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**CLOSING GAPS IN THE INFORMATION SOCIETY:
PROVIDING HIGH-SPEED BROADBAND ACCESS TO
RURAL AREAS**

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Closing gaps in the information society: Providing high-speed broadband access to rural areas

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ABSTRACT

Broadband, in particular the national level of broadband penetration is a significant driver for economic growth. Whilst the availability of broadband in terms of bandwidth and variety of competitive communication providers is highly sufficient in population dense areas, rural areas suffer massively from the digital divide effect. The term “digital divide” refers to the absence of high performance broadband connections in remote rural areas. This divide is not only the case for some specific areas; it is moreover a well known general phenomenon in industrialized countries. Recently, public pressure for an accelerated comprehensive roll-out of high performance broadband has become more intense. It can be observed, that access to broadband seems to receive more and more the status of a public good, where public engagement is required for provision. Resulting governmental activities to foster broadband penetration and usage especially in less populated and rural areas are easily comprehensible. But the question is now if and how public intervention is required for the provisioning of broadband access infrastructure. The feasibility of rural FTTH networks is hence at the core of the study at hand. 37 FTTH projects in rural areas were analyzed in this study according to a framework developed.

In the end, the results suggest public private partnerships as a combination of public and private financing in funding (local) fibre infrastructure investment projects.

Keywords: broadband coverage, information society, public goods, public investment, rural areas

JEL Classifications: E61, H54, K23, R53

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1 Introduction

Broadband networks have gained the same status as streets, public transport systems, and water and energy networks³. Unsurprisingly, a massive increase in broadband penetration is key to the European Union's (EU) Lisbon Strategy⁴ and has been confirmed in the Digital Agenda for Europe 2020⁵. As a result, in November 2008, the European Commission earmarked 1 billion EUR in financial aid to increase the availability of rural broadband⁶. Especially Australia took a straight forward approach with an investment of 43 billion AUD (about 26 billion EUR) into the nationwide "National Broadband Network"⁷.

These and similar programs are being, or have been, approved and "Why broadband?" is now a moot question. Broadband plans have been published by many nations and governments. But as the implementation stages approach, there are a plethora of opinions on the *how* but few concrete solutions.

For purely economic reasons, fiber networks are mostly only available within population-dense areas, while rural areas often have inferior or no broadband access technology at all. Research has focused on these business cases of network operators, deploying (V)DSL or fibre-based broadband access technologies⁸. The phenomenon of undersupply in rural areas has been identified and described by Preston, Cawley and Metykova⁹ as well as Ramirez and Richardson¹⁰. In addition, Huigen and Cave¹¹ requested further governmental intervention in order to foster broadband penetration in rural areas. And Wernick¹² and Frieden¹³ proved that there is no significant link between infrastructure investment and regulatory interventions on national level. It stands to reason that government action is very necessary to foster broadband de-

³ See BMWi (2009a) and OECD (2008), p. 8 and Chapter 2.3.

⁴ See EP (2000).

⁵ See EC (2010), p. 19.

⁶ See EC (2008), p. 16 and EC (2009).

⁷ See DBCDE (2009).

⁸ See Amendola and Pupillo (2008).

⁹ See Preston, Cawley and Metykova (2007).

¹⁰ See Ramirez and Richardson (2005).

¹¹ See Huigen and Cave (2008).

¹² See Wernick (2007).

¹³ See Frieden (2010).

ployment in rural areas. Research on the *how* is crucial. But so far, the engagement of incumbents and competitors in population-sparse areas has necessitated the injection of massive subsidies by the public sector¹⁴. Therefore, this study's central question is:

How can public engagement help deploy broadband access, especially in the rural areas?

Based on theoretical and case study analysis this study seeks to develop practical guidance and recommendations regarding the level of public engagement in order to increase broadband coverage in rural areas. In the following Chapter 2 the phenomenon of the Digital Divide and the extraordinary socioeconomic importance of broadband is established. Broadband, the lack of access to and the analysis of different technologies capable of delivering broadband into rural areas is focused in Chapter 3, while core fibre-based technologies are selected for further investigation. Thereafter Chapter 4 focuses on infrastructure enforcement mechanisms from a theoretical perspective and Chapter 5 presents the outcomes of the case study analysis on an aggregated level. A summary and recommendations for action are presented in Chapter 6.

¹⁴ For example, in the case of OnsNet; see Rovers (2008).

2 The digital divide

The availability of modern information and communication technology has fundamentally changed human communication behaviour and social interaction. Moreover, the possibility to overcome spatial distances in combination with the ubiquitous presence of information had a massive positive impact on economic growth and led to the creation of the information society¹⁵. Common information services are consumed in the meanwhile by the majority of citizens of industrialized nations via the Internet¹⁶. Some of these services are entirely and only available online. In consequence, being offline means being excluded from the information society. This phenomenon is referred to as *Digital Divide*. Its economic and social effects are described in the following.

2.1 The development and meaning of the term

The Digital Divide phenomenon was identified more than 10 years ago. Since then, there has been broad consent that this effect intensifies existing social imbalances and creates new unfairness within and for the society. According to Hoffman/Novak (1998) the term Digital Divide was coined by Lloyd Morrisett, former president of the Markle Foundation¹⁷, who used it to describe a gap “between information ‘haves’ and ‘have-nots’.”¹⁸ Welling (2000) refers to the *Digital Divide* as the difference in Internet usage between various groups of the population with identical socio-demographic attributes (e.g. gender, income, education). Consequently, some specific population groups, compared to the entire population, are accessing the Internet significantly less than others¹⁹. Recently, the term Digital Divide is used in a broader sense by Jackson et al. (2008) to describe the gap in intensity and nature of Internet usage. In this paper, Digital Divide refers to the gap between the population with access, respective skills and usage patterns of the Internet and those without.

¹⁵ See Picot/Reichwald/Wigand (2008), p. 132

¹⁶ See Picot (2009a)

¹⁷ See Markle (2009)

¹⁸ Hoffman/Novak (1998), p. 2

¹⁹ See Welling (2000), p. 1

Internet usage correlates – positively or negatively - with income and education, but also gender and age²⁰. The absence of communication infrastructure has massive negative effects on the economy and the society as a whole. These effects can be observed even better in developing countries, where communications infrastructure penetration levels are far behind industrialized nations. In the end, the same time lag effects, developing countries have in the overall penetration in access to communication technologies can be compared to the gap between the people in industrialized nations with broadband access, and those, living in rural areas without. Torero and von Braun did prove that the willingness to pay for communication services in rural areas in developing countries is even higher than the normal price levels within cities²¹. Results can be transferred to rural areas in industrialized nations.

2.2 Economic and social impact

Information and communication technologies are essential in the process of economic growth, social interaction and enhancing the standard of living²².

The OECD identified a positive correlation between the availability of broadband and growth in GDP²³. In consequence, broadband was regarded to be a “General Purpose Technology”²⁴ already in 2007. Specific case studies from, e.g., Lehr et al (2006) show substantial positive effects by the availability of broadband to growth in employment, growth in rents and even a significant positive effect on the number of new business establishments in the United States. These results are drawn from a regression model based on the data of the FCC for the United States between 1998 and 2002²⁵.

