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The Role of Municipalities for Broadband Deployment in Rural Areas: An Economic Perspective

Authors:

Dr. Christian Wernick
Dr. Christian M. Bender

WIK Wissenschaftliches Institut für Infrastruktur
und Kommunikationsdienste GmbH
Rhöndorfer Str. 68
53604 Bad Honnef
Germany

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wik Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste

Contents

1 Economic Impact of Digitization and Broadband Deployment

Numerous international and national studies have shown the significant positive impact of broadband usage on the overall economic development:[1]

1. Contribution to economic growth (positive externalities):

For Germany, it is estimated that an increase in broadband coverage of 1% will increase per capita GDP by up to 850 € within a year. This increases up to 2,450 € per year in the long-run.[2] The available bandwidth plays an important role as well: It is estimated that doubling the bandwidth will lead to an additional 0.3%.growth of GDP [3]

2. Contribution to productivity and efficiency:

1% increase in broadband availability for enterprises is estimated to increase annual productivity by 0.94%. The availability of mobile broadband technologies primarily affects the productivity in service sectors, whereas productivity gains in industrial sectors mainly depend on the availability of fixed-line broadband technologies.[4] Moreover, improvements in efficiency through the expansion of business activities, product and process innovations as well as the implementation of new business models become feasible.

3. Contribution to employment:

Beside obvious direct positive effects on employment (creation of jobs directly related to the roll-out and in connected sectors) also indirect positive effects may occur, as the realisation of innovations is expected to increase household spending and induce further employment. Falk & Biagi (2015) estimates that the construction of fibre optics networks enabling bandwidths of at least 100 Mbit/s for half of the population will result in the creation of around 561,000 new jobs in Germany between 2015 and 2020.[5]

4. Creation of consumer surplus:

The availability of broadband access affects consumer surplus in two ways. On the one hand, availability of broadband access directly increases consumer welfare. On the other hand, availability of ICT services leads to lower prices due to increasing productivity and stronger competition. The consumer surplus created by broadband was estimated to a total of US $ 7.5 billion for the United States in 2006.[6]

Overall, broadband availability represents a key location factor and necessary prerequisite for the benefits of the digitisation and the creation of the information society.

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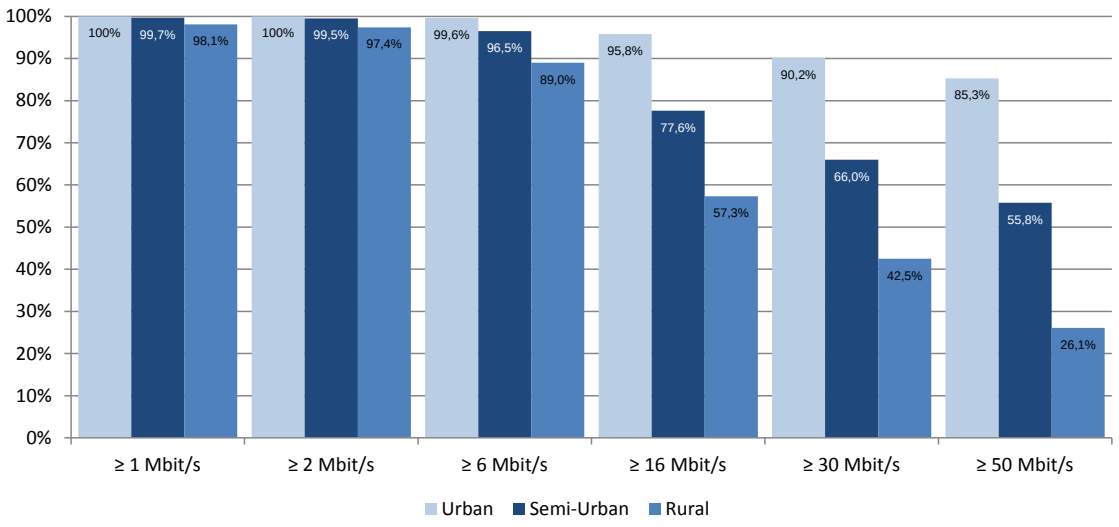
1 See Röller & Waverman (2001), Katz (2012).
2 See Castaldo et al. (2015).
3 See Rohman & Bohlin (2012).
4 See Falk & Biagi (2015).
5 See Falk & Biagi (2015).
6 See Greenstein & McDevitt (2009).

