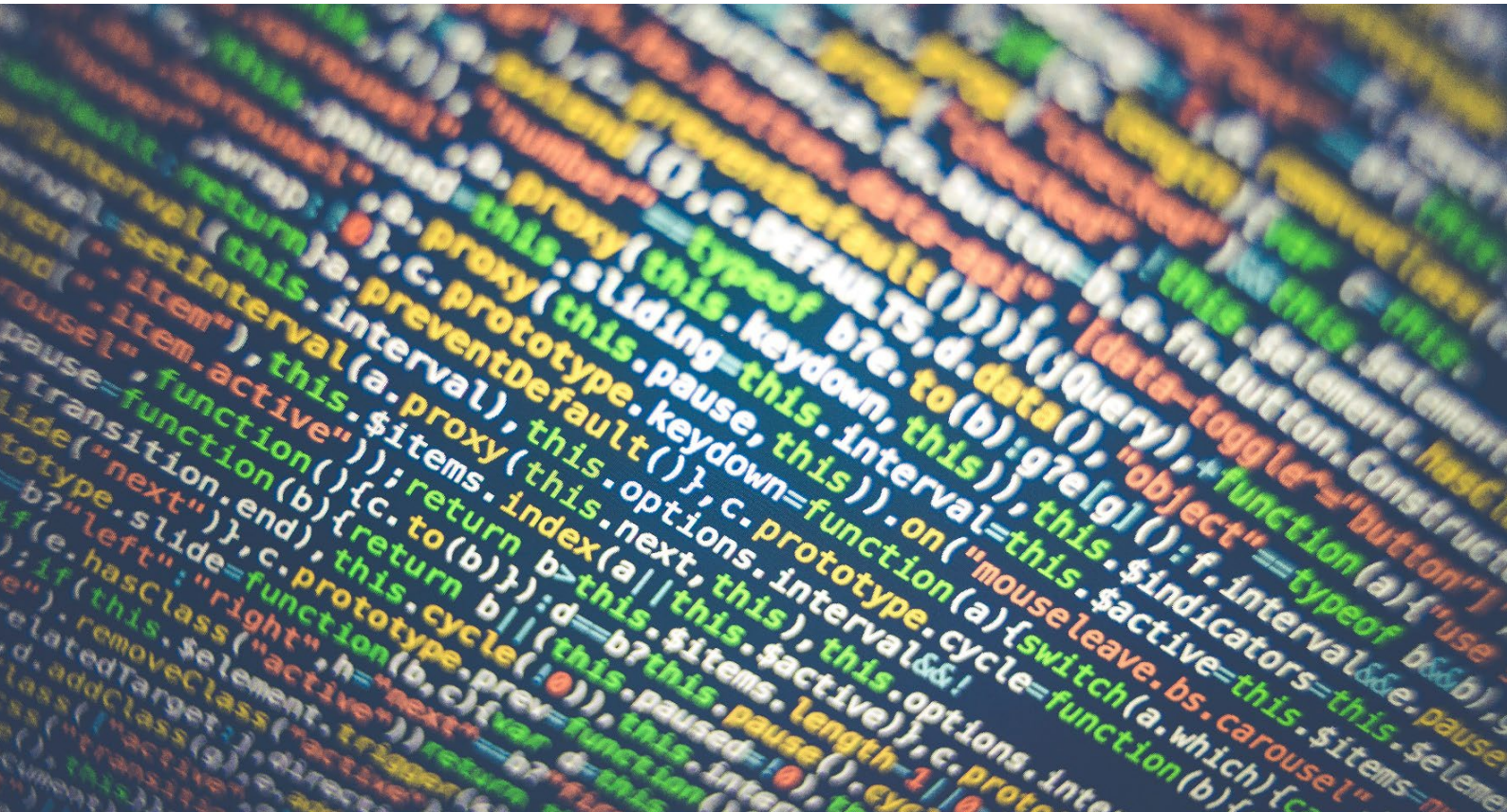
JASPERS Broadband CBA

Model guidance

March 2020



Disclaimer and Copyright

Contents

1. Introduction

JASPERS aim is to speed up the absorption of EUR 350 billion of ESIF Funds intended to achieve greater cohesion in Europe, through projects which are planned, prepared, procured and run to the highest technical, social and environmental standards possible. In a similar fashion, we also help with the absorption of funds available under the Connecting Europe Facility (CEF) and the Instrument for Pre-Accession Assistance (IPA).

JASPERS assistance draws on the experience and business practices of its partners, the European Commission (EC) and the European Investment Bank (EIB). During the previous financial perspective (2007–13), JASPERS identified the need for a common cost–benefit analysis (CBA) model that could be deployed by beneficiaries of broadband projects.[1] This approach was aimed at helping to improve assessments of broadband connectivity-based intervention projects in a consistent manner.

In 2012, JASPERS commissioned independent consultancy firm Analysys Mason to develop the required CBA model and its accompanying guidance paper. The model drew on global research as to the impact of basic and next-generation access (NGA) broadband connectivity based on a literature review exercise carried out towards the end of 2012.

The CBA model was initially published in 2013[2] for use across JASPERS-mandated countries (Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia). The CBA model could also be used for other European countries, but only after relevant amendments.

The model published in 2013 used assumptions regarding the scale of impact that were based on the averages of impacts seen elsewhere, but (necessarily) at different times and under different conditions. The resulting coefficients and quantification of variables for each project or country were used as default values in the absence of more accurate information from the project beneficiary. The model was developed in such a way that the assumptions themselves could be amended, if required. The project beneficiary was invited to verify the suitability of the model assumptions and amend them if more relevant or accurate information is available. In such cases, full justification of any proposed amendment had to be provided.

Since the CBA model was initially published in 2013, the broadband landscape has changed with an increased focus in Europe on ultrafast and Gigabit broadband via Fibre-To-The-Home (FTTH) technology, a number of new studies on economic outcomes have been published and new policy initiatives have been introduced. The regulatory context of the 2014–20 perspective[3] of the European Structural and Investment Funds replaced the previous programming perspective, including new CBA guidelines[4] from the EC as well as other EC policy initiatives, such as the Gigabit Society.[5]

In light of these developments, an updated CBA model was needed to more accurately estimate the potential socio-economic benefits and costs that a project is likely to bring to the local and

---

1 Organisation wishing to make an investment in delivering broadband connectivity to residential and business premises in broadband intervention areas.

2 Published in October 2013 at www.jaspersnetwork.org ((

3 Regulation documents for the 2014 – 2020 perspective are available at http://ec.europa.eu/regional_policy/en/information/legislation/regulations/.

4 Guide to Cost-Benefit Analysis of Investment Projects, Economic appraisal tool for Cohesion Policy 2014-2020, European Commission, December 2014.

5 Connectivity for a European Gigabit Society (https://ec.europa.eu/digital-single-market/en/policies/improving-connectivity-and-access).

national economies. JASPERS has commissioned Analysys Mason to update the current CBA model. The updated model takes into account JASPERS enlarged mandate, to cover all EU countries, as well as an increased focus on intervention on the access network level. Baseline for the new analysis has been the latest published research on benefits of broadband as well as the feedback received from project beneficiaries on the previous CBA model. This has resulted in the modification of parameters and reduction in the number of economic benefits. To complement the previous focus on economic benefits, the updated model has been expanded to include the financial analysis section, allowing a more granular breakdown of costs (i.e. capital and operating costs) and more details on sources of project finance.

The model was presented during a CBA event organized by JASPERS in May 2019 and has been tested in some of the ongoing JASPERS supported projects.

Developing a detailed CBA-model generally applicable for all European countries would be a great challenge, bearing in mind the difference in needs and present situation for the various regions. The aim has therefore been to produce a more generic and user-friendly model. The model also allows for flexibility, so that assumptions can be easily adapted to the specific needs of different Beneficiaries. The user is therefore invited to carefully consider the different parameters against each particular project case. In particular the level of broadband connectivity already present in the project target area.

It is important to stress that the model and benefits presented are linked to infrastructure investments aimed at improving connectivity of a given area/region and not to the development of specific ICT services in a given sector or industry, such as in the healthcare, education or government services. Projects aimed solely or primarily at, for example, improving connectivity to schools, expanding on the eGovernment or eHealth services are usually distinct undertakings, requiring consideration of additional economic costs and benefits that are sector- and project-specific.

Why a CBA?

A CBA is a tool for deciding which projects should be co-financed with public funds. It can enable an efficient use of limited resources and demonstrate value and convenience for society, i.e. making sure the project with the best value for money, quality and potential to affect the economy is chosen.

1.1 Rationale

The need for a consistent and comparable assessment methodology in the broadband sector has been driven by an appreciation that the EC's guidance on completing a CBA may be interpreted differently by different potential project beneficiaries. This often results in inconsistencies of approach in terms of development of CBA among different broadband projects, although the scope of intervention might be similar. The availability of the current template model will mean that CBAs can be carried out in a consistent fashion, applying a streamlined approach based on recent sector surveys and developments. It will contribute to a greater level of consistency in the appraisal and funding approvals. It should, however, be noted that the use of the model should only be seen as a recommendation and as a complement to the current EC CBA guidelines, on which it is based. Project beneficiaries have the flexibility to use alternative types of benefits in their funding applications or can modify parameters of the benefits considered in the model, as long as the approach is in line with the EU regulations. In such case it should however be ensured that the methodology and assumptions used are properly explained.

Objective of the paper

The objective of this paper is to provide guidance on the use of the updated CBA model in order to evaluate economic viability of investments in broadband projects across the EU, including sensitivity and risk assessment, along with job creation estimates.

The assumptions used are also explained so that they can be amended if more accurate information is available for a specific project.

1.2 Overview of CBA model methodology

A review of the previous CBA model guidance and socio-economic benefit parameters served as a starting point in suggesting inputs for an updated CBA. A fresh literature review of the socio-economic benefits and costs associated with broadband connectivity was carried out, with an emphasis on differentiating the benefits by speed (e.g. 'Superfast' and 'Ultrafast' broadband as defined in Figure 1.1 below). The category of "nothing to basic" broadband has been removed from the model. In light of the past and current policy objectives of the EU, such as the Gigabit Society, it is unlikely that there would be any larger-scale projects aimed at providing solely basic broadband connectivity.

During this wide-ranging exercise, two areas were identified as more likely to see significant benefit from the extension and enhancement of broadband roll-out and where quantification of this impact is considered possible in a generic model. These areas drive the analysis:

- *Consumer benefits* – measured as consumer surplus per month per household.
- *Business benefits* – calculated as a productivity improvement that captures all gains, including the benefits resulting from teleworking.

Other areas, such as education, environment, e-government, farming and social inclusion were reviewed, but the evidence base was insufficient to adequately quantify and value the resulting benefits in a manner that keeps its explanatory power in a broad variety of circumstances. The key references used in the literature review exercise are provided in Annex A.

It is assumed that the impact on the local economy will depend on the difference in speeds between the existing broadband provision and that proposed. Hence, three broadband speed categories have been assessed in the CBA model. A brief description of the broadband speed categories is given in the table below.

A project Beneficiary should carefully consider the existing broadband provision before taking the final decision on the value of parameters (in case of availability of basic or fast broadband in the project area, it is suggested to lower the parameters). Introducing discrete speed categories between move from nothing to superfast broadband, basic to superfast broadband and fast to superfast broadband (and consequently for the ultrafast broadband) would result in overly complicated model and it cannot be guaranteed that there would be sufficient data available.