It has to be stated that broadband by itself does not lever an economy. It acts as a complementary technology to other information technologies²⁶. That is why network effects play an important role in the Digital Divide phenomenon, too²⁷.

²⁰ See Jackson et al. (2008), p. 437 and Gerhards/Mende (2008)

²¹ See Torero/von Braun (2006)

²² See e.g. Pohjola (2001)

²³ See OECD (2008),

²⁴ See OECD (2007), p. 9

²⁵ See Lehr et al. (2006), p. 12 - 15

²⁶ See Lehr et al. (2006), p. 4

²⁷ See Picot/Reichwald/Wigand (2008)

Greenstein/McDevitt (2009) observed 29 billion USD in total revenues for Internet access in 2006, creating another 8.3 to 10.6 billion US\$ in new GDP as direct effect of the availability of broadband. But furthermore, they show that another 4.8 to 6.7 billion USD in consumer surplus was created, which is not directly quantifiable by regular GDP calculation²⁸.

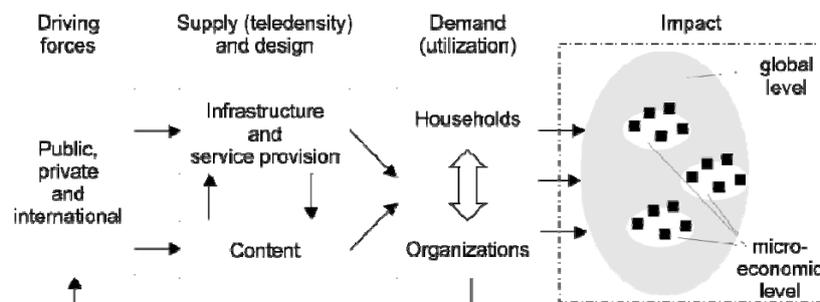


Figure 1: Framework for Broadband Demand, Supply and Impact²⁹

Torero and von Braun (2006) describe the effects of information and telecommunication technologies on a global level as indicated in Figure 1. The figure tries to value the indirect effects of the availability of broadband, which is even harder to measure. Despite the direct impact of broadband on the GDP, the driving forces of infrastructure and service provision as well as content can be either of public or private origin, generated on national or international level. In a next stage, the availability of broadband and/or the content have a direct effect on the demand on business and private consumers. In consequence, both impacts of being online have two effects, one on the household/organization itself, and the other created by network effects on global level. Additionally, the household impact has a positive effect on global level and, again, vice versa. These impacts include positive effects on employment, wealth, education, skills and quality of labor force, community participation and quality of life³⁰.

The latter facts focus on the social perspective of broadband. E-Mail, instant messaging and social communities already have the same relevance as the telephone. For sure, especially these indirect effects are hard to measure, however, the presence of ICT infrastructure in developing countries is positively correlated to Foreign Direct Investment (FDI), education and access to education. In industrialized nations, the

²⁸ See Greenstein/McDevitt (2009)

²⁹ According to Torero/von Braun (2006), p. 22

³⁰ See Torero/von Braun (2006) and Lehr et al (2006), p. 6

younger generation of today is already planning and organizing their private live with “web 2.0” applications³¹. Leaving the ongoing discussion about the meaningfulness of these social communities aside, it’s a matter of fact, that, e.g., *facebook* is used by more than 100 million users per day actively³². One could imagine a school class, where the pupils organize their spare time activities online. One child lives in a rural place, where broadband Internet access is not available yet and in consequence, she is not able to communicate online via a social online community. Moreover, financially it does not pay off to be offline. For example, airlines charge additional fees for off-line bookings and the Deutsche Bahn AG started an approach of introducing offline service fees in 2008³³. Beside the communication services described above, browser based software³⁴ or services like e-learning, e-home or e-health bring additional comfort into home and live. Hence, being excluded from a broadband connection to access a social community platform leads sooner or later to social exclusion.

Rural areas suffer already from the migration of young workers to cities, leading to a rural exodus. This rural exodus, or so called devastation is principally caused by incorrect political decisions regarding the provision of modern and future-proof communal patterns and infrastructure³⁵. This effect is intensified by the fact that high performance communication infrastructure is regarded today as a matter of course, when it comes to location and investment decisions of firms and workers³⁶. If broadband infrastructure is not available, this results in a location disadvantage which cannot be compensated by other factors³⁷. Even more so, it is important to spread broadband to rural schools, libraries and other public institutions in order to comply with the demands on the job market³⁸. Recently, Jackson et al (2008) could prove that the time using computers and the Internet is a positive predictor of academic performance³⁹. Furthermore, the presence of broadband drives innovation. And that is why lagging behind when it comes to broadband internet access can develop into a vicious circle

³¹ See Pick/Azari (2008), p. 112 or More et al. (2002)

³² See Facebook (2009)

³³ See Deutsche Bahn AG (2008)

³⁴ See Buxmann/Hess/Lehamnn (2008), 500ff.

³⁵ See Klüter (2005)

³⁶ See Büllingen/Stamm (2008)

³⁷ See Holznagel/Deckers (2009)

³⁸ EP (2000) and BMWi (2009a), p. 7

³⁹ See Jackson et al (2008), p. 440

for a certain region which is even harder to break for developing countries⁴⁰. Access to broadband will improve especially the economic plight of developing countries⁴¹. This is not only why, especially for rural areas, the availability of broadband access is of major importance in order to compensate for existing disadvantages.

Consequences of a widening Digital Divide as shown are harsh, not only for offliners, but for entire nations. It can not only increase social injustice, but also lead to new inequalities and distortions among the entire population. That's why there is broad consent on the fact that adequate countermeasures have to be taken in order to fulfill governmental duties of care, responsibility and preservation of equal opportunities for every member of the society⁴².

Summing up, the biggest lever to get rid of the Digital Divide gap will be the availability of a broadband connection in general. "Leaving regions out of the digital economy is not an option."⁴³ Being online means being part of the community, of communications, of education and many more; in the end being online means participating at the knowledge economy. And being offline leads to exclusion.

*"Rather than spending considerable amounts of money on governmental or other "high level" conferences simply to talk about the digital divide, and repeatedly study the phenomenon, one would be better advised to create conditions for these efforts to concretize, and provide the necessary support for the networks to take off and grow."*⁴⁴

Therefore the problem of access has to be solved first. Additional measures can be taken afterwards, like education, usability or reduction of technology adversity.

⁴⁰ See James (2008), p. 59

⁴¹ See Fink/Kenny (2003), p. 15

⁴² See Kubicek/Welling (2001), p. 497

⁴³ Reding (2007), p. 2

⁴⁴ Menou (2001), p. 6

3 Broadband Access

Defining broadband has become more complex in recent years. Before the year 2000, a broadband Internet connection meant anything with a significantly higher performance than a normal PSTN connection of 56 kBit/s⁴⁵. The ITU defines broadband as a “transmission capacity that is faster than primary rate Integrated Services Digital Network (ISDN) at 1.5 or 2.0 Megabits per second (Mbits)”⁴⁶. The OECD considers a service broadband when it “offer[s] Internet connectivity which are capable of download speeds of at least 256 kbit/s”⁴⁷. These specifications were recently changed by governmental intervention, leading to the following examples: In order to regroup different kinds of Internet services, the FCC came up with “First Generation data: 200k up to 768k [and] Basic broadband: 768k to 1.5mbps”⁴⁸. In Germany’s recently announced broadband strategy, broadband services are defined as consisting of at least 1 MBit/s⁴⁹. Switzerland considers broadband a part of the Universal Service Obligation, at 600 kBit/s downstream and 100 kBit/s upstream⁵⁰.