2 Broadband Availability in Germany

The public debate in Germany has a strong focus on the objective of the German Federal Government, to achieve a nationwide broadband infrastructure providing access to broadband with download-bandwidths of at least 50 Mbit/s by 2018. Currently, broadband access with download-bandwidths of 16 Mbit/s and upload-bandwidths of 1 Mbit/s is available throughout the country. However, connections enabling bandwidths of at least 50 Mbit/s download are available for only 68.7% of private households. Moreover, we observe considerable differences between urban, semi-urban and rural areas (see Figure 2-1).[7]

Figure 2-1: Broadband availability for private households (% of households passed, mid-2015)

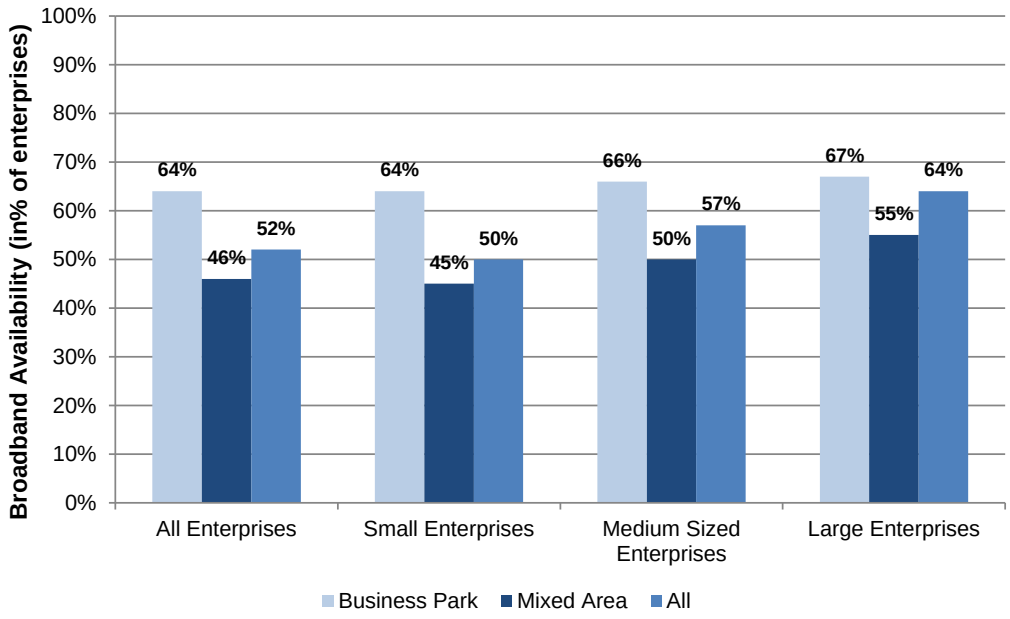


Source: WIK based on data from TÜV Rheinland (2015).

7 See TÜV Rheinland (2015).

A similar gap between the actual deployment with high speed broadband and the defined task of the German government can be observed with respect to broadband access for business users, both in business parks and in mixed areas (see Figure 2-2).

Figure 2-2: Broadband availability for commercial users in Germany (≥ 50 Mbit/s upload, mid-2015)



Source: WIK based on data from TÜV Rheinland (2015).

A crucial aspect is that business parks are mostly located in peripheral areas and thus, do not benefit from the rollout of FTTC technologies, which is pursued in many regions in Germany. This is due to the connection between the availability of bandwidth and the distance to the network node in copper networks.[8]

Notwithstanding the high level of ambition which will be necessary to achieve the current objective of a nationwide broadband coverage with bandwidth of at least 50 Mbit/s, this will only represent an interim objective: Nearly half of German households, mainly in urban areas, already enjoy access to download bandwidths of 200 Mbit/s via cable and FTTB/H networks and the digital gap continues to grow.[9]

8 See Fornefeld & Windolph (2012), S. 19.
9 http://www.vodafone.de/unternehmen/presse/pressearchiv2015-328710.html

3 The Economics of Broadband Deployment

The main cost drivers in the deployment of fibre optics networks are investments in passive network infrastructure. Depending on the chosen architecture, civil engineering works account for 80-90% of the costs of fibre optics rollout. The remaining 10-20% of costs can be distributed to the provision of active infrastructure.[10]

This cost structure implies cost benefits for the rollout of VDSL or Vectoring in comparison to FTTB or FTTH networks, as the construction of VDSL- or Vectoring-infrastructures require significantly less civil engineering works.

