, these estimates are highly uncertain).

A review of the literature suggests that there are no evaluations providing quantitative estimates of the cost-effectiveness of comparable initiatives in bringing forward broadband coverage. As such, it has not been possible to benchmark the scheme to explore issues relating to how far the programme design was optimal. However, a study for the European Commission does provide estimates of the projected cost per covered premises, and it

appears that the cost per premises covered for the Superfast Broadband Programme is lower than the projected costs for comparable schemes in the EU.[83]

Question 7: Did the aid lead to commercially sustainable networks?

None of the 51 Phase 3 contracts currently listed on the Superfast Broadband management system have had services withdrawn by the network provider. This means that there have been no premises which have not been upgraded as a result of a beneficiary withdrawing from the programme.

However, a total of five contracts have been terminated. All of these contracts were awarded and terminated by the same Local Body and were awarded to the same beneficiary. These contracts were terminated by the Local Body, due to the inability of the beneficiary (and its supply chain) to deliver the network build outlined in their bids to the required quality within the specified timeframe of the contract. These contracts were not terminated due to the commercial viability of the contract.

Analysis of Phase 3 contracts shows that take-up is currently below the expected level of take-up at the start of the projects, and in some cases this is significantly lower than expectations. However, the lower level of take-up is expected, given that the delivery of Phase 3 contracts is behind schedule. The beneficiaries did not raise any concerns about the long-term level of expected take-up in the qualitative interviews, suggesting that they expect the networks to be commercially sustainable.

The pre-delivery Average Revenue Per User was compared to the Average Operational Cost per User, which showed that all the beneficiaries expected their revenue to be higher than their Operational Cost. Actual revenues and operational costs per user are not monitored by BDUK and therefore it is not possible to assess any updated average costs and revenues for beneficiaries.

Wider economy effects

The present value of net public spending required to deliver the Superfast Broadband Programme over the lifetime of Phase 1, 2 and 3 contracts was estimated to be £815m in nominal terms. This is less than estimated total cost of the programme of £1.9bn, as there is expected to be a large amount of clawback generated from the beneficiaries delivering the programme.

The findings of the evaluation indicate that the programme has led to a range of economic and social benefits in the areas benefitting from subsidised coverage between 2012 and 2018. The key results included:

- **Local employment impacts:** Subsidised coverage was estimated to have increased employment in the areas benefitting from the programme by 0.6 percent, leading to the creation of 17,600 local jobs by the end of 2018.

- **Turnover:** Subsidised coverage also increased the turnover of firms located in the areas benefitting from the programme by almost 1.0 percent by 2018, increasing the annual turnover of local businesses by £1.9bn per annum.

[83] European Commission (2020) The role of State aid for the rapid deployment of broadband networks in the EU

- **Number of firms:** The evidence indicated that a share of these local economic impacts were driven by the relocation of firms to the programme area. The evidence indicated that subsidised coverage increased the number of businesses located in the areas benefitting by around 0.5 percent – suggesting the programme may have encouraged the relocation of economic activity to rural areas.

- **Turnover per worker:** There were also signals of efficiency gains - turnover per worker of firms in the areas benefitting rose by 0.4 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.7 percent by 2018, indicating that subsidised coverage has also raised the efficiency of firms. However, the strength of these gains appeared to decay with time because these firms employed more workers as time passed.

- **Wages:** The impacts of the programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by 0.7 percent in response to the upgrade. This gives greater confidence that the programme led to an increase in productivity.

- **Unemployment:** Local job creation also appeared to translate into reductions in unemployment, with the number of unemployed claimants falling by 32 for every 10,000 premises upgraded by 2018.

- **House prices:** The programme led to an increase in house prices (of between £1,700 and £3,500) suggesting that buyers valued the technology.

It is important to note that while most of these findings account for the possibility that businesses benefitting from the programme may have claimed market share from local competitors, they should not be interpreted as net economic impacts at the national level. At the national level, the programme is estimated to have resulted in:

- **Economic benefits:** The programme is estimated to have led to a cumulative total of £1.1bn in productivity gains between 2012 and 2019. This rises to between £1.6bn and £1.8bn over the 2012 to 2030 period.

