De Minimis Assessment: Self-Certification

Department for Digital, Culture Media & Sport

Title of regulatory proposal	European Electronic Communications Code (EECC)[1] - Access Regulation
Stage	Final
Lead Department/Agency	DCMS
Expected date of implementation	Transposition Deadline: 21/12/2020
Origin	EU Directive
Date	24/06/2020
Lead Departmental Contact	eecc@culture.gov.uk
Departmental Triage Assessment	Equivalent Annual Cost to Business (EANDCB) = £0.3m

Call in criteria check-list	
Significant distributional impacts (e.g. significant transfers between different businesses or sectors)	No
Disproportionate burdens on small businesses	No
Significant gross effects despite small net impacts	No
Significant wider social, environmental, financial, or economic impacts	No
Significant, novel, or contentious elements	No

Spoke Analyst: Fraser McNeil	Date: 08/09/2020

[1] European Parliament (2018), Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast)Text with EEA relevance. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.321.01.0036.01.ENG

BRU signoff: Kobini Ananth	Date: 08/09/2020
Chief Economist signoff: Dipti Bhadresa	Date: 08/09/2020

Summary: Analysis & Evidence Policy Option 2

Description: Transposing the minimum requirements of the directive - Preferred Option

FULL ECONOMIC ASSESSMENT

Price Base Year	PV Base Year	Time Period Years	Net Benefit (Present Value (PV)) (£m)		
2016	**2017**	**15**	**Low:** 238.1	**High:** 6,308.1	**Best Estimate: 2,593.7**

COSTS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	1.1		62.1	**712.0**
High	1.3		180.2	**2,070.6**
Best Estimate	**1.2**		**95.4**	**1,096.7**

Description and scale of key monetised costs by 'main affected groups'

Under option 2 we assume the industry will deploy in a portion (around 65% with applied sensitivity analysis[2]) of the areas of the UK that the FTIR identified can support commercial roll out of single fibre networks (the intervention area considered for the Impact Assessment), which are estimated to be 6.1%-18.8% of total UK households. Transposing the minimum requirements of the EECC will create incentives to encourage a more effective roll-out of gigabit-capable networks.[3] The industry will face a capital and operational expenditure cost for deploying in the intervention area, which are included here as indirect costs. The cost of deployment to business will be an indirect cost as the Government is not mandating investment, but instead providing the right market environment for firms to invest.The government has recently announced £5 billion of funding for the 20% hardest to reach premises in the UK which will work in tandem with the proposed legislation to unlock investment in these areas. There are also likely to be some familiarisation/transition costs as businesses understand and implement the interested articles. These will be the only direct costs applied to firms. Ofcom and the Government will also incur the cost of implementing the EECC.

Other key non-monetised costs by 'main affected groups'

As we assume industry will deploy only in a portion of the areas of the UK that the FTIR identified can support commercial roll out of single gigabit-capable networks, industry will forego potential revenues of fully deploying in these areas. There can also be administrative costs such as the time it takes to arrange a full fibre connection, which we have not included in the model.

BENEFITS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	0.0		212.0	**2,308.7**
High	0.0		644.3	**7,020.2**
Best Estimate	**0.0**		**338.6**	**3,690.4**

[2] Optimism bias has been applied to deployment as the analysis is objective driven. The optimism parameter was selected based on Green book advice. See optimism bias section below

[3] For more information see DCMS (2018), Future Telecoms Infrastructure Review. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

Description and scale of key monetised benefits by 'main affected groups'

The main benefits that have been monetised are around increased labour force participation and increased productivity of teleworkers. Wider benefits have also been included around the wellbeing gain to households and potential spillover effects from connecting nearby premises. Overall, the total benefit of this policy option in comparison to the do nothing scenario is estimated in a range of £2.4-7.1bn with a £3.8bn best estimate, over a 15 year appraisal period. There will also be a direct benefit to industry and Ofcom as market reviews will happen every five years instead of three.

Other key non-monetised benefits by 'main affected groups'

There can be wider benefits to households that have not been quantified. This includes access to public services like education and healthcare, the ability to shop online and a reduction in travel.

Key assumptions/sensitivities/risks	**Discount rate**	**3.5 %**
A key risk to this economic appraisal is the cost of installing digital networks. We have accounted for some of this risk by including an optimism bias of 35% (in line with HM Treasury Green Book guidance) though, as telecoms operators are already installing these technologies meaning the costs are relatively known, the bias could arguably be much lower than this. This, and other assumptions like the level of house building per annum, are tested as part of sensitivity. In addition, as noted above, some wider benefits are backed by less robust evidence. To account for this, we have presented the appraisal including and excluding these wider benefits.		

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs:	**Benefits:**	**Net:**	
0.1	**0.5**	**-0.4**	**-1.7**

Summary: Analysis & Evidence

Policy Option 3

Description: Alternative approach to transposition

FULL ECONOMIC ASSESSMENT

Price Base Year	PV Base Year	Time Period Years	Net Benefit (Present Value (PV)) (£m)		
2016	**2017**	**15**	**Low:** 165.6	**High:** 6,778.6	**Best Estimate: 2,755.4**

COSTS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	1.5		66.1	**810.2**
High	1.8		191.1	**2,346.3**
Best Estimate	**1.6**		**101.5**	**1,246.6**

Description and scale of key monetised costs by 'main affected groups'

Under option 3 we assume the industry will start deploying new networks earlier than in option 2 in areas of the UK that the FTIR identified can support commercial roll out of single fibre networks (the intervention area considered for the Impact Assessment), which are estimated to be 6.1%-18.8% of total UK households. This will result in higher benefits, as benefits will be taken forward and they will be discounted less than in option 2. This option should help to address the hold-up problem within these areas of the UK. Hold-up areas are defined as areas in which premises will be in harder to reach, rural or other costly areas where investment in gigabit-capable networks may be able to support at least one commercially funded network but suffer from operators holding off their investments due to strategic uncertainties[4]. The industry will face a capital and operational expenditure cost for deploying in the intervention area, these are going to be indirect costs. There are also likely to be direct costs for businesses: (i) familiarisation costs as businesses understand and implement the interested articles and (ii) a cost related to conduct geographic surveys of the current and future reach of electronic communications networks capable of delivering broadband via fixed and / or wireless channels. Ofcom and the Government will also incur the cost of implementing the EECC.

Other key non-monetised costs by 'main affected groups'

As we assume industry will deploy only in a portion of the areas of the UK that the FTIR identified can support commercial roll out of single fibre networks, industry will forego potential revenues of fully deploying in the these areas. There can also be administrative costs such as the time it takes to arrange a full fibre connection, which we have not included in the model.

BENEFITS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	0.0		220.4	**2,511.8**
High	0.0		665.2	**7,558.8**
Best Estimate	**0.0**		**350.9**	**4,002.0**

[4] DCMS (2018), Future Telecoms Infrastructure Review. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

Description and scale of key monetised benefits by 'main affected groups'

The main benefits that have been monetised are around increased labour force participation and increased productivity of teleworkers. Wider benefits have also been included around the wellbeing gain to households and potential spillover effects from connecting nearby premises. Overall, the total benefit of this policy option in comparison to the do nothing scenario is estimated in a range of £3.5-10.7bn with a £7.4bn best estimate, over a 15 year appraisal period. There will also be a direct benefit to industry and Ofcom as (i) market reviews will happen every five years instead of three and as (ii) requests to industry for providing data related to current reach of electronic communications networks capable of delivering broadband via fixed and / or wireless channels will be streamlined and consolidated into a single request.

Other key non-monetised benefits by 'main affected groups'

There can be wider benefits to households that have not been quantified. This includes access to public services like education and healthcare, the ability to shop online and a reduction in travel.

Key assumptions/sensitivities/risks	**Discount rate**	**3.5 %**
A key risk to this economic appraisal is the cost of installing digital networks. We have accounted for some of this risk by including an optimism bias of 35% (in line with HM Treasury Green Book guidance) though, as telecoms operators are already installing these technologies meaning the costs are relatively known, the bias could arguably be much lower than this. This, and other assumptions like the level of house building per annum, are tested as part of sensitivity. In addition, as noted above, some wider benefits are backed by less robust evidence. To account for this, we have presented the appraisal including and excluding these wider benefits.		

BUSINESS ASSESSMENT (Option 3)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs:	**Benefits:**	**Net:**	
0.7	**0.6**	**0.2**	**0.7**

Evidence Base (for summary sheets)

Context

Aims

1. The government's ambition is for nationwide coverage of gigabit-capable broadband. To meet this ambition, our overarching strategy is to:
    a. incentivise investment in gigabit-capable networks by promoting network competition and commercial investment wherever possible
    b. make the cost of deploying gigabit-capable networks as low as possible by addressing barriers to deployment
    c. support market entry and expansion by alternative operators through effective access to Openreach's ducts and poles complemented by access to other telecoms and utility infrastructure
    d. promote stable and long term regulation that supports network investment and ensures fair and effective competition between new and existing operators
    e. invest in the areas that are unlikely to get gigabit-capable broadband commercially. In the 2020 Budget, we announced a record £5 billion investment in gigabit-capable broadband roll-out in the hardest-to-reach areas of the UK[5]. This investment is expected to work in tandem with the proposed legislation to incentivise broadband deployment in the hardest to reach premises in the UK.
    f. ensure that there is a copper to fibre switchover process to enable consumer migration to faster and more resilient gigabit-capable networks

2. The UK's transposition of the European Electronic Communications Code not only meets the UK's obligations under the Withdrawal Agreement which makes transposition compulsory but it also supports this strategy. Transposition will build on our existing regulatory framework to:
    a. allow Ofcom to impose longer term, pro-investment regulation, focused on promoting higher capacity networks
    b. support availability of build plan information to industry and the government to better inform any roll-out plans
    c. Allow co-operation between network providers which should support these primarily rural deployments

Background

3. In the past few years, the UK has made significant progress in both fixed and mobile connectivity.
    a. **Mobile:** 91% of the UK landmass has 4G signal from at least one operator.[6] The Government also recently announced a deal will take 4G coverage to 95 per cent of the UK landmass by end of 2025.[7] The Government is also looking forward to the next generation of mobile technology - 5G. It has been facilitating the creation of testbeds and trials to better understand the potential benefits and challenges of 5G deployment.

[5] https://www.gov.uk/Government/publications/budget-2020-documents/budget-2020

[6] OFCOM (2019) Connected Nations 2019: Main report. Available at: https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2019/main-report; In 2017 the UK was seventh in the EU for superfast fixed coverage, and fourth in the world for 4G. Ofcom (2017) International Communications Market Report. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0032/108896/icmr-2017.pdf

[7] See https://www.gov.uk/government/news/shared-rural-network

Ofcom released radio spectrum bands to support 5G in 2018 and is planning further releases.[8]

b. **Fixed:** Ofcom's Connected Nations report 2019 puts current full fibre coverage at 10%, or 3 million premises (up from 6%, 1.8 million premises in December 2018).[9] This is below the overall EU fibre to the premise (FTTP) service availability where, by June 2018, coverage had already reached 29.6% overall, and 14.2% in rural areas.[10] The UK is also lagging globally, with Asian countries such as South Korea and Japan at near-ubiquitous full fibre coverage. This lag could impact the Government's mobile connectivity objectives as gigabit-capable networks underpin improved mobile infrastructure, including 5G networks.

4. The Government is committed to ensuring that everyone in the UK has the connectivity they need now, and ensuring it will be fit for the future. When considering which technologies will provide this, it is clear that gigabit-capable networks and 5G are the solution. In the coming decades, gigabit capable and 5G networks will be the enabling infrastructure that drives economic growth. For the UK to be the best place to foster innovation, we need to ensure that the underlying infrastructure required is ready. This infrastructure will underpin the UK's wider economic objectives - the modern Industrial Strategy and help address the Grand Challenges identified.[11]

Identifying the problem

5. The FTIR estimated that current market and policy conditions could, at best, support gigabit-capable network rollout to three-quarters of the country, and that this would take more than 20 years. Many of the remaining premises, which would be left without access, are likely to be in harder-to-reach rural, or other costly areas where investment in gigabit-capable networks is not commercially viable. Some of these areas (described by the FTIR as "hold up areas") may be able to support at least one commercially funded network but suffer from operators holding off their investments due to strategic uncertainties[12]. This is because in these areas the existing copper provider has little incentive to invest in FTTP unless it faces losing customers to a rival FTTP network. However, a rival network contemplating investment in these areas will anticipate that if it invests the incumbent will follow, leveraging its advantage of existing infrastructure and

[8] OFCOM (2019) Connected Nations: Main report. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdfhttps://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf

[9] OFCOM (2019) Connected Nations: Main report.

[10] European Commission (2019), Broadband Coverage in Europe. Available at: https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2018

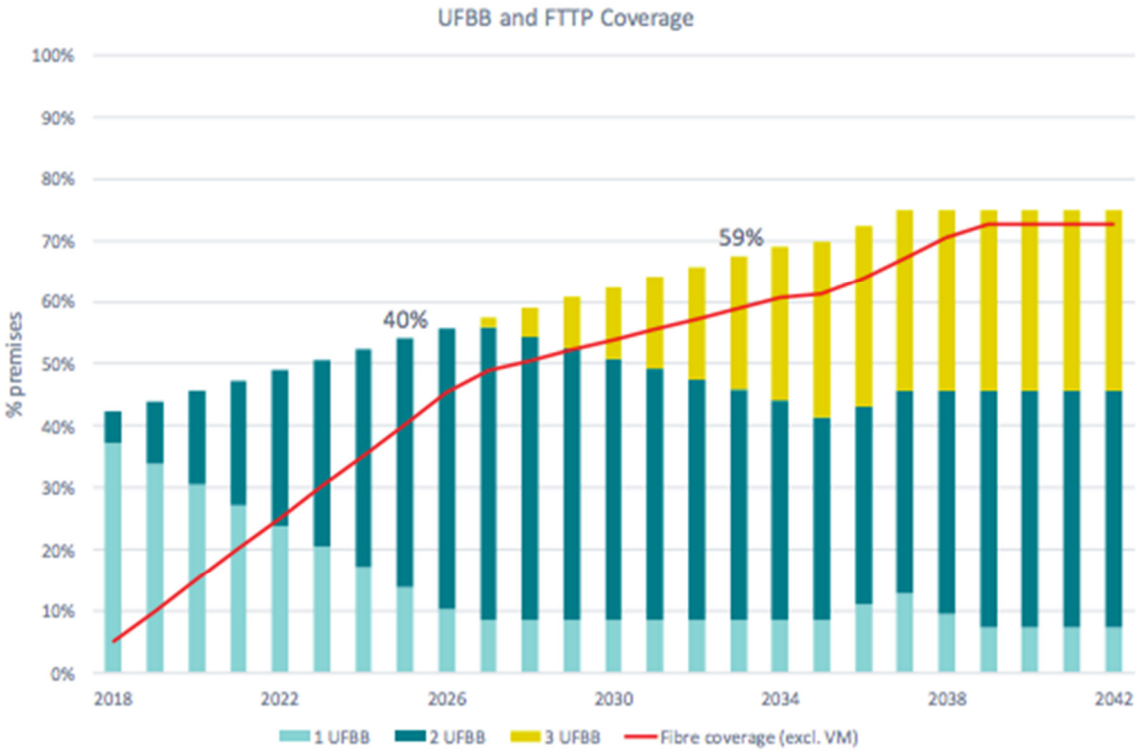
[11] https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges

[12] The analysis suggests that 30% of the country will be able to support competition between at least three gigabit capable networks, whilst 40% will have a choice between two (likely the current two largest players, Virgin and Openreach).
Frontier Economics (2018), UK Telecoms Market Dynamics, Future Telecoms Infrastructure Review Annex A. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727890/FTIR_Annex_A_-_FE_Report.pdf

customers. The incumbent, in turn, will be aware that this risk will be sufficient to deter new providers from entering the area. As a result, there is no investment.[13]

6. Absent intervention, we anticipate that harder-to-reach areas and/or those areas where demographic characteristics are such that providers do not find it attractive to invest, may lose out on investment – thereby entrenching a digital divide for the next generation of technology.