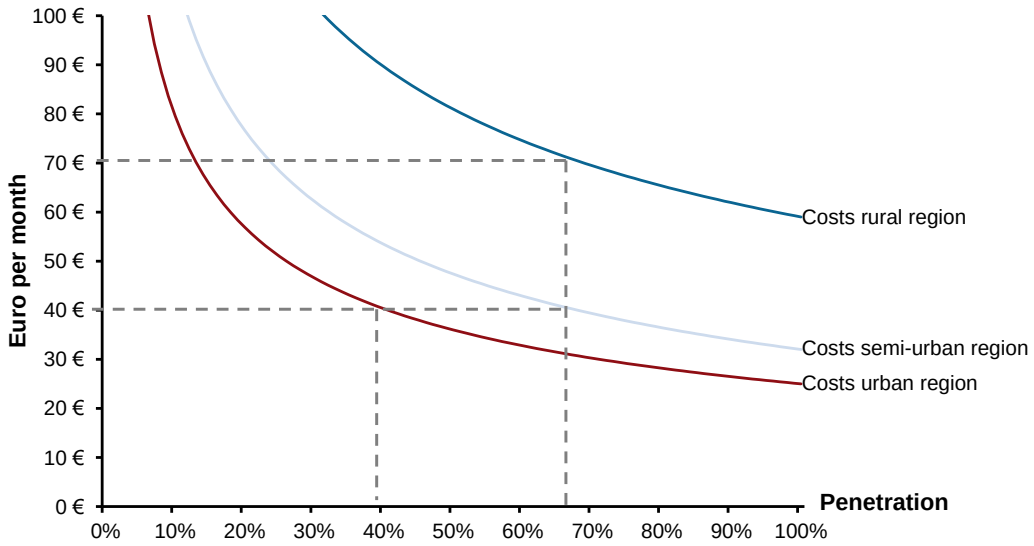
The profitability of business plans of broadband rollout projects is mainly determined by three aspects:[11]

1. The population density
   (that is the number of accessible customers per area unit),
2. The penetration rate
   (that is the number of actual subscribers that can be attracted per area unit), and
3. The average revenue per user (ARPU).

Investment costs per potential customer are heavily driven by population density. For a given ARPU, a relatively low penetration rate is sufficient in densely populated urban areas in order to recover the cost of a FTTH deployment, whereas a substantially higher penetration rate is required in semi-urban areas. In less densely populated rural areas, investment costs per customer are such that a profitable rollout and operation is not feasible at common market prices. In order to achieve coverage in these regions, the customers would have to pay higher prices (see Figure 3-1).

10 See Jay et al. (2011).
11 In addition, strategic considerations may play a role (see Section 4).

Figure 3-1: Schematic representation of the cost of broadband deployment per customer depending on the penetration



Source: Own illustration based on Jay et al. (2011).

For this reason, densely populated regions may be served by several infrastructures whereas the deployment of parallel infrastructures is no longer profitable in less densely populated areas and, consequently, only one infrastructure will be provided. In sparsely populated rural areas, a profitability gap exists that prevents a roll-out without subsidies.[12]

12 See Faulhaber & Hogendorn (2000); Elixmann et al. (2008).

4 Investment Behaviour in the Deployment of NGA Infrastructure

Inter country comparisons on the deployment of NGA infrastructure in leading economies show that a variety of different market players is involved. Key factors for the spread of fibre networks are the level of infrastructure competition[13] and stable legal and regulatory frameworks.[14]

In Germany, infrastructure competition in commercially attractive, densely populated regions has resulted in the rollout of parallel infrastructures allowing for high bit rate services. Moreover, the German BNetzA's Vectoring Decision of August 2013[15] had strong impact on the investment behaviour of market participants. The decision set strong incentives for the realization of first-mover advantages for Deutsche Telekom as well as for competitors. This initiated a "greyhound race" for the connection of street cabinets and thus the roll-out of FTTC infrastructure, in particular in densely populated areas. In addition to profitability considerations also strategic considerations play a major role for this kind of investment behaviour.

In the economic literature it is well documented how firms, analogue to price-setting decisions in contestable markets[16], make investment decisions to deter or to blockade market entry of competitors.[17] Reconsidering the relevance of the penetration rate and the average revenue per user (ARPU), as discussed in Section 3 above, this behaviour is easily comprehensible. Such strategic investment does not require an investment in the same technology. It is sufficient to ensure that a potential entrant is unable to attract enough demand to recover its market entry cost.