Figure 1.1: Broadband speed categories used in the CBA model

Broadband speed category	Description
From nothing/basic/fast broadband to superfast broadband[6]	This category represents premises with either no broadband, basic broadband (>2Mbit/s) or fast broadband (>10Mbit/s) currently but will get superfast broadband (>30Mbit/s) due to this project
From nothing/basic/fast broadband to ultrafast broadband	This category represents premises with either no broadband, basic broadband (>2Mbit/s) or fast broadband (>10Mbit/s)

6 Basic broadband is defined as being between 2Mbit/s and 10Mbit/s, fast broadband defined as 10Mbit/s to 30Mbit/s, superfast broadband is defined as 30Mbit/s to 100Mbit/s, ultrafast broadband is defined as greater than 100Mbit/s.

	currently but will get ultrafast broadband (>100Mbit/s) due to this project
From superfast to ultrafast broadband	This category represents premises currently getting superfast broadband, but will get ultrafast broadband due to this project

1.2.1 Literature review summary

In the five years since the initial research into the socio-economic benefits of broadband that informed the previous CBA guidance, the research literature has developed. New areas of research have opened up and there are also an increasing number of actual outcomes that provide a data set for econometric-based analysis. All this has occurred alongside continued growth in the reach of such networks, the numbers of their users and the range of applications available.

It is now clear that connectivity is delivering significant benefits: allowing consumers to access wider choice and cheaper goods, businesses to extend their markets, access innovation and buy better, social organisations to transform both their offerings and effectiveness, while Government finds new ways to simplify its services and communications.

The literature recognises this positive transformation but is becoming more sophisticated, noting that evaluation of impacts is often complex, dynamic and with implications that can run contrary to expectations. It is recognized that, although thorough, the literature review is by no means exhaustive. Depending on scope and even area of implementation, parameters and assumptions, could, and should, vary. Where differing studies are in conflict as to likely impact, a prudent course has therefore been adopted. This again underlines the baseline scenario, that the model is generic in its nature, and assumptions should be revisited in order to ensure that they are applicable for a project.

The world of business has been quick to take up the advantages of Superfast broadband, but the evidencing of the expected higher productivity is less obvious. It may be that its real contribution lies in avoiding the large economic loss that would result from not supporting a network, as existing activity would quickly move to better-served areas.

The foregoing means that building a generic CBA model for broadband across European countries remains a challenge.

As shown in Figure 1.2, the paper addresses nine categories of project benefits. The literature review found **two main areas where benefit was sufficiently evidenced to be brought into a generic CBA model.**

In addition, seven categories of benefits are described in this note only qualitatively, recognising that quantification of these benefits may be possible in case of individual projects (e.g. if connection to schools, public administration agencies, hospitals, etc is an important policy area or project objective, and sufficient evidence exists to quantify the relevant benefits).

Figure 1.2: Benefits identified through the literature review

Quantitative	Qualitative
Consumers: consumer surplus per household, from online savings, communication and entertainment	**e-education:** benefit of connectivity to home learning is insufficiently evidenced to adequately quantify for a broadband CBA
Business: business benefit per employee – calculated as a composite productivity rise	**Environment:** benefit of networks to limit environmental impacts is mixed, moreover

reflecting improved efficiency and innovation at the connected premises	there is a variety of small effects which are difficult to estimate, so overall effect cannot be quantified
	e-health: based on savings from development of e-health initiatives
	e-government: more pervasive and faster networks aid delivery of online services but majority of benefits in this area are already captured by availability of basic broadband
	Social inclusion: inherently intangible benefit, but of importance for the project's outcomes
	Farming: increase in farm production/output through adoption of new methods, breeds/crops, and higher value added

Quantitative benefits

- *Consumer benefit*

Consumers have experienced considerable benefits, as evidenced by their high take-up of Superfast broadband services. It also appears that consumers that take a service are very likely to continue to do so demonstrating very high levels of continuing satisfaction. The 'consumer surplus' (difference between willingness to pay and subscription fee) is projected to have risen since the 2013 model as applications are now more developed and broader in range, and connection speeds have greatly improved with the typical Superfast broadband customer seeing a doubling or more of the speed in this period. However, estimating consumer surplus is difficult, as consumers tend to respond to questions around value (e.g. willingness-to-pay) with their estimate of the current cost.

In general, areas with higher incomes will have a higher willingness to pay as they have a greater disposable income. Where possible it is recommended to seek a project specific value of consumer benefits. If there is lack of such value, a single estimate can be considered for the generic CBA model across all Europe. The research literature, including EC, OECD and national studies, suggests a very wide range for consumer surplus, including even what is being measured, as illustrated in the table below.

Figure 1.3: Consumer surplus estimates

Study	Consumer surplus estimate
EC average savings per household from buying cross-border online (2011)	EUR745 per household per year or EUR62 per household per month (note excludes wider benefits from connectivity)
UK benefits per household (SQW 2008)	GBP23 (~EUR26) for poorest 10% of households to GBP148 (~EUR170) for richest 10% per household per month

Impact on house prices of higher connection speeds (Ahlfeldt, et al, 2017)	3% rise in property prices with a doubling in speed, tailing off as speeds rise. Implies consumer surplus per household of around GBP70 (~EUR80) per month with fibre connection
NBER (Nevo) demand for Residential Broadband (2015)	~USD85–114 (EUR74–100) per household per month for NGA, rising to USD175–279 (EUR153–244) for fibre connections (includes some business / work related benefit)
KPMG – Delivering Britain's Digital Future (2015)	EUR38 for 8Mbit/s, EUR45 for 50Mbit/s and EUR50 for 100Mbit/s per household per month (this implies an incremental consumer surplus from basic to superfast is EUR7 and from superfast to ultrafast is EUR5)
Huawei Study (Draca) on Fibre (2018)	Total 'consumer' surplus – including business users – as high as 12-15% of total GDP
DCMS (UK) Superfast Evaluation (2018)	Increase in the sense of 'well-being' (which is here analogous to consumer surplus) is ~GBP19 (EUR22) per household per month in moving from basic broadband to NGA broadband

These estimates range across time, place, currency and scope. The US studies, in particular, need to be adjusted to remove business benefits which, in this model, are captured elsewhere. There is then a reasonably close alignment between the prudent (lower) estimates derived from recent research (of EUR174 a year[7]) and that generated by updating the 2013 estimate (EUR180 per year).

Given that much higher values are also seen in the recent research, it is considered appropriate to align this analysis with the slightly higher per year estimate than EUR180, bearing in mind too that speeds and applications continue to improve, including the development of Smart Home applications. Note though that some Smart Home applications, for example around the important use case of heating, can be achieved with basic broadband. In addition, more advanced applications, which will be developed and used in the future, are likely to result in a higher consumer surplus.

It is suggested in this model that a consumer surplus for Europe is centred around EUR200 per year (~EUR17 per month) for the increase achieved with Superfast provision, compared to basic broadband, which has therefore been adopted as the base case. A consumer surplus of EUR240 (EUR20 per month) is suggested for Ultrafast provision compared from basic broadband.

As already outlined, the value of the parameters should be carefully considered on a project by project basis, including assessment of speeds already available. Thus, in case there is already

7 The yearly consumer surplus per household is derived from the monthly average of EUR7 (KPMG, 2015) and EUR22 (DCMS, 2018) applying foreign exchange rate as of 09 November 2018

relatively good basic broadband internet, the value could be considered to be lowered. The project promoters can also propose higher values if these can be properly justified.

Where a local estimate of consumer surplus is available this can be substituted into the model.

- *Businesses benefit in particular from the enhancement of business productivity*

Businesses (especially SMEs) are seeing that broadband confers such benefit that it is now regarded as a necessity, with nearly universal adoption. There is evidence for productivity benefit, but also some conflicting studies.

Figure 1.4: Productivity estimates

Study	Productivity estimate
EC (2008)	A constant increase in e-business adoption at 3% per year (2006 rates) yields an annual productivity improvement of 0.25% per year at the macro-economic level
Frontier Economics (2011) for European firms	Every 1% increase in telecoms capital stock is associated with a 0.05% to 0.06% increase in productivity
Grimes *et al*.: New Zealand (2011)	A productivity effect of broadband (relative to no broadband) of approximately 7% to 10% across all firms
Deutsche Telecom: Germany (2011, 2013)	The effects of broadband adoption vary between firms, and more extensive data might be needed to observe the long-run benefits of broadband usage
Haller *et al.*: Ireland (2015)	Neither productivity nor productivity growth is significantly affected by broadband adoption

The 'no impact' and 'insignificant impact' studies are discounted as likely affected by methodological problems, given that businesses are clearly very keen to adopt ever better connectivity. The remaining studies suggest an impact on productivity between 3% and 10%, though only after a prolonged period. **A productivity[8] rise of 3% is suggested for Ultrafast broadband deployment (the most conservative approach from between 3% and 10% has been chosen) but the maximum productivity rise is realised after a number of years to maintain prudence.**

Another area that has started to appear more in the literature review is tele-working. A number of teleworking studies tend to be short and highly focused (e.g. on a single firm). While beneficial impacts have been noted from Spain, the US and elsewhere quantification has been challenging. The highest reported contribution to productivity is 13%, reflecting reduced absence and less distraction amongst teleworking call centre personnel in a Chinese study (Bloom et al). This group however reported a general desire to reduce the teleworking element and the longer term sustainability of such high increases in productivity are therefore doubtful.

High-speed broadband makes working from home easier and there is likely to be a rise in the number of employees doing so. However, this rise is limited as firstly many industries require the worker to be present, whether doctor, teacher or factory worker. As a result, the projection is limited

8 Productivity is Gross Value Added (GVA) output per employee hour and is expressed as per employee to help scale it to the intervention area.

to a proportion of those in the private service sector. Secondly, tele-working could reduce the sense of 'team' that an employee needs, ultimately reducing productivity. It is therefore further assumed that tele-workers do so for only part of the week. For the CBA model, we have prudently assumed the addition of a 0.1% rise in GVA per employee when quantifying business benefit to reflect the potential of tele-working. This means the starting year will be 0.3% rise in GVA per employee instead of 0.2% rise in GVA per employee in case of superfast broadband; and 0.4% rise in GVA per employee in case of ultrafast broadband (resulting in 4% rise in GVA in year 10 of the analysis).

The literature review noted other areas of benefit, such as the fostering of innovation, which can be added to productivity to generate a composite measure of impact on business.

However, it is worth noting that the literature review found also that other often quoted benefits such as extending market reach or achieving savings on materials and purchases were likely overstated. The greater market reach works both ways, exposing firms to greater competition in their home markets, and similarly one's firm saving from switching to a new supplier is another firm's loss. In general, the impact of greater connectivity is likely to be greater competition.

1.2.2 Socio-economic parameters used within the CBA model

A summary of the parameters and assumptions used in the model, which have been derived from research within the literature review, is provided in Figure 1.5.