Figure A: Ultrafast broadband and penetration anticipated without additional Government intervention[14]



Source: Frontier Economics

Note: The % figures above the bars show the overall level of unique fibre coverage in 2025 and 2033

7. This scenario identified in the FTIR falls short of the UK's gigabit-capable network objectives. Furthermore, this scenario would constrain the ability of mobile operators to deploy 5G networks.[15] Therefore, to achieve the Government's digital ambitions in 2018, the FTIR set out a number of strategic priorities, including:
    a. Making the cost of deploying fibre networks as low as possible by addressing barriers to deployment, which both increase costs and cause delays;
    b. Supporting market entry and expansion by alternative network operators through easy access to Openreach's ducts and poles, complemented by access to other utilities' infrastructure (for example, sewers);
    c. Stable and long-term regulation that incentivises competitive network investment;

[13] Page 41, DCMS (2018), Future Telecoms Infrastructure Review

[14] The chart shows how new fibre (FTTP) will be rolled out (represented by the red line) and how the level of Ultrafast competition (total of stacked bars) will change over time. Each coloured stack represents a different network provider, with the total number shifting from 2 to 3 providers from 2027 onwards.

[15] Mobile networks usually rely on fixed networks to provide backhaul, usually using fibre. With 5G, this will require a significant increase in the amount of backhaul required across the UK. Therefore, meeting the gigabit-capable networks ambition is important to ensure we have sufficient capacity in the networks to meet the needs of the mobile networks.

d. An 'outside in' approach to deployment that means gigabit-capable connectivity across all areas of the UK is achieved at the same time, and no areas are systematically left behind; and
e. A switchover process to increase demand for full fibre services.

8. Some of these priorities can be progressed using the existing legislative and regulatory framework. For example, Ofcom introduced new regulations to facilitate unrestricted access for third parties to Openreach's ducts and poles in 2019.[16] Additionally, the Government agreed voluntary commitments from Openreach to share its build plans which can serve to mitigate demand uncertainty and the risk of overbuild.[17]

9. Given there are limits to Ofcom's powers, FTIR noted areas where changes to legislation could have a positive impact on our ability to meet the connectivity targets. Transposition of the EECC into UK law presents an opportunity to enhance the legislative framework to support the Government and Ofcom to deliver on the Government's wider digital ambitions.

Existing market failures

Addressing market failures through regulation

10. In the FTIR, DCMS stated that "the most effective way to deliver nationwide full fibre connectivity at pace is to promote competition and commercial investment where possible, and to intervene where necessary". We think that further steps are required to promote competition and commercial investment in the UK to deliver better connectivity. We set out below the existing competition issues in the UK telecoms markets.

11. Since its inception in the early 2000s, the approach to regulation has been to develop competition with the historic monopoly providers at each market level, starting closest to those affected - end users.[18]

12. The deployment of a telecommunications network requires the construction of an extensive, complex network of civil engineering assets, cabling, hardware and software. It therefore requires a considerable amount of raw materials, specialist staff, engineers and significant capital investment. It would also require ongoing work to maintain the network and innovate, requiring further operating spend. This meant BT, which had an existing, widespread network, had significant advantages when offering retail services to end-users. Therefore, Ofcom placed regulation on BT (and later Openreach[19]), to ensure wholesale access to BT's network so that

[16] Ofcom (20198), Statement: Promoting competition and investment in fibre networks – review of the physical infrastructure and business connectivity markets. Supporting fibre investment: unrestricted duct and pole access, and the BCMR. Available at: https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-markets https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-marketshttps://www.ofcom.org.uk/__data/assets/pdf_file/0014/125420/PIMR-consultation.pdfhttps://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2018/fibre-investment-bcmr

[17] More information available at https://gigabitvoucher.culture.gov.uk/

[18] We mostly refer to BT here because it is designated as having significant market power in most of the UK. KCOM is designated as having significant market power in Kingston upon Hull.
End-users are those not providing a network or service, but using them. Typically this would be a consumer or a business.

[19] In 2005, a new division of BT was created to manage the network and the regulated product portfolio. It was called Openreach. In 2018, BT and Openreach completed a legal separation. Openreach is now a separate

third parties could sustainably offer alternative services to end-users and grow their businesses, without their own network.

13. This approach has had considerable success at breaking down BT's market share at the retail level. There are currently four main players in the retail fixed broadband market: BT, Sky, Virgin Media and TalkTalk. In 2017 BT's market share was 37%[20], Sky – 23%, Virgin Media – 20%, TalkTalk – 16%, and the remaining players (e.g. KCOM, Vodafone) represent around 4%[21]. Sky and TalkTalk largely rely on regulated wholesale access to Openreach's network. Virgin Media offers services over its own cable and fibre network.

14. Given that the retail market is still largely reliant on regulated wholesale access to Openreach's network, we think that the next step to improve the function of the telecommunications markets is to promote competition at the wholesale level. In other words - encourage the creation of alternative gigabit-capable network operators.

15. However, the enduring advantage BT has in the retail markets also impacts the ability of new networks to enter the market at the wholesale level. This is in large part due to the high costs of network build described at paragraph 3. Therefore, in line with Ofcom's aim of promoting competition, it analysed the barriers to entry for new networks. It identified that the biggest costs of deploying a new network sat in building the physical infrastructure to house the cabling. This cost is a barrier to large-scale network deployment by competing operators. Ofcom determined that BT Group had significant market power across the UK (excluding Hull) in the telecoms physical infrastructure markets. It required BT to provide regulated access to third parties. This would allow them to deploy their own networks in BT's physical infrastructure, which will reduce the cost and time it takes to deploy new networks.[22]

16. This approach to regulation, combined with the Government's own policy development has encouraged alternative providers to deploy their own fibre networks in certain parts of the country. These include vertically integrated fibre providers Gigaclear and Hyperoptic, and the wholesale-only operator CityFibre. These alternative providers currently account for a small portion of the broadband market but have ambitions to expand significantly over the next few years.[23] We expect the access to physical infrastructure and pro-investment regulation should provide the basis for a sustainable entry into the wholesale telecoms markets.

Outstanding issues

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legal entity that operates and manages the network on BT's behalf. BT Group fully owns Openreach and the network Openreach operates.

[20] According to a more updated publication by Ofcom, BT share in Q2 has decreased to 35.5%. See more at Ofcom (2018), Telecommunications Market Data Update Q2 2018. Available online at: https://www.ofcom.org.uk/research-and-data/telecoms-research/data-updates/telecommunications-market-data-update-q2-2018

[21] Frontier Economics (2018), Future Telecoms Infrastructure Review: Annex A. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727890/FTIR_Annex_A_-_FE_Report.pdf

[22] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/154593/volume-1-pimr-final-statement.pdf

[23] According to a report for the Independent Networks Cooperative Association (INCA), as of April 2018, there were 207,000 connections to alternative fibre networks, which represents less than 1% of all broadband connections See more at Point Topic (2018), Metrics for the UK altnet sector: Scale, coverage, ambitions, concerns (a report for INCA). Available online at: https://www.inca.coop/sites/default/files/Altnet-report-INCA%20April-2018.pdf

17. Regulation has, to an extent, been successful in ensuring an efficient and competitive market in many parts of the country. Regulation has been successful in opening up the retail market to other providers but the infrastructure and wholesale markets remain less competitive. Parts of the country (about 50%, where the alternative network Virgin Media has coverage) have access to at least two competing networks but others do not. While the infrastructure market is a natural monopoly and therefore extensive competition is not sustainable nationwide, the Government aims to improve on competition in areas where it is possible. We think it will continue to generate good outcomes for end-users - we estimate that at least a third (with the potential to be substantially higher) of UK premises are likely to be able to support three or more competing gigabit-capable networks and up to half (or lower if there are more three network areas) of premises are likely to be in areas that can support competition between two gigabit-capable networks. Commercial investment in gigabit-capable networks is gaining momentum with major investments by established and alternative network operators. The broadband retail market is largely a well-functioning and competitive market, with a choice of services for end-users available - and crucially, several service providers who could agree deals with any of the gigabit-capable network providers in the future.

18. However, FTIR analysis suggests that gigabit-capable coverage will, at best, only ever reach three quarters of the country, and take more than 20 years to do so.[24] The remaining premises would be left without access to gigabit-capable networks. Many of these premises will be in harder to reach, rural or other costly areas where investment in gigabit-capable connections is not commercially viable. These are the areas in which the monopoly issue is most acute as it is unlikely that alternative operators will be willing to make an investment due to the potential for no to little return.

Information failure

Demand Uncertainty

19. A number of stakeholders have highlighted significant uncertainty around the inherent demand for gigabit capable connectivity – in particular, the premium people would be willing to pay for gigabit capable connectivity over-and-above the services that can currently be delivered using legacy infrastructure. This is not because the consumers are actively hiding this information from the operators, but because their need for higher speed is usually unknown to them from the outset. As a consequence operators might supply speed at a level below the optimal without consumers realising the missed opportunity for higher speed.

20. Households may not be fully aware of the extent of the benefits that improved broadband brings them, and therefore may not make optimal choices about purchasing a broadband connection. For example, common drivers for residential broadband consumers to upgrade were faster download speeds for entertainment services or facilitating home working. A key improvement not fully taken account of by these consumers before upgrading is increased reliability. Better reliability tends to lead to more frequent use of online services for example, as a result of

[24] DCMS (2018), Future Telecoms Infrastructure Review. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

increased confidence that disruption to their broadband connection is less likely to arise whilst using online shopping or banking services.[25]

21. Demand uncertainty is also an impediment to future proofing the network for increased data usage. While consumers might often find sufficient superfast broadband uses, there is ample evidence that fixed data traffic is rapidly increasing every year[26] as customers become more accustomed to using high speed broadband services, while also new use cases appear in the market, i.e. virtual reality. Ensuring that networks remain resilient and capable of handling rapidly growing usage requires coordinating market demand with supply in advance of increase in demand; the investment required to achieve that often needs to be planned well in advance, i.e. usually up to 10 years, while consumers are likely to delay their demand until their existing service has reached its limits, deterring investment in networks.

Incomplete Markets

22. An incomplete market possesses only some of the necessary conditions for full market formation. Some firms may enter this type of market because profits are possible. However, the firms that do start-up will only satisfy a small proportion of potential consumer demand and the market will fail to develop completely. The "hold-up areas" identified by the FTIR have many of the characteristics of an incomplete market. These hold-up areas may be able to support at least one commercially funded full fibre network but suffer from operators holding off their investments due to strategic uncertainties.

Our intervention

The European Electronic Communications Code Directive (EECC)

23. The European Electronic Communications Code was published in the Official Journal of the European Union in December 2018. Member states, and the UK, have until 21 December 2020 to implement the provisions in domestic law. The European Electronic Communications Code is a revision of the current EU regulatory framework for electronic communications. The transposition of the Directive provides an opportunity to introduce new provisions that will help facilitate our digital objectives set out by the government in the 2020 Budget and in the Future Telecoms Infrastructure Review.[27]

24. The existing telecommunications legislative and regulatory framework in the UK is largely underpinned by six European Union directives:
    a. the Framework Directive[28]
    b. the Access Directive[29]
    c. the Authorisation Directive[30]

[25] Ipsos Mori (2018), Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme. Available online at: https://www.gov.uk/government/publications/evaluation-of-the-economic-impact-and-public-value-of-the-superfast-broadband-programme

[26] BEREC and PWC (2015), Desk research on the demand side of Internet use. Available online at: https://berec.europa.eu/eng/document_register/subject_matter/berec/download/1/5024-berec-report-on-how-consumers-value-net-_1.pdf

[27] HMT, 2020. Budget 2020; DCMS, 2018. Future Telecoms Infrastructure Review

[28] European Commission, 2002. Framework Directive

[29] European Commission, 2002. Access Directive

[30] European Commission, 2002. Authorisation Directive

d. the Universal Service Directive[31]
e. the ePrivacy Directive[32]
f. the Better Regulation Directive[33]

25. These set out the core objectives for member states in regard to telecoms markets and provide for the duties and powers for the 'national regulatory authorities' - in the UK this is Ofcom. These earlier directives were largely transposed in the UK through the Communications Act 2003 and the Wireless Telegraphy Act 2006. The Better Regulation Directive made modifications to the existing framework, which were reflected in UK legislation using The Electronic Communications and Wireless Telegraphy Regulations 2011.

26. The European Electronic Communications Code combines and updates these directives to create a revised telecoms regulatory framework for the EU. The UK played a leading role in the negotiations for the European Electronic Communications Code prior to its exit from the EU, and in the development of the directives which preceded it, which for the most part reflect UK best practice. The Directive's core objectives are to:
    a. drive investment in very high capacity networks and services through sustainable competition
    b. support efficient and effective use of radio spectrum frequencies
    c. maintain the security of networks and services
    d. provide an improved level of protections for consumers

27. The European Electronic Communications Code broadly aligns with the principles of the original directives, but makes changes to accommodate technological evolution and consumer behaviour. The Directive recasts the objectives and regulatory tools of the current framework to place a stronger emphasis on incentivising investment in very high-capacity broadband networks, e.g. full fibre networks, promoting more efficient spectrum management to support 5G roll-out, and ensuring effective consumer protection and engagement. It also introduces a new flexibility to assign duties and powers to bodies that are not the national regulatory authority, bodies that are known as competent authorities.

Scope of this assessment

28. Given the breadth of the EECC, we have assessed the impact on business across several de minimis assessments. This assessment will focus on specific updates to the Framework Directive and the Access Directive that support competition and investment through regulated network access and transparency.

29. The changes made to this part of the EECC update the regulatory framework with an increased emphasis on promoting infrastructure competition and investment in future-proofed networks. The EECC introduces an additional objective to the regulatory framework that reflects changes in technology and the desire to improve digital connectivity across the EU. This objective is to "promote connectivity and access to, and take-up of, very high capacity networks, including fixed, mobile and wireless networks, by all Union citizens and businesses"[34]. The EECC also strengthens the existing principle that competition can best be fostered through an economically efficient level of investment in infrastructure, and regulation should only be used where necessary to achieve effective competition[35].

[31] European Commission, 2002. Universal Service Directive
[32] European Commission, 2002. ePrivacy Directive
[33] European Commission, 2009. Better Regulation Directive.
[34] Article 3, EECC.
[35] As set out in the EECC recitals.

Transposition options

Introduction

30. In line with the purpose of this assessment, we identified the articles with a potentially higher direct impact on business that relate to network access, competition and investment, which include General Objectives of the framework. The measures included consist of new provisions and amendments to existing regulatory tools in line with the updated objectives and principles. The impact on business of the remaining access articles not considered to be material.
31. The changes introduced by these articles broadly align with the policy objectives outlined in the FTIR. The new measures we are introducing through these articles can be summarised as:
    - New and revised regulatory objectives focused on promoting rollout of very high capacity networks, including fixed, mobile and wireless networks.
    - A new process for the regulator to make binding voluntary commitments by significant market power (SMP) operators (currently BT or KCOM) as an alternative to ex ante SMP obligations[36] where appropriate – which should provide flexibility to incentivise new network deployment as far as possible;
    - Increasing the periods between market reviews from three to five years to provide investors with greater certainty on the returns of their investments;[37]
    - New powers for Ofcom to gather information on future deployment plans of gigabit-capable networks and the ability to share the results with the relevant public authorities so they can take account of the results when undertaking national broadband planning and the allocation of public funds (including the £5 billion specified in Budget 2020) for the deployment of electronic communications networks.

32. For the UK to meet its obligations to transpose the EECC, it has a choice between implementing the articles as set out in the directive, or transposing an alternative approach to transposition that still meets the minimum requirements introduced by the Framework. The Government's policy[38] on transposition is to not go beyond the minimum requirements of European Directives, unless there are exceptional circumstances, justified by a cost/benefit analysis and consultation with stakeholders. The guiding principle to this impact assessment and accompanying consultation is to endeavour to ensure that UK businesses are not put at a competitive disadvantage compared with their European counterparts.

Our approach

33. Broadly speaking, we have decided to transpose the minimum requirements of the Directive, in line with the UK Government's principle of minimal regulation. At consultation, we considered three transposition scenarios – no transposition, transposing the minimum requirements of the directive and an alternative approach to transposition. These options were:
    - **Option 1: Do nothing:** The UK telecoms access regulatory framework – as set out in the Communications Act – remains as is. This option is not applicable for the articles described below as it is a legal requirement to transpose all of them into UK law. Doing nothing would likely reduce the investment incentives of industry.