- **Social benefits:** Based on its impacts on house prices between 2012 and 2019, the programme is estimated to have led to social benefits valued at between £0.7bn and £1.5bn.

The estimated Benefit to Cost Ratio (BCR) was £2.7 to £3.8 per £1 of net public sector spending based on its impacts between 2012 and 2019. Allowing for future economic benefits to 2030, the BCR is estimated to rise to £3.6 to £5.1 per £1 of net public sector spending.

Compliance

A sample of 15 project contracts were selected to evaluate the compliance of the programme with the State aid guidance. These project contracts were selected to represent different locations within the UK and contracts with each of the Phase 3 programme beneficiaries.

Across all the project contracts, there has been a high level of compliance with the State aid guidance. However, there are some gaps in the evidence provided for some projects. Given the other evidence that has been provided for these projects, it has been assessed that these

are gaps in the evidence base, rather than evidence of non-compliance. The one area where there was evidence of a lack of compliance with European Commission Guidelines was around the timing of the Invitation to Tender (ITT) being issued, with this being more than a month after the public consultation exercise closed in most cases.

Annex A – Additional ThinkBroadband data tables

Table A1.1 – Network providers included in ThinkBroadband dataset

Network providers in ThinkBroadband			
Airband (including Airband wireless and Airband FTTP)	fibre nest persimmon fttp	kcom lightstream fttp	tove valley fttp
aylesbury vale fttp	FibreFirst FTTP	kijoma wireless	trooli fttp
b4rn fttp	fullfibreltd fttp	lothian wireless	truespeed fttp
balquhidder fttp	gigaclear fttp	ofnl ifnl fttp	vfast wireless
blackfibre fttp	gigafast fttp	Openreach (including Openreach WBC and Openreach FTTP)	virair wireless
boundless wireless	glide fttp	purefibre fttp	Virgin (including virgin rfog fttp, virgin gig1 gigabit 1000 50, virgin cable)
box broadband fttp	gnetwork fttp	raveningham residents fttp	vision fibre fttp
Callflow	grain connect fttp	reeth wireless	voneus wireless
Cityfibre (including Cityfibre and Gigler)	greenco wireless	Relish (including Relish fibre, Relish wireless and Relish swindon wireless)	Wessex (including Wessex fibre and Wessex wireless)
colchester fttp	hampshire broadband fttp	ridgehill residents fttp	Wight (including Wight ftttp, Wight wireless and Wight cable)
Community Fibre FTTP	hereford cic fttp	ruralcomms wirelss	zoom wireless
County Broadband (including County Broadband Wireless and County Broadband FTTP)	hiwifi wireless	sky llu	zzoomm fttp
ecom fttp	hyperoptic fttp	solway comms wireless	
f4rn fttp	internetty fttp	spectrum internet wireless	
factco fttp	its fttp	talktalk llu	