Figure 1.5: Summary of socio-economic parameters used in the CBA model

Parameter	Assumptions
Consumer surplus per household	• **For Superfast:** the assumed consumer surplus per connected household for the JASPERS CBA template is set at **EUR17 per month** • **For Ultrafast:** the assumed consumer surplus per connected household for the JASPERS CBA template is set at **EUR20 per month** • **For Superfast to Ultrafast:** the benefit will be the difference between the two, i.e. EUR3 per month
Business benefit per employee – productivity rise	• **For Superfast**: business benefit per employee, rising at 0.3% (incremental) per year, is projected to **reach 3% after 9 years** and then stabilise • **For Ultrafast**: business benefit per employee is projected to **reach 4% after 9 years,** rising with a steady profile of 0.4% (incremental) per year • **For Superfast to Ultrafast:** the benefit will be the difference between the two, i.e. 1% after 9 years

In addition to socio-economic benefits, the direct and indirect impact of the total spending on the network is likely to generate a number of job years for each million euro invested. This will depend on the Member State designation and our assumptions are as follows:[9]

- Projects in 'Cohesion' member states are likely to generate **40 job years per EUR1 million.**
- Projects in 'Other' member states are likely to generate **15 job years per EUR1 million.**

Qualitative benefit

The literature review found many benefits likely to be of significance, but which were insufficiently evidenced to provide an adequate scale of benefit in a generic model.

▶ *Farming benefit through the adoption of best practice and simplified administration*

The relevance of advanced networks to farming has had little attention, probably because rural areas have been difficult to serve. A study by PWC for the National Broadband Plan in Ireland found that such connectivity could benefit farms in many ways, from accessing CCTV to simplifying the considerable administration around farming, grants, environmental measures and business generally.

The PWC study noted that a 'smart farm' could be 30–59% more than a 'traditional' farm. Only a proportion of this will be due to connectivity however.

▶ *Government benefit – enhancement of e-government services*

Government benefits from the development of e-services, reducing its administration costs while offering a quicker and more convenient service to its users. In general, e-government services are capable of being operated at lower than Superfast speeds. Consequently, expansion and enhancement of networks will significantly positively affect e-government savings only where a proposed network brings broadband to a populous area that is either unserved or very poorly served. Such regions are now rare in Europe. Accordingly, this area of potential benefit is excluded from the model but should be highlighted as a qualitative benefit in the CBA.

If there is a particular project that is likely to lead to significant e-government savings as a key benefit, an estimation of e-government savings can be derived using the proportion of intervention premises to total premises multiplied by an estimated yearly e-government savings (typically can be found in the e-government strategy of the Government). However, this savings figure is expected to be relatively small when compared to consumer and business benefits.

▶ *Health benefit*

The health sector has been disappointingly slow to realise the undoubted benefits that a pervasive broadband network could achieve. In one key area alone, telecare, the provision of remote monitoring and care guidance, it has been shown in trials that health outcomes can be improved, and hospital admissions reduced, thus improving care while cutting costs. Hospital stays are so expensive that a single avoided stay might largely justify the capital cost of the connection. There is then the possibility that health benefits alone might be enough to fully justify a comprehensive fibre roll-out. However, attainment of these benefits is dependent on a wider change and investment

[9] Cohesion Member States (as specified by the EC guidelines): Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia. Other Member States: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, UK.

within the health sector, arguably shifting from a hospital or provision led system to one that is centred on the individual.

Health-related benefits are therefore excluded from the model, but it should be noted that already a Superfast connection is an enabler for e-health benefit, which is a significantly positive point to be recognised.

- *Education benefit*

Education in schools and colleges has benefitted greatly from connectivity, allowing pupils and students to access a vast range of educational material and resources that can make the learning process more engaging and productive.

Projects that bring Ultrafast broadband to schools and colleges will build on this foundation and bring the potential for new developments such as Augmented Reality (AR) and Virtual Reality (VR) allowing a physics class to journey into space, a geology student the chance to venture into a volcano, a history student a visit to ancient Rome. This future is however still being built and an independent assessment of its potential contribution to educational attainment remains distant. Thus, while enhancement of connectivity to educational institutions will undoubtedly bring benefits, these cannot be assessed at present in a generic analysis, and consequently are not included in the model.

The effects of bringing improved connectivity to the homes of pupils and students is more developed but the evidence in this case is mixed: there are studies, which find that it improves some performance and general agreement that it raises core digital skills, through familiarisation. However, other studies find that the distraction that the Internet presents outweighs the benefits and thus impairs academic attainment.

Consequently, while education is regarded as both important and an area where connectivity can contribute, the evidence base is currently insufficiently established to permit inclusion in the CBA model. Projects that provide support to the enhancement of educational networks would be helpful in providing the required evidence, permitting the inclusion of this area in the future.

- *Environmental benefit*

Similarly, and as foreshadowed above, the impact on the environment is a matter of great policy interest. The scope for connectivity to reduce environmental impact is potentially vast, through promoting teleworking or efficiency such as (car based) lift sharing, or promotion of best practice in waste reduction, energy use or other area. However, studies that attempt to quantify this have been weak methodologically and cannot accordingly bear the weight of EUR multi-million investment. Further some studies have highlighted the extent to which digital activities have generated costs to the environment, notably around electricity consumption. As a result, benefit to the environment cannot be robustly quantified and accordingly was excluded from the CBA model.

- *Social inclusion*

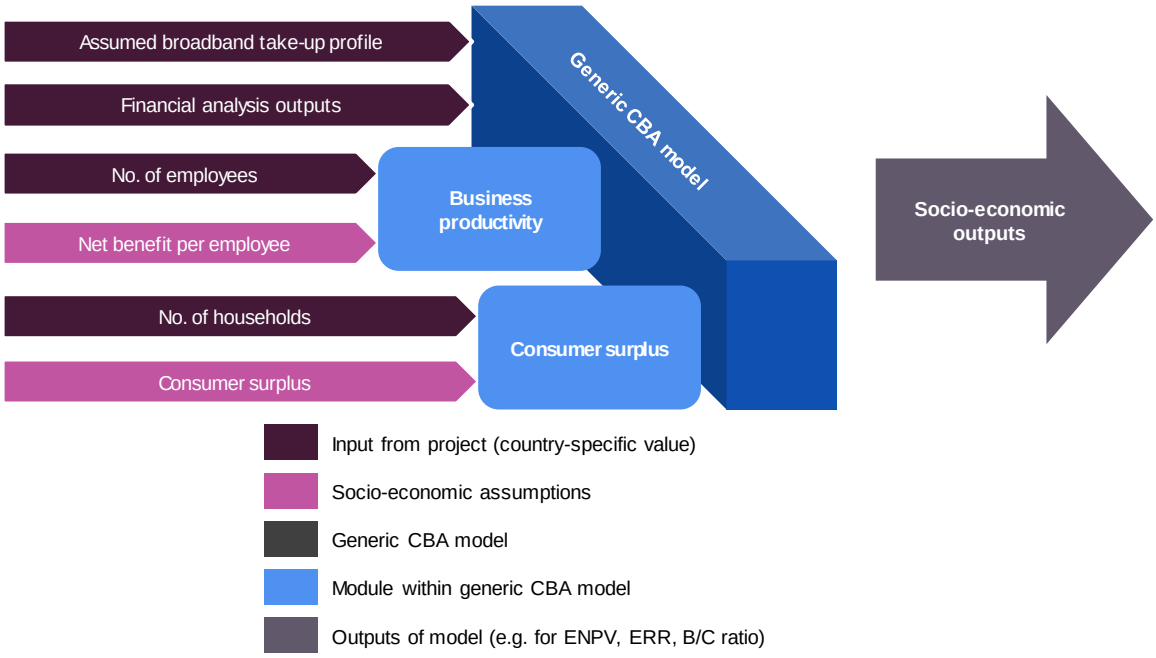
Social inclusion is a priority for the EU. This area is though inherently much more intangible than education or the environment. There is a presumption amongst many that the greater contact that digital methods provide will inevitably increase bonds and thus social cohesion. This is not yet a settled matter however with some studies highlighting the extent to which social media, for example, can lead to greater polarisation.

1.2.3 Modelling approach

The previous Excel-based CBA model was updated and revised using project inputs and the above assumptions drawn from the recent literature review to drive CBA outputs. Values recommended

in the EC CBA guidelines for certain key parameters such as reference period and discount rates have been applied. The approach is depicted in the figure below.

Figure 1.6: CBA modelling approach



The model was tested using real data from projects and some assumptions were refined during that process. These assumptions can be further refined when more accurate information becomes available.

A separate model, called 'Risk analysis – Monte Carlo', can be used for the quantitative risk analysis section. The model can be found on this website and guidance regarding the lower and upper bounds of capital expenditure (capex), operating expenditure (opex) and benefits to be used in the 'Risk analysis – Monte Carlo' model is provided in this note.

1.3 Guidance note structure

The remainder of this note is structured as follows:

- Section 2 (CBA model structure) explains how the model has been designed and how it works
- Section 3 (Instructions on using the CBA model):
  - explains the inputs required in the model
  - gives guidance on how to derive input figures if they are not available
  - describes how the model calculations work and the model outputs to be used in the EC application form and CBA documentation.

2. CBA model structure

The revised CBA model consists of 10 worksheets. The function of each worksheet is described below.

Figure 2.1: CBA model structure

Model worksheet	Functions
Information	This worksheet provides the style guidelines and parameter definitions used in the model.
Inputs	This worksheet provides a template for the project beneficiary to insert all project inputs such as capex, revenues, sources of finance etc. It is required to fill in this worksheet to allow the calculation of the financial and economic outputs.
Parameters	This worksheet shows the parameter assumptions used in the socio-economic benefit model, which are mainly derived from the literature review. These parameter assumptions should be used as default values in the absence of more accurate information. If these values are altered, relevant justification is expected to be provided in the project documentation.
Financial analysis	This worksheet performs the financial analysis based upon the information provided in the '*Inputs*' worksheet. This worksheet calculates financial net present value (FNPV) for the designated project. The corresponding outputs are presented in the '*Output-financial*' worksheet.
Economic analysis	This worksheet performs the socio-economic analysis based on the information provided in the '*Inputs*' worksheet and the parameters defined in the '*Parameters*' worksheet. This worksheet calculates the economic net present value (ENPV) for the designated project. The corresponding outputs are presented in the '*Output-economic*' worksheet.
Sensitivity	This worksheet carries out the sensitivity analysis. The corresponding outputs are presented in the '*Output-economic*' worksheet.
Output-economic	This worksheet presents the socio-economic and sensitivity analyses outputs in the formats prescribed by the EC application form. A command button needs to be clicked to calculated switching values for critical variables.
Output-financial	This worksheet presents the financial analyses and financing plan of the project as prescribed by the EC application form.
Estimated job created	This worksheet presents an estimated number of jobs created for the project under consideration. The output is derived based on a combination of literature review and project inputs.
Qualitative risk	This worksheet provides a template for project beneficiaries to complete their assessment in the prescribed format.

2.1 Financial analysis

Financial analysis is carried out within the '*Financial analysis*' worksheet of the model based on project inputs such as capex, opex, revenues, sources of finance, loan disbursements, inflation and replacement costs. The analysis has been split into three blocks to provide flexibility of having different ownership and operating models (also referred as business models in this document):

- *Consolidated cashflows* – which shows the consolidated project cashflow from both the owner and operator, and flows through to the rest of the model.
- *Owner cashflows* – which shows the internal cashflows attributed to financial inputs associated with the network owner (public-sector or private-sector body).
- *Operator cashflows* – which shows the internal cashflows attributed to the financial inputs associated with the network operators (public-sector or private-sector body).

The model has been designed to provide flexibility to choose different business models, which is explained in Section 3.1.2.