[36] Regulatory forbearance allows the regulator to refrain from applying certain regulations on the market in particular circumstances.

[37] The EECC defines a market review as the point when the national regulatory authority has issued a notification including a new assessment of the definition of a market and of significant market power.

[38] TRANSPOSITION GUIDANCE How to implement European Directives effectively, p3 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/682752/eu-transposition-guidance.pdf

- **Option 2: Transposing the minimum requirements of the directive (preferred):** Transpose text as adopted at European level, in line with existing convention where there is discretion. This means assigning all new powers to Ofcom (rather than another competent authority), and allowing Ofcom full discretion over exercising these powers, to the extent allowed by the EECC. Under the option 2 transposition scenario, which is our preferred option because of lower direct costs to businesses and government guidance on European directives implementation, the articles would be transposed as described in the section above.
- **Option 3: Alternative approach to transposition:** Clarify and supplement EECC text to further support delivery of the FTIR strategy by supporting opportunities whilst minimising risks. This option also has the potential to increase benefits to business, which is described in the economic impact analysis below.

34. We consider the Articles which could have a material impact on business below.

Promoting very high capacity networks (Article 3)

35. The European Electronic Communications Code introduces a new general objective requiring national regulatory authorities, and other authorities carrying out regulatory functions, to promote availability and take-up of very high capacity networks (VHCNs).[39] Recital 13 provides more information about how to interpret this objective, including confirmation we should maintain a technologically neutral regulatory approach as established in the existing framework. As noted in our consultation, it also provides further background on defining VHCNs, including two examples of distribution points.

36. Furthermore, the Body of European Regulators for Electronic Communications (BEREC) will publish non-binding guidelines by 21 December 2020 on the criteria that a network should fulfil in order to be considered a VHCN. These guidelines are expected to provide criteria on down- and uplink bandwidth, resilience, error-related parameters and latency. BEREC consulted on draft guidelines earlier this year.[40]

37. In our consultation, we proposed the following options:

    - **Option 2 (transpose the minimum requirements):** Transposing the minimum requirements would involve bringing the new objective and accompanying definition of very high capacity networks into UK law.
    - **Option 3 (alternative approach to transposition):** The European Electronic Communications Code recitals provide clarification that Ofcom may differentiate between different technologies in its regulatory decision-making, and that the objective of promoting VHCNs is to further increase network capabilities, paving the way for future generations of wireless networks. To ensure that Ofcom is able to reflect these in its regulatory actions, we proposed an option of clarifying Ofcom's duty to act in accordance with the principle of neutrality under section 4 of the communications act, specifically that:

[39] A VHCN is an electronic communications network which consists wholly of optical fibre, or one that contains a mix of technologies that would provide a similar network performance. See European Electronic Communications Code definition 2 for the full explanation.
[40] BEREC, 2020. Draft BEREC Guidelines on Very High Capacity Networks

i. Ofcom must aim for the highest capacity networks and services economically sustainable in a given area – balancing this with the pursuit of convergence in capacity between different areas
ii. certain technologies have physical characteristics and architectural features that can be superior in terms of quality of service, capacity, maintenance cost, energy efficiency, management flexibility, reliability, robustness and scalability, and performance – which must be reflected in regulatory actions
iii. Ofcom's regulatory actions related to fixed and wireless networks must aim to further increase the capabilities of networks and support 5G roll-out

Our decision

38. Option 2 - transposition of Article 2 and some elements of Recital 13 without compromising technological neutrality - is our preferred approach. We think this is sufficient to meet our digital ambitions, including our wider digital ambitions for the delivery of 5G services.

39. There is a well established practice of technological neutrality in UK and EU telecoms legislation and regulation which has produced good outcomes for UK end-users. Diverging from this approach could have unintended consequences for the telecoms market. We do not think this would be appropriate given our intention to encourage a pro-investment climate, particularly considering potential impacts of EU Transition period exit and COVID-19. In many cases, having the flexibility to create innovative solutions will be a benefit, particularly when providing connectivity to those in remote locations. This option supports our wider approach of a minimalist transposition.

Improving transparency (Article 22)

40. Article 22 is a new provision that requires national regulatory authorities, Ofcom in the UK, or another competent authority, to conduct a geographical survey of the reach of electronic communications networks capable of delivering broadband by 21 December 2023 and at least every three years afterwards.

41. This survey must include the details required for the relevant authorities to fulfill their responsibilities under the Directive and for the application of state aid rules.[41] In addition to current network coverage, the survey may include a forecast of planned build by all networks in a specific area (up to and including the whole of the UK).[42] It also creates the option for Ofcom, or another competent authority, to designate areas of the country as those without existing network coverage or planned very high capacity network build and invite interest from operators for building in that area.

42. In our consultation, we described the following options in regard to Article 22:

- **Option 2 (Ofcom only transposition):** There are two aspects to this:
  i. *Forecasting*: in this scenario, Ofcom would be obliged to conduct a survey of current network coverage, and make non-confidential survey information public, similar to the process it already undertakes for its Connected Nations reports.
  ii. *Designation and build plan clarification:* transposing discretionary provisions would involve giving Ofcom powers to designate areas in which there is no

[41] In practice this means that the survey can require data that would inform Ofcom's regulatory functions, such as market analysis. The results can also be used to inform the government's State aid programme.
[42] Current network coverage being information about the reach and capabilities of the network at present and planned build being the future reach and capabilities of the network. Also see recital 17 European Electronic Communications Code: "Level 3 in the Nomenclature of Territorial Units for Statistics (NUTS) is unlikely to be a sufficiently small territorial unit in most circumstances".

planned build for VHCNs in the forecast period and follow the procedure described in the article - the use of these powers would be at Ofcom's discretion

- **Option 3 (alternative approach to transposition):**
  i. *Forecasting:* going further than a copy out transposition of Article 22, by tailoring Ofcom's survey and forecast process to better support accelerated commercial roll-out of gigabit-capable broadband, removal of barriers and broadband planning initiatives, reducing costs to operators
  ii. *Designation and build plan clarification*: rather than Ofcom, the government would be the competent authority for the designation process in Article 22 - we consider that the ability for the government to designate areas where there is no planned build could help to resolve the 'hold-up' problem identified in our Future Telecoms Infrastructure Review and facilitate government support for areas where commercial deployment may not be feasible[43]

Our decision

43. Following analysis of responses to the consultation, we have decided to implement some of the Option 2 proposals.We will maintain Ofcom's powers to undertake infrastructure surveys, introducing new requirements for it to conduct forecasts of network build. Authorities will also be required to take into account the results of the geographical survey when undertaking the allocation of public funds for the deployment of electronic communications networks or for the design of national broadband plans.

44. We remain of the view that Ofcom should continue to complete the geographic survey of current network coverage given that it already undertakes the Connected Nations report, which we consider to be equivalent to the required survey, three times a year. As part of the survey, we also consider that Ofcom should conduct a forecast of near and medium-term planned builds which it will be required to publish to the extent that it is non-confidential. In practice, we anticipate Ofcom publishing an aggregated forecast of areas which are not currently in any operators forecast. We think this additional transparency will help unlock additional investment in these areas.

45. We have decided to ensure the survey results are available to the government and the devolved administrations. Taking account of the results of Ofcom's surveys will be important for meeting the government's ambition for nationwide gigabit-capable networks, particularly to identifying harder to reach areas where there is not planned build.

46. We carefully considered the responses on the designation mechanism and associated penalties. We have decided not to implement the discretionary designation mechanism. In the short term, we think that our approach to transposition for Article 22 is a proportionate response to address immediate policy concerns in the market. It will allow Ofcom, government and devolved administrations to better understand network reach and planned extensions of these networks. It will also give industry a better understanding of where the unserved areas are likely to be in the future, unlocking additional commercial investment. If our concerns raised in the consultation persist following the transposition of Article 22, we will consider legislating further.

Increasing regulatory stability (Article 67)

[43] "Hold-up" issues were identified in the Future Telecoms Infrastructure Review 2018. There may be a 'hold-up' problem in areas where competing with other providers may not be profitable, i.e. it is an area that is only commercial for a single network. In these areas the existing copper provider has little incentive to invest in gigabit-capable networks unless it faces losing customers to a rival gigabit-capable network. However, a rival network contemplating investment in these areas will anticipate that if it invests the incumbent will follow, with a headstart on existing infrastructure and customers. The incumbent, in turn, will be aware that this risk will be sufficient to deter new providers from entering the area. As a result, there is no investment.

47. This requires Ofcom to undertake regular market reviews. These include market identification, a forward looking analysis of these markets and the imposition of remedies to resolve any competition concerns. The European Electronic Communications Code requires Ofcom to undertake these reviews at least every five years, compared to every three years in the current framework.

48. It is designed to support investor confidence by promoting greater regulatory stability and predictability.

49. We do not intend on going further than the requirements set out in the Directive. We will transpose this Article to meet the Government's objective of increasing the market review cycle to five years as set out in the FTIR.

Commitments procedure (Articles 76 and 79)

50. Where Ofcom identifies a competition concern in the market and intends to, or has already, imposed regulation, the operator with Significant Market Power (SMP) will sometimes offer commitments to the regulator. These are voluntary actions that the SMP provider commits to in order to address the competition concern identified by Ofcom. If Ofcom considers that these actions are sufficient to resolve the issue, Ofcom may accept the commitments and choose not to impose any regulatory obligations in the relevant area. These commitments are not enforceable but the threat of regulation combined with potential reputational damage incentivises the SMP provider to keep its commitments.

51. Article 79 provides for Ofcom to make commitments proposed by a SMP provider in relation to network access enforceable as if the commitments were SMP regulations. This is a new provision and it is designed to incentivise enforceable alternatives to SMP regulation.

52. Article 76 and Annex IV sets out further criteria for assessing a specific type of commitment where there is a proposed co-investment between an SMP operator and other operators to deploy a very high capacity network. Co-investment arrangements typically allow operators to share parts of their networks and this could be an important means to reduce the costs of gigabit-capable broadband deployment. Such arrangements involving operators with SMP raise more complicated regulatory issues and this article sets the framework for Ofcom when considering and monitoring such arrangements.

53. In our consultation we set out the following options:
    - **Option 2 (transpose the minimum requirements):** transposition of this provision in order to meet the requirements of Article 76, 79 and Annex IV. At its discretion, Ofcom would be able to consider additional criteria.
    - **Option 3 (alternative approach to transposition):** we are considering how the implementation of Article 76 can best support gigabit-capable broadband investment and efficient competition. This option would clarify that Ofcom has the power to publish guidance which would set out in advance how it intends to assess co-investment offers. Where Ofcom exercises its power to add additional criteria, we propose that it must consult on these criteria in draft.

Our decision

54. In line with our overarching approach of a minimal transposition, we have decided to implement Option 2, a transposition to meet the minimum requirements, on the basis that it will provide Ofcom with the appropriate powers to manage commitment offers and allow industry to share risk with certain investments.

Conclusion

55. Broadly speaking we have decided to adopt a minimal approach to transposition (Option 2). We think this will provide key levers to Government and Ofcom to meet Government's policy objectives. It will support the investment in and deployment of gigabit-capable networks, including 5G. The broader rationale for this approach can be broken down into the following areas:
    - **Promote deployment of full fibre and 5G:** It supports the Government's connectivity ambitions, by creating tools for Government that will better inform national broadband planning, unlock more commercial investment in hold up or boardline commercial areas and providing for pro-investment regulation that promotes roll out of VHCNs.
    - **Promote investor confidence:** The extension of maximum periods between market reviews, introduced by Article 67, adds to the regulatory stability and predictability needed for investment in infrastructure with long payback periods – per recommendations in the FTIR.
    - **Business impact**: Our preference for Option 2 has a number of advantages over option 3, despite having a lower estimate of social net benefits:
        i. Positive net direct benefits for businesses, which will be bearing the full costs of implementing the legislation.
        ii. Option 2 can unlock investments of a similar scale to option 3 without the associated costs, as long as operators familiarise themselves with the legislation and it is implemented efficiently by the regulator. This is particularly important given the economic uncertainties and pressures of Covid-19.

Impact Analysis

Assumptions and methodology

Baseline scenario

56. The underlying model for which the costs and benefits have been estimated is based on the Future Telecoms Infrastructure Review (FTIR) and its own underlying model. This includes information about the type of existing broadband connections in different parts of the UK, distributed into different areas based on the physical characteristics of the land itself (such as terrain and geological composition) as well as the development and type of settlement on it.

57. The data from FTIR provides estimates on the costs of rolling out broadband in each different area as well as the viability of commercial rollout with intervention. According to the FTIR approximately 80% of households are considered commercially viable to roll out high speed broadband connectivity and about 10% will remain commercially unviable and for which government intervention will be required to cover with high speed connectivity. As part of the drive to provide nationwide fibre coverage, DCMS estimates that for the aforementioned 80% of the country little to no government intervention will be required due to the commercial viability of fibre rollouts, while for the uncommercial 10% it has announced its "Outside in"[44] approach which will see public funds used to provide coverage in these areas. Our focus was on the

[44] DCMS(2018), £200 million to kickstart full fibre broadband across UK. Available at: https://www.gov.uk/government/news/200-million-to-kickstart-full-fibre-broadband-across-uk

remaining 10% that, while defined in the FTIR[45] as being commercially viable for at least one operator, may not benefit from investment.

58. The "hold-up" areas are harder to reach, and usually more costly. While these areas may be able to support at least one commercially funded FTTP network they suffer from operators holding off their investments due to strategic uncertainties. Such an uncertainty is the possibility of the incumbent overbuilding key locations in such an area but without connecting all households, driving out competitors but also without providing the required connectivity coverage. Such key locations might include large premises that need to be passed to connect neighbouring premises, and often premise owners will refuse access to a second provider once at least one has passed. Another example are low-cost and high-revenue premises such as apartment blocks that might make the investment in an otherwise low profitability area viable, but once connected competing providers might lose the incentive to enter the area. As outlined in the document, the proposed EECC measures will be instrumental in unlocking investment in these areas by providing a more predictable investment regime by:
    - introducing a new regulatory objective for Ofcom to promote deployment and take-up of VHCNs,
    - providing a clearer framework for Ofcom to survey existing network reach and planned deployment, and publish the results of the survey.
    - reducing the frequency of Ofcom's market reviews from at least every 3 to at least every 5 years, and
    - enabling co-investment projects between the incumbent and alternative operators.
59. The counterfactual employed is that there will be no FTTP rollout in these areas without implementing the legislation. As of Q3 2020 there is still uncertainty on the side of operators on the commerciality of these areas, with operators having limited public commitments in expanding their network in these areas.

Modelling approach and assumptions

Costs and benefits

60. As part of the analysis the focus of the impact assessment is on those households that according to FTIR are commercially viable but will likely remain uncovered without intervention ("hold-up areas"). Identifying the exact number of households is challenging and several models have been used to identify these across government organisations (see paragraph 50). These range from 1.79m households (6% of total UK households), to 5.5m households (19% of total households), with costs differing in each scenario reflecting the different geological, urbanisation, and existing infrastructure characteristics; expected costs ranged from £1.31bn to £3.81bn in total. The different estimates on the exact size and nature of the deadlocked areas formed the core of the impact assessment and were incorporated into the model as different scenarios to provide a low, best, and high estimate.

61. The model estimates the cost of installing a full fibre connection to each dwelling by density decile (10 deciles of UK households, from most remote to mostly densely populated areas). The cost estimates (by density decile) are informed by the median of BDUK approximations of the cost of delivery experienced by different suppliers and in different areas. This information predominantly relates to the Superfast Broadband Programme and other programmes that

[45] DCMS(2018), Future Telecoms Infrastructure Review . Available at: https://www.gov.uk/government/publications/future-telecoms-infrastructure-review

BDUK manages. Broadly, costs are estimated to be progressively higher the less urbanised an area is, making the least densely populated areas more expensive to cover than the more densely ones.

62. The cost output of the EECC model is the relative cost to upgrade a telecoms connection. However, the absolute (or base) costs can nonetheless be inferred. Openreach has previously shared with DCMS confidential average cost of installing an ADSL line. The BDUK approximations based on the available evidence suggest that the average cost to install FTTC is roughly £1,250 and full fibre is around £1,700 on average. This does vary between rural and urban areas, and between different suppliers though.