Table A1.2 – Mapping ISP to Network Provider in ThinkBroadband dataset

ISP	Network provider	ISP	Network provider	ISP	Network provider
186k	Openreach	**AAISP**	Openreach	**AB Internet**	Openreach
Ai Networks	Openreach	**Air Broadband**	OFNL / Gigaclear	**Airband**	Airband
Amatis Networks	Openreach	**AOL**	Openreach	**AQL**	Openreach
Ask4	Ask4	**Avanti Satellite Broadband**	Avanti	**Avonline**	Openreach
Aylesbury Vale Broadband	Aylesbury Vale	**B4RN**	B4RN	**Beeline Broadband**	Beeline
Bentley Walker Satellite Broad	Bentley	**bigblu**	biblu	**Boundless Communications**	Boundless
Box Broadband	Pure	**Bridge Fibre**	Openreach	**BT**	Openreach
BT Business Broadband	Openreach	**BT WiFi**	Openreach	**Buckminster Broadband**	Openreach
Cable and Wireless	Vodafone	**CableCom Networking**	Openreach	**Call Flow Solutions**	Callflow
Cerberus Networks	Openreach	**CityFibre**	Cityfibre	**Claranet SOHO**	Openreach
CloudScape	Openreach	**Commsworld**	Openreach	**Community Fibre**	Community Fibre
connexin	Openreach	**CORETX(C4L)**	Openreach	**Cotswold Wireless**	Cotswold
County Broadband	County Broadband	**Daisy Wholesale**	Openreach	**Datanet**	Openreach
Demon Internet	Vodafone	**Dragon WiFi**	Dragon	**Dyfed Superfast**	Openreach
Eclipse Internet	Openreach	**Ecom**	Ecom	**EE**	Openreach
Elite	Openreach	**Entanet**	Cityfibre	**Evolving Networks**	Openreach
Exa Networks	Openreach	**Exascale**	Fluiddata	**exponential-e**	Openreach
Fast	Openreach	**FastNet**	Openreach	**Fibre for Rural Nottinghamshir**	B4rn
Fibre Nest	Openreach	**FidoNet**	Openreach	**Fluidata**	Openreach
FluidOne	Openreach	**G Network**	G Network	**Gamma**	Openreach
GCI (Edge Telecoms)	Openreach	**Gigabeam**	Gigabeam	**Gigaclear**	Gigaclear
Giganet	Openreach	**Glide Business**	Glide	**Goscomb Technologies**	Openreach
Gradwell	Openreach	**Green Co**	Openreach	**HighNet**	Openreach
HiWiFi	HiWifi	**Hotchilli Internet**	Openreach	**hSO**	Openreach

ISP	Network provider	ISP	Network provider	ISP	Network provider
Hyperoptic	Hyperoptic	**I Love Broadband**	Sky	**ICUK**	Openreach
IDNet	Openreach	**ineedbroadband**	Fullfibreco	**Internet For Business**	Openreach
InTouch Systems	Intouch	**IP River**	TalkTalk	**its Technology**	Openreach
Jersey Telecom	Jersey	**Juice Broadband**	Juice	**KCOM**	KCOM
Keycom	Keycom	**Kijoma Broadband**	Kijoma	**LonsdaleNET**	Lonsdale
Lothian Broadband	Openreach	**Luminet (Urban Wimax)**	Luminet	**M247**	Openreach
Merula Limited	Openreach	**Michaelston-y-Fedw Internet CI**	Michaelston-y-Fedw Internet CI	**O2**	Openreach
O2 Wifi	Openreach	**Oakford Technology**	Openreach	**Optimity**	optimity
Orbital Net	Openreach	**Origin Broadband**	Openreach	**Pembs Wifi**	Openreach
Pine Media	Pine	**Plusnet**	Openreach	**Post Office**	talktalk
Pure Broadband	Pure	**PureFibre (Also Derwenthorpe +**	Pure	**Quickline**	Quickline
Redcentric	Openreach	**Relish**	Relish	**Resqnet Wireless Broadband**	Resqnet
RM Broadband	Openreach	**Satellite Internet**	Openreach	**Scotnet**	Openreach
SeeTheLight(IFNL)	OFNL	**SES Satellite Broadband**	SES	**Sky**	Sky
Sky Corporate	Sky	**Solway Communications**	Solway	**Spectrum Internet**	Sectrum
Spitfire	Openreach	**Stream Networks**	Openreach	**Structured Communications Ltd**	Openreach
Sure	Openreach	**SW Internet**	SW	**SWS Broadband**	Openreach
TalkTalk	TalkTalk	**TalkTalk Business**	TalkTalk	**Technological**	Openreach
Telcom Networks	Openreach	**Tesco Broadband**	TalkTalk	**The Cloud**	Openreach
Timico	Openreach	**toob**	Toob	**Total Web Solutions Ltd**	Openreach
Tove Valley Broadband	Tove	**Truespeed Communications**	Truespeed	**Trunk Networks**	Openreach
UK Broadband	UKB/Relish	**uno Communications**	Openreach	**Userve (Unitron Systems)**	Userve
vaioni	Openreach	**Velocity1**	Openreach	**Vfast Internet**	Openreach
Virgin Media	Virgin	**Virgin Media Business**	Virgin	**VISPA**	Openreach