3.1 How much broadband is enough?

This brings us to the question: How much bandwidth is enough? The question is important as it arises continuously in the context of network costs. Seeking an answer, Nielsen introduced ‘Nielsen’s Law’ (a relationship derived from Gilder’s Law), according to which home user network speed will increase by 50% per year. Therefore, bandwidth is said to double every 21 months⁵¹. Tests prove that Nielsen’s Law still holds and that all available bandwidth will be used⁵². As upload rates are presently becoming increasingly important, so is the need for symmetrical bandwidth. This effect also drives global IP traffic, which is likely to increase five-fold between 2008 and 2013⁵³.

⁴⁵ See Tanenbaum (2003), p. 155.

⁴⁶ See ITU (2003).

⁴⁷ See OECD (2009).

⁴⁸ Martin (2008), p. 2.

⁴⁹ See BMWi (2009a), p. 5.

⁵⁰ See Schweizerische Bundesrat (2007), FDV, Art. 16 Paragraph 2c.

⁵¹ See Nielsen (1998).

⁵² See Bogaert (2008), p. 24f.

⁵³ See Cisco Systems (2009), p. 6.

This is another reason why defining broadband can no longer be limited to a specific upload or download capacity. A broadband connection should rather be capable of a bundle of the latest applications⁵⁴, services and tasks, and should consist of:

- Communication services (e.g., voice-messaging and e-mail)
- File services (e.g., uploading and downloading files)
- Multimedia capabilities (e.g., audio, video and Internet browsing)
- Real-time applications (e.g., voice, videoconferencing and virtual reality)
- Remote access (e.g., collaboration, tele-work, maintenance and service).

3.2 The lack of broadband access in rural areas

The rural areas are subject to a massive undersupply of broadband access. Telephone lines are available almost everywhere, also in rural areas. So why not broadband?

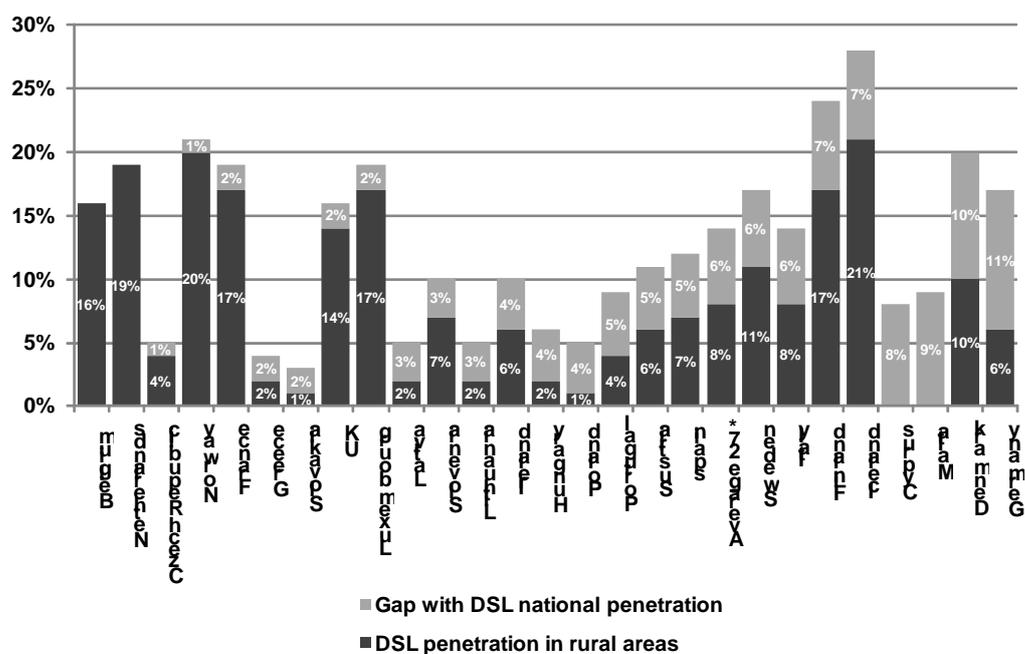


Figure 2: Gaps between DSL in rural areas and national penetration in Europe⁵⁵

This question has three main answers: First, the Universal Service Doctrine does not yet include broadband access in industrialized nations, except for Switzerland⁵⁶. For example, the European Union guarantees no more than 56 kBit/s for telephone lines⁵⁷.

⁵⁴ See Atkinson et al. (2009), p. 5-7; Xavier (2003), p. 10 and Picot (2009a).

⁵⁵ See Idate (2007), p. 8; whereas penetration refers to use of DSL technology on telephone lines.

⁵⁶ See Schweizerische Bundesrat (2007), FDV, Art. 16 Paragraph 2c.

⁵⁷ See EC (2002), Universal Service Directive, See Chapter 4.1 for discussion.

Second, there exist many technological restrictions to broadband technologies, and most of them are sensitive to distances.

Third, in a competitive environment, expected revenues do not yet justify company investments in broadband infrastructure roll-out in rural, population-sparse areas. In the rural areas, low broadband usage and availability are not due to a low demand but due to missing availability of broadband access providers and technologies. Looking at DSL technology, which is the dominant broadband technology in Europe, coverage was about 90% in 2006⁵⁸. The discrepancies between different countries' rural areas are significant. In terms of the penetration levels, as shown in Figure 2, the gaps between the rural areas and the national averages are massive. The total of the column in the graphic indicates DSL penetration per household per country, which shows for e.g. Denmark the overall broadband penetration of 20 per cent on a national household basis. This total is separated into DSL penetration in rural areas of 10 % (dark area) and the resulting gap with DSL penetration of rural areas to national average of 10 % (light area). This situation indicates the spread between broadband penetration levels within cities and rural areas as even wider in reality, due to the fact, that the rural areas penetration average decreases national average in addition. While these figures date from 2006, little has changed in the case of Germany⁵⁹. The German *Breitbandatlas*, indicates that more than 1 million people in Germany do not have physical access to broadband at all⁶⁰.

In other countries, like Australia, the situation is even worse. The availability of DSL, according to the ACMA⁶¹, is lower than in Germany. While Australia's land mass is much larger than Germany's, one major advantage for Australia's telecommunication providers is that more than 66,3% of the population lives within the major cities. 31,1% of the population is situated in the inner and outer regional areas around metropolitan areas, and a mere 2,6% lives in the remote or very remote areas known as

⁵⁸ See Idate (2007); whereas coverage refers to availability of DSL technology on telephone lines.

⁵⁹ See BMWi (2009b).

⁶⁰ See Holznagel and Deckers (2009), p. 2.

Broadband is defined at > 128 kBit/s for the "Breitbandatlas". Increasing the If the capacity definition is increased to 1 MBit/s, this would reduce the national household broadband availability by another 8% according to the BMWi.