63. These cost estimates have been previously benchmarked against estimates from other studies, informing the existing model and reused in this analysis. However, these estimates generally assume that an ADSL connection will already be in place, so they are more representative of the 'upgrade' rather than the 'absolute' cost. This is especially true in the types of areas investigated in the EECC model, as the premises in the "hold-up" areas we investigated generally already had ADSL but commercial challenges remained in upgrading them. These benchmarks include:
    - **Tactis and Prism estimates for the National Infrastructure Commission**. Tactis and Prism estimated the costs for installing full fibre as part of their work for the National infrastructure Commission[46]. They estimate the capex per premise passed (i.e. to install the network) and the capex per premise connected (i.e. premises that take up the service) for six geotypes that vary from rural to urban areas.
    - **Frontier Economics estimates for the FTIR**. For the FTIR, Frontier Economics modelled the potential rollout of full fibre across the UK[47]. As part of this, they also looked at the cost to roll out full fibre, which is loosely based on the Tactis and Prism estimates discussed above that informed their own estimates. The capex costs were broken down into duct, fibre and equipment per home passed (similar to the New Builds model approach) and cost per home connected. They did this for 13 geotypes ranging from whether it is a low or high cost area, and existing competitive market conditions.

64. Overall, the BDUK estimates are in line with the benchmarks. They are within the range for the various geotypes and in line with previous analysis conducted, such as for the New Builds model[48]. The main explanation for any divergence between the estimates is a difference in approach. For instance, both the Tactis and Prism and the Frontier models estimate the cost for a geo-type as a whole, whereas the BDUK model is more granular and can look at the individual components of cost within a specific density decile. Nonetheless, the relative difference between technologies is reasonably in line.

[46] Tactic & Prism (2017), A Cost Analysis of the UK's Digital Communications Infrastructure options 2017- 2050. Available online at: https://www.nic.org.uk/wp-content/uploads/Cost-analysis.pdf

[47] Frontier Economics (2018), Future Telecoms Infrastructure Review, Annex A. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727890/FTIR_Annex_A_-_FE_Report.pdf

[48] DCMS (2018), New Build Developments: Delivering gigabit-capable connections. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752146/New_Build_Developments_Impact_Assessment_FINAL.pdf

65. Over time, there may be some cost efficiencies from installing connectivity to these "hold-up" areas that could lower these estimates. For example, operators may become more efficient at installing digital networks across urban and rural areas over time, which could help reduce the overall installation cost. Similarly, developers and authorities could coordinate construction further leading to efficiency gains, such as coordinating civil work so that dig costs only occur once. However, the extent of these cost efficiencies is highly uncertain and, therefore, not accounted for in the model.

Indirect costs: operating expenditure

66. The above relates to the capital expenditure associated with installing telecoms connectivity. In addition to this, there are also ongoing operating costs to maintain the network. These costs are indirect, as the legislation is not mandating operators to deploy, however it is facilitating them to materialise their investment plans. In our analysis we have assumed that operators would deploy and that the costs incurred by them would be an indirect impact of these provisions. In previous studies, such as the studies by Frontier Economics for the FTIR, it has been assumed that these operating costs are recovered by telecoms operators through wholesale and retail revenue, for wholesaler and retailer operators respectively. Nonetheless, in this analysis operating expenditure is included to provide a more conservative estimation of total benefits. This is in line with both the reasonable uncertainty on the actual size of the hold-up areas and their commercial viability.

67. Additionally, evidence suggests fibre networks have lower ongoing costs than copper networks, meaning there can be some genuine cost savings from upgrading to fibre. For instance, the NIC[49]estimated that running a fibre network can save up to £5 billion in operating costs compared with copper. The potential potential cost saving has not been estimated in this analysis due to uncertainty around its likely magnitude, especially as operators are likely to run both a fibre and copper network in the short to medium run, but we plan to use the consultation to understand this potential potential saving better. For the purposes of this model an approximation of operating expenditures forming about 10% of total network costs is used, which is benchmarked against the reported costs of running a majority copper-based network[50].

Direct costs: familiarisation costs

68. In addition to the capital expenditure, there will likely be some familiarisation costs as operators get ready for the policies. This includes reading the regulations and planning how to meet them. It is hard to estimate the potential time it will take to do this, but a broad assumption could be that 5% of the staff at operators (around 4,400 employees) will spend ten hours each reading and implementing the policy in option 2 and fourteen hours in option 3, as more documents will be produced by Government and Ofcom to explain how the option 3 transposition will be transposed in practice. The median hourly pay for Private, Information Technology and

[49] NIC (2018), National Infrastructure Assessment. Available online at: https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf

[50] This includes both the FTIR analysis for UK-related network costs, as well as a broader view of European operators. See more at: NIC (2018), National Infrastructure Assessment. Available online at: https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf and https://www.cnmc.es/sites/default/files/editor_contenidos/Telecomunicaciones/Modelos%20de%20coste/20180221_Descripci%C3%B3n%20modelo%20BU_LRIC%20red%20de%20acceso.pdf

Telecommunications Professionals in the Annual Survey of Hours and Earning[51] was £21.90 in 2016. A 22% overhead rate (i.e. the additional costs of employment borne by business) was applied in line with UK accounting practice[52]. Consequently, the overall familiarisation cost is estimated at approximately £1.2m in option 2 and £1.6m in option 3 (in 2016 prices). These estimates were presented during consultation stage and stakeholders were invited to comment and contribute their own estimates. The estimates met broad acceptance and no stakeholder estimates were provided. Stakeholders have been regularly consulted as part of the legislative process which started in 2016. The finalised Directive was adopted by the European Commission in 2018. Therefore stakeholders have had sufficient time to study the changes extensively.

69. These costs have remained the same since consulting with the stakeholders in 2019. Stakeholders did not raise any concerns about the estimated costs and did not provide any new evidence contradicting these estimates. This is also partly due to the continuous engagement between the stakeholders in the industry, the regulator, and government around the proposed legislation and its implementation since the directive was first drafted in 2016.

Other indirect costs

70. The indirect costs to business and homeowners of purchasing potentially more expensive broadband products is not included in this analysis as the legislation does not mandate this on anyone. Purchasing fibre services remains a decision for customers to make, with copper based DSL services remaining in place until the operators decide to retire them, after consulting with the regulator. The latest update from the regulator on this plan envisions a gradual shutdown of the copper network in areas that fibre coverage has been achieved[53]. The roadmap to achieve this is not yet agreed on and this will be decided by the independent regulator after it conducts the relevant consultation and impact assessment. Regardless, the current plans do not envision retiring the copper network before 2030, while mandated fibre premiums over existing copper products are already minimal (less than £2 per month), with a view to decrease further as both the result of competition but also regulatory intervention (if it is so mandated to protect consumer interests).

Other direct costs considered

71. For option 3, additional costs were considered on both the regulator and operators arising from the periodical requirement to conduct surveys of their networks and provide granular forecasts on their expansions over a 3 year period. This process requires a coordinated effort on the side of operators and the regulator, as well as between the staff within these organisations and stakeholders were asked to provide estimates on existing and predicted forecast costs - limited forecasts are already conducted and data is provided to Ofcom as part of its Connected Nations periodical research survey. Based on stakeholders' responses an estimate of £0.6m yearly for all operators was included, marginally decreased by £0.1m yearly for streamlining all existing

[51] ONS (2018), Employee earnings in the UK: 2018. Available online: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2018

[52] OECD, International Standard Cost Model Manual. Available at: https://www.oecd.org/regreform/regulatory-policy/34227698.pdf

[53] Ofcom (2019, Promoting competition and investment in fibre networks. Available online: https://www.ofcom.org.uk/__data/assets/pdf_file/0028/158167/promoting-competition-and-investment-fibre-networks-consultation.pdf

Government and regulatory information collection processes (BDUK, DCMS, Ofcom), and thus reducing time and money spent on data requests. These estimates were confirmed during the consultation stage and no new evidence has been provided by stakeholders to revise them.

72. The proposed legislation includes the power of the regulator and Government to impose fines (article 29) for operators that misreport information as part of the mapping exercises of article 22. These fines are provided to minimise any potential deliberate misreporting of information and avoid gaming of the rules, such as purposely misreporting information to undercut competitors. The highest fine Ofcom currently can impose in the case of misreporting information (Comms Act, section 139) in violation of article 22 is £2m. While these potential costs are not included in our analysis, as we assume that operators will be compliant with Article 22, they were taken in consideration as part of designing policy.

73. According to the European Commission Impact Assessment on the EECC[54], each Member State competent authority will employ 25 full time employees (FTEs) in order to transpose the EECC[55]. We have taken this number and divided it for the number of existing directives recast into the EECC (four directives) and assumed that six employees (three from DCMS and three from Ofcom) will work on transposing each directive. Hence three FTEs from DCMS and three from Ofcom will work on transposing the access aspects of the EECC. We have then taken the median pay for an Ofcom[56] and a DCMS[57] employee and multiplied it by three. We have subsequently carried this annual cost from 2020 to 2026, when we assume these policies will be reviewed. We have also uplifted the transposition costs by 22% to include overheads[58]. These costs in a best estimate scenario are £0.3m. Ofcom is funded through Network and Services administrative charges imposed on operators determined by turnover, and by partial retainment of money collected on behalf of HM Treasury to fund some of Ofcom's core responsibilities, £54.3m in 2018/19[59]. We have not included the implementation costs as a direct cost on business as Ofcom's levees are set outside of DCMS' legislation but also as Ofcom will receive a saving of £7.5m in option 2 and 3 from the decreased frequency of market reviews over the appraisal period, which likely lead Ofcom to not raise its charges.

Indirect Benefits

74. High speed fibre connectivity is increasingly becoming the infrastructure underpinning all technology sectors, either indirectly by facilitating communications or by directly enabling new technologies. Industry experts have repeatedly pointed out sectors that are likely to be enabled and/or created on the back of high speed connectivity, such as cloud services, virtual reality

[54] European Commission (2016), COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT accompanying the document Proposals for a Directive of the European Parliament and of the Council establishing the European Electronic Communications Code (Recast) and a Regulation of the European Parliament and of the Council establishing the Body of European Regulators for Electronic Communications. Online at: https://ec.europa.eu/digital-single-market/en/news/proposed-directive-establishing-european-electronic-communications-code

[55] We have also consulted Ofcom on the transposition cost and they have agreed that the European Commission proposed number is in line with the expected transposition cost.

[56] Ofcom (2018), The Office of Communications Annual Report & Accounts. Online at: https://www.ofcom.org.uk/__data/assets/pdf_file/0021/115185/annual-report-1718-interactive.pdf

[57] Institute for Government (2018), Civil service pay. Available online at: https://www.instituteforgovernment.org.uk/explainers/civil-service-pay

[58] OECD (2005), International Standard Cost Model Manual. Available online at: https://www.oecd.org/regreform/regulatory-policy/34227698.pdf

[59] Ofcom (2019) The Office of Communications Annual Report and Accounts. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0024/156156/annual-report-18-19.pdf

technology and others. As part of the European Commission EECC impact assessment, the European Commission[60] argued that the technology sectors of countries like Japan and South Korea benefitted from the early presence of fibre networks and boosted their competitiveness. On that basis, the commission predicted that the reforms (EECC as a whole) will increase labour productivity and bring it closer to the growth levels observed in some of the more technologically advanced international competitors such as Japan, South Korea, and the USA. This should provide a boost to the UK and the EU competitiveness. In the absence of knowing what benefits fibre will ultimately bring in terms of new technologies, we focused on more empirical evidence currently available, making assumptions around the marginal benefit of additional internet speed using the SQW study; in this study benefits are calculated on the basis of absolute broadband speed increases. Since these marginal benefits are on the basis of current usage and reflect the experience largely of the migration from premises with existing xDSL connections to fibre networks, these are likely to be an overestimate of the marginal benefit of boosting further fibre networks. Over the longer-term, and as technology develops, the benefits are likely to be much bigger however. For this reason the operating costs were also included in the analysis; to provide a more conservative estimation on the cost side and countermand the optimism on the benefits side. Overall stakeholders during consultation did not express any concerns on our approach during consultation stage.

75. In 2013, DCMS commissioned a report into the economic, social and environmental impacts of faster broadband. The report was the product of a rigorous and detailed analysis, which drew on the best data available, by economic and social consultancy firm SQW in partnership with Cambridge Econometrics and Dr Pantelis Koutroumpis. The final published report, the UK Broadband Impact Study[61], describes the avenues through which economic, social, and environmental benefits accrue as a result of improved broadband.

76. To inform the report SQW developed a detailed econometric model to quantify benefits. As well as drawing on findings reported in the academic literature, the model developed for the study was informed by a review undertaken by Cambridge Econometrics of broadband impact studies previously carried out for local authorities and devolved administrations across the UK. The design of the model sought to expand on the best aspects of these previous approaches, while excluding some mooted routes to impact which appeared to be too speculative, or unsupported by the available evidence, in the study team's opinion. The report stated that the resulting analysis is considered "to be the most in-depth and rigorous forward-looking quantification of broadband impacts developed to date in the UK".

77. The underlying hypothesis for the model is that speed matters: faster broadband will enable businesses and individuals to change the way they do things. In order to capture the effect of continuing improvements in broadband speed over time, the model incorporates explicit links between the projected broadband speeds available, the projected speeds used, and their projected net impacts. For most impacts, it is the relative broadband speed (i.e. the speed available in an area compared with the national average) that is the key driver, rather than the

[60] See footnote 29

[61] SQW (2013) UK Broadband Impact Study . Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf

absolute speed. This translates to the impacts applying to users increasing their speeds rather than getting broadband altogether for the first time, as is the case in practice. Given that upstream speeds are important, as well as downstream speeds, (e.g. for cloud computing and video applications), this is reflected in the model by combining the two into a notional 'total speed'.

78. A full list of the inputs and assumptions of the model are included in Annex A of the UK Broadband Impact Study[62]. The evidence behind the various "routes to impact" in the model, including the most important assumptions is set out in the section below.

79. On completion of the project the model was handed over to analysts in DCMS and has been used to model various public broadband interventions since. Whenever it is used it is updated with the latest data on actual broadband rollout to ensure that the counterfactual estimated in 2013 reflects how broadband rollout has actually developed over the preceding years. In late 2015 SQW were commissioned to carry out a more comprehensive update to the model, including extending the time period covered (out to 2035), building in more technologies and reviewing updates to the evidence base to ensure that the key assumptions still held. Primarily it is this updated model that has been used as the basis of the benefits calculations.

80. For the purposes of this analysis the benefits are summarised and provided as total GVA (Gross Value Added) impact. This has been done for simplicity and due to revisions that are taking place to the benefits model to better reflect the latest empirical evidence being collected for the programme. As the overall impacts on business are small, using a GVA approach is considered appropriate. Metrics such as net profit would require forecasting future prices of services that is hard to predict ex-ante, especially for the time horizon in question.

81. The UK Broadband Impact Study also identified several non-monetised social benefits like improved sense of wellbeing, improved access to education and health services and increased civic participation. Since that publication, some work has been undertaken to try and monetise these benefits, most notably the Superfast Broadband evaluation has estimated the monetary impact of broadband on wellbeing. These have been included to supplement the benefits model.

Monetised benefits

Decreased market review savings - direct benefits

82. The direct compliance costs on operators and Ofcom associated with market review cycles are expected to decrease due to the extension of review cycles from 3 to 5 years. Estimates on the extent of the cost reduction were collected in terms of operating costs (i.e.

[62]SQW (2013) Broadband Impact Study . Annex A. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf

FTE) reduced from Ofcom and operators and are included in the analysis. However, it should be noted that telecom operators and their trade associations observed in the course of interviews for this study that they consider the indirect costs (especially in the case of SMP operators) or benefits (in the case of operators making use of regulated access) significantly exceed the direct costs, given the overall scale of the sector and its impact on the economy. In this context, the direct costs per se are not considered to present the main 'problem' as regards regulation of the electronic communications sector.