ISP	Network provider	ISP	Network provider	ISP	Network provider
Vivaciti	Openreach	**Vodafone Broadband**	Vodafone	**Voipfone**	Openreach
Voneus	Voneus	**W3Z Wireless Broadband**	W3Z	**Watchfront**	Openreach
Waveney Internet	Openreach	**webmate**	Openreach	**Wessex Internet**	Wessex
wifinity	wifinity	**Wight Fibre**	Wight fibre	**Wild West Net**	Wild West Net
wildcard networks	Wildcard	**WiSpire**	WiSpire	**Zen Internet**	Openreach
Zoom Internet	zoom	**Zzoomm**	Zzoom		

Table A1.3 – Number of completed speed tests by contract area

Contract	Beneficiary	Phase	Speed tests – total		Speed tests - NGA	
			2016	*2020*	*2016*	*2020*
SUFF101	**[Redacted]**	1	17,988	12,071	6,947	7,288
SUFF201	**[Redacted]**	2	8,936	6,941	1,543	3,458
SUFF202	**[Redacted]**	3	-	-	-	-
BEDS101	**[Redacted]**	1	7,191	4,299	3,344	2,830
BEDS201	**[Redacted]**	2	3,340	2,777	513	1,619
BEDS202	**[Redacted]**	3	8	3	2	0
BEDS203	**[Redacted]**	3	10	8	0	0
BERK101	**[Redacted]**	1	3,144	1,810	1,647	1,297
BERK201	**[Redacted]**	2	3,337	2,041	1,177	1,133
BERK202	**[Redacted]**	2	-	-	-	-
BERK203	**[Redacted]**	3	132	123	44	63
BERK204	**[Redacted]**	3	527	631	141	282
BUCK101	**[Redacted]**	1	10,709	6,847	5,555	4,719
BUCK201	**[Redacted]**	2	8,160	7,054	1,043	3,274
CAMB101	**[Redacted]**	1	20,532	13,642	9,846	9,053
CAMB101a	**[Redacted]**	2	-	-	-	-
CAMB202	**[Redacted]**	3	-	-	-	-
CHES101	**[Redacted]**	1	14,165	9,198	6,170	5,732
CHES201	**[Redacted]**	2	4,026	3,215	689	1,039
CMBR101	**[Redacted]**	1	21,241	12,705	8,958	8,535
CMBR201	**[Redacted]**	2	2,516	1,727	250	858
DRBY101	**[Redacted]**	1	17,805	10,880	7,589	7,053
DRBY201	**[Redacted]**	2	3,658	2,566	537	1,001
DEVO101	**[Redacted]**	1	73,065	42,252	28,234	25,301
DEVO201	**[Redacted]**	2	-	-	-	-
DEVO205	**[Redacted]**	3	1,767	1,771	392	855