⁶¹ ACMA (2008), the Australian Communications and Media Authority.

the Outback⁶². Despite this, DSL penetration in Australia is relatively low. However, in September 2008, more than 46% of Australia's exchanges were not yet equipped with DSL capabilities⁶³.

Summing up, neither the former incumbent nor the competitors have been willing to provide broadband in the rural areas. So competition has not yet solved broadband coverage issues in many countries, and it does not seem that this situation will change in the next few years without public intervention. Broadband has been described as a matter of public interest and this is why some sort of action has to be taken in order to efficiently and sustainably deploy broadband access to all citizens. In the following chapter, this question will be addressed from a technological perspective.

3.3 Sustainable broadband infrastructure access technologies

Broadband Internet access can be categorized into wireline (based on a physical cable made from a specific material) and wireless technologies (which use the air as transmission medium). Common broadband technologies based on wireline are DSL (digital subscriber line), COAX (coaxial cable), optical fiber, and hybrid FTTx (like FTTH, fibre to the home, FTTB, fibre to the building, or FTTC, fibre to the curb).

Wireless technologies can either be integrated into the CPE itself or into a central point, which transmits the wireless signal to the in-house infrastructure. Technologies used are WLAN (wireless local area network), WiMAX (worldwide inter-operability for microwave access), satellite, or 3G/UMTS (universal mobile telecommunication service). However, all wireless technologies have one key characteristic in common: The air as shared medium⁶⁴. All users connected to the same base station share the total available bandwidth. And wireless connections have historically always had less bandwidth and have been less reliable than wireline⁶⁵. These major disadvantages must be addressed in detail in the context of infrastructure projects and policies.

Each of the different technologies presented above has specific technical and geographical usage patterns. This is why they also reveal major differences when it comes to their broadband provision capabilities in order to close the white spots in

⁶² See Australian Bureau of Statistics (2004), p. 94.

⁶³ See ACMA (2008), p. 8.

⁶⁴ See Holznagel et al. (2010).

⁶⁵ See Szafran (1993), p. 18 and Part I.

rural areas. Wireline connections appear highly reliable, have high capacity, and – above all – are very expensive due to roll-out costs. In contrast, wireless solutions are always regarded as an easy, fast and inexpensive way to swiftly set up a broadband connection with households in underserved areas⁶⁶.

As this study seeks to focus on the effective provision of broadband access to the rural areas, it raises the questions of efficient resource allocation and sustainability. Wireless technologies are limited compared to wireline due to a number of physical and economic drawbacks, like availability and reach, quality, or acceptance. However, the biggest drawback by far is the fact that it is a shared medium. This describes the limits of a transfer channel due to its being open to all connected users⁶⁷. This gives rise to negative externalities as every single use will reduce or even restrict the usage of all other users accessing the network simultaneously.

To conclude, there are simply too many reasons why wireless should only be seen as a supplementary technology for rural broadband access. While this approach seems advantageous as the digital dividend seems to politically solve an urgent socio-economic problem, we must distinguish between the digital divide and the digital dividend. Wireless has an undeniable inherent fault: It's a physically shared medium. In terms of sustainability⁶⁸, wireless can be considered as a supplementary approach but not as the whole solution for getting societies online. What is considered sufficient bandwidth today is insufficient tomorrow. So building rural wireless Internet access will in the long run accelerate the rural exodus and widen the digital divide.

⁶⁶ See BMWi (2009a), p. 14.

⁶⁷ See Holnagel et al. (2010).

⁶⁸ From a technical perspective, sustainability is defined as the ability to be upgraded with low financial and/or hardware restrictions.

4 Mechanisms of infrastructure enforcement

From a public policy standpoint, broadband can be considered from two perspectives: The perspective of a public good (where a specific level of area-wide broadband access is guaranteed to each citizen by the state) and the perspective of competition policy (market structure and network effects)⁶⁹. In the current case of rural undersupply, broadband is not offered by private market participants due to profitability reasons. This is why the competition perspective does not primarily apply to this study. In the present study broadband must be focused on from the perspective of the public good.

Rural broadband deployment via governmental intervention can be supported in three ways – public prescription of broadband provision by law, regulation of subnational markets, and public engagement, including development programs combined with public financing and/or the public deployment of infrastructure.

4.1 Public prescription by law

By adjusting the Universal Service Directive network operators can be forced to deploy a predefined level of service. But broadband is not included, and its implementation would require government action in the form of a legislative procedure⁷⁰.

The European Universal Service Directive refers to 56 kBit/s⁷¹, which can be regarded as somewhat outdated. A modernization of the Universal Service Directive could effectively accelerate rural broadband delivery. Recently, the Digital Agenda for Europe 2020 contains of a “universal broadband coverage with increasing speeds” goal⁷². However, the financing should not be realized through some sort of universal service fund (as in the US); it should rather be managed through an indirect incentive scheme – for example, in accordance with the German telecommunications law.

The mechanism presented in Figure 3 works as follows: After the authorities have defined a minimum broadband availability level (I), the underserved areas are published and regularly checked as to what progress has been made (II). If the progress is not satisfactory, all providers with a market share of >4% – for example – will be

⁶⁹ See Wernick (2007), p. 5, and Picot and Wernick (2007), p. 663.

⁷⁰ See Holznagel and Deckers (2009), p. 7.

⁷¹ See EC (2002), Universal Service Directive.

⁷² See EC (2010), p. 19.

obliged to finance the missing infrastructure in proportion to their relative market share (III). The regulator publishes an invitation to tender for the underserved areas and grants contracts in a bidding contest (IV). Based on step III, the contracts are paid for by the market players (V).

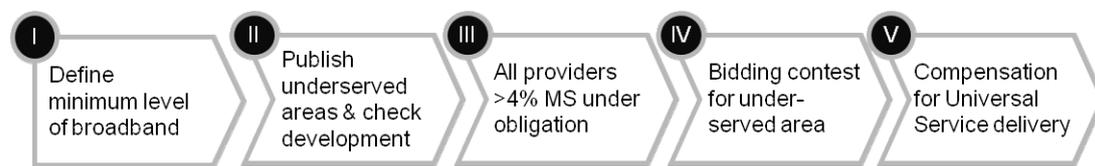


Figure 3: The enforcement of universal service⁷³

This format should offer maximum incentives to serve an area without formal obligation while avoiding the misuse of universal service funds that we are seeing in some countries. “Thus, it creates an implicit race to invest in otherwise unattractive areas among NGA market players”⁷⁴.

But due to long lasting legal coordination activities, the implementation of broadband as a Universal Service would take too much time due to the time-frames of legislative procedures. If the European Commission would agree on these new standards, the law has to be adjusted. This could take several years. But immediate action is required for rural broadband, and waiting another five years could turn the *digital divide* into a *digital frontier*.

4.2 Regulation of subnational markets

Continued trust in the power of demand and supply as well as free competition will not bring us rural broadband. There have been no investments in rural fibre roll-out projects without some sort of public engagement. Thus private competition would need higher revenues for the new entrant(s) or some kind of public support.

Something that can be done is for regulatory authorities to allow so-called subnational price levels. To date there has been an obligation to have identical price policies nationwide with respect to enforced regulated prices especially on wholesale level. By introducing subnational markets, the cost advantages of population-dense areas as

⁷³ See Picot (2008).