13 See Godlovitch et al. (2015).
14 See Wernick (2007).
15 See BNetzA (2013).
16 In contestable markets without irreversible entry costs, the incumbent sets his price just in the way that a potential competitor cannot realize positive profits and thus market entries does not occure. See. Baumol et al. (1982).
17 See Spence (1977), Dixit (1980), Fudenberg & Tirole (1983), Maskin & Tirole (1988).

Entry deterrence through investment

A simple example can illustrate how market entries may be deterred by strategic investments. In a stylized region, two firms can sequentially invest in the deployment of broadband networks and then enter into retail competition. Both firms face the same fixed investment costs ($F = 900$) for the broadband deployment and the market price is subject to the total number of broadband connections in the region ($P = 160 - K_1 - K_2$).

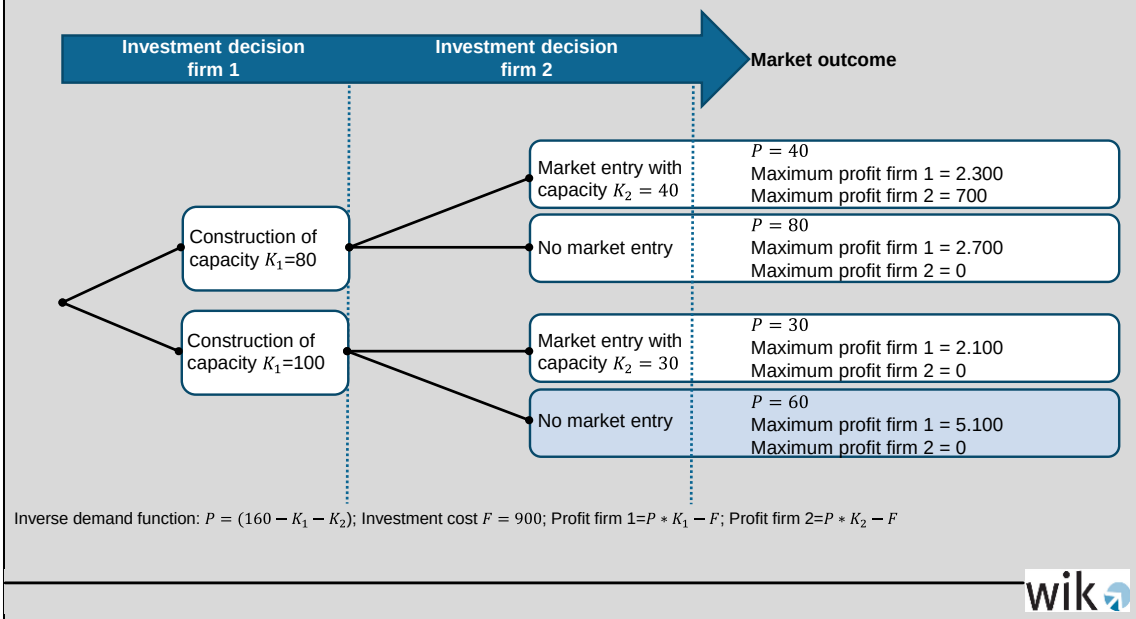
Firm 1 invests first. Firm 2 considers in its investment decision the number of broadband connections already established by firm 1. Firm 1 anticipates this investment behaviour and, consequently, is able to influence the investment decision of firm 2 and the resulting market result by its initial investment (see Figure 4-1).

- Firm 1 is able to realize a first-mover advantage by providing a greater number of broadband connections ($K_1 = 80$). Firm 2 will then enter the market and maximizing its profit by choosing a lower capacity ($K_2 = 40$) than firm 1.
- Firm 1 is able to reduce the remaining (unfulfilled) demand in the region such that firm 2 cannot realize a positive profit by building an even higher capacity ($K_1 \geq 100$). Consequentially, firm 2 will not invest in this region.

The profit of firm 1 is greater if it deters the market entry of firm 2 (even if the price - as in the case with market entry - would be fixed at 40) and consequently, this market equilibrium will be realized.

In this example a later market entry by firm 2 would only be possible, if either the fixed investment cost would decline or the willingness to pay - for example as a result of new technology - would increase in a way that a positive profit could be realized.

Figure 4-1: Example: Strategic investment to deter market entry



Source: Own illustration.