Contract	Beneficiary	Phase	Speed tests – total		Speed tests - NGA	
			2016	*2020*	*2016*	*2020*
DEVO101a	**[Redacted]**	1	-	-	-	-
DORS101	**[Redacted]**	1	17,020	10,930	8,078	7,505
DORS201	**[Redacted]**	2	908	725	167	304
DORS202	**[Redacted]**	3	525	570	63	175
DURH101	**[Redacted]**	1	18,322	10,304	8,642	7,199
DURH201	**[Redacted]**	2	3,512	2,303	632	1,383
DURH202	**[Redacted]**	2				
EYRK101	**[Redacted]**	1	8,585	5,278	4,020	3,667
EYRK201	**[Redacted]**	2	2,412	1,584	655	792
EYRK202	**[Redacted]**	3	1,407	1,171	266	442
ESUS101	**[Redacted]**	1	11,530	7,382	4,715	4,398
ESUS201	**[Redacted]**	2	1,577	1,118	212	454
ESUS202	**[Redacted]**	3	240	210	90	123
ESSX101	**[Redacted]**	1	12,487	8,119	5,966	5,711
ESSX201	**[Redacted]**	2	10,926	9,032	1,614	5,112
ESSX202	**[Redacted]**	2	649	338	137	165
ESSX203	**[Redacted]**	3	266	166	97	82
ESSX204	**[Redacted]**	3	403	315	70	158
ESSX205	**[Redacted]**	3	1,248	965	342	404
ESSX206	**[Redacted]**	3	622	744	133	296
ESSX207	**[Redacted]**	3	-	-	-	-
ESSX208	**[Redacted]**	3	29	22	18	15
ESSX209	**[Redacted]**	3	132	105	27	33
ESSX210	**[Redacted]**	3	-	-	-	-
ESSX211	**[Redacted]**	3	-	-	-	-
ESSX212	**[Redacted]**	3	-	-	-	-
MANC101	**[Redacted]**	1	6,207	3,598	2,827	2,608
MANC101a	**[Redacted]**	2	-	-	-	-
HAMP101	**[Redacted]**	1	14,281	10,119	6,242	6,360
HAMP201	**[Redacted]**	2	10,630	8,033	2,046	3,914
HERE101	**[Redacted]**	1	26,049	15,021	9,018	8,426
HERE201	**[Redacted]**	2	2,383	1,139	734	667
HERE202	**[Redacted]**	3	-	-	-	-
HERE204	**[Redacted]**	3	2,516	1,554	631	898
HERE205	**[Redacted]**	3	992	674	268	365
HERE206	**[Redacted]**	3	1,366	735	358	432
HERE203	**[Redacted]**	3	684	398	153	217
HERE207	**[Redacted]**	3	340	199	83	93
HERE208	**[Redacted]**	3	-	-	-	-
HIGH101	**[Redacted]**	1	34,981	21,504	10,948	11,683

Contract	Beneficiary	Phase	Speed tests – total		Speed tests - NGA	
			2016	*2020*	*2016*	*2020*
IOFW101	**[Redacted]**	1	3,035	2,152	1,278	1,178
KENT101	**[Redacted]**	1	25,332	16,789	11,073	10,363
KENT201	**[Redacted]**	2	4,107	2,683	601	1,422
KENT202	**[Redacted]**	2				
LANC101	**[Redacted]**	1	24,219	15,598	10,520	10,143
LANC201	**[Redacted]**	2	1,812	1,088	343	532
LEIC101	**[Redacted]**	1	24,219	15,598	10,520	10,143
LEIC201	**[Redacted]**	2	1,812	1,088	343	532
LEIC202	**[Redacted]**	3	-	-	-	-
LINC101	**[Redacted]**	1	33,284	20,674	14,290	12,712
LINC201	**[Redacted]**	2	3,602	2,380	370	952
MERS101	**[Redacted]**	1	7,674	4,169	3,862	2,937
NCST101	**[Redacted]**	1	1,349	797	567	614
NORF101	**[Redacted]**	1	32,439	22,589	14,192	14,721
NORF201	**[Redacted]**	2	9,139	6,636	1,623	3,439
NORF202	**[Redacted]**	3	-	-	-	-
NLNC101	**[Redacted]**	1	5,131	2,985	2,721	2,184
NLNC201	**[Redacted]**	2	1,457	658	650	390
NYRK101	**[Redacted]**	1	21,838	15,317	9,763	10,402
NYRK201	**[Redacted]**	2	4,767	3,079	1,226	1,529
NYRK202	**[Redacted]**	3	-	-	0	0
NTNS101	**[Redacted]**	1	10,361	6,381	5,399	4,561
NTNS201	**[Redacted]**	2	3,983	2,596	910	1,654
NTNS202	**[Redacted]**	3	274	218	87	134
NTNS203	**[Redacted]**	3	111	140	48	68
NIRE101	**[Redacted]**	1	10,004	5,989	3,202	2,746
NIRE201	**[Redacted]**	2	8,798	7,544	1,576	3,259
NTHM101	**[Redacted]**	1	8,524	5,767	3,499	3,635
NTHM201	**[Redacted]**	2	1,910	1,455	264	512
NOTT101	**[Redacted]**	1	10,397	5,413	5,461	3,950
NOTT201	**[Redacted]**	2	5,132	2,730	1,561	1,254
NOTT202	**[Redacted]**	3	1	2	0	0
OXFD101	**[Redacted]**	1	15,719	9,887	7,647	7,058
OXFD101a	**[Redacted]**	2	-	-	-	-
OXFD202	**[Redacted]**	3	23	9	19	4
OXFD204	**[Redacted]**	3	-	-	-	-
SCOT101	**[Redacted]**	1	121,922	80,100	43,566	49,146
RUTL101	**[Redacted]**	1	1,299	998	804	755
RUTL201	**[Redacted]**	2	292	142	102	101
RUTL202	**[Redacted]**	2	169	94	30	39