⁷⁴ Picot (2008).

well as the cost disadvantages of population-sparse areas could be reflected in subnational rent pricing schemes for access lines.

At present, there is significant resistance to this model from politicians and other participants. This model is appropriate to extend broadband's reach. However, it will lead to extremely high prices for outlying rural areas and require some time for the initialization by the regulatory authority as well as the execution by market participants. Again, this could take years.

4.3 Public engagement: Subsidies

As a matter of public interest governments would be in the position to provide financial aid in order to deploy rural broadband. This can be done through subsidies: The consumer buying at a lower price or the producer offering a higher supply.

Demand-side and supply-side subsidies for broadband will have different effects on rural broadband coverage. The primary difference between subsidy types lie in overall coverage output. Subsidizing the monthly usage fee and hence demand would also attract marginal customers and subsidize customers, who would buy the product at market price anyway. And whereas demand-side subsidies depend on a subscriber base only, supply-side subsidies depend on the household base. This is why supply-side subsidies will produce a much higher coverage. However, research using a preliminary calculation has shown that consumer welfare gains are approximately 14 times higher than the supply-side subsidy revenue cost⁷⁵.

Competition law presents a major obstacle to the subsidization of broadband operators. Especially European Community competition law restricts the unequal treatment of market participants. In the following this study will therefore focus on hybrid models, which are already delivering infrastructure in some regions.

4.4 Public engagement: Hybrid solutions

Neither law, competition nor subsidization can deliver feasible results for the swift, efficient and sustainable deployment of rural broadband. This is why discussions and political practice have explored the possibility of the deployment of a state-controlled

⁷⁵ See Goolsbee (2002).

“core network provider”⁷⁶. As hybrid solutions, *public private partnerships* (PPPs) seem to offer a potential solution for rural broadband provisioning⁷⁷. In terms of infrastructure investment projects, PPPs as cooperation between public (owned) institutions and private companies have established themselves as a sustainable option for infrastructure provision. Three types of PPPs can be distinguished: Financing PPPs, management PPPs and innovation PPPs⁷⁸. Some authors point out that PPPs can be understood as an attempt to get the best of both worlds and combine the values of government regulation with the qualities of market-oriented private actors⁷⁹. Within this analysis, only hybrid forms relevant to rural broadband deployment will be considered.

At the national level, the approach of establishing a public core network has only been followed in the UK⁸⁰, while work is in progress in Australia and the United Arab Emirates. Recently PPPs have been quite successful in deploying FTTN or even FTTH solutions in regional areas. Some public-owned regional utility companies offering telecommunication services have also already deployed fibre networks.

However, legal clarification is required on PPPs under e.g. European common law. Especially measures to exclude open access networks from regulatory interference seem to be a promising option⁸¹.

⁷⁶ See Dasgupta and Waverman (2007); and Budäus (2004).

⁷⁷ See Eichener and Brandt (2000), p. 5.

⁷⁸ See Budäus (2004), p. 6.

⁷⁹ See Klijn and Tseiman (2000), p. 84.

⁸⁰ See Wernick (2007), p. 160f.

⁸¹ See Holznagel et al. (2010).

5 Explorative case studies on broadband infrastructure roll-out projects

Today, almost 85% of worldwide FTTH/B subscribers are located in Asia⁸². Around the world, several local fibre broadband initiatives and projects were launched in the past few years. The majority of these fibre broadband projects – either already deployed or in development – are located in large, population-dense cities. As we focused on rural fibre deployment projects, a major task was the identification and data collection of fibre roll-out projects in rural areas.

5.1 The selection of case studies

Information about rural fibre deployment projects is hard to come by. This is due to the limited requirements for public presence of local fibre providers on a national or international level. The case study selection was conducted as depicted in Figure 4.

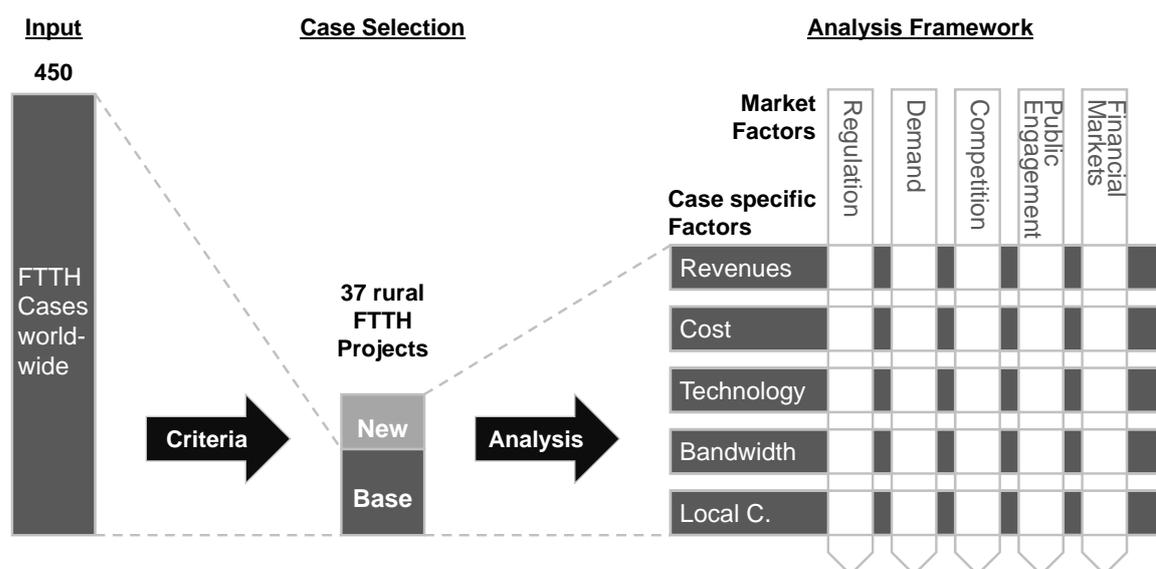


Figure 4: The case study selection mechanism

For an initial indication, data collection was started on basis of Fiberevolution.com. The names and locations of 450 fibre infrastructure projects worldwide known to them are listed. However, as our study only concentrates on rural fibre, high-level information about each of the projects had to be collected in order to deselect projects in large cities and population-dense areas. This shortlist was merged with information

⁸² See Idate (2007).

several other projects not listed on Fiberevolution.com that emerged during research, conferences, expert interviews and panel discussions. As a result, 37 projects could be identified. Appendix 1 contains a schematic overview.

5.2 The shortcomings of the case studies

The selected case studies already provide an astonishing overview of the success stories of rural FTTH broadband. In almost every case, the investment in rural FTTH might not *ex ante* have fulfilled the return expectations of the private market participants. However, the high level of broadband adoption after FTTH became available proves the demand from the population in these areas. This does not even begin to take into account the network's socioeconomic benefits. Selected cases are presented as example in Figure 1.

Regarding *regulatory influence*, neither US nor EU telecommunications laws place restrictions on rural FTTH projects. However, public engagement in financing these projects were problematic in regard to competition law and state aid law.