As required by the EC CBA guidelines and EC Regulations 1303/2013,[10] 2015/207[11] and 2014/480,[12] two cashflows have been produced to flow through the model:

- Cashflow without project financial structure, which gives FNPV on the investment cost – referred to as FNPV(C) – and the financial rate of return (FRR) on investment cost – referred to as FRR(C) – as main outputs.
- Cashflow with project financial structure, which gives FNPV on national capital – referred to as FNPV(K) – and FRR on national capital – referred to as FRR(K) – as main outputs.

Full guidance on the CBA financial analysis can be found in the EC CBA guidelines as mentioned above.

2.2 Socio-economic analysis

Socio-economic analysis is carried out in the '*Economic analysis*' worksheet of the model based on project inputs (e.g. number of residential premises and business employees connected) and parameter assumptions from the literature review (e.g. consumer surplus and GVA rise per employee). Two socio-economic benefit areas (i.e. business employee benefits and household consumer surplus) have been quantified to give the following outputs, which can be found on the '*Output-economic*' worksheet:

- ENPV
- ERR
- ratio between discounted benefits and costs (referred to as B/C ratio).

Full guidance on CBA socio-economic analysis can be found in the EC CBA guidelines.

---

10 https://ec.europa.eu/digital-single-market/en/news/regulation-eu-no-13032013-european-parliament-and-council.

11 https://publications.europa.eu/en/publication-detail/-/publication/101cb9e6-b349-11e4-b5b2-01aa75ed71a1/language-en.

12 Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, European Commission, December 2014.

2.3 Risk analysis

Risk analysis comprises three tasks, as follows:

- **Sensitivity analysis** including switching values[13] of critical variables[14] – this analysis is carried out in the '*Sensitivity*' worksheet and the corresponding outputs are presented in the '*Output-economic*' worksheet.
- **Qualitative risk analysis** – this needs to be carried out by the project beneficiary using the template provided in the '*Qualitative risk*' worksheet. All mandatory risks as detailed in Table 2 of Annex III of Commission Implementing Regulation (EU) 2015/207 should be assessed. An example of risk assessment can be found in the EC CBA guidelines, but it is the responsibility of the project beneficiary to assess all project risks, not just the ones provided in the mandatory list.
- **Quantitative risk analysis** – this analysis is carried out using the 'Risk analysis - Monte Carlo' model. Lower and upper bounds on economic benefits and costs will have to be provided by the project beneficiary.

Full guidance on CBA risk analysis can be found in the EC CBA guidelines.

2.4 Estimated number of jobs created

The network, as a major piece of infrastructure investment, generates employment in its establishment and in its on-going operations. This direct network-associated employment is projected within the model. Indirect job effect is not part of the socio-economic analysis. Also, it should be noted that the major contribution of the network to employment is in the way it transforms the economy and aids businesses, and this impact is gathered in the assessment of impact on the economy.

An estimation of the number of jobs created following investment in the project under consideration is provided in the '*Estimated job created*' worksheet of the model based upon project inputs and literature review findings.

The model's estimate of the number of jobs created is dependent upon the categorisation of the Member State in which the beneficiary's project is being implemented, which is driven by the differences in labour costs across Europe. Therefore, Member States that are categorised as 'Cohesion' Member States have a different number of jobs created per EUR1 million value to Member States that are categorised as 'Other' Member States.[15] The selection of the Member State category is found in the '*Inputs*' worksheet.

---

[13] The value of a variable which would have to occur in order for the NPV of the project to become zero, or more generally, for the outcome of the project to fall below the minimum level of acceptability.

[14] Those variables or parameters for which an absolute variation of 1% around the best estimate gives rise to a corresponding variation of not less than 1% (one percentage point) in the ENPV or FNPV(K) (i.e. elasticity is unity or greater).

[15] Cohesion Member States (as specified by the EC guidelines): Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia. Other Member States: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, UK.

3. Instructions on using the CBA model

Before using the CBA model, it is recommended that project beneficiaries read the '*Information*' worksheet to familiarise themselves with the following elements:

- *Style guidelines* – different cell styles are used to differentiate between inputs, outputs and parameter values cells.
- *Parameters description* – definition of all parameters used in the model.

3.1 Inputs

The model inputs are available in the '*Inputs*' worksheet of the CBA model. All model inputs must be filled in by the project beneficiary.

The screenshot in this section are for illustrative purposes only. Project beneficiaries should fill in these parameters based on their project.

Note: only the **solid blue bordered cells** should be filled in.

3.1.1 Generic parameters

The first section of the '*Inputs*' worksheet covers the generic, correction factor and socio-economic parameters, as shown below.

Figure 3.1: Generic, correction factor and socio-economic parameters in 'Inputs' worksheet

Generic input parameters	**Unit**	**Value**
First year of infrastructure roll-out	Year	2019
Number of roll-out years	Year	4
Currency used in the model		EUR
EUR to EUR conversion ratio	#	1
Price level of financial analysis		Constant
Member state classification		Other
Financial discount rate used in the model - Real discount rate	%	4.0%
Social discount rate used in the model	%	3.0%
Co-financing rate of the priority axis	%	85.0%
Total number of households in the intervention area	#	90,000
Total number of premises in the intervention area	#	100,000
Reference period	Year	20
Correction factor parameters	**Unit**	**Value**
CAPEX Correction factor due to fiscal corrections / shadow pricing	#	1.00
OPEX Correction factor due to fiscal corrections / shadow pricing	#	1.00
Socio-economic parameters	**Unit**	**Value**
Current (localised) GVA per employee	EUR	10,000

Project beneficiaries should use the following guidelines when providing inputs to "*Price level of financial analysis*" and annual inflation rate parameters.

Figure 3.2: Price level of financial analysis options

Price level of financial analysis	Financial discount rate	Annual inflation rate data
Constant	Real discount rate	Project beneficiary is **not** required to fill in projection of inflation rate
Current	Nominal discount rate	Project beneficiary is required to fill in projection of inflation rate

Inflation rate input will need to be completed if the "*Price level of financial analysis*" is carried out using **Current** prices as mentioned above. Inflation is required because the socio-economic analysis is always carried out using real discount rate. A snapshot of the inflation rate input section is shown below. Inputs should be provided for the whole reference period (15-20 years for broadband).

Figure 3.3: Inflation rate in 'Inputs' worksheet

Inflation	Unit	2016	2017	2018	2019	2020
Annual Inflation rate	%	0.0%	2.8%	2.5%	2.5%	2.5%
Value after applying inflation rate	%	100.0%	97.3%	94.9%	92.6%	90.3%

Project beneficiaries should also select the relevant '*Member State classification*', as described below, which determines the social discount rate used within the model.

Figure 3.4: Social discount determination options

Member State classification	Definition	Social discount rate used in model
Cohesion	Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia	5%
Other	Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, UK	3%

3.1.2 Business models

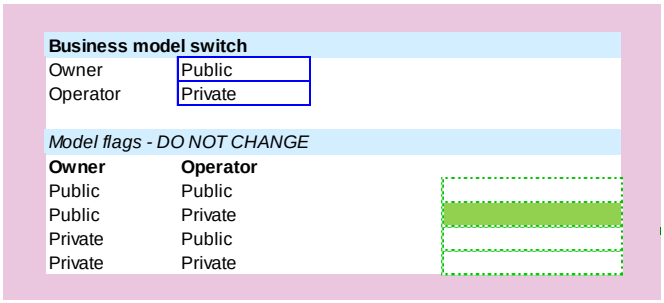
The CBA model accounts for 'Owner' and 'Operator' inputs to represent scenarios where the infrastructure owner may be different from the operator. Both the 'Owner' and 'Operator' could be either a public body or a private enterprise, therefore there are four possible business models that could arise:

- **Public Owner – Public Operator:** the public body should **only** fill in the 'Owner' section of the 'Inputs' sheet. This will avoid any potential double-counting of financing, costs or revenues in the 'Inputs' sheet.
- **Public Owner – Private Operator**: both 'Owner' and 'Operator' blocks need to be filled in. For this option, the "private contribution" (under 'Sources of Finance') for the 'Owner' should be set to zero and similarly, the "public contribution" (under 'Sources of Finance') for the 'Operator' should be set to zero. An opex-only model is used by many operators worldwide and the individual cash flow analysis is still useful. Even though there is no capex for Private operator, the profitability of the operator is still interesting as well as sustainability even though the NPV and FRR values are not meaningful (therefore no conclusion should be drawn from the NPV and FRR values).
- **Private Owner – Public Operator:** Whenever this option is selected, a "red" flag is shown in the 'Inputs' sheet of the model (as depicted in Figure 3.5) because this option is unlikely but for completeness, this option has been kept in the model.
- **Private Owner – Private Operator:** the private body should **only** fill in the 'Operator' section of the 'Inputs' sheet. This will avoid any potential double-counting of financing, costs or revenues in the 'Inputs' sheet.

Note: for the business model option to work correctly, project beneficiaries should ensure that "Sources of finance" block is completed accurately (see Section 3.1.7).

Project beneficiaries should select the appropriate business model from the 'Business model switch' section in the 'Inputs' worksheet, using the drop-down boxes, as shown below. **It is imperative that project beneficiaries input data in the appropriate section of the 'Inputs' sheet** for the results in the 'Financial analysis' sheet to get sensible results for interpretation.

Figure 3.5: Business model options in 'Inputs' worksheet



3.1.3 Socio-economic parameters

In order to tailor the socio-economic parameters to the intervention area (and country), country-specific information needs to be added within the first section of the '*Inputs*' sheet.

The current localised GVA per employee should be available within each country (or calculated as a proportion of the intervention area within the country). If such data is not readily available from the local Government statistics body, it can be derived from other sources such as Eurostat website[16].

16 https://ec.europa.eu/eurostat/news/themes-in-the-spotlight/gva-employment-2017

3.1.4 Breakdown of Owner, Operator and Consolidated 'Input' sheet blocks

The next section of the '*Inputs*' worksheet is separated into 'Owner' and 'Operator' inputs. These two blocks are principally the same and represent the potentially different broadband network ownership and operating model scenarios (e.g. publicly owned, privately operated; publicly funded, privately owned, etc.) and the different capex, opex and revenue inputs that may result from this. The 'Owner' and 'Operator' inputs are combined into a 'Consolidated' block, which calculates the total capex, opex and revenue values for the project. In other words, it means that payments from the operator to the owner are automatically netted in the consolidated cash flows.

The section on financial inputs is not meant to replace more detailed financial models, which are understood to be prepared separately by the project beneficiaries.

3.1.5 Eligible and ineligible capex

Within the 'Owner' and 'Operator' input blocks, capex is broken down into eligible and ineligible expenditure,[17] similar to the format used in Section C.1 of the EC CBA guidelines. The only addition to the categories shown in Section C.1 of the EC CBA guidelines centres around a further breakdown of capex items 3 and 4 to show backhaul and access network expenditure. The project beneficiary is required to provide these inputs in the CBA model. A screenshot is shown below.