83. Indirect costs of 'overregulation' cited by operators subject to SMP regulation include the opportunity cost of reduced investment in high speed broadband infrastructure and the consequent impacts on the quality of service to consumers. However, there are different views amongst the industry and analysts as regards the existence and scale of these costs, and the public consultation is expected to serve as a forum to identify these further. This cost may be mitigated by the proposal in the 'continuity and simplification option' to require Ofcom to first identify a market failure at retail level before intervening (ex-post), limiting pre-emptive regulatory inspections (ex-ante) for major cases. Another cost which stakeholders and some NRAs have identified with the current set-up is the uncertainty created by short review cycles and obligations which are reviewed (and prices revised) on a frequent basis. This problem will be addressed under both options 2 and 3, and should reduce procedural costs as well as increasing regulatory certainty[63].

Local enterprise and labour productivity growth - Indirect Benefits

84. Evidence suggests that making superfast broadband available improves local economic performance[64]. Firms located on postcodes receiving enhanced access can see their efficiency improved, either by enabling faster processing or exchange of digital information, or indirectly by encouraging product and process innovation or increasing the productivity of teleworkers. The adoption of superfast broadband may also aid firms in expanding their sales by opening new channels to market. Sales may also grow indirectly if any productivity gains enable them to lower their prices or raise quality, and claim market share from their competitors. Firms expanding may increase the size of their workforce to meet additional demand, creating jobs in the local economy. Local economies may also see employment growth if firms choose to relocate to areas newly enabled with superfast broadband services, or if incumbent firms are encouraged to remain.

85. Based on comparison of postcodes that received subsidised superfast broadband and neighbouring ones that did not, the UK Broadband Impact Study[65] estimated that local firm

[63] Further analysis on the benefits of increased timescales for market reviews can be found in SMART 2015/0002. European Commission (2015), Regulatory, in particular access, regimes for network investment models in Europe" (SMART 2015/0002). Available online at: https://ec.europa.eu/digital-single-market/en/news/access-regimes-network-investment-and-business-models-europe-smart-20150002

[64] See for example "The Economic Impact of Broadband: Evidence from OECD countries, Pantelis Koutroumpis for Ofcom, April 2018". Available at: https://www.ofcom.org.uk/research-and-data/telecomsresearch/broadband-research/economic-impact-broadband

[65] DCMS, (2018), Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734855/Superfast_Integrated_Report.pdf

employment rose by 0.8% and turnover grow by 1.2% in response to improved infrastructure. This was a result of both creation and retention of existing jobs, while total firm turnover increased substantially raising estimated local productivity levels, defined as turnover per employee, by approximately 0.32% as a result of increased broadband speeds. There was evidence, however, that over 80% of these impacts were driven by the relocation of firms to postcodes receiving subsidised coverage, and this impact was taken into account in the study. As such, only impacts in terms of raising productivity can be considered to qualify as an economic benefit at the national level. The impact on firms that did not change location while the programme was delivered was estimated at 0.38%. This gives assurance that the economic impacts of the programme were not purely driven by the relocation of firms.

Teleworker productivity - Indirect Benefits

86. The monetised benefits are estimated using the UK Broadband Impact Study adjusted to fit to the current analysis. In all cases, it is assumed that interventions such as the Superfast Programme and the Local Full Fibre Network will continue, which feeds into our wider assumption that the rollout of full fibre will continue and gather pace affecting the baseline.

87. The UK Broadband Impact Study reported that “as levels of connectivity at home improve, this will tend to encourage higher levels of working from home” . The time that these teleworkers save by not commuting could be put to more productive use, which is assumed here to be split between leisure and business in a ratio of 40:60. There is also some evidence that teleworkers may also be more efficient, but this is not accounted for.

88. To quantify the impact of improved internet connectivity, the model first estimates the proportion of home workers by standard occupational classification (SOC) and by density decile using ONS Census 2011 data[66]. Then, a function (i.e. a curve) of internet speed use and the number of days worked from home is calculated - within reasonable limits (there is no point in which there will be exclusive home working). Given that not everyone will work from home, the relative propensity to do so is also estimated using Census data. Overall, combining an increase in internet speed, which translates into number of days working at home and multiplied with the propensity to do so produces an estimate of total number of days worked from home attributed to a change in speed. The benefit itself is the time saved from commuting. This is estimated by combining Census data that shows the average distance travelled to work (9 to 16 km) and the National Travel Survey[67] that reports the average commuting travel time (49 to 87 minutes) for each density decile.

89. Displacement has also been included. This refers to the case where a policy may lead to an increase in outputs in one area, but also a reduction in outputs elsewhere. In this specific case, this could include a change in the use of transport modes, or more widely, the effect on other businesses providing similar telecoms services. SQW estimated displacement using

[66] SQW analysis of ONS Census data. See: SQW (2013), UK Broadband Impact Study. Available online at: https://www.gov.uk/government/publications/uk-broadband-impact-study--2

[67] Department for Transport (2018). National travel survey 2017. Available online at: https://www.gov.uk/government/statistics/national-travel-survey-2017

ready-estimates and tested these using Monte Carlo analysis[68]. Overall, they judged displacement for teleworkers' productivity to be 50%.

90. The time savings can be converted into monetary units by multiplying the number of hours saved with the gross value added (GVA) per hour worked. Using the latest data[69], GVA per hour was estimated at £33 in 2016 (and in 2016 prices). Only private sector workers have been included as SQW argued that any time saved by public sector employees would lead to improved public services rather an increase in GVA. Acknowledging this, private sector workers represented around 83% of all jobs in 2016 based on ONS Labour Force Survey data.

Labour force participation - disabled people and carers - Indirect Benefits

91. Similarly, the UK Broadband Impact Study identified that "the ability to work from home, using improved levels of connectivity, also reduces the barriers to employment for certain parts of the working age population"[70] . In particular, they identified carers who would otherwise be economically inactive looking after the home or family, and disabled people who would otherwise potentially find it difficult to find suitable work environments. The study recognises that some barriers are lifted enabling participation, although not completely eliminated. This is reflected in the time and proportion of carers that are able to join the workforce.

92. Like above, the model estimates the proportion of disabled people and carers who are unemployed/economically inactive, want a job and are able to work from home as a function (i.e. curve) of internet speed use . There is an assumption that new entrants to[7172] the labour market can sustain work. Displacement, which here can include other interventions to support disabled people and carers into work, has been estimated by SQW using the same approach as that described previously to be 40%.[73]

93. To convert this into a monetary value, the number of people entering the labour market because of improved connectivity is multiplied with the average GVA per worker. Disabled people are assumed to work full time, while carers are assumed to work part time. The latest

[68] For example: English Partnerships (2008), Additionality Guide. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/191511/Additionality_ Guide_0.pdf; and BIS (2009), 'Research to improve the assessment of additionality' http://webarchive.nationalarchives.gov.uk/20121106103730/http://www.bis.gov.uk/assets/biscore/economics-and-statistic s/docs/09-1302-bis-occasional-paper-01

[69] ONS (2018), Employee earnings in the UK: 2018. Available online: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2018

[70] Ibid.

[71] Jones, M (2010) SQW analysis of ONS Annual Population Survey data and estimates, Disability, education and training, Economics and Labour Market Review, 4, 4. Available online at: https://www.researchonline.org.uk/sds/search/download.do;jsessionid=DECBBBECE480F0935A63389F1C8A8FAE?ref= A27862. See: SQW (2013), 'UK Broadband Impact Study'.

[72] The DCMS (2018) Superfast Broadband Programme evaluation sets out a different approach to measuring this benefit by looking at the impact on local (long-term) unemployment and out of work benefits. However, this has not been used here given the fact that the evaluation looks at the impact on both residential and commercial premises

[73] Ibid

estimate of GVA per worker is £55,100 for full-time workers and £18,100 for part-time workers in 2016 (and in 2016 prices)[74].

Wellbeing - Indirect benefits

94. As noted earlier, the UK Broadband Impact Study reported that higher internet speeds can lead to an improved sense of wellbeing. This is in line with other studies that showed a higher subjectively felt sense of wellbeing because of: communicating with friends and family; using social media and online communication tools[75]; reducing the need to travel to work[76]; and a general feeling of empowerment[77]. However, while most studies have shown the impact of the internet on wellbeing as being positive, some suggest that the impact could be negative[78] or non-existent[79].

95. Acknowledging the above, the UK Broadband Impact Study benefit model did not quantify or monetise the potential impact on wellbeing at the time. However, more recently, the evaluation of the Superfast Broadband Programme did attempt this in line with HM Treasury Green Book guidance[80]. It suggested that the wellbeing improvement to households with a superfast connection - an average of those taking up a superfast service and those that do not - was £222 per year excluding any impact associated with household incomes. The evaluation noted "this benefit [is expected] to increase over time as consumer demand for superfast broadband increases".

96. This wellbeing benefit has been included in this model. While it could be argued that an increase in wellbeing could capture some of the benefits of being able to work remotely or entering the labour market - and therefore includes an element of double counting - it also captures wider wellbeing benefits of being able to access online entertainment, communicate with friends and family and shopping online for instance. The risk of double counting is also

[74] ONS Regional GVA (balanced estimates) and ONS Labour Force Survey

[75] Townsend, L, Wallace, C & Fairhurst, G (2015), 'Stuck out here': the critical role of Broadband for remote rural places', Scottish Geographical Journal, 131, 3-4. Available at: http://dx.doi.org/10.1080/14702541.2014.978807; Kraut, R & Burke, M (2015), Internet use and psychological well-being, Communications of the ACM, 58, 12. Available at: https://cacm.acm.org/magazines/2015/12/194633-internet-use-and-psychological-well-being/fulltext; and Valkenburg, P & Peter, J (2007), Internet communication and its relation to well-being, Media Psychology, 9, 1. Available online at: https://doi.org/10.1080/15213260709336802

[76] Deloitte (2013), Benefits of high-speed broadband for Australian Household'. Available online at: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-benefitshighspeed-broadband-v2-2 40914.pdf

[77] Ashmore, F, Farrington, J & Skerratt, S (2015), Superfast Broadband and Rural Community Resilience, Scottish Geographical Journal, 131, 3-4. Available online at: https://doi.org/10.1080/14702541.2014.978808

[78] Kraut, R et al (2002), Internet paradox revisited, Social Issues, 58, 1. Available online at: https://spssi.onlinelibrary.wiley.com/doi/10.1111/1540-4560.00248

[79] Huang, C (2010), Internet use and psychological well-being: a meta-analysis, Cyberpsychology, Behaviour and Social Networking, 13, 3. Available online at: https://doi.org/10.1089/cyber.2009.0217

[80] HMT (2018), Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme. Available at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

minimised given that the wellbeing value from the Superfast Broadband Programme excludes the wellbeing effect associated with household incomes (i.e. an increase in wages).

97. Nonetheless, as there is nothing to compare this wellbeing value with, especially given the relatively early stage of including wellbeing in cost benefit analysis, this benefit is only included as part of sensitivity. It has also only been applied to households with a FTTC or FTTP connection to illustrate those with at least a superfast connection compared with an ADSL line. Whilst it is possible that the wellbeing gains last more than a year, we have also only counted it once (in the year of connection).

Non-monetised benefits

98. The UK Broadband Impact Study surmised that "beyond its economic impacts, broadband has, of course, become an integral part of modern life, affecting various aspects of our day-to-day activities as individuals, families and communities" . This is supported by similar findings[81] by the Superfast Broadband Programme evaluation and a report by Regeneris looking at the economic impact of full fibre infrastructure[82] among others. Many are social benefits which are difficult to measure and value, take some time to materialise and depend on the take up of the service. Nonetheless, they should be considered alongside the quantitative cost benefit analysis.

Reduction in travel

99. A number of sources highlight the benefits for many (especially those in rural or remote areas) through a reduction in the need to travel. Examples given include areas such as e-government, for example; filing taxes and conducting other business with local and national governments[83], online shopping and employment[84]. The rise of teleworking gives rise to economic benefits as described above, and it also has social benefits related to reduced travelling.

100. The benefits from avoiding travel can potentially be measured in two ways – firstly through the monetary savings that can be made by not travelling (e.g. on petrol, parking, other costs), and secondly through being able to use the time that would have been spent travelling on leisure, or another purpose entirely. Ashmore, Farrington and Skerratt (2015) note that the ability to get banking and other shopping activities organised online meant that the participants

[81] Ibid.

[82] Regeneris (2018), The economic impact of full fibre infrastructure in 100 UK towns and cities. Available online at: https://www.cityfibre.com/wp-content/uploads/2018/03/The-Economic-Impact-of-Full-Fibre-Infrastructure-in-100-UK-Town s-and-Cities-12.03.18.pdf

[83] Van de Wee, M., S. Verbrugge, B Sadowski, M. Driesse & M. Pickavet (2015), Identifying and quantifying the indirect benefits of broadband networks for e-government and e-business: a bottom-up approach, Telecommunications Policy, 39, 3-4, pg.176-191. Available online at: http://www.sciencedirect.com/science/article/pii/S030859611300205X

[84] Philip, L, Cottrill, C, Farrington, J, Williams, F & Ashmore, F (2017), The digital divide: patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain, Journal of Rural Studies, pg.1-13. Available online at: https://www.sciencedirect.com/science/article/pii/S0743016716306799

they spoke to were afforded "greater control over how they planned their physical shopping excursions" [85].

Access to education

101. Improved broadband is seen as making the provision of education and remote training more successful. Citing the increasing availability of the option to gain formal qualifications entirely remotely through the use of video conferencing for lectures and tutorials, Meador (2016) notes that the provision of superfast broadband to those areas in Dumfries and Galloway currently without it would allow residents to participate in formal and informal distance education[86].This could raise educational attainment in an area of Scotland where the proportion with tertiary education is lower than the national (Scottish) average.

Access to health and social services

102. There is a large potential for remote services to improve health and social services. Telemedicine applications that enable remote screening, diagnosis, treatment and monitoring allow people to receive quality care in the communities in which they work and live. There are challenges associated with fully realising the potential of telemedicine benefits. More vulnerable people who might benefit most from telemedicine may be least likely to have interest in using the internet or taking up better broadband should it become available. Additionally, a literature review from 2013 notes that this sort of benefit relies on local health services being structured to provide telemedicine, which was not the case at that time, and seems unlikely to be the case now[87]. However, in recent years remote GP services accessed through video-conferencing have started to reach the mainstream market.

Consumer access benefits

103. Another similar benefit relates to savings more generally through increased availability of online shopping. This operates at both ends; consumers will be better able to use online shopping platforms to shop around and find cheaper goods and services, saving money that can be used elsewhere, while rural-based businesses may be able to offer more competitive prices through a reduction in the business costs of physical isolation[88].

104. More broadly, those without good quality broadband are unable to reliably access some online services that others take for granted. The UK Government assumes 'digital by default' in the provision of public services. Currently all public services can be accessed with a 2Mbps download speed, but should the bandwidth requirements of government websites increase (in

[85] Ashmore, F, Farrington, J & Skerratt, S (2015), Superfast broadband and rural community resilience: examining the rural need for speed. Available at: https://www.tandfonline.com/doi/full/10.1080/14702541.2014.978808

[86] Meador, E (2016), Superfast broadband in Scotland: implications for Dumfries and Galloway. Available at: https://www.researchgate.net/profile/John_Meador/publication/308163239_Policy_Briefing_10_Superfast_Broadband_in _Scotland_Implications_for_Dumfries_and_Galloway/links/57dbad6808ae5292a376bd14.pdf

[87] SQW (2013), UK broadband impact study. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85961/UK_Broadband_Impact_Study_-_Li terature_Review_-_Final_-_February_2013.pdf

[88] Philip, L, Cottrill, C, Farrington, J, Williams, F & Ashmore, F (2017), The digital divide: patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain, Journal of Rural Studies, pg.1-13. Available online at: https://www.sciencedirect.com/science/article/pii/S0743016716306799

line with the general growth in the size of websites), then faster broadband may become necessary for universal reliable access to public services. A number of articles cite a longer-term concern that the withdrawal of commercial and public organisations from physical locations to being solely available online will be damaging to non-users of the internet, with the suggestion that an inability to access online services may "generate a new dimension of social exclusion that transcends conventional 'causes' of disadvantage such as low income"[89]. A report by Deloitte from 2013 outlines that "there is some evidence that these greater impacts [of good quality broadband] are where households face difficult circumstances, such as needing to find employment, move residence or where additional education is of significant benefit"[90].