	Schwerte (D)	OnsNet (NL)	DiamondNet (USA)
Avg. cost/HH	1.050 EUR	2.100 EUR	2.285 USD
Technology	P2P	P2P	PON
Adoption	85 %	80 %	50 %
Funding	Municipality/ private company	Citizen "club"/ ministry	Municipality

Table 1: Selected variables for rural FTTH deployment cases⁸³

Theoretical assumptions about the high level of *demand* for rural broadband have been confirmed. Wherever rural broadband became available, rural broadband penetration levels in every single case were higher than the national average⁸⁴.

Analysis of the existing *competition* levels in the target areas reveals that the previous lack of competition has not been overcome. After the start of the broadband service, offerings by the incumbent were either not available or barely available. In the major-

⁸³ See Holnagel et al. (2010).

⁸⁴ The lowest value observed was for Chealan County PUD, USA, with 32% broadband penetration, which is 7% above the US average. For further details see Holznagel et al. (2010).

ity of cases, predominantly in the US, citizens were forced to use low-bandwidth dial-up connections for Internet access.

Diamond Net and Schwerte are considered paradigmatic with respect to *public engagement* and the conditions of the *financial markets*. It was observed that additional public funding (e.g., in the case of OnsNet) had a positive effect on project realization – as expected. In addition, credit guarantees from the public as well as lower return expectations on the part of the municipality were responsible for the successful initiation of these projects. Therefore, it was discovered that *public engagement* and *financial markets* were closely interconnected.

Case-specific factors

Revenues from rural FTTH projects were generated by standard telecommunication provider pricing scheme models consisting of single-play, double-play and triple-play offerings. Especially in the US, pay TV is a significant driver of broadband subscription models. In Europe, TV offerings over FTTH (including video on demand) are successful, compared to incumbents' IPTV offerings via (V)DSL⁸⁵. In the European cases, pricing in particular was more than competitive at the national level, although, in most cases, no incumbent or competitor had previously offered a broadband Internet access service.

It appears that the average roll-out *costs* per household depended primarily on the construction methodology and the technology deployed. Point to Point (P2P) architecture was observed to be more expensive than passive optical network (PON) architecture – as expected. However, the example of Schwerte shows that (and how) the development of a simultaneous and integrated drilling procedure for water, sewerage and fibre can significantly reduce the P2P roll-out cost in rural areas to 880 EUR per household. The various legal restrictions on communication line infrastructure installation have a significant impact on costs. A promising approach – and an economically feasible compromise – could be the so-called micro-trenching technology. This makes deployment swift and easy, and it reduces cost by up to 80% compared to

⁸⁵ Stadtwerke Schwerte, with 16% TV customers, is way ahead of DTAG (only 6%). For TV subscribers and broadband subscribers, see Grüll (2009), BNetzA (2009), p. 71, and Handelsblatt (2009).

burying the cable in the ground⁸⁶. However, as noted, national law currently interdicts trenching in Germany, and Germany is not the only country to face this hurdle.

In short, a key finding is the high presence of PPP within the rural FTTH case studies. In terms of the framework, it can be concluded that the combination of municipal initiative and private engagement presents a feasible, swift and sustainable approach to rural FTTH. In addition, the case study of the National Broadband Network in Australia comprises a significant and successful contribution towards the information society. State intervention by founding a government-controlled company and allowing private investments in that company represents another promising PPP approach. In consequence, the advantages and disadvantages of the PPP model for rural FTTH cases must be addressed in detail.

⁸⁶ See Wulf (2008).

6 Conclusions and recommendations

In summary, we have sought to answer the research question:

How can public engagement deploy broadband access, especially in the rural areas?

It is evident that public engagement is very necessary in order to bring broadband to the rural areas. Market conditions have not been and will not be able to provide nationwide broadband in a competitive environment in the near future. With a sound PPP approach, lawful public engagement is possible and has the potential to fulfill rural broadband needs, as shown.

Regarding infrastructure investments fibre infrastructure resulted as the only viable infrastructure in terms of sustainability. Wireless – and, therefore, the digital dividend – was not selected as primary broadband infrastructure because of its failure as a shared access medium. As the case studies show, a rural FTTH deployment also meets sustainability criteria.

A significant part of this study addressed PPPs, establishing them as the ideal vehicle for the successful delivery of high bandwidth and sustainable infrastructure. Hence, the major question for politicians and governments in terms of nationwide broadband should not be short-sighted with regard to necessary funding. The ideal of nationwide broadband access is always called into question as costs rise exponentially with increasing coverage. However, this decision should rather depend on the rollout costs today than on what it costs to be offline tomorrow. We are on the way to treat broadband access in much the same way as access to electricity. Time has come to stop questioning broadband and what's in for us like we did for electric energy centuries ago. The idea of conducting a study to ascertain whether the availability of electricity had a positive impact on GDP growth seems ludicrous today. Electrical energy is classified as a general-purpose technology. And Broadband was accorded the status of general-purpose technology by the OECD in 2007⁸⁷.

Political decision-makers should treat nationwide broadband access as a matter of urgency. This can be done by increasing the universal service level and by helping to create the right market conditions for investments. Clear and streamlined regulation

⁸⁷ See OECD (2007).

about rural FTTH investment is required in order to give potential investors some kind of certainty in respect of their possible future returns. . Governments can actively support private investments in rural FTTH by creating clear financial investment incentives through subsidies or any other long-term commitments. It might not be necessary in all cases, as it was in Australia, to build up the entire infrastructure. Especially for PPPs, actively pursuing the enforcement of the *Community Guidelines for the application of state aid rules in relation to rapid development of broadband networks* on national level is crucial in order to funnel money to rural PPP FTTH projects. Actual debates in favor of network neutrality in the US as well as in Europe had an additional impact also on open access networks. This is why under certain conditions rural FTTH networks with an open access model are to be exempt from regulation within these guidelines. Regarding sustainability and implementation speed, rural FTTH PPPs enjoy active support from the political arena. Moving forward, open access and network neutrality should be integrated into funding policies for rural FTTH PPPs. This will keep local markets open for service competition and provide users with access to the information society. The major focus of broadband politics should be access to, and participation in, the information society⁸⁸.

Further research should concentrate on the creation of guidelines for a public and/or private financing of infrastructure provision, including a database for PPP projects and the standardization of procurement processes and contract documentation. This will also help establish two-way communication channels with the private sector⁸⁹.

The overall results of this study can contribute to discussions about massive infrastructure investment plans to lay the foundations for future growth in the context of the present global financial crisis. After all:

“There is no reason to believe that network transmission speeds of 5 Mbps will not seem every bit as antiquated to us in five to ten years as 56 Kbps seems to us today.”⁹⁰

⁸⁸ A detailed feasibility analysis of rural broadband focusing besides economic perspectives legal constraints was done by Holznagel, Picot, Grove, Deckers, and Schramm in 2010. See Holznagel (2010) for details.

⁸⁹ See Kwak, Chih and Ibbs (2009), p. 73f.

⁹⁰ See Atkinson et al. (2009).