Contract	Beneficiary	Phase	Speed tests – total		Speed tests - NGA	
			2016	*2020*	*2016*	*2020*
SHRP101	**[Redacted]**	1	12,404	7,118	4,549	4,317
SHRP201	**[Redacted]**	2	957	926	103	386
SHRP202	**[Redacted]**	3	1,616	1,109	490	581
SYRK201	**[Redacted]**	2	16,060	11,015	3,604	7,469
SYRK202	**[Redacted]**	3	502	258	117	125
STAF101	**[Redacted]**	1	16,007	8,810	7,539	6,015
STAF201	**[Redacted]**	2	4,180	2,907	662	1,003
SURR101	**[Redacted]**	1	12,372	8,655	6,175	5,569
SURR201	**[Redacted]**	2	1,252	1,082	169	410
WALE101	**[Redacted]**	1	120,026	74,848	47,817	45,923
WALE101a	**[Redacted]**	2	-	-	-	-
WALE201	**[Redacted]**	3	387	251	121	136
WALE202	**[Redacted]**	3	748	356	332	231
WALE203	**[Redacted]**	3	551	389	208	237
WILT101	**[Redacted]**	1	13,988	8,268	6,674	5,660
WILT201	**[Redacted]**	2	81	45	44	37
WILT202	**[Redacted]**	3	473	327	180	115
WILT203	**[Redacted]**	3	566	400	134	138
SGLO101	**[Redacted]**	1	3,053	1,892	1,613	1,421
SGLO201	**[Redacted]**	2	1,169	816	241	434
SGLO202	**[Redacted]**	3	260	277	175	265
WORC101	**[Redacted]**	1	10,902	6,525	4,686	4,186
WORC201	**[Redacted]**	2	4,285	2,742	930	1,314
WORC202	**[Redacted]**	3	286	307	52	84
WWCK101	**[Redacted]**	1	7,895	5,145	3,903	3,700
WWCK201	**[Redacted]**	2	4,357	3,450	718	1,613
WWCK202	**[Redacted]**	3	571	599	0	0
WYRK101	**[Redacted]**	1	7,895	5,145	3,903	3,700
WYRK201	**[Redacted]**	2	4,357	3,450	718	1,613
WSUS101	**[Redacted]**	1	9,326	5,905	4,283	3,867
WSUS201	**[Redacted]**	2	2,459	1,735	251	688
BLAC201	**[Redacted]**	2	6,346	3,765	2,622	2,830
TELF201	**[Redacted]**	2	2,760	1,417	854	950
CORN201	**[Redacted]**	2	2,835	2,038	389	640
CORN202	**[Redacted]**	3	1,450	1,301	98	88
SWIN201	**[Redacted]**	2	3,823	2,725	981	1,468
WOXF201	**[Redacted]**	3	1,488	1,119	524	707
HERT202	**[Redacted]**	3	-	-	-	-
BKSR202	**[Redacted]**	3	-	-	-	-
SGOV202	**[Redacted]**	3	-	-	-	-

Contract	Beneficiary	Phase	Speed tests – total		Speed tests - NGA	
			2016	*2020*	*2016*	*2020*
SGOV203	**[Redacted]**	3	-	-	-	-

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