For achieving a nationwide provision of high speed broadband networks, strategic investments deterring market entries by competitors are not necessarily negative. However, in a medium and long-term perspective, various shortcomings are associated with this kind of behaviour:

- NGA infrastructures will be preferred which can be rolled-out quicker and at lower cost.
- Incentives to upgrade these infrastructures at a later time are virtually non-existent - as already the initial investment was not based on profitability considerations there will be no incentives at a later stage.
- Due to newly created market entry barriers, alternative providers are prevented from rolling out parallel infrastructure in the long-run, too.[18]

Consequently, strategic investment behaviour bears the risk of carbonising the situation in rural areas and thus the digital divide in comparison to urban and semi-urban regions.

18 See Elixmann et al. (2008).

5 The Role of Municipalities

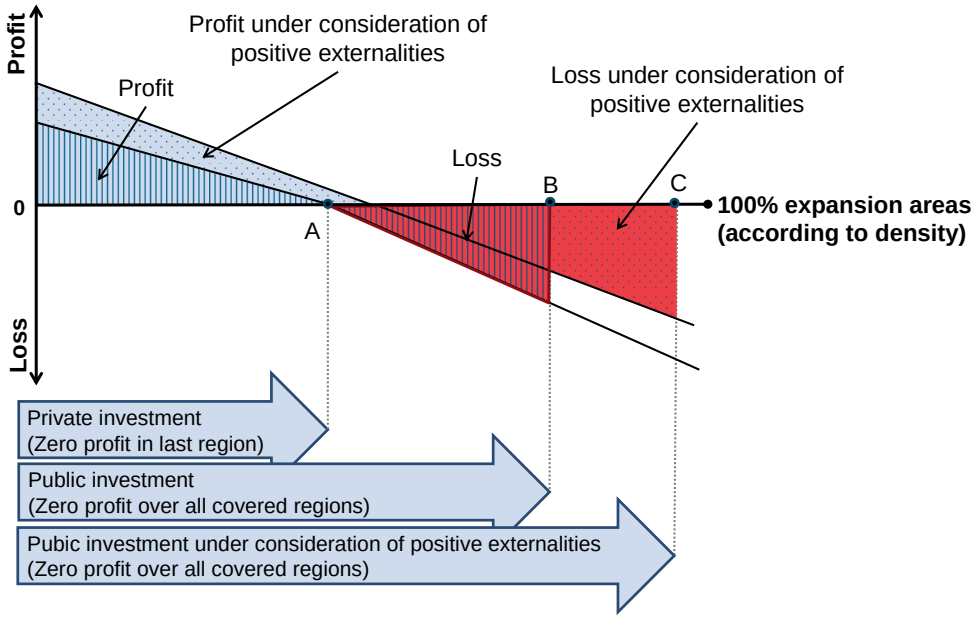
Broadband coverage is of particular importance for the strengthening of regional economies and represents a major location factor: It may foster economic growth, strengthen regional value chains, increase effectiveness, efficiency and, last but not least, the quality of life of its inhabitants in general.[19] A delayed or inadequate deployment of broadband networks in rural areas is vice versa likely to become a considerable competitive disadvantage, which may result in the relocation of businesses and private homes and thus in the weakening of entire regions in the medium term.[20]

We therefore expect public policy actors to make significantly different investment decisions than private sector actors, which is illustrated in a stylized way in Figure 5 1. A profit-maximizing firm will invest, when it expects to make profits. Taking the different levels of profitability in different regional settings into account, broadband networks will be deployed to all regions which allow at least to break-even, i.e. to realize a zero profit (Point A). In contrast to this, an investor who maximizes total welfare instead of profit will deploy broadband until cost recovery is achieved over all covered regions. This investment decision implies cross-subsidization such that the positive profits in the profitable regions will just equal the losses in those regions in which cost recovery of broadband deployment is not feasible (Point B).

Furthermore, private firms do not consider any of the positive overall economic effects described in Section 1 above in their investment decision. For municipalities and communities, however, these positive externalities provide an additional "profit" and the deployment of broadband networks may be profitable even in less populated areas due to the overall welfare effects. This is illustrated by an outward shift of the profit function in Figure 5-1, which illustrates that broadband is deployed even in regions with a lower population density (Point C).

19 See BMVI (2015).
20 See IHK Pfalz (2014).

Figure 5-1: Investment decision for broadband deployment



Source: Own illustration based on Inderst et al. (2011).