Figure 3.6: Breakdown of eligible and ineligible capex in 'Inputs' worksheet

ELIGIBLE capital expenditure		**2019**	**2020**	**2021**	**2022**
1. Planning/design fees	EUR	2,000,000	3,000,000	3,000,000	1,000,000
2. Land purchase	EUR	0	0	0	0
3. Building and construction					
a. Backhaul network infrastructure	EUR	0	0	0	0
b. Access network infrastructure	EUR	5,000,000	20,000,000	25,000,000	15,000,000
4. Plant and machinery					
a. Backhaul equipment infrastructure	EUR	0	0	0	0
b. Access equipment infrastructure	EUR	0	0	0	0
5. Contingencies	EUR	0	0	0	0
6. Price adjustment	EUR	0	0	0	0
7. Publicity	EUR	200,000	300,000	400,000	500,000
8. Supervision during contrusction implementation	EUR	500,000	2,000,000	2,500,000	1,500,000
9. Technical assistance	EUR	0	0	0	0
10. Sub-TOTAL	**EUR**	**7,700,000**	**25,300,000**	**30,900,000**	**18,000,000**
11. VAT	EUR	0	0	0	0
12. TOTAL	**EUR**	**7,700,000**	**25,300,000**	**30,900,000**	**18,000,000**

INELIGIBLE capital expenditure		**2019**	**2020**	**2021**	**2022**
1. Planning/design fees	EUR	0	0	0	0
2. Land purchase	EUR	0	0	0	0
3. Building and construction					
a. Backhaul network infrastructure	EUR	0	0	0	0
b. Access network infrastructure	EUR	0	0	0	0
4. Plant and machinery					
a. Backhaul equipment infrastructure	EUR	0	0	0	0
b. Access equipment infrastructure	EUR	0	0	0	0
5. Contingencies	EUR	0	0	0	0
6. Price adjustment	EUR	0	0	0	0
7. Publicity	EUR	0	0	0	0
8. Supervision during contrusction implementation	EUR	0	0	0	0
9. Technical assistance	EUR	0	0	0	0
10. Sub-TOTAL	**EUR**	**0**	**0**	**0**	**0**
11. VAT	EUR	1,540,000	5,060,000	6,180,000	3,600,000
12. TOTAL	**EUR**	**1,540,000**	**5,060,000**	**6,180,000**	**3,600,000**

[17] Eligible and ineligible capex are defined in the EC application form, and in the '*Information*' worksheet.

3.1.6 Opex, revenues and residual value

The project beneficiary also needs to fill in project opex, revenues and residual value, as shown in the following screenshot. Some spares have been provided to give project beneficiary flexibility on adding any significant opex and revenue items.

Figure 3.7: Opex, revenues and residual value in 'Inputs' worksheet

Operational expenditure		**2019**	**2020**	**2021**	**2022**	**2023**
Maintenance	EUR	0	275,000	1,375,000	2,750,000	3,575,000
Marketing	EUR	0	82,500	412,500	825,000	1,072,500
Passive infrastrucutre rental (e.g. ducts, poles)	EUR	0	171,875	572,917	1,250,000	1,625,000
Energy costs	EUR	0	165,000	825,000	1,650,000	2,145,000
Administrative	EUR	0	0	0	0	500,000
<spare (owner1)>	EUR	0	0	0	0	0
<spare (operator1)>	EUR	0	0	0	0	0
Operational expenditure total	**EUR**	**0**	**694,375**	**3,185,417**	**6,475,000**	**8,917,500**

Revenues		**2019**	**2020**	**2021**	**2022**	**2023**
Fast/Superfast Revenues	EUR	0	144,000	316,800	918,000	1,296,000
Ultrafast revenues	EUR	0	288,000	633,600	1,530,000	2,160,000
Business revenue	EUR	0	1,296,000	2,678,400	4,662,000	5,544,000
<spare>	EUR	0	288,000	633,600	1,530,000	2,160,000
<spare>	EUR	0	0	0	0	0
<spare>	EUR	0	0	0	0	0
Revenues total	**EUR**	**0**	**2,016,000**	**4,262,400**	**8,640,000**	**11,160,000**
Residual value	EUR	0	0	0	0	0
Residual value (Economic analysis)	EUR	0	0	0	0	0

Residual value is a critical input for the financial analysis as it represents the extent of the remaining service potential of the assets. The EC CBA guidance (Sections 2.7.3 and 2.8.9) should be applied to derive this input.

Note: In the economic analysis, for simplicity, the residual value is based on the financial inputs presented in constant prices. The project beneficiaries are invited to enter project specific value based on the EC CBA guidance.

3.1.7 Sources of finance

The 'Sources of finance' input block should be filled in by project beneficiaries to show the various types of public and private grants and loans, along with the relevant loan expenditures. The inputs are split across 'Owner' and 'Operator' funding, with further sections for different public and private financing. These inputs are critical in financial analysis and related financial outputs. It is of critical importance that project beneficiaries fill in this section correctly, with the correct attribution of funds to the relevant area (e.g. 'Owner' or 'Operator'). A screenshot of the input block is shown below.

Figure 3.8: Sources of finance input block in 'Inputs' worksheet

Public sources - OWNER	Unit	2019	2020	2021	2022	2023
Public contribution						
ERDF grant	EUR	1,155,000	3,795,000	4,635,000	2,700,000	0
Other public contribution	EUR	6,715,000	20,635,000	24,855,000	14,800,000	0
Total public contribution	**EUR**	**7,870,000**	**24,430,000**	**29,490,000**	**17,500,000**	**0**

Private sources - OPERATOR	Unit	2019	2020	2021	2022	2023
Private contribution						
Private equity	EUR	385,000	1,265,000	1,545,000	900,000	
Private loan	EUR	1,485,000	5,665,000	7,045,000	4,200,000	
Total private contribution	**EUR**	**1,870,000**	**6,930,000**	**8,590,000**	**5,100,000**	0

Expenditures						
Interest payments	EUR	0	0	0	0	517,359
Principal repayments	EUR	0	0	0	0	1,149,688
Total expenditure	**EUR**	**0**	**0**	**0**	**0**	**1,667,047**

3.1.8 Broadband take-up/number of connected households and business employees

The last section of the '*Inputs*' worksheet is broadband take-up/number of connected households and business employees.

Figure 3.9: Broadband take-up and number of covered households and business employees in 'Inputs' worksheet

COVERAGE AND TAKE-UP
MUST BE FILLED IN BY PROJECT BENEFICIARY

Cumulative broadband take-up in intervention project - Households	Unit	2019	2020	2021	2022	2023
From Superfast broadband to Ultrafast	%	0%	30%	31%	37%	44%

Cumulative broadband take-up in intervention project - Business emplo	Unit	2019	2020	2021	2022	2023
From Nothing/Basic/Fast to Superfast broadband (greater than 30Mbit/s)	%	0%	10%	11%	17%	24%
From Nothing/Basic/Fast to Ultrafast (greater than 100Mbit/s)	%	0%	10%	11%	17%	24%
From Superfast broadband to Ultrafast	%	0%	30%	31%	37%	44%

Cumulative no. of households covered by intervention project	Unit	2019	2020	2021	2022	2023
From Nothing/Basic/Fast to Superfast broadband (greater than 30Mbit/s)	#	3,000	12,000	24,000	30,000	30,000
From Nothing/Basic/Fast to Ultrafast (greater than 100Mbit/s)	#	3,000	12,000	24,000	30,000	30,000
From Superfast broadband to Ultrafast	#	3,000	12,000	24,000	30,000	30,000
Total number of households addressed by this project	**#**	**9,000**	**36,000**	**72,000**	**90,000**	**90,000**
% of households covered in the intervention area	**%**	**10%**	**40%**	**80%**	**100%**	**100%**

Cumulative no. of business employees covered by intervention project	Unit	2019	2020	2021	2022	2023
From Superfast broadband to Ultrafast	#	30,000	150,000	240,000	300,000	300,000

3.2 Parameter assumptions

The parameter assumptions can be read from the '*Parameters*' worksheet of the CBA model. This section explains how these assumptions can be modified if more accurate information is available. Should the project beneficiary decide to alter some of the assumptions, then full justification together with evidence will need to be provided.

Note: only the **solid green bordered cells** should be modified if the project beneficiary has more accurate information.

3.2.1 GVA rise per employee

From the literature review, the assumed GVA rise per employee values for the first year for different broadband speed categories are shown below.

Figure 3.10: GVA rise per employee assumptions in 'Parameters' worksheet

GVA rise per employee due to Nothing/Basic/Fast to Superfast broadband (full realisation)	%	0.30%
GVA rise per employee due to Nothing/Basic/Fast to Ultrafast broadband (full realisation)	%	0.40%
GVA rise per employee from Superfast to Ultrafast broadband (full realisation)	%	0.10%

3.2.2 Household consumer surplus

The literature review suggested that consumer surplus per household are approximately EUR17 (from no/basic/fast broadband to Superfast) and EUR20 (from no/basic/fast broadband to Ultrafast) monthly respectively. Consumer surplus per household for Superfast to Ultrafast broadband is the differential between Superfast and Ultrafast broadband consumer surplus figures.

3.2.3 Number of job years per EUR1 million

The number of job years per EUR1 million is dependent on the relevant country categorisation (Cohesion or Other) as shown below.

Figure 3.11: Number of jobs per EUR1 million based on country classification

Jobs creation parameter	Unit	Value
Number of job years per EUR million (Other Member States)	#	15
Number of job years per EUR million (Cohsesion Member States)	#	40

From the literature review, it was found that 15 job years per EUR1 million of network expenditure is a reasonable estimate for an 'Other' Member State. The number of jobs per EUR1 million for 'Cohesion' Member States is estimated using the ratio of average labour cost between 'Other' and 'Cohesion' Member States.[18]

3.3 Analysis

The main model analysis occurs across the '*Financial analysis*', '*Economic analysis*' and '*Sensitivity*' worksheets.

3.3.1 Financial analysis

The '*Financial analysis*' worksheet details the 'Consolidated' project cashflow which flows through to the economic analysis. The FNPV(C/K) are also calculated – using the input financial discount rate – for each cashflow. A financial sustainability assessment (based upon the EC CBA guidelines) is also carried out for the 'Consolidated' cashflow.

Figure 3.12: Consolidated cashflow projection in the 'Financial analysis' worksheet (example figures)

CONSOLIDATED (OPERATOR + OWNER) (All national sources)						
Cashflow projections (constant 2019 prices)						
Project expenditures and revenues	**Unit**	**2019**	**2020**	**2021**	**2022**	**2023**
Capital expenditure	EUR	8,200,000	26,300,000	31,900,000	19,000,000	0
Operational expenditure	EUR	0	694,375	3,185,417	6,475,000	8,917,500
Revenue	EUR	0	2,246,400	4,769,280	8,035,200	10,454,400
Residual value	EUR	0	0	0	0	0
Replacement costs	EUR	0	0	0	0	0
Net project cashflow without project	**EUR**	**-8,200,000**	**-24,747,975**	**-30,316,137**	**-17,439,800**	**1,536,900**
Interest payments	EUR	0	0	0	0	517,359
Principal repayments	EUR	0	0	0	0	1,149,688
Public contribution (without loan repayments	EUR	6,715,000	20,635,000	24,855,000	14,800,000	0
Private contribution (without loan repayments	EUR	385,000	1,265,000	1,545,000	900,000	0
Net project cashflow considering financial	**EUR**	**-7,100,000**	**-20,347,975**	**-24,816,137**	**-14,139,800**	**-130,147**
FNPV(C)	**EUR**	-19,133,303				
FRR(C)	**%**	1.5%				
FNPV(K)	**EUR**	-20,451,929				
FRR(K)	**%**	0.9%				

18 Ratio is calculated from labour cost data from the International Labour Organisation. The average of data available for 'Other' Member States was divided against the average of data available for 'Cohesion' Member States, to give a ratio of 2.67.

3.3.2 Economic analysis

The '*Economic analysis*' worksheet calculates the socio-economic benefits associated with the project using project specific inputs, the defined socio-economic parameter assumptions and the 'Consolidated' project cashflow. The analysis also calculates the ENPV and ERR (using the defined social discount rate), and benefit-cost (B/C) ratio for the project.