Community resilience

*105.*A number of academic sources use the framework of 'enhancing resilience' as a measure of the impacts of better broadband. In the literature this operates mostly within a rural context, where community resilience is highlighted as a particular issue. Ashmore, Farrington & Skerratt (2015) describe resilience as[91]:

> *"Social–ecological resilience builds upon this understanding to represent the ability of a community to withstand shocks due to external, ecological factors (Adger 2000). In relation to rural areas, shocks, or changes, can include depopulation, a loss of, or a disinclination to develop, public services for small populations and demographic ageing (see Delfmann et al. 2014), which require individuals and communities to be able to adapt and adopt new practices (i.e. be resilient) to address such changes to their community structure and livelihood."*

*106.*Recent papers define a framework for assessing the impact of better broadband on individual and community resilience. Heesen, Farrington & Skerratt (2013)[92] identify the impact on technological engagement (for instance through improving unreliable internet connections), the ability to live and work in a rural setting (the use of superfast in maintaining a rural life), and the capability for the local community to act together as key parts of community resilience that could be affected by a Universal Service Obligation.

Environmental benefits

107.The UK Broadband Impact Report identified three routes to environmental saving as a result of improved broadband: the effect of reduced commuting as teleworking becomes more viable, the fall in business travel due to similar reasons, and the reduction in energy consumption as cloud storage becomes more viable[93]. Environmental benefits are not included in the quantified benefits below.

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[89] Ibid.

[90] Deloitte Access Economics (2013), Benefits of high-speed broadband for Australian Households. Available online at: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-benefits-highspeed-broadband-v2- 240914.pdf

[91] Ibid.

[92] Heesen, F, Farrington, J & Skerratt, S (2013), Analysing the role of superfast broadband in enhancing rural community resilience. Available online at: http://aura.abdn.ac.uk/bitstream/handle/2164/4002/FHeesen_ESRS_Analysing_sfbb_in_enhancing_rural_community_re silience_ShortPaper_ESRS2013.pdf?sequence=1

[93] Ibid.

Productivity gains from home businesses

108. Home businesses can also benefit from having improved broadband. For example, it can lead to more productive and efficient ways of working and enabling access to larger markets. This includes taking advantage of cloud services, having an online presence on websites and social media, interacting with suppliers and customers, and offering e-commerce[94]. It is also a similar argument used in the UK Broadband Impact Study for all businesses[95]. However, quantifying this impact is difficult as there is no reliable information describing the number of home businesses (though some estimates suggest that there were approximately 2.7 million home businesses in the UK in 2017[96]) or what the likely magnitude of impact could be.

Health Impacts

109. Public Health England released a statement on the health impacts of 5G in October 2019, this said "the overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health.".[97]

Trade and Investment

110. Infrastructure underpins investment and trade for the broader economy. The economic impacts of superior network connectivity stems from enabling the delivery to affected households and businesses of applications such as cloud computing and other services which require high and/pr symmetric bandwidth (as next gen TVM, video conferencing, e-Education and e-Health, and remote monitoring applications). In turn, weak links in connectivity within the UK and Europe in general may have broader impacts on the UK's attractiveness as a centre for innovation and business development in the ICT sector. In this context, it is notable that countries[98] such as China, Japan, and South Korea have well-developed ICT industries,which may have been supported by the early derive for very high speed connectivity. Divergent regulatory practices can have a negative impact on cross-border trade, competition and attractiveness to investment; the access provision set out will address these issues.[99]

Optimism Bias, rollout profiles, and multipliers

111. An optimism bias of 35% has been applied to both the costs and expected rollout targets associated with the various policy options. This is based on the suggested upper bound optimism bias for non-standard civil engineering projects included in HM Treasury Green Book

[94] SBA (2010), Impact of broadband speeds and price on small business. Available at: https://www.sba.gov/sites/default/files/rs373tot_0.pdf

[95] Ibid.

[96] Vonage (2018), Unlocking the UK's home business potential. Available at: http://www.homebusiness100.co.uk/wp-content/uploads/2017/09/StepUps-Report-FINAL-DIGITAL.pdf

[97] Public Health England (2019) 5G technologies: radio waves and health. Available at: https://www.gov.uk/government/publications/5g-technologies-radio-waves-and-health/5g-technologies-radio-waves-and-health

[98] For example, in Japan, where very fast broadband coverage had reached 90% by 2012, the ICT market accounted for around 8.9% of all industries and for 7.1% of total employment. In contrast, EU coverage in the EU was around 53%, ICT employment in the EU represented just 4% of GDP and 2.7% of total EU employment in 2011

[99] European Commission (2016) Proposed Directive establishing the European Electronic Communications Code Impact Assessment part 1. Available at: https://ec.europa.eu/digital-single-market/en/news/proposed-directive-establishing-european-electronic-communications-code

guidance. This is within the range of optimism biases used in the past for the assessment models mentioned above, such as the UK Broadband Impact Study. The technology and installation processes are already proven reducing some uncertainty, while the costs used in the model are based on actual past experience of delivery. These costs are generally higher than other benchmarks, suggesting that they have the potential to be lower, especially considering that operating expenditure has been included in this study. Altogether, we have later tested the analysis using different levels of bias.

112. To produce the cost and benefit structures, network rollout profiles were forecasted. These profiles are based follow the same sigmoid function (S-shaped curve); this function often characterises the evolution of technology models[100] and similar forecast profiles were estimated both in the FTIR[101] and the European Commission as part of its impact assessment[102]. The forecast profiles were constructed to reflect the expected coverage of the new networks under each option in 2034; Options 2 and 3 forecasted to cover the total hold-up areas, however at different pace (i.e. with a two year delay for option B over option C). The differences in the achieved extent of rollouts between profiles stems largely from the requirements placed on the regulator to conduct geographical mapping exercises sooner in option 3 than in option 2, with intervention zones being identified by the government to achieve broader connectivity results. This leads to a two year delay in network rollouts in option 2, but the overall coverage is expected to be similar in both options by 2034, which leads to different discount rates and thus different present values of benefits and costs. This is largely due to the bulk of the rollouts being expected to take place after the first two mapping exercises take place, with network rollouts slowing down afterwards and resulting in the two trend-lines converging to one another. Furthermore the optimism bias was applied on total coverage achieved in both options[103], leading to a total coverage of approximately 65% by 2034 for both options (see chart below). The different rollout profiles are combined with an assumption of earlier rollout to urban over rural areas, due to the more favourable economics associated with covering urban areas over more remote areas; the majority of poorly serviced households in terms of connectivity in the UK remain overwhelmingly in rural areas[104].

Figure B: Estimated network rollout profiles for Options 2 and 3

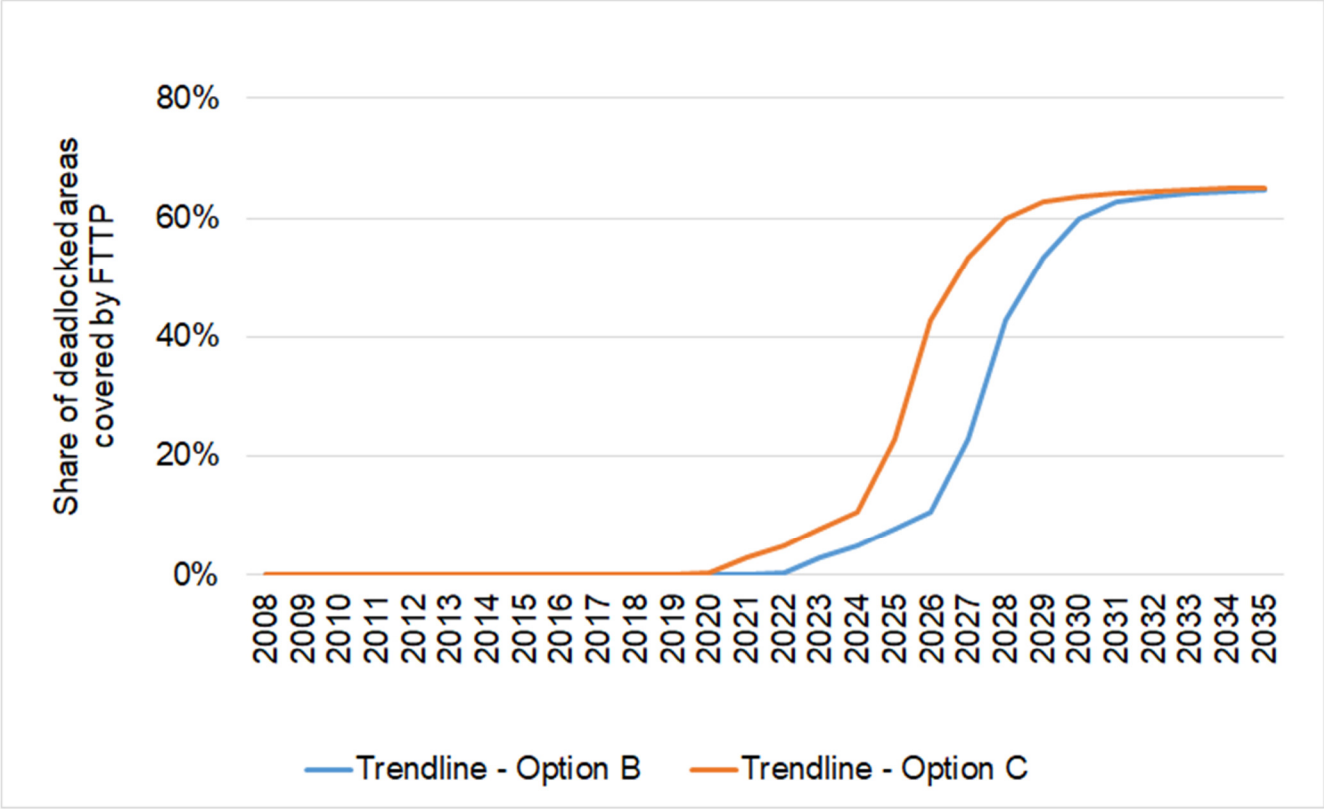
[100] For a detailed analysis, see Kucharavy, De Guio (2007), Application of S-shaped curves. Available at https://ac.els-cdn.com/S1877705811001597/1-s2.0-S1877705811001597-main.pdf?_tid=3e6631c9-a6cb-4f35-9129-6e373a3a5f8e&acdnat=1547831468_b6e2f5d955a0fec418c8972c524b0bbe

[101] Frontier Economics (2018), UK Telecoms Market Dynamics, Future Telecoms Infrastructure Review Annex A. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727890/FTIR_Annex_A_-_FE_Report.pdf

[102] European Commission (2016), EECC Impact Assessment. Available online at: https://ec.europa.eu/digital-single-market/en/news/proposed-directive-establishing-european-electronic-communications-code

[103] According to government guidelines an optimism bias relevant to non-standard civil engineering projects was used. See more at HMT (2018), The Green Book central government guidance on appraisal and evaluation. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

[104] Ofcom (2018) Connected Nations. Available online at: https://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2018/getting-rural-areas-connected. Eurostat provides a detailed view on the share of broadband coverage in rural and urban households in the UK, available at: https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2017



Source: DCMS own analysis based on SQW model

113. Other parameters and assumptions used include the cost distribution parameter. Capital investment in networks is generally assumed to be front loaded[105], and this trend is captured in this model, using a decreasing exponential function. The cost curve (ie, the decreasing exponential function) utilises a parameter that determines the extent of the front-loading of costs, for the purpose of which the value was set at 2%.

Competition Analysis

114. Competition analysis was undertaken to assess the impact of the publication of aggregated forecast, pursuant to article 22. The competition analysis aimed to assess how the introduction of aggregated forecasts of networks would alter operators behaviour in regards to deployment plans.

115. The analysis uses 13 geotypes; the geotypes are differentiated by cost and the technology present. The Payoffs for operators are calculated, the formula below is a simplified version of that used in the model:

$$\varepsilon\pi = ((ARPU/n * t) - c) * \delta$$

[105] This is often cited by network operators themselves, such as by Vodafone https://www.vodafone.com/content/dam/vodafone/about/public_policy/position_papers/vodafone_report_final_wkconsult.pdf, but is largely a documented fact in the industry. For more information on CAPEX structures in fibre technologies see Ventura Team (2017), Financing Stimulus for FTTH, Fibre to the Home Council Europe. Available online at: https://www.ftthcouncil.eu/documents/Reports/FTTH_Finance_Report.pdf

116. That is the expected payoff is equal to the Average Revenue Per User (ARPU) divided by the number of operators (n), multiplied by the time period (t). Minus the costs (Capex, Opex, Connection) then multiplied by an uncertainty parameter (δ). The expected payoffs are then discounted by the Weighted Average Cost of Capital (WACC).

117. A game theory approach was then used to assess where operators would build. This consisted of a game where there are no forecasts (i.e. each operator chooses where to build at once) and a game where aggregated forecasts were published (i.e. each operator forecasts where to build, then can change their deployment plans on the basis of the forecast). Operators chose which areas to deploy to maximise their payoffs, bounded by the available capital to realise their investments. Available capital by operator was estimated based on their publicly announced targets and projected network investment spending, Operators also had a range of strategies to play:

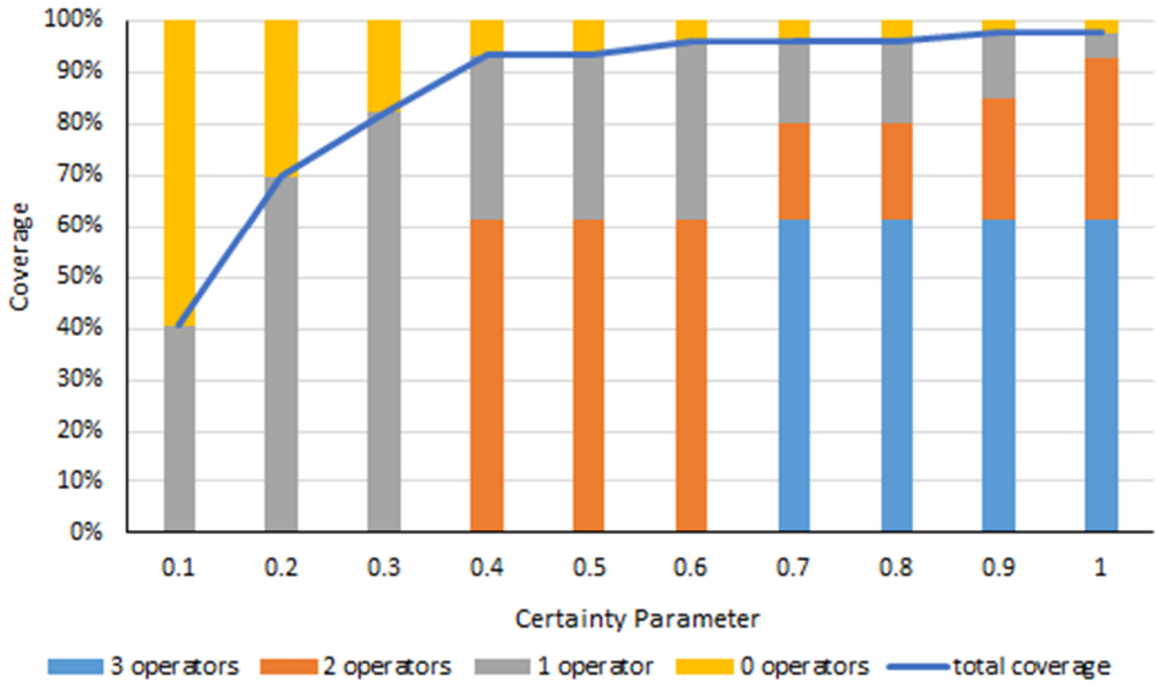
- Maximizing expected payoff per premise
- Maximizing coverage
- Aggressive strategy (i.e. attempting to overbuild competitors to diminish their payoffs)

118. The results from the analysis were:

- Operators will attempt to avoid overbuilding each other at first to try and claim localised monopolies (i.e. be the first operator in an area, making the area less attractive for competitors to deploy in)
- Aggregated forecasts will allow part of the deadlock area to be deployed in, due to a first mover advantage making the area commercially attractive for a single network operator (see point above, operators attempt to claim localised monopolies) and a more complete information set establishing to competitors where to focus their efforts
- To prevent the 'aggressive' strategy being used by operators a penalty mechanism is important to deter this behaviour
- An increase in certainty for business can increase commercial coverage and competition (see para 106)

119. Figure C below shows how an increase in certainty for business can lead to higher coverage and competition. It is not possible to ascertain the current level of certainty nor the impact of a policy. However, as a theoretical exercise the graph shows how measures that increase certainty for business such as the publishing of aggregated forecasts can increase commercial coverage and competition in the UK digital infrastructure market.