There are further differences in the investment decisions of municipalities that have a positive impact on the deployment of broadband networks by municipalities:

- **Sustainability of infrastructure:** Investment decisions of private enterprises are solely based on commercial considerations and the profitability calculation is decisive for or against an investment project. By contrast, municipalities may consider positive externalities, for example with regard to the long-term positioning as a location factor for business or private users.
- **Higher penetration rates due to local involvement:** It is observable that municipal broadband projects achieve a better relation between actually connected (Homes Connected) and accessible households (Homes Passed) than commercial projects. Typically, the pre-marketing rates, and thus the required demand for a rollout, are well above 20% and up to 60%[21] in municipal FTTB/H deployment projects. In contrast, Deutsche Telekom applied pre-marketing rates of 10% in previous FTTB/H deployment projects and currently reaches a take-up rate of approximately 13% in its FTTB/H network.[22] It can be argued that this is due to a higher pronounced local involvement and greater participation of part of the population

21 See Volksstimme (2015c), http://www.nordischnet.de/ihr-glasfaser-anschluss-106.html.
22 See Langer & Tauber (2013).

- **Longer amortization periods:** Municipalities are able to depreciate investment over a longer period which has a positive effect on financing terms.
- **Synergies between municipal infrastructures:** Municipalities can benefit from synergies between already existing municipal infrastructure. Furthermore, the coordination of construction works is easier in comparison to external partners. This allows for a higher deployment speed and lower construction costs.

In summary, it is likely to expect, that the results of profitability analyses of municipalities or affiliated enterprises will lead to different results than those of commercially driven private-sector projects.

We notice that municipalities have started to establish special-purpose associations or use municipal utilities for the acceleration of broadband deployment in light of limited investments by private firms in rural regions with low population densities. For example, the special-purpose association High-Speed-Netz Rhein-Neckar (fibrenet.rn) started in 2015 with the construction of a fibre optics network for 530,000 households and more than 25,000 enterprises in the Rhine-Neckar region.[23]

Economic analyses have shown that private investment in new broadband infrastructure and upgrade of existing telecommunications infrastructures are carried out earlier if municipalities are involved. An empirical study of the investment behaviour of 3,000 US cable networks in the years 2001 to 2009 shows, for example, that the probability of investing in an upgrade of the cable network by the cable operators was 27% higher per year in regions with municipal utilities than in regions without such entities. The presence of private firms as potential competitors, and thus of potential broadband deployment by private competitors in the considered regions, had no significant effect on the investment decisions. This suggests that incumbents act more aggressively against public "competitors" that promote broadband deployment than against private entrants.[24]

There are indications that such investment behaviour applies in Germany, too: The special-purpose association Zweckverband Breitband Altmark (ZBA) intends to deploy a FTTB/H network for a total of 210,000 inhabitants in the districts Altmarkkreis and Salzwedel in northern Saxony-Anhalt. In mid-2015, the expression of interest procedure was completed and the deployment of broadband networks started in the first communities. Interestingly, Deutsche Telekom announced to intensify their investment in broadband deployment in these counties shortly afterwards.[25]

In addition to a simple entry deterrence strategy, a possible cause for this strategic investment behaviour may be that municipalities have a broader, i.e. a welfare optimizing, perspective which potentially yields - directly or through an Open Access regime – to a more intensive competition.

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23 See AVR (2015).
24 See Seamans (2012).
25 See Volksstimme (2015a); Volksstimme (2015b); Altmark Zeitung (2015).

These observations underline the positive effects of municipal commitment on the deployment of broadband networks - even if a particular project is actually not implemented by the municipality or a municipal enterprise but by the incumbent telecommunications provider or a competitor. In any case, it seems important to consider the motivation of the interested parties when deciding in favour or against a public broadband deployment project in order to ensure long-term viable and sustainable solutions.