Figure 3.13: Economic appraisal of project in the 'Economic analysis' worksheet

Economic appraisal carried out using Real Social Discount rate							
Adjusted project expenditures and revenues	**Unit**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Capital expenditure	EUR	8,200,000	26,300,000	31,900,000	19,000,000	0	0
Operational expenditure	EUR	0	694,375	3,185,417	6,475,000	8,917,500	7,551,558
Residual value	EUR	0	0	0	0	0	0
Replacement costs	EUR	0	0	0	0	0	0
Undiscounted socio-economic benefits	**Unit**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Business employee benefits	EUR	0	900,000	2,232,000	4,440,000	6,600,000	8,100,000
Household consumer surplus	EUR	0	662,400	1,440,000	2,664,000	3,672,000	3,816,000
Total	**EUR**	**0**	**1,562,400**	**3,672,000**	**7,104,000**	**10,272,000**	**11,916,000**
Total undiscounted socio-economic benefits	EUR	0	1,562,400	3,672,000	7,104,000	10,272,000	11,916,000
Total undiscounted socio-economic costs	EUR	8,200,000	26,994,375	35,085,417	25,475,000	8,917,500	7,551,558
Net undiscounted socio-economic benefits	EUR	**-8,200,000**	**-25,431,975**	**-31,413,417**	**-18,371,000**	**1,354,500**	**4,364,442**
ENPV	**EUR**	67,015,544					
ERR	**%**	8.9%					
B/C ratio	**#**	1.26					

3.3.3 Sensitivity analysis

The '*Sensitivity*' worksheet calculates the effect on key outputs based on the changing of main specific financial and socio-economic input parameters by 1%. The specific outputs that are included in the analysis are FNPV(K)/FRR(K), FNPV(C)/FRR(C) and ENPV/ERR. A screenshot of the sensitivity analysis on ENPV and ERR is shown below.

Figure 3.14: Sensitivity analysis on ENPV and ERR in the 'Sensitivity' worksheet

Net socio-economic benefits						
Sensitivity analysis on ENPV and ERR	**% change**	**Unit**	**2019**	**2021**	**2023**	**2024**
Capital expenditure with 1% increase	1%	EUR	-8,282,000	-31,732,417	1,354,500	4,364,442
Capital expenditure with 1% decrease	-1%	EUR	-8,118,000	-31,094,417	1,354,500	4,364,442
Operational expenditure with 1% increase	1%	EUR	-8,200,000	-31,445,271	1,265,325	4,288,926
Operational expenditure with 1% decrease	-1%	EUR	-8,200,000	-31,381,563	1,443,675	4,439,958
Benefits with 1% increase	1%	EUR	-8,200,000	-31,376,697	1,457,220	4,483,602
Benefits with 1% decrease	-1%	EUR	-8,200,000	-31,450,137	1,251,780	4,245,282
Business employee benefits with 1% increase	1%	EUR	-8,200,000	-31,391,097	1,420,500	4,445,442
Business employee benefits with 1% decrease	-1%	EUR	-8,200,000	-31,435,737	1,288,500	4,283,442
Household consumer surplus with 1% increase	1%	EUR	-8,200,000	-31,399,017	1,391,220	4,402,602
Household consumer surplus with 1% decrease	-1%	EUR	-8,200,000	-31,427,817	1,317,780	4,326,282

3.4 Outputs

The CBA model outputs are shown across the '*Output-economic*', '*Output-financial*', '*Estimated job created*' and '*Qualitative risk*' worksheets.

3.4.1 Output-economic

The outputs of the socio-economic analyses are provided in the '*Output-economic*' worksheet in line with Section E of the EC application form.[19]

19 See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015R0207

Figure 3.15: Outputs of the socio-economic analyses in the 'Output-economic' worksheet

SOCIO-ECONOMIC ANALYSIS

E.2.2 Detail of economic benefits and costs

	Benefit	Unit value (where applicable)	Total value (in euro, discounted)	% of total benefits
1	Business employee benefits	N/A	231,236,497	71.2%
2	Household consumer surplus	N/A	90,793,686	28.0%
3	Residual value	N/A	2,768,379	0.9%
4	**Total**	**N/A**	**324,798,561**	**100.0%**

	Cost	Unit value (where applicable)	Total value (in euro, discounted)	% of total cost
1	Capital expenditure	N/A	78,825,710	30.9%
2	Operational expenditure	N/A	164,738,983	64.6%
3	Replacement costs	N/A	11,449,946	4.5%
4	**Total**	**N/A**	**255,014,639**	**100.0%**

E.2.3 Main indicators of the economic analysis

	Main parameters and indicators	Values	Reference to CBA document
1	Social discount rate (%)	3.0%	[indicate]
2	Economic rate of return (ERR) (%)	9.0%	[indicate]
3	Economic net present value (ENPV) (EUR)	69,783,922	[indicate]
4	Benefit-cost ratio	1.27	[indicate]

The sensitivity analysis and switching values of critical variables are also presented in this worksheet, as illustrated below.

Figure 3.16: Outputs of sensitivity analysis in 'Output-economic' worksheet

E.3.2 Sensitivity analysis - variables tested

	Variable tested	Financial net present value (FNPV/K) variation	Financial net present value (FNPV/C) variation	Economic rate of return (ERR) variation	Economic net present value (ENPV) variation	Critical variable*
						1%
1	Capital expenditure with 1% increase	-0.3%	-4.0%	-0.1%	-1.2%	YES
2	Capital expenditure with 1% decrease	0.3%	4.0%	0.1%	1.2%	YES
3	Operational expenditure with 1% increase	-7.2%	-7.7%	-0.1%	-2.5%	YES
4	Operational expenditure with 1% decrease	7.2%	7.7%	0.1%	2.5%	YES
5	Revenues with 1% change	10.4%	11.1%			YES
6	Revenues with -1% change	-10.4%	-11.1%			YES
7	Benefits with 1% change			0.2%	4.8%	YES
8	Benefits with -1% change			-0.2%	-4.8%	YES
9	Business employee benefits with 1% increase			0.2%	3.5%	YES
10	Business employee benefits with 1% decrease			-0.2%	-3.5%	YES
11	Household consumer surplus with 1% increase			0.1%	1.4%	YES
12	Household consumer surplus with 1% decrease			-0.1%	-1.4%	YES

E.3.2 Sensitivity analysis - switching values for critical variables *

	Critical variable	Switching value	
1	Benefits	Maximum change before **ENPV** turns zero (%)	-20.8%
2	Capital expenditure	Maximum change before **ENPV** turns zero (%)	85.0%
3	Operational expenditure	Maximum change before **ENPV** turns zero (%)	40.7%
4	Capital expenditure	Maximum change before **FNPV/K** turns zero (%)	-299.6%
5	Operational expenditure	Maximum change before **FNPV/K** turns zero (%)	-14.0%
6	Revenues	Maximum change before **FNPV/K** turns zero (%)	9.7%

Calculate Switching Values

A command button needs to be clicked to calculate switching values for the critical variables.

3.4.2 Output-financial

The outputs of the financial analyses are provided in the '*Output-financial*' worksheet in line with Sections C, E and G of the EC application form. The worksheet also provided the financing plan for the project under consideration in accordance with the EC CBA guidelines. It should be noted that the project beneficiary is expected to complete parts of the table that are labelled 'indicate'.

Figure 3.17: Partial output of financial analyses in 'Output-financial' worksheet

FINANCING PLAN

C.1 Cost breakdown

Euro	Total project costs (A)	Ineligible costs (B)	Eligible costs (C)=(A)-(B)	Percentage of total eligible costs
1. Planning/design fees	9,000,000	0	9,000,000	11%
2. Land purchase	0	0	0	0%
3. Building and construction	68,500,000	3,500,000	65,000,000	79%
4. Plant and machinery	0	0	0	0%
5. Contingencies	0	0	0	0%
6. Price adjustment (if applicable)	0	0	0	0%
7. Publicity	1,400,000	0	1,400,000	2%
8. Supervision during construction implementation	6,500,000	0	6,500,000	8%
9. Technical assistance	0	0	0	0%
10. Sub-TOTAL	**85,400,000**	**3,500,000**	**81,900,000**	**100%**
11. VAT	16,380,000	16,380,000	0	0%
12. TOTAL	**101,780,000**	**19,880,000**	**81,900,000**	**100%**

C.3 Calculation of the discounted net revenue

1. Total eligible cost before taking into account of the requirements set out in Article 61 of Regulation (EU) No 1303/2013 (in EUR, not discounted) (Section C.1.12 C)	81,900,000
2. Pro-rata application of discounted net revenue (%) (if applicable) = (E.1.2.9)	18.0%
3. Total eligble cost after taking into account of the requirements set out in Article 61 of Regulation (EU) No 1303/2013 (in EUR, not discounted) = (1)*(2)	14,704,214

E.1.2. Main elements and parameters used in the CBA for financial analysis

Main elements and parameters	Value (EUR)
1. Reference period (years)	20
2. Financial discount rate (%) (1)	4%

Main elements and parameters	Value not discounted	Value discounted (net present value)	Reference to CBA document
3. Total investment cost excluding contingencies	85,400,000	76,800,707	[indicate]
4. Residual value	5,000,000	2,281,935	[indicate]
5. Revenues		211,774,151	[indicate]
6. Operating and replacement costs (2)		151,044,073	[indicate]
Pro-rata application of discounted net revenue (3)			
7. Net revenue = revenues - operating and replacement costs + residual value = (5) - (6) + (4)		63,012,013	[indicate]
8. Total investment cost - net revenue = (3) - (7)		13,788,694	[indicate]
9. Pro-rata application of discounted net revenue (%) = (8) / (3)	18.0%		[indicate]

Where VAT is recoverable, the costs and revenues should be based on figures excluding VAT.
(1) Preferably in real terms
(2) In the meaning of Article 17 of Commission Delegated Regulation (EU) No 480/2014
(3) This does not apply: 1) for projects subject to the rules on State aids in the meaning of Article 107 of the Treaty (see point G1), pursuant to Article 61(8) of Regulation (EU) No 1303/2013; 2) if flat rate (Article 61(3)(a) of Regulation (EU) No 1303/2013) or decreased co financing rate (Article 61(5) of Regulation (EU) No 1303/2013) is used; and 3) if the sum of the present values of operating and replacement costs are higher than the present value of revenues the project is not considered as revenue generating, in w hich case items 7 and 8 can be ignored and pro-rata application of discounted net revenue should be set at 100%.

3.4.3 Estimated job creation

This worksheet provides the estimated number of jobs created based on the project investment and categorisation of Member State, as illustrated below.

Figure 3.18: Number of jobs created in 'Estimated job creation' worksheet

	2019	2020	2021	2022	2023	2024	2025
No. of estimated jobs created	139	466	604	421	134	113	156

3.4.4 Qualitative risk

This worksheet provides a template, listing some risks of typical broadband projects (as defined by the EC regulation), whilst also allowing the project beneficiary to complete its assessment and add more risks as captured in the project risk register. A screenshot of the template is shown below.