Figure C: Impact of increasing business plan certainty on commercial rollout and competition



Summary of costs and benefits

120. This section summarises the costs and benefits identified above for the three policy options. A starting point is to illustrate the impact the policy options have on the actual number of households expected to receive high speed connectivity. Table A provides this breakdown over 15 years using different scenarios of the expected size of the "hold-up" areas.

Table A: Forecasted share of UK households (HHs) covered by FTTP services as a share of all households in 2034

Scenario	Option 1	Option 2	Option 3
A - low scenario (6% of UK HHs)	21.7%	24.6%	24.7%
B - high scenario (19% of UK HHs)		30.0%	30.8%
C - best scenario (10% of UK HHs)		26.0%	26.6%

Source: DCMS own analysis

121. The costs are essentially estimated by multiplying the unit costs of installing a connection with the number of new households connected. This is done on a per decile basis. The costs also include an optimism bias of 34.85%. Using a 15 year appraisal period[106], we have discounted values using a rate of 3.5%. The 15 year appraisal period has been used in agreement and encouragement of HM Treasury. The estimated lifetime of fibre optic networks,

[106] The 15 year appraisal period has been used in agreement and encouragement of HM Treasury. The estimated lifetime of fibre optic networks appears to range anywhere between 15 to 25 years according to expert advice. We are using the lower range to remain conservative in our estimates

in common with most infrastructure projects, are considerably longer than the usual 10-year appraisal period used in the Government's impact assessments (for instance, parts of the old copper telephone line network in the UK has exceeded a lifespan of 100 years). Specifically for fibre, the network lifetime ranges anywhere between 15 to 50 years according to expert advice[107]. We are using the lower range to remain conservative in our estimates

122. The benefits are estimated using the approach outlined in the previous section. Given that the evidence supporting some benefits is more robust than others, we have separated them out. The more robust benefits include the uplift in Gross Value Added, which consists of the uplift in enterprise growth, boosted labour force participation of carers and disabled people, and increased productivity from teleworkers. The less robust benefits also include wellbeing effects. Like above, the benefits have been analysed over a 15 year period and discounted using a 3.5% rate. There are also a number of non-quantified benefits that should be considered alongside these monetised ones.

123. Table B summarises the social costs and benefits and presents the net present value relative to the do nothing scenario. However, it should be considered against the fact that: the unit costs are relatively high in comparison with other benchmarks (also including OPEX); and there are several non-quantified benefits that need considering as well. Acknowledging this, no policy options have a chance of a negative net impact[108] even when only looking at the main monetised benefits (GVA). When the welfare benefit estimates (summary compared to summary with welfare, see table below) are also included in the calculations then the net present value increases further for all options.

Table B: Social cost benefit analysis over 15 years relative to do nothing, constant 2018 prices, £m

£m	Option 2			Option 3		
Costs	**Best**	**Low**	**High**	**Best**	**Low**	**High**
Familiarisation costs (Direct)	1.3	1.1	1.4	1.8	1.6	1.9
Implementation costs (Indirect)	2.3	2.0	2.5	2.3	2.0	2.5
Network CAPEX/OPEX (Indirect)	1,428.7	929.3	2,700.4	1,511.1	983.7	2,856.0
Network mapping forecast costs (Direct)	-	-	-	8.8	6.1	7.5

[107] For instance, See more at Regulatory approaches to risky bottleneck assets: International case studies (WIK, 2016), available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0027/82728/wik_regulatory_approaches_to_risky_bottleneck_assets.pdf

[108] For option 3, that is in the case of the high cost and the low benefit realisation (see summary tables at the start of the document).

Total - undiscounted	1,432.3	932.4	2,704.3	1,523.9	993.4	2,867.9
Total - discounted	1,096.9	712.1	2,070.7	1,246.8	810.3	2,346.3
Benefits	**Best**	**Low**	**High**	**Best**	**Low**	**High**
Market review savings operators (Direct)	6.8	0.6	12.2	6.8	0.6	12.2
Market review savings – Ofcom (Indirect)	7.5	6.0	9.0	7.5	6.0	9.0
GVA impact (Indirect)	1,571.5	1,022.3	3,063.6	1,726.8	1,130.5	3,325.0
Network mapping efforts consolidation (Direct)	-	-	-	1.7	1.5	1.9
Total - undiscounted	1,585.9	1,029.0	3,084.8	1,742.8	1,138.6	3,348.1
Total - discounted	1,101.4	714.0	2,144.6	1,264.5	825.5	2,433.7
Welfare benefits	3,493.7	2,151.2	6,579.4	3,520.7	2,167.8	6,630.2
Total - discounted	2,589.0	1,594.6	4,875.6	2,773.4	1,706.3	5,155.1
Summary	**Best**	**Low**	**High**	**Best**	**Low**	**High**
Net present value	4.5	1.9	73.9	17.7	15.2	87.4
Summary with welfare	**Best**	**Low**	**High**	**Best**	**Low**	**High**
Net present value	2,593.5	1,596.5	4,949.5	2,755.1	1,701.5	5,242.5

Source: DCMS own analysis based on SQW model

124. The impact on businesses only is shown in Table C. While the costs are expected to be incurred entirely by businesses (telecoms operators) and the government, benefits are expected to be spread both between businesses in the form of increased productivity and turnover as well as for for consumers (including welfare which is largely due to an increase in public welfare). Exceptions are the increased savings to operators from the reduction of market reviews and the productivity from teleworkers which can impact both residential and commercial premises but this cannot be separated out. While acknowledging that not all the direct benefits can be included, and also the optimism bias and relatively high costs listed above, the net present value for businesses is positive across all policy options.

Table C: Business NPV over 15 years relative to do nothing, constant 2018 prices, £ m

£m	Option 2	Option 3
Total Business Costs	1,021.2	1,161.0
Total Business Benefits	1,021.7	1,173.9
Net Total Business Impact	0.6	12.9

Source: DCMS own analysis based on SQW model

125. The estimated annual net direct cost to businesses (EANDCB) is based on the total discounted cost (including optimism bias) shown above. The total cost is divided by the annuity rate of 11.9 associated with the 15 year appraisal period and the discount rate of 3.5%. Overall, the EANDCB is expected to be less than £5 million per annum across all policy options, while the direct costs to businesses are positive for policy option 2 and negative for policy option 3 (Table D).

Table D: Estimated annual net direct cost to businesses (EANDCB), constant 2018 prices, £ m

£m	Option 2	Option 3
EANDCB	-0.3	0.2

Source: DCMS own analysis based on SQW model

126. Based on the above, the preferred option is option 2. While option 3 delivers the largest positive net present value, the net direct costs to businesses are likely to be negative. It is also against the backdrop that these net present values and benefit cost ratios are likely to be optimistic despite the modest optimism bias and relatively high costs, as the uncertainty over the full impact of the new regulation on actual business plans cannot be eliminated.

Small and Micro Business Assessment (SaMBA)

127. The recommended policy is designed to deliver a Gigabit capable connection to residential and business properties in hold-up areas. The recommended policy option will only affect small and micro businesses indirectly, in that they will be able to benefit from the deployment of digital infrastructure.

128. The model produced by SQW indicates small and micro businesses will see an uplift in GVA from improved productivity attributable to the intervention. These benefits are shown in table E below. The model estimates the number of businesses by sector and size in each area by geotype. This allows us to get more granularity on the impact on SaMBAs.

Table E: Total uplift in GVA for small and micro businesses from improved productivity attributable to intervention, cumulative over 15 year appraisal period, constant 2018 prices, £m

Business size	Estimate	Option 2	Option 3	% of benefits for SAMBA out of total benefits to businesses option 2	% of benefits for SAMBA out of total benefits to businesses option 3
Micro (1-9 employees)	**Low**	415.4	456.7	37%	38%
	High	1263	1360	38%	38%
	Best	642.4	700.6	37%	38%
Small (10-49 employees)	**Low**	281	306.5	25%	25%
	High	842	900.9	25%	25%
	Best	434	470.4	25%	25%

Source: DCMS own analysis based on SQW model

129. We have not identified any small or micro telecommunications operators that would fall in scope of this policy and therefore be relevant in our analysis. On the telecoms operator side, most exceed the SaMB definition of fewer than 50 employees. For instance, even some of the smaller (compared to Openreach and Virgin Media) operators installing full fibre like Gigaclear[109], CityFibre[110] and Hyperoptic[111] have more than 100 employees and over 300 in some cases.

Distributional analysis

130. The proposed policy is likely to have three main distributional impacts: the effect on disabled people; carers; and urban and rural areas. In all cases, we expect to use the consultation to identify other groups that might be affected by this policy and to estimate the likely impact.

Disabled people and carers

131. Improved broadband connections will help disabled people and carers to enter the labour market through the prospects of teleworking. The employment rate for disabled people aged 16-

[109] Gigaclear (2018), Annual report and accounts 2016. Available online at: https://www.gigaclear.com/wp-content/uploads/2016-Annual-Report-Gigaclear-Plc-FINAL-Companies-House.pdf

[110] CityFibre (2018), Audited full-year results for the year ending 31 December 2017. Available online at: https://irpages2.equitystory.com/websites/rns_news/English/1100/news-tool---rns---eqs-group.html?article=27370120&co mpany=city

[111] Hyperoptic (2018), Report and financial statement: year ended 31 December 2017. Available online at: https://beta.companieshouse.gov.uk/company/07222543/filing-history

64 is statistically lower than for non-disabled people across the UK[112]; in 2017, the employment rate was 53.3% for disabled people compared with 75.1% for the general population[113]. Instead, disabled people were more likely to be unemployed. There were approximately 362,000 unemployed disabled people aged 16-64 who want and are looking for a job in the UK in June 2018, giving an unemployment rate of 8.4%. That compared with an unemployment rate of 4.3% for the UK as a whole. Consequently, this policy has the potential to reduce these inequalities.

132. In comparison with the do nothing scenario, the (gross) number of disabled people and carers that enter employment can be up by 3,800 over 15 years (for option 2). Displacement[114] - which refers to the policy also having a reduction in the number of employed disabled people elsewhere due to displacement (i.e. reduced jobs for disabled people outside the impacted areas) - was estimated at 40% by SQW[115]. So, even after accounting for this, the policy is expected to have a positive, albeit small, effect on the number of employed disabled people overall.

Rural and urban areas

133. The present model has been developed in such a way that the analysis can be broken down into decile groups based on housing density and local authority. Due to the use of confidential data, local authority breakdowns were aggregated to NUTS1[116] regions. As is expected, the cost of installing a connection is generally higher in low density areas and lower in high density areas.

134. The estimated size of the hold-up area, as discussed above, varies depending on each model used. However the current estimates regarding it seem to indicate an even mix of urban/suburban (approximately 60%) and more rural areas (about 40%). This varies by geography as well, with England having the highest share of densely populated areas and Northern Ireland, Scotland, and Wales having a higher share of rural areas. With that in mind, the GVA impact at a nation level, as well as for urban/rural areas were estimated using the SQW model and are provided below.

Table F: Nation-level net GVA impacts in the best estimate scenario over 15 years in comparison to doing nothing, constant 2018 prices, £m

£m	Option 2	Option 3	Share%

[112] ONS (2018), Employee earnings in the UK: 2018. Available at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2018

[113] People reporting having an Equality Act core and/or work-limiting disability

[114] This refers to the case where a policy may lead to an increase in outputs in one area, but also a reduction in outputs elsewhere. See previous section for a discussion on the topic

[115] SQW (2013), UK Broadband Impact Study. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85961/UK_Broadband_Impact_Study_-_Literature_Review_-_Final_-_February_2013.pdf

[116] Nomenclature of Territorial Units for Statistics (NUTS) are standard definitions of geographical areas used in statistics in Europe. The NUTS1 regions for the UK include: North East, North West, Yorkshire & Humber, East Midlands, West Midlands, South East, South West, Wales, Scotland and Northern Ireland.

England	1,606.6	1,702.0	79%
Northern Ireland	82.0	87.0	4%
Scotland	207.0	219.0	10%
Wales	151.0	160.0	7%
Total	2,046.0	2,169.0	100%
Urban	839.0	887.0	42%
Rural	1,127.0	1,201.0	58%
Total	1,966.0	2,088.0	100%

Source: DCMS own analysis based on SQW model

135. The higher deployment costs for rural and remote areas, as well as areas with challenging geographies, is widely known. For example, the FTIR noted that these factors "increase the costs of deployment and reduce returns from fewer premises... [and] means the market is unlikely to reach them" . The Review will adopt an 'outside in' approach[117] to try and reach these, predominantly rural, areas which could involve using wireless and fixed technologies. The proposed EECC policy is planned to be able to work with other programmes - potentially including 'outside in'.

Sensitivity analysis

136. This section looks at the sensitivity of the cost benefit analysis by adjusting some of the key assumptions. Of which, the main assumptions are around the level of the cost to install/upgrade connectivity, the optimism bias, and the rollout scenarios. The optimism bias and rollout scenarios can be shown to have the biggest impact on the costs benefit analysis.

Different cost estimates

137. Comparisons between the modelled cost estimates and those from other studies suggest that, while they are in line with the range for the various local geologies, they are often higher than the average figures. Consequently, the net present values and benefit cost ratios are likely to be understated. Several sensitivity analyses on cost benchmarks have been previously conducted, such as for the New builds assessment[118], and the outputs have been reused here as well. Therefore no additional sensitivity analysis has been conducted here.

138. As part of the analysis, different front-loaded cost parameter values were used to forecast costs for network rollouts. Costs are largely derived from the rollout profiles, with

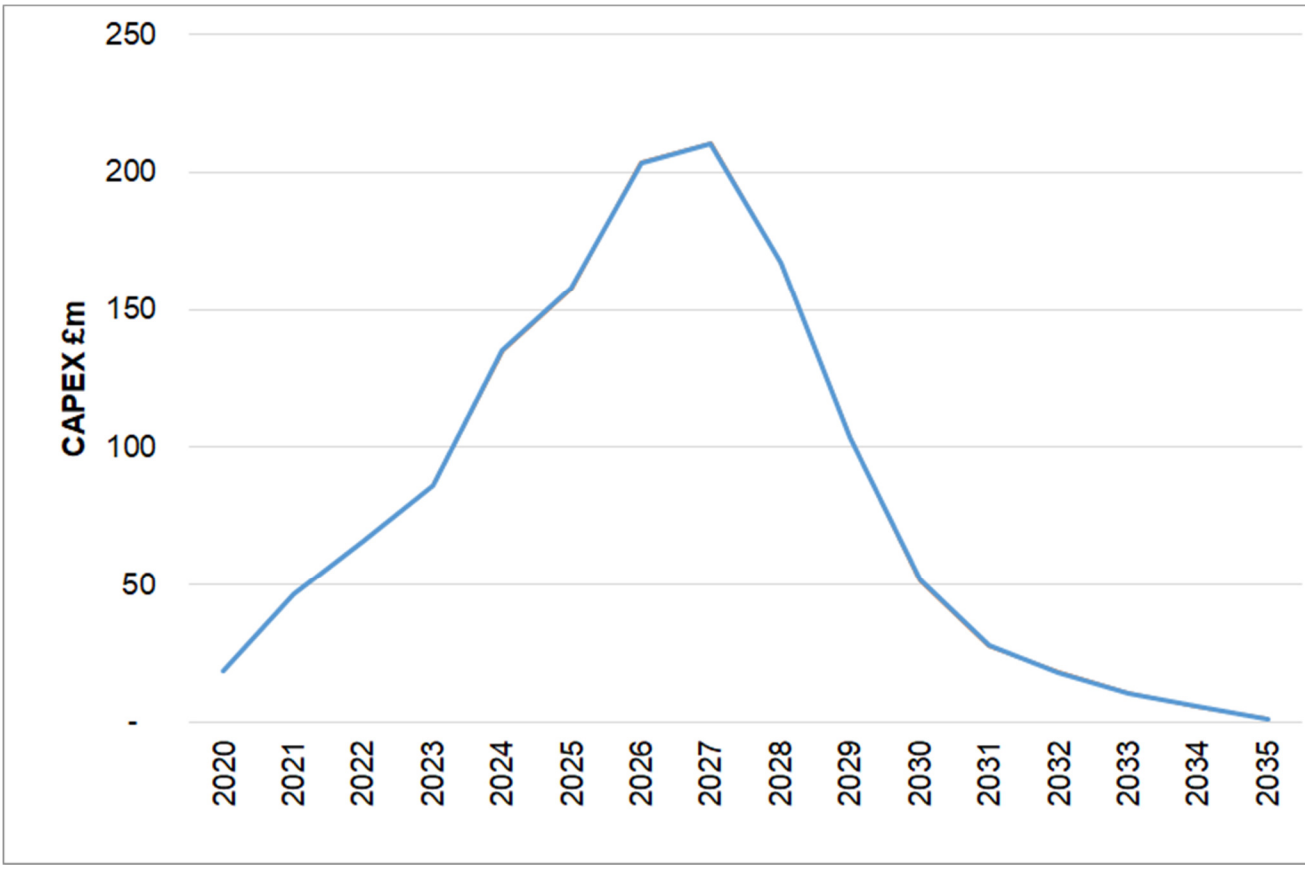
[117] DCMS (2018), 'Future Telecoms Infrastructure Review'. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727889/Future_Telecoms_Infrastructure_Review.pdf

[118] DCMS (2018), "New Build Developments: Delivering gigabit-capable connections". Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752146/New_Building_Developments_Impact_Assessment_FINAL.pdf

different population density deciles being composed of different geographical characteristics and therefore costs (as described previously); gradual network roll-out completion by density decile informs the cost estimates. Therefore total costs are structured around the rollout profiles, providing a bottom-up view of the cost curves. This approach was preferred since there is already plenty of regarding costs structures from previous studies, as outlined in previous paragraphs. As a result no strong assumptions were made regarding the distribution of costs across time (front/even/back loaded). Regardless, a front-loaded cost parameter was used to align our projections more with established industry practice (as outlined previously, broadband investment tends to be front loaded), but only marginally interfered in producing the cost function, as can be seen in Figure D below.