Appendix

Appendix 1: FTTH Cases in rural Areas

	Date	City/Cities	Area
Europe			
Germany			
21921 Schwert Update 2009 in folder	2008	one	56,2 sq. Km
21933 Nordersted	2009	Ballungsgebiet	58,1 km²
Netherlands			
21903 Nuenen	2008	one	33,9 sq. Km
21922 OnsNet	siehe Schweiz		
France			
21901 Pau	2007-2008	Pau, Ousse,	31,51 sq. Km
21931 Vario	siehe 21931		
Finnland			
21905 Kuusiokunnat	2006	Kuortane,	
Norway			
21908 Fredrikstad		Fredrikstad	288,1 sq km
21925 Bykle	Partner von		
21926 NTEBredband			
21927 TromsBynett			
21928 VarangerKraft	Varanger Kraft		
21929 Sandefjord	Partner von		
21930 Agder		In the county	
21932 EB			
21934 Dalane region	2006	4 municipalities	about 1800 sq
Spain			
21906 Asturien	2006	Region Asturia	10.604 sq km
21935 Catalonia		Lleida, Tortosa,	
Island			
21907 Reykjavik	2003	Reykjavik	274,5 sq km
Slovenia			
21904 TelekomSlovenia		Slovenia	20.256 sq km
Swiss			
21931 Sierre	2007	Sierre	19,2 sq km
Sweden			
21902 Stokab		Today	
America			
United States			
21909 Utopia	2004	Tremonton,	
21910 Danville			113,8 sq km
21911 Loma Linda			19,0 sq km
21912 iProvo	2008	Provo	108,2 sq km
21913 DimondNet	2008	Sallisaw	33.4 sq km
21914 Crawfordsville			21.7 sq km
21915 Glasgow	By 2000,		
21916 iINKCity		City	12.0 sq km
21917 MINET		Independence	
21918 GVTC		covers 2,000	
21919 Chelan	interessante	Chelan County	7,754 sq km
21923 Dalton			51.3 sq. km
21924 HomeTel	Momentan zu		
Asia/Pacific			
Australia			
National Broadband Network	2009		

References

- ACMA (2008): “Communications Infrastructure and Services Availability Report 2007-2008”, Report of the Australian Communications and Media Authority and Australian Competition and Consumer Commission, Canberra, 2008
- Amendola, G. B./Pupillo, L. M. (2008): “The Economics of Next Generation Access Networks and Regulatory Governance: Towards Geographic Patterns of Regulation”, MPRA Paper No. 8823
- Atkinson, R. D. et al. (2009): “The Need for Speed: The Importance of Next-Generation Broadband Networks”, ITFT, Washington, 2009
- Australian Bureau of Statistics (2004): “1301.0 Yearbook Australia”, Australian Bureau of Statistics, Canberra, 2004
- BMWi (2009a): “Breitbandstrategie der Bundesregierung“, Berlin, 2009
- BMWi (2009b): “Flächendeckende Breitbandversorgung forcieren - Aufbau von Hochleistungsnetzen unterstützen“ available online: <http://www.zukunft-breitband.de/BBA/Navigation/breitbandstrategie.html>, [cited on March 18th 2009]
- van Bogaert, J. (2008): “Test of new law proves bandwidth will be used”, in Global Telecoms Business, Nr. 80701, p. 24 – 25, 2008
- Budäus, D. (2004): “Public Private Partnership – Ansätze, Funktionen, Gestaltungsbedarfe”, in: Gesellschaft für öffentliche Wirtschaft (Hrsg.), Public Private Partnership: Formen – Risiken – Chancen (Volume 21, S. 9ff.). Berlin, 2004
- Büllingen, F., Stamm, P. (2008). Breitband für jedermann- Infrastruktur für einen innovativen Standort. Studie für das Ministerium für Wirtschaft, Verkehr, Landwirtschaft und Weinbau Rheinland-Pfalz. Wik Consult. Bad Honnef.
- Buxmann, P., Hess, T., Lehmann, S. (2008). Software as a Service. in: Wirtschaftsinformatik 6., S. 500-504.
- Carlaw, K. I./Lipsey, R. G./Webb, R. (2007): “The Past, Present and Future of the GPT-Driven Modern ICT revolution”, Final (Blue) Report, Industry Canada, 2007

- Cisco Systems (2009): "Cisco Visual Networking Index: Forecast and Methodology, 2008-2013", available online:
http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.pdf [cited on June 24th 2009]
- Dasgupta, K./Waverman, L. (2007): "Investment in Telecommunications Network: A 21st Century Perspective", London Business School, Working Paper
- DBCDE (2009): "National Broadband Network, Department of Broadband, Communications and the Digital Economy, Government of Australia", available online:
http://www.dbcde.gov.au/communications_for_business/funding_programs__and__support/national_broadband_network [cited on March 29th 2009]
- Destatis (2009). Statistisches Bundesamt Deutschland.
<http://www.destatis.de/jetspeed/portal/cms/>. Accessed 15 July 2009.
- Deutsche Bahn AG (2008). Bahnpreise steigen zum Jahresende um durchschnittlich 3,9 Prozent / Gleichzeitig neue Angebote und Service-Offensive. Press Report of Deutsche Bahn AG, 29th of August 2008.
<http://www.deutschebahn.com/site/bahn/de/unternehmen/presse/presseinformationen/ubp/p20080829.html>. Accessed 15 July 2009.
- EC (2010): "COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - A Digital Agenda for Europe, COM(2010) 245, Brussels, 2010
- EC (2009): "Commission earmarks €1bn for investment in broadband - – Frequently Asked Questions", Memo/09/35, Brussels, 2009
- EC (2008): "A European Recovery Plan", COM(2008) 800 final, Brussels, 2008
- EC (2002): "Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive)", Official Journal of the European Communities L, Vol. 108, 24.04.2002, pp. 51-77.
- Eichener, V./Brandt, M. (2000): "Bürgerschaftliches Engagement bei Errichtung und Betrieb von öffentlicher Infrastruktur in den Bereichen Freizeit, Kultur und Sport",

- Bochum, Study on behalf of Institut für Wohnungswesen, Immobilienwirtschaft, Stadt- und Regionalentwicklung an der Ruhr-Universität Bochum, 2000
- EP (2000): “Lisbon European Council 23 and 24 March 2000”, Presidency Conclusions, http://www.europarl.europa.eu/summits/lis1_en.htm [cited on March 29th 2009]
- Facebook (2009). Statistics. <http://www.facebook.com/press/info.php?statistics>. Accessed 15 July 2009.
- Fiberevolution (2009): “A World of Fiber”, available online: <http://www.fiberevolution.com> [cited on March 28th 2009]
- Fink, C., Kenney C. (2003). W(h)ither the digital divide?. in: info Nr. 5. Vol. 6. p. 15 – 24. 2003.
- Frieden, R. (2010): “Determining Causality in Telecommunications”, available online: <http://www.publicknowledge.org/node/3051> [cited on May 30th 2010].
- Gerhards, M., Mende, A. (2008). Ein Drittel der Deutschen liebt weiter offline. Ergebnisse der ARD/ZDF-Offlinestudie 2008. Media Perspektiven 7. 2008. S. 365-376.
- Goolsbee, A. (2002): “Subsidies, the Value of Broadband, and the Importance of Fixed Costs”, in “Broadband: Should we Regulate High-Speed Internet Access?”,
- Grüll, M. (2009): “Glasfaserausbau in Schwerte”, Speech at “BREKO-WIK-BREKO-WIK- Workshop FFB/H-Ausbau in Deutschland“, 24.3.2009, Berlin
- Greenstein, S., McDevitt, R. (2009). The Broadband Bonus: Accounting for Broadband's Impact on U.S. GDP. NBER Working Paper 14758. 2009.
- Holznagel, B./Picot, A./Deckers, S./Grove, N./Schramm, M. (2010): “ Strategies for Rural Broadband: An economic and legal feasibility analysis“, Wiesbaden, Gabler.
- Hoffman, D. L./Novak, T. P. (1998): “Bridging the Racial Divide on the Internet”, SCIENCE, 280 (April 17), 390-391, 1998
- Holznagel, B./Deckers, S. (2009): “Breites Band im weiten Land –Neue Herausforderungen für die Daseinsvorsorge im föderalen Bundesstaat“, DVBI 01/2009.