Figure 3.19: Representative example of qualitative risk assessment template in 'Qualitative risk' worksheet

Risk description	Variable	Causes	Effect
Context and regulatory risks			
Change of orientation of the strategic policy			
Change in expected behaviour of fututre private investors			
Change in regulations in the retail market			
Unsuccessful State-aid application			
Demand risks			
Lower than estimated service take-up from retail- and/or wholesale providers			
Low investments in 'last mile' network by service providers			
Design risks			
Inadequate design cost estimates			
Administrative and procurement risks			
Delays in project procurement			
Risk of not obtaining required property rights			
Operational and financial risks			
Increase in operational costs			
Insufficient committed funding on a national/regional level during the operational phase			
Loss of key personnel during project operation			

The project beneficiary should undertake a qualitative risk assessment using the approach provided in the EU CBA guide.[20]

[20] See Table 5 on page 266 of http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

4. Annex A: Key references used in the literature review exercise

Figure 4.1: Key literature review references

Category	References
General economic impact	• Zaber, Moinul and Bohlin, Erik and Lindmark, Sven. 'What is the impact of broadband bandwidth variability on quality of life? Lessons from Sweden' (March 30, 2017) • 'Overselling Broadband', C Kenny, Dec 2011, Centre for Global Development, www.cgdev.org/content/publications/detail/1425798 • Kenny, R. and Kenny, C., 2011. NGA broadband: is it really worth a subsidy? info, 13(4), pp3 – 29 • SETDA (2016). The broadband imperative II: Equitable Access for Learning. p.2. • Ferro, E., De Leonardis, D. and Dadayan, L., 2007, January. Broadband and e-government diffusion. In System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference (pp. 109-109) IEEE • Bastug, E. et al. (2017), "Towards Interconnected Virtual Reality: Opportunities, Challenges and Enablers", IEEE Communications Magazine, 55 (6), 110-117, p.114. • Rohman, Ibrahim Kholilul, and Erik Bohlin. 2012. "Does Broadband Speed Really Matter for Driving Economic Growth? Investigating OECD Countries." SSRN Electronic Journal. doi:10.2139/ssrn.2034284 • Gruber, Harald, and Pantelis Koutroumpis. 2013. "Broadband Access in the EU: An Assessment of Future Economic Benefits" • Forzati, Marco, and Claus Popp Larsen. 2008. "Broadband Access and Its Impact on the Economy, a Swedish Perspective." In 2008 10th Anniversary International Conference on Transparent Optical Networks, 2:190–193. IEEE. doi:10.1109/ICTON.2008.4598628 • Gruber, H., Hätönen, J. and Koutroumpis, P., 2014. Broadband access in the EU: An assessment of future economic benefits. Telecommunications Policy, 38(11), pp1046 – 1058 • Brynjolfsson, Erik, and Lorin M. Hitt. 2003. "Computing Productivity: Firm-Level Evidence." Review of Economics and Statistics 85 (4) (November 13): 793–808. doi:10.1162/003465303772815736 • Bloom, Nicholas, Raffaella Sadun, and John Van Reenen. 2012. "Americans Do IT Better: US Multinationals and the Productivity Miracle." American Economic Review 102 (1) (February): 167–201. doi:10.1257/aer.102.1.167 • Bresnahan, T. F., E. Brynjolfsson, and L. M. Hitt. 2002. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence." The Quarterly Journal of Economics 117 (1) (February 1): 339–376. doi:10.1162/003355302753399526 • Gust, Christopher, and Jaime Marquez. 2004. "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices." Labour Economics 11 (1) (February): 33–58. doi:10.1016/S0927-5371(03)00055-1 • Van Reenen, John, Nicholas Bloom, Tobias Kretschmer, Raffaella Sadun, Henry Overman, and Mark Schankerman. 2010. "The Economic Impact of ICT." • Koutroumpis, Pantelis. 2009. "The Economic Impact of Broadband on Growth: A Simultaneous Approach." Telecommunications Policy 33 (9) (October): 471–485. doi:10.1016/j.telpol.2009.07.004

Category	References
	• Gillett, Sharon, William Lehr, Carlos Osorio, and Marvin Sirbu. 2006. “Measuring Broadband's Economic Impact.” • Katz, Raul. 2012. “Impact of Broadband on the Economy.” • Lelkes, Y, Sood, G. and Iyengar, S. (2017), The Hostile Audience: The Effect of Access to Broadband Internet on Partisan Affect. American Journal of Political Science, 61: 5-20. doi:10.1111/ajps.12237 • Zaber, Moinul and Bohlin, Erik and Lindmark, Sven. ‘What is the impact of broadband bandwidth variability on quality of life? Lessons from Sweden’ (March 30, 2017)
Business and productivity	• https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/national-broadband-plan/state-intervention/Pages/Strategy%20Dec%202015.aspx • UK Broadband Impact Study, November 2013 (UK Government) • Whitacre, B., Gallardo, R. and S. Strover (2014), Broadband's Contribution to Economic Growth in Rural Areas: Moving Towards a Causal Relationship, Telecommunications Policy, 38(11) • Mölleryd. B. (2015), Development of High-speed Networks and the Role of Municipal Networks, OECD Science, Technology and Industry Policy Papers, No. 26, OECD Publishing, Paris • Hasbi, M., 2016, Impact of Very High-Speed Broadband on Local Economic Growth: Empirical Evidence, Chalmers University of Technology • Varian, Hal, Robert E Litan, Andrew Elder, and Jay Shutter. 2002. “The Net Impact Study.” • LECG. 2009. “Economic Impact of Broadband: An Empirical Study.” • MICUS. 2008. “The Impact of Broadband on Growth and Productivity.” • Clayton, Tony, Mark Franklin, Peter Stam, Eric Bartelsman, Shikeb Farooqui, Simon Quantin, Yoann Barbesol, et al. 2008. “Information Society : ICT Impact Assessment by Linking Data from Different Sources.” • Frontier. 2011. “Contribution of the Digital Communications Sector to Economic Growth and Productivity in the UK - Economic Analysis Paper.” • Grimes, Arthur, Cleo Ren, and Philip Stevens. 2011. “The Need for Speed: Impacts of Internet Connectivity on Firm Productivity.” Journal of Productivity Analysis 37 (2) (July 23): 187–201. doi:10.1007/s11123-011-0237-z. • Bertschek, Irene, Daniel Cerquera, and Gordon Klein. 2011. “More Bits – More Bucks? Measuring the Impact of Broadband Internet on Firm Performance.” SSRN Electronic Journal. doi:10.2139/ssrn.1852365. • Bertschek, I., Niebel, T. (2013). Mobile and More Productive? Firm-Level Evidence on the Productivity Effects of Mobile Internet Use. Telecommunications Policy. • Clayton, Tony, Mark Franklin, Peter Stam, Eric Bartelsman, Shikeb Farooqui, Simon Quantin, Yoann Barbesol, et al. 2008. “Information Society : ICT Impact Assessment by Linking Data from Different Sources.” • WERU (2017), NGA broadband business exploitation project: Economic impact report, Cardiff University. • Colombo, M. G., Croce, A., Grilli, L. (2013). ICT Services and Small Businesses’ Productivity Gains: An Analysis of the Adoption of Broadband Internet Technology. Information Economics and Policy, 25(3), pp. 171-189. • Akerman, A., Gaarder, I., Mogstad, M. (2015). The Skill Complementarity of Broadband Internet. Quarterly Journal of Economics, 130(4), pp. 1781-1824.

Category	References
	• Haller, S. A., Lyons, S. (2015). Broadband Adoption and Firm Productivity: Evidence from Irish Manufacturing Firms. Telecommunications Policy, 39(1), pp. 1-13. • Bertschek, I., Niebel, T. (2016). Mobile and More Productive? Firm-Level Evidence on the Productivity Effects of Mobile Internet Use. Telecommunications Policy. • OECD (2018), Labour productivity forecast (indicator). doi: 10.1787/cb12b189-en (Accessed on 14 May 2018) • Meijers, Huub. 2012. "Does the Internet Generate Economic Growth, International Trade, or Both?" • Forzati, Marco, and Claus Popp Larsen. 2008. "Broadband Access and Its Impact on the Economy, a Swedish Perspective." In 2008 10th Anniversary International Conference on Transparent Optical Networks, 2:190–193. IEEE. doi:10.1109/ICTON.2008.4598628. • Hasbi, M., 2016, Impact of Very High-Speed Broadband on Local Eco-nomic Growth: Empirical Evidence, Chalmers University of Technology).
Teleworking	• Access Economics. 2010. "Impacts of Teleworking Under the NBN." • Telework Exchange, and Cisco. 2012. "Bank on Telework: The Telework Week 2012 Impact and Year-over-Year Benchmark." • Sánchez, Angel Martínez, Manuela Pérez Pérez, Pilar De Luis Carnicer, and Maria José Vela Jiménez. 2007. "Teleworking and Workplace Flexibility: a Study of Impact on Firm Performance." Personnel Review 36 (1): 42–64. doi:10.1108/00483480710716713. • Bloom, Nicholas, James Liang, John Roberts, and Zhichun Jenny Ying. 2012. "Does Working from Home Work? Evidence from a Chinese Experiment." • Gajendran, Ravi S., and David A. Harrison. 2007. "The Good, the Bad, and the Unknown About Telecommuting: Meta-analysis of Psychological Mediators and Individual Consequences." The Journal of Applied Psychology 92 (6) (November): 1524–41. doi:10.1037/0021-9010.92.6.1524.
Consumer	• BARB (2017). UK TV households by reception type, http://www.barb.co.uk/tv-landscape-reports/tracker-uk-households-by-tv-platform/ • Cisco VNI 2016-2021 forecast • Crandall, Robert, and Charles L Jackson. 2001. "The $ 500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access." • Dutz, Mark, Jonathan Orszag, and Robert Willig. 2009. "The Substantial Consumer Benefits of Broadband Connectivity for US Households." • Rosston, Gregory, Scott Savage, and Donald Waldman. 2011. "Household Demand for Broadband Internet Service." Communications of the ACM 54 (2) (February 1): 29. doi:10.1145/1897816.1897830 • Greenstein, Shane, and Ryan McDevitt. 2012. "Measuring the Broadband Bonus in Thirty OECD Countries." • Civic Consulting. 2011. "Consumer Market Study on the Functioning of E-commerce and Internet Marketing and Selling Techniques in the Retail of Goods - Part I - Synthesis Report." • 2011. "Europe's Single Market, Together for New Growth." doi:10.2780/38591. • SQW. 2008. "Broadband in the Home : An Analysis of the Financial Costs and Benefits."