139. Sensitivity analysis was conducted regarding the effects on the cost-benefit analysis of changing the front-loaded cost parameters, but with negligible effects being identified. A maximum of 10% was used in the parameter analysis, as using any value higher than that resulted in negative CAPEX in the period 2034-2035. A parameter value of 0.02% was used eventually to retain the effects of the bottom approach to the fullest extent.

Figure D: Different Capex profiles based on front-loaded parameters for best estimate scenario, option 2



Source: DCMS own analysis

Optimism Bias

140. The optimism bias used in the main analysis is 34.85%, relatively close to the 44% upper bound, which is based on non-standard civil engineering projects within the HM Treasury Green

Book. However, the costs involved in this policy are relatively known and while we test the upper bound optimism bias as part of our sensitivity analysis, ultimately we believe that 34.85% appears to be more accurate. For example, the process for installing full fibre connections is proven and in use today. Similarly, the input costs to this model are based on BDUK approximations of the cost of delivery by different suppliers in different areas. Given this, the optimism bias could reasonably be lower than the one used.

141. Table G shows the impact on the cost benefit analysis for different optimism biases ranging from 3% (lower bound) to 44% (upper bound, HMT's Green Book). The analysis suggests that an optimism bias of up to around 38% would generally produce a positive net present value even when discounting welfare benefits, while when including them even the 44% upper limit returns highly positive results.

Table G: Sensitivity analysis of different optimism bias (all benefits of best estimate scenario relative to do nothing), constant 2018 prices, £m

Optimism Bias	Option 2		Option 3	
Social net present value, £ millions	Without Welfare benefits	With welfare benefits	Without Welfare benefits	With welfare benefits
3%	901.3	5,597.8	1,020.5	5,986.3
10%	626.2	4,706.6	714.6	5,028.8
20%	316.6	3,641.4	368.6	3,883.9
35%	4.5	2,593.5	17.7	2,755.1
44%	-116.3	1,823.1	-120.7	1,929.9

Source: DCMS own analysis based on SQW model

Rollout scenarios

142. In the main analysis, it was assumed that the entirety of the hold-up areas will not be covered even in the best case scenario. This was applied to derive a more realistic benefits profile, rendering the upper bound of coverage of hold-up areas to 65% (option 3), based on the optimism bias parameter. Sensitivity analysis was conducted by benchmarking the optimism bias and the results can be found above. Shifting the optimism bias changed not only the costs upwards, but also the extent of the rollouts downwards with the least optimistic scenario predicting a 56% network coverage (i.e. 100% - 44% optimism bias), with the net present value of the legislation remaining positive in all scenarios.

Risks and mitigating factors

Policy Risks

Full fibre investment incentives do not materialise

143. Per the General Objectives set out in **Article 3**, the EECC is designed to promote the deployment of VHCN, which includes full fibre and 5G in addition to upgrades to legacy infrastructure that use older technologies. This technology-flexible[119] approach will allow for flexibility as new innovations around quality and speed emerge – though may not protect against prolonging costly reliance on legacy networks. This is mitigated by:

The pro-investment focus of the EECC overall, as providers choosing to deploy their own networks rather than rely on access to legacy infrastructure are likely to choose a future-proof technology for deployment; and

Ofcom's continued focus on promoting the deployment of full fibre.

Uncertain consumer outcomes

144. In its EECC impact assessment, the EC acknowledges that a shift away from ex ante regulation, and towards longer market review cycles, would result in a more hands-off approach to shaping consumer outcomes. It found that this would be set off against the benefits of a competitive market on consumer outcomes. FTIR analysis found that competitive investment is key to improving consumer outcomes, in terms of choice, service quality, innovation and price over the longer-term.

Strategic play entrenching market power

145. A reduction in SMP obligations including a shift towards an alternative approach, and additional symmetrical mechanisms such as transparency, can encourage investment for SMP providers and their competitors. Implementation and regulatory decisions could affect the balance of these advantages with regards to the geographic survey and forecasts under Article 22, and forbearance under certain SMP co-investment scenarios under Article 76.

146. The granularity of geographic survey and forecast information made directly accessible under Article 22 will have implications for opportunities for strategic play. It is unlikely that information that providers consider to be commercially sensitive will be shared publicly. It is also unlikely that Ofcom will publish information that could result in a breach of competition law, or fail to act where there is evidence of a breach.

147. Sharing information on specific areas' coverage prospects will be restricted to about 10% of the country, a decade from now. We anticipate that it will create competitive incentives to seek first-mover advantage – including through earlier network extension, to support the business case for new network deployment in adjacent areas. It is reasonable to assume that all mechanisms within the EECC will be compliant with EU competition law.

148. With regards to Article 76, advance knowledge of the co-investment conditions that would mandate forbearance on SMP obligations has the potential to create opportunities for SMP providers to circumvent necessary SMP obligations. This will depend on the type of advance guidance Ofcom provides on criteria to qualify for co-investment.

[119] Whilst a number of technologies could comprise VHCN, the inclusion of fibre elements in the definition implies a shift away from pure technological neutrality.

Competition does not develop

149. In addition to the risk of entrenched market power at national level, certain transparency measures may give operators enough information to plan deployment in a way that may lead to the formation of regional monopolies. Here, again, it is unlikely that Ofcom will publish information that could result in a breach of competition law, or fail to act on breaches of competition law should they arise. We also anticipate that providers will continue to deploy in areas where the profit is commensurate with the level of risk assumed – including in areas where they would have to share the market.

Modelling Risks

150. There are risks to the proposed policy, both on the upside and downside. This includes:

Potential cost efficiencies. The model does not account for any cost efficiencies with delivering connectivity. It could be the case that factors such as 'dig once' where infrastructure can be delivered at the same time can reduce installation costs. Similarly, the underlying cost inputs to the model are based on 'upgrade' costs only, so there could be some further cost efficiencies as it would be 'first fit'. We will use the consultation to gauge the prospect of these cost efficiencies and introduce them as part of sensitivity to the economic appraisal.

Potential overestimation of coverage targets. It is likely that actual additional coverage unlocked by the proposed legislation is overestimated even when using the maximum optimism bias (44%). While several shareholders, especially competitors of the incumbent, have already indicated the value of the legislation in boosting competition and expected rollouts, it remains an uncertain scenario that requires to be modeled and therefore conservative estimates were preferred. The public consultation will be used to update these estimates according to telecom operators' own estimates.

Monitoring and evaluation

151. As part of this policy, a Post Implementation Review (PIR) will be conducted five years after implementation. BDUK runs constant evaluations to check the impact of its policies in the sector, informing our work. These results combined with observing and analysing market outputs should help us evaluate the impact of the legislation. Some of the research questions that we propose in order to assess impact include:

- Has the policy been successful in deploying fibre in hold-up areas? If so how actual coverage matches the forecast scenarios?
- Is the rationale for intervention still valid? For instance, whether the information failures that existed between telecoms operators and the regulator still persist.
- Business impacts - what were the overall impacts on business?
- Direct and indirect impacts - did the assumed impacts occur and were there others that were not identified both direct and indirect?
- Cost assessment - did any efficiencies materialise and potentially decrease total costs?
- Assessment of compliance and enforcement - Did stakeholders comply, if not, how did Government respond to ensure adherence to the policy?
- Market structure impacts - was there any impact on the market structures of network providers?

Annex: Glossary of terms

Term	Definition
5G	The term used to describe the next generation of wireless networks beyond 4G LTE mobile networks. 5G is expected to deliver faster data rates and better user experience. Technical standards are still under development and are likely to include both an evolution of existing and new radio technologies. Generations of technology are often defined as 2G (the introduction of rudimentary data and SMS services), 3G (upgraded online data services and connectivity quality), 4G (introduction of high-speed data services).
5G Testbeds and Trials programme	A programme that coordinates the development of 5G services and applications through a series of trials, which contribute to the development of the 5G ecosystem across the UK.
Access	The making available of facilities and/or services to another undertaking, under defined conditions, on either an exclusive or non-exclusive basis, for the purpose of providing electronic communications services, including when they are used for the delivery of information society services or broadcast content services.
Bandwidth	The measure of the maximum capacity of a data link in the network.
Body of European Regulators for Electronic Communications (BEREC)	The Body of European Regulators for Electronic Communications (BEREC) was created in 2009 to improve consistency of the EU telecoms rules and to contribute to the development of the Single Market. The mission of BEREC is to assist the Commission and the national regulatory authorities (NRAs) in the implementation of the EU telecoms rules, to give advice on request and on its own initiative to the European institutions and to complement at European level the regulatory tasks performed at national level by the regulatory authorities.
Broadband	A service or connection generally defined as being ‘always on’ and providing a bandwidth greater than narrowband. Broadband has been

	the norm for Internet connectivity (non-mobile) since the mid-2000s, with ADSL being the first mainstream technology standard adopted.
Bundled offers, services, or 'bundles'	A contract that includes more than one service, such as a landline, broadband, pay TV and/or mobile service. The majority of Internet broadband services in the UK come bundled with a telephone line, and increasingly so with a pay-TV offer.
Competent Authority	A person or organisation that has the capacity and legally delegated authority to perform the functions assigned to it. In many places, for example spectrum management, the EECC updates the current framework to give Member States the flexibility of assigning certain functions to a competent authority other than the National Regulatory Authority.
Devolved Administrations	The governments of the devolved nations of the UK. These are the Scottish Government, the Welsh Government and the Northern Ireland Executive.
European Commission	The European Commission is the EU institution that has the monopoly on legislative initiative and important executive powers in policies such as competition and external trade. It is the principal executive body of the European Union and it is formed by a College of members composed of one Commissioner per Member State.
European Electronic Communications Code (EECC)	The EECC is a European directive setting out current rules for telecoms. The EECC will replace the following four existing telecoms directives: Framework, Access, Authorisation and Universal Service.
EU institutions	There are a number of EU bodies which are defined under the Treaties as EU institutions including the European Parliament, the European Council, the Council of the European Union and the European Commission.
Electronic Communications Network	Transmission systems, whether or not based on a permanent infrastructure or centralised administration capacity, and, where applicable, switching or routing equipment and other resources, including network elements which are not active, which permit the conveyance of signals by wire, radio, optical or other electromagnetic means, including satellite networks, fixed (circuit- and packet-switched, including internet) and mobile networks, electricity cable systems, to the extent that they are used for the purpose of

	transmitting signals, networks used for radio and television broadcasting, and cable television networks, irrespective of the type of information conveyed.
Fibre to the Premises (FTTP), or Full Fibre	An access network using optical fibre to provide the connection between the local exchange and the end users' houses or business premises. The optical fibre may be point-to-point – a dedicated fibre connection for each home – or may use a shared infrastructure such as GPON (Gigabit passive optical network). This type of connectivity is considered in general more reliable and being capable of providing higher throughput and speeds than legacy copper-based networks (i.e. DSL services provided over telephone lines).
Future Telecoms Infrastructure Review (FTIR)	The FTIR, published in July 2018, set out a national, long-term strategy for digital infrastructure in the UK, with the aim of securing world-class connectivity that is gigabit-capable, reliable, secure and widely available.
General Conditions of Entitlement, or 'General Conditions'	Regulatory conditions that all providers of electronic communications networks and services must comply with in order to provide services in the UK.
GHz	Gigahertz – a unit of frequency of 1 billion cycles per second.
Gigabit-capable networks	A network connection that is capable of achieving 1,000 Megabits per second (Mbps), i.e. 1 Gigabits per second (Gbps), download speeds.
Interconnection	The physical and logical linking of public communications networks used by the same or a different undertaking in order to allow the users of one undertaking to communicate with users of the same or another undertaking, or to access services provided by another undertaking. Services may be provided by the parties involved or other parties who have access to the network. Interconnection is a specific type of access implemented between public network operators.
Latency	The amount of time a message takes to travel across a system.
National Regulatory Authority (NRA)	The body or bodies charged by a Member State with any of the regulatory tasks assigned in the EECC. Ofcom is the UK's National Regulatory Authority and is responsible for regulating the telecoms, broadcasting, and postal sectors.
Number-independent interpersonal	An interpersonal communications service which does not connect through the use of publicly assigned numbering resources, namely, a

communication service (NIICS)	number or numbers in national or international numbering plans, or which does not enable communication through a number or numbers in national or international numbering plans. This includes several over-the-top (OTT) communication apps that allow users to communicate using Internet Protocol (IP) communications. Some OTT communication apps enable voice-over-ip (VoIP) using assigned numbered resources while being enabled by the Internet.
Ofcom	Ofcom is the regulator and competition authority for the UK communications industries. It regulates the TV and radio sectors, fixed line telecoms, mobiles, postal services, plus the airwaves over which wireless devices operate.
Ofgem (Office of Gas and Electricity Markets)	Ofgem is the independent regulator for the electricity and gas industries. It is a non-ministerial government department and an independent National Regulatory Authority, recognised by EU Directives. Its principal objective when carrying out its functions is to protect the interests of existing and future electricity and gas consumers.
'Outside-in' approach	The Government's approach to ensure connectivity across all areas of the UK is achieved at the same time, and no areas are systematically left behind.
Over the top (OTT) services	An Over-The-Top (OTT) application is any digital product that disrupts or provides an alternative to the traditional billing models of telcos or cable/satellite companies.
Spectrum	The descriptor of the range of electromagnetic frequencies which can be modulated to carry information. Spectrum is a finite resource and a critical national asset that the Government wants to ensure is maximised for its economic and social value.
Significant market power (SMP)	A communications provider is deemed to have significant market power if, either individually or jointly with others, it enjoys a position in the market equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers.
Statement of Strategic Priorities (SSP) for Ofcom	As described in Clause 98 of the Digital Economy Act 2017, the SSP will set out the Government's strategic priorities for Ofcom in telecommunications, the management of radio spectrum, and postal services. Under the legislation Ofcom must have regard to the Statement when carrying out its regulatory functions.

Universal service obligation (USO)	A legal right established by the UK Government for everyone to access high speed fixed broadband (10 Mbps download, 1 Mbps upload) if they do not have it, subject to a cost threshold.