- Huigen, J./Cave, M. (2008): "Regulation and the promotion of investment in next generation networks - A European dilemma", *Telecommunications Policy* 32 (2008), p. 713 – 721
- IDATE (2007): "Broadband Coverage in Europe", IDATE, Montpellier, 2007
- ITU (2003): "The birth of Broadband", ITU Internet Reports, Geneva, 2003
- Jackson L. et al (2008). Race, gender, and information technology use: the new digital divide. *CyberPsychology & Behavior*. August 2008, 11(4): 437-442.
- James, J. (2008). Digital Divide Complacency: Misconceptions and Dangers. *Information Society* Nr. 1 Vol. 24. p. 54 – 61. 2008.
- Klijn, E. H./Tseiman, G. R. (2000): "Governing public-private partnerships", in Osborne, S. P. (2000): "Public-private Partnerships: Theory and Practice in International Perspective", Routledge, New York, pp. 84 - 102
- Klüter, H. (2005). Wüstung in Vorpommern – Bedrohung für den ländlichen Raum. in Steingrube, W. (2005). Beiträge zur Regionalentwicklung in Mecklenburg-Vorpommern. in Greifswalder Beiträge zur Regional-, Freizeit- und Tourismusforschung. Forum für Regional-, Freizeit- und Tourismusforschung an der Universität Greifswald, Greifswald.
- Kubicek, H., Welling, S. (2001). Vor einer digitalen Spaltung in Deutschland? Annäherung an ein verdecktes Problem von wirtschafts- und gesellschaftspolitischer Brisanz. in: *Medien- & Kommunikationswissenschaft*. 48(4). S. 497-517.
- Kwak, Y. H./Chih, Y./Ibbs, C. W. (2009): "Towards a Comprehensive Understanding of Public Private Partnerships for Infrastructure Development", *California Management Review* 51 (2), CMR.BERKELEY.EDU, p. 73f.
- Lehr, W.H., Osorio, C.A. Gillett, S.E. (2006). Measuring Broadband's Economic Impact. 33rd Research Conference on Communication, Information, and Internet Policy (TPRC). Arlington. 2005.
- Markle Foundation (2009). Markle Foundation – Addressing Critical Public Needs for Health and National Security in the Information Age. <http://www.markle.org/>. Accessed 15 July 2009.

- Martin, K. J. (2008): "FCC Broadband Definition", available online from http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280909A2.doc [cited on March 9th, 2009]
- Menou, M. J. 2001. Digital and social equity? Opportunities and threats on the road to empowerment. Paper presented at the LIDA (Libraries in the Digital Age) 2001 Annual Course and Conference. Dubrovnik. Croatia. http://www.cnam.fr/instituts/INTD/Menou_intd-er.pdf. Accessed 15 July 2009.
- Nielsen, J. (1998): "Jakob Nielsen's Alertbox for April 5, 1998: Nielsen's Law of Internet Bandwidth", available online at: <http://www.useit.com/alertbox/980405.html> [cited on March 19th, 2009]
- OECD (2009): "OECD Broadband Portal", available online: http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html
- OECD (2008): "OECD Broadband Portal", available online at: <http://www.oecd.org/sti/ict/broadband>, [cited on March 18th 2009]
- OECD (2007): "Broadband and the Economy", Paris, OECD Publishing, 2007.
- Pick, J., Azari, R.(2008). Global digital divide: Influence of socioeconomic, governmental, and accessibility factors on information technology. Information Technology for Development. Vol 14. Number 2. pages 91-115. 2008.
- Picot, A. (2009a): "Schlüsselproblem Breitbandzugänge", in Information Technology, Vol. 4, Nr. 51, 2009.
- Picot, A. (2008): "Briefing Note. Next ("Now") Generation Access (NGA)" in Cave/Picot (2008): Workshop Next („Now“) Generation Access (NGA): How to Adapt the Electronic Communications Framework to Foster Investment and Promote Competition for the Benefit of Consumers?, ITRE, Brussels, 2008
- Picot, A./Wernick, C. (2007): "The role of government in broadband access", Telecommunications Policy 31 (2007), p. 660 - 674
- Picot, A./Reichwald, R./Wigand, R. (2008). Information, Organization and Management. Springer. Berlin. 2008.

- Pohjola, M. (2001). Information Technology, Productivity, and Economic Growth: International Evidence and Implications for Economic Development. Oxford University Press. UK. 2001.
- Preston, P./Cawley, A./Metykova, M. (2007): "Broadband and rural areas in the EU: From technology to applications and use", Telecommunications Policy 31 (2007), p. 389 -400
- Ramirez, R./Richardson, D. (2005): "Measuring the impact of telecommunication services on rural and remote communities", Telecommunications Policy 29 (2005), p. 297 - 319
- Reding, Viviane (2007). How Europe can Bridge the Broadband Gap. Speech at Broadband Gap 2007. Conference & Exhibition 14th of May 2007. Brussels 2007.
- Rovers, K. (2008): "Nuenen: A proven concept", speech at the e-Inclusion Ministerial Conference & Expo, 1st December 2008, Vienna, 2008
- Schweizerische Bundesrat (2007): "Verordnung über Fernmeldedienste (FDV)", SR 0.275.11, Schweizerische Eidgenossenschaft, 2007
- Szafran, U. (1993): "Der Markt für Satellitendienste", WIK Diskussionsbreitag 107, WIK, Bad Honnef
- Tanenbaum, A. S. (2003): "Computer Networks", fourth edition, Pearson, New Jersey, 2003
- Torero M., von Braun J. (2006). Information and Communication Technology for Development and Poverty Reduction. Baltimore. Johns Hopkins University Press. Washington. 2006.
- Welling, S. (2000). Der Digital Divide in der Wissens- und Informationsgesellschaft. Forschungsgruppe Telekommunikation. Universität Bremen.
- Wernick, C. (2007): "Strategic Investment Decisions in Regulated Markets", Gabler, Wiesbaden, 2007
- Wulf, A. (2008): "Netze der Zukunft – Welchen Beitrag werden neue Glasfasernetze zur Breitbandversorgung ländlicher Räume leisten?", Presentation at the WIK Workshop: „Breitbandschere“ –Verlieren ländliche Regionen den Anschluss?“ 6th of June 2006, Bonn, 2006