Category	References
	• Tom Hargreaves, Richard Hauxwell-Baldwin, Charlie Wilson, Mike Coleman, Tom Kane, Lina Stankovic, Vladimir Stankovic, David Murray, Jing Liao, Steven Firth, Tarek Hassan, Smart homes, control and energy management: How do smart home technologies influence control over energy use and domestic life?, European Council for an Energy Efficient Economy (ECEEE), 2015 • Charlie Wilson, Tom Hargreaves, Richard Hauxwell-Baldwin, Smart homes and their uses: a systematic analysis and key challenges, Personal and Ubiquitous Computing, 2015 • Tom Hargreaves, Richard Hauxwell-Baldwin, Charlie Wilson, Mike Coleman, Tom Kane, Lina Stankovic, Vladimir Stankovic, David Murray, Jing Liao, Steven Firth, Tarek Hassan, Smart homes, control and energy management: How do smart home technologies influence control over energy use and domestic life?, European Council for an Energy Efficient Economy (ECEEE), 2015 • Aviv Nevo; John Turner and Jonathan W. Williams, (2015), Usage-Based Pricing and Demand for Residential Broadband, No 21321, NBER Working Papers, National Bureau of Economic Research, Inc https://www.nber.org/papers/w21321.pdf • KPMG, DELIVERING BRITAIN'S DIGITAL FUTURE: (2015) An Economic Impact Study: A report for BT • Gabriele Lobaccaro, Salvatore Carlucci, Erica Lofstrom, A review of systems and technologies for smart homes and smart grids, MDPI Energies, 2016 • Prices and Costs of EU Energy, Final report Ecofys for European Commission: Katharina Grave, Barbara Breitschopf, Jose Ordonez, Jakob Wachsmuth, Sil Boeve, Matthew Smith, Torben Schubert, Nele Friedrichsen, Andrea Herbst, Katharina Eckartz, Martin Pudlik, Marian Bons, Mario Ragwitz, Joachim Schleich April 2016 • Ahlfeldt, Gabriel M. and Koutroumpis, Pantelis and Valletti, Tommaso (2017) Speed 2.0: evaluating access to universal digital highways. Journal of the European Economic Association, 15 (3). pp. 586-625. ISSN 1542-4766 http://eprints.lse.ac.uk/65339/ • Lukasz Grzybowski, Maude Hasbi, Julienne Liang: 2017, Transition from copper to fiber broadband: the role of connection speed and switching costs https://www.orange.com/fr/content/download/45276/1347134/version/2/file/fibre-trans_v26.pdf • Does State Aid for Broadband Deployment in Rural Areas Close the Digital and Economic Divide? Wolfgang Briglauer, Niklas S. Dürr, Oliver Falck, Kai Hüschelrath. CESifo Working Paper No. 6947, March 2018, www.cesifogroup.de/DocDL/cesifo1_wp6947.pdf • Mirko Draca, Ralf Martin & Rosa Sanchis-Guarner, The Evolving Role of ICT in the Economy: A Report by LSE Consulting for Huawei, 2018 http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/the-evolving-role-of-ict-in-the-economy.pdf • Department for Digital, Culture, Media and Sport (2018) Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme, https://www.gov.uk/government/publications/evaluation-of-the-economic-impact-and-public-value-of-the-superfast-broadband-programme
Health	• https://www.gov.uk/government/uploads/system/uploads/attachment data/file/215264/dh_131689.pdf

Category	References
	• *Telehealth: Mapping the Evidence for Patient Outcomes from Systematic Reviews* Totten AM, Womack DM, Eden KB, et al. Rockville (MD): Agency for Healthcare Research and Quality • i2 media research. 2010. “Next Generation Services for Older and Disabled People.” • Access Economics. 2010. “Financial and Externality Impacts of High-speed Broadband for Telehealth.” • Kenny, Robert, and Charles Kenny. 2011. “NGA Broadband: Is It Really Worth a Subsidy?” *Info* 13 (4) (June 28): 3–29. doi:10.1108/14636691111146127 • Economist Intelligence Unit. 2012. “NGA Britain? Myths and Realities About the UK ’ s Broadband Future.” which notes “Broadband speed alone is not enough to effect a transformation”. • Forzati, M. and C. Mattson (2014), FTTH-enabled digital home care – A study of economic gains, Department for Networking and Transmission, Acreo AB • Ford, George S, and Sherry G Ford. 2009. “Internet Use and Depression Among the Elderly.”
Education	• Casey, Alice, Richard Layte, Seán Lyons, and Mary Silles. 2012. “Home Computer Use and Academic Performance of Nine-year-olds.” *Oxford Review of Education* 38 (5) (October): 617–634. doi:10.1080/03054985.2012.731207. • Oxford Review of Education, Vol. 38, October 2012 • See for example: Bernard R. McCoy. "Digital Distractions in the Classroom Phase II: Student Classroom Use of Digital Devices for Non-Class Related Purposes" Journal of Media Education Vol. 7 Issue. 1 (2016) p. 5 – 32 • SQW, London Knowledge Lab, and Ipsos MORI. 2011. “Evaluation of the Home Access Programme - Final Report.” • Valentine, Gill, Jackie Marsh, Charles Pattie, and BMRB. 2005. “Children and Young People’ s Home Use of ICT for Educational Purposes : The Impact on Attainment at Key Stages 1-4.” • Vigdor, Jacob, and Helen Ladd. 2010. “Scaling the Digital Divide: Home Computer Technology and Student Achievement.” • Fairlie, Robert W, and Jonathan Robinson. 2011. “The Effects of Home Computers on Educational Outcomes: Evidence from a Field Experiment with Schoolchildren.” • LSE Centerpiece Autumn 2016 discussion of research: cep.lse.ac.uk/pubs/download/cp480.pdf • Ward, Michael R., Cutting Class to Play Video Games (July 1, 2015). Available at SSRN: https://ssrn.com/abstract=2061726
Tourism	https://www.ihf.ie/content/press-release-technology-making-hotels-smarter

Category	References
Environment	• https://www.globalservices.bt.com/uk/en/casestudy/NGA-cornwall accessed 27/04/2018. • https://ec.europa.eu/clima/policies/ets_en • GeSI, and Boston Consulting Group. 2012. “GeSI SMARTer 2020 : The Role of ICT in Driving a Sustainable Future.” • www.digiconomist.net/bitcoin-energy-consumption • 2011a. “Code of Conduct on Energy Consumption of Broadband Equipment Version 4.” • Yankee Group, and American Council for an Energy-Efficient Economy. 2012. “Measuring the Energy Reduction Impact of Selected Broadband-Enabled Activities Within Households.” • Fuhr, Joseph P., and Stephen Pociask. 2011. “Broadband and Telecommuting: Helping the U.S. Environment and the Economy.” *Low Carbon Economy* 02 (01): 41–47. doi:10.4236/lce.2011.21007. • Lister, Kate, and Tom Harnish. 2011. “The Shifting Nature of Work in the UK Bottom Line Benefits of Telework.” • Helminen, Ville, and Mika Ristimäki. 2007. “Relationships Between Commuting Distance, Frequency and Telework in Finland.” *Journal of Transport Geography* 15 (5) (September): 331–342. doi:10.1016/j.jtrangeo.2006.12.004. • Oseland, Nigel, and Chris Webber. 2012. “Flexible Working Benefits: Collated Evidence and Case Studies.” • Banister, David, Carey Newson, and Matthew Ledbury. 2007. “The Costs of Transport on the Environment - the Role of Teleworking in Reducing Carbon Emissions.” • Penfold, Clarissa, Stephen Webster, Hayley Neil, Helen Ranns, and Jenny Graham. 2009. “Understanding the Needs , Attitudes and Behaviours of Teleworkers.” • Civil Aviation Authority. 2011. “Flying on Business: a Study of the UK Business Air Travel Market.” • Haynes, Paul. 2010. “Information and Communication Technology and International Business Travel: Mobility Allies?” *Mobilities* 5 (4) (November): 547–564. doi:10.1080/17450101.2010.510337.
Social Inclusion	• Lelkes, Y, Sood, G. and Iyengar, S. (2017), The Hostile Audience: The Effect of Access to Broadband Internet on Partisan Affect. American Journal of Political Science, 61: 5-20. doi:10.1111/ajps.12237 • Selouani, Sid-Ahmed, and Habib Hamam. 2007. “Social Impact of Broadband Internet : A Case Study in the Shippagan Area , a Rural Zone in Atlantic Canada.” *Journal of Information, Information Technology, and Organizations* 2. • Jones, Martin, and Chris Rowbottom. 2010. “The Role of Telecare in Overcoming Social Exclusion in Older People.” *Journal of Assistive Technologies* 4 (3): 54–59. • Dini, Paolo, Claire Milne, and Robert Milne. 2012. “Costs and Benefits of NGA Broadband in the UK.” • Zaber, Moinul and Bohlin, Erik and Lindmark, Sven, What is the Impact of Broadband Bandwidth Variability on Quality of Life?: Lessons from Sweden (March 30, 2017). Available at SSRN: https://ssrn.com/abstract=2943723 • Pénard, Thierry, Raphael Suire, and Nicolas Poussing. 2011. “Does the Internet Make People Happier ?”

Category	References
	• Kavetsos, Georgios, and Pantelis Koutroumpis. 2011. “Technological Affluence and Subjective Well-being.” *Journal of Economic Psychology* 32 (5) (October): 742–753. doi:10.1016/j.joep.2011.05.004. • Dutton, William H, and Grant Blank. 2011. “Next Generation Users : The Internet in Britain - Oxford Internet Survey 2011 Report.”
GDP/GVA/Jobs	• Qiang, Christine Zhen-wei, and Carlo M Rossotto. 2009. “Economic Impacts of Broadband.” In *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, 35–50. World Bank. • Koutroumpis, Pantelis. 2009. “The Economic Impact of Broadband on Growth: A Simultaneous Approach.” *Telecommunications Policy* 33 (9) (October): 471–485. doi:10.1016/j.telpol.2009.07.004. • Czernich, Nina, Oliver Falck, Tobias Kretschmer, and Ludger Woessmann. 2011. “Broadband Infrastructure and Economic Growth.” *The Economic Journal* 121 (552) (May 12): 505–532. doi:10.1111/j.1468-0297.2011.02420.x. • McKinsey. 2011. “Internet Matters: The Net’s Sweeping Impact on Growth, Jobs, and Prosperity.” • Katz, Raul. 2012. “Impact of Broadband on the Economy.” ITU • WIK-Consult, ECORYS and VVA Consulting (2016): Support for the preparation of the impact assessment accompanying the review of the regulatory framework for e-communications, Study for the European Commission, DG Communications Networks, Content and Technology; in particular Annex II. • Booz, and Raul Katz. 2012. “Maximising the Impact of Digitization.” In *The Global Information Technology Report 2012 Living in a Hyperconnected World*. World Economic Forum. • Booz. 2012. “‘ This Is for Everyone ’ The Case for Universal Digitisation.” • Minges: Exploring the Relationship Between Broadband and Economic Growth, 2016, World Development Report, ictData.org who suggests connections per 100 premises might be a superior guide • Gillett, Sharon, William Lehr, Carlos Osorio, and Marvin Sirbu. 2006. “Measuring Broadband's Economic Impact.” • Van Gaasbeck, Kristin, Stephen Perez, Ryan Sharp, Helen Schaubmayer, Angela Owens, and Lindsay Cox. 2007. “Economic Effects of Increased Broadband Use in California.” • Shideler, David, Narine Badasyan, and Laura Taylor. 2007. “The Economic Impact of Broadband Deployment in Kentucky.” *Federal Reserve Bank of St Louis Regional Economic Development* 3 (2): 88–118. • Kolko, Jed. 2011. “Broadband and Local Growth.” *Journal of Urban Economics* 71 (1) (January): 100–113. doi:10.1016/j.jue.2011.07.004. • Crandall, Robert, William Lehr, and Robert Litan. 2007. “The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data.” *The Brookings Institution: Issues in Economic Policy* 6. • MICUS. 2008. “The Impact of Broadband on Growth and Productivity.” • McKinsey. 2011. “Internet Matters: The Net’s Sweeping Impact on Growth, Jobs, and Prosperity.” • Lapointe, P. (2015), Does speed matter? The employment impacts of increasing access to fiber In-ternet, Georgetown University.

Category	References
	• Singer, H., Caves K. and A.Koyfman (2015) Economists Incorporated: The Empirical Link Between Fibre-to-the-Premises Deployment and Employment: A case study in Canada, Annex to the Petition to Vary TRP 2015-326, Bell Canada.