6 Status Quo of Municipal Commitment in German Broadband Deployment

An international perspective reveals the variety of local commitment in broadband deployment. This ranges from financial contributions to the provision of passive infrastructure up to the complete operation of high speed broadband networks by municipal utilities or public-private partnerships.[26]

In Germany, municipalities no longer restrict themselves to a passive role in the deployment of broadband networks in rural areas by providing subsidies for the rollout of infrastructure to private companies. They promote the rollout independently, for example by establishing municipal special purpose associations (German: Zweckverband):[27]

- In 2015, the Zweckverband Breitband Altmark, which is supported by the counties Altmark Salzwedel and Stendal and 20 county accompanying communities, started to roll-out FTTB/H-broadband infrastructure in rural areas in northern Saxony-Anhalt.
- Since 2012, the Wege Zweckverband, which had been established in 1954 and which is supported by 94 municipalities in the county Segeberg, is building FTTH networks in rural communities in Schleswig-Holstein in the context of its own broadband initiative.
- In 2010 the county Ravensburg commissioned the elaboration of a county wide approach for the inter-municipal rollout of fiber optics networks. Since then the resulting Zweckverband Breitbandversorgung Ravensburg, which is supported by the county and 18 county accompanying communities, has been working on the FTTH expansion in the region.

26 See Mölleryd (2015).
27 See BMVI (2015b); fibrenet.rn.

- In 2015, the Zweckverband High-Speed-Netz Rhein-Neckar, which is supported by the county Rhein-Neckar in the federal state Baden-Württemberg and 54 county accompanying cities and communities, started with the rollout of FTTB/H-fiber-optic network in the Rhine-Neckar region.

Conspicuously, there are considerable regional differences between the roles of municipalities. For some reasons, it seems likely that these differences are driven by differences in the purpose and the design of the funding guidelines through the broadband initiatives in the federal states (German: Bundesländer).

In some federal states, for example in Bavaria[28], funding is concentrated on bridging profitability gaps in the short-run. In the context of the so-called gap-funding model, municipalities do not actively participate in the deployment of broadband networks. Instead, their commitment is limited to subsidize individual telecommunications operators by funding the gap between economically viable and desired levels of broadband deployment.

Other federal states, for example Baden-Württemberg[29], strive for an active commitment of municipalities by encouraging publicly run municipal networks (also known as public PDO). The municipalities participate directly in broadband deployment by providing the passive infrastructure elements on their own. The network is then operated either by a municipal utility or through standard procurement to the market.[30]

It can be observed that public PDO often target the rollout of FTTB and FTTH networks. This indicates that municipal commitment may not only enable a large-area rollout, but also a capital-intensive deployment with future-proof fiber optic technology.

It is striking that municipal broadband deployment seems to be particularly successful if municipalities and counties are able to coordinate themselves in public PDOs.[31] Larger delineations of development areas, for example at county level, appear more successful than small-scale delineations as cooperation between municipalities can generate additional benefits. This includes among others:

28 See STMF (2014).
29 See MLR (2015).
30 See European Commission (2015) for the advantages and disadvanteges of different investment models for public authorities.
31 See BMVI (2015b).

- the opportunity to take advantage of economies of scale and learning effects,
- the chance to practice negotiating power towards equipment suppliers and
- a higher level of efficiency by bundling standardized activities (for example invoicing customers) when operating the network.[32]

In addition, an inter-communal approach and, consequently, the expansion of the rollout area allow a balance between economically attractive and less attractive areas. This contributes to an improvement of the overall investment and hence to an expansion of the exploitable area.[33]

The objectives and regulations of federal broadband initiatives play a role in this respect, too. This is due to differences in the definition of the intervention thresholds for funding measures. In Bavaria, for example, the possibility to subsidize the rollout of gray spots has been eliminated by an updated funding policy ruling. Consequently development areas are narrowed and thus roll-out projects become more fragmented.[34]

Empirical evidence points at the relevance of the commitment of the community, the county and even of local citizens. An intensive and sustainable support of local stakeholders results in viable solutions for the deployment of broadband networks. This local commitment should be supported by politics at national, federal and regional state level. Regional broadband offices can play important roles in assisting and accompanying regional initiatives. To sum up, it seems crucial whether and how national and federal policy promotes regional approaches.

32 See Europäische Kommission (2015).
33 See Abschnitt 4.
34 See STMF (2012); STMF (2014)

7 Conclusions

We are convinced that municipalities can play an important role for the deployment of broadband networks in rural areas:

- They are able to exhibit lower profitability gaps due to higher penetration rates and longer periods of amortization. This reduces the necessity for subsidies.
- They can deploy broadband faster by leveraging existing synergies in civil engineering and thus realize positive economic effects of broadband deployment more quickly.
- Their different investment calculus allows the deployment of broadband in regions in which purely profit-oriented providers would not invest.
- They are able to enter the market as an additional player by own investment and hence to give new impetus for the region, the technological progress, and competition.

The role of municipalities should therefore be seen in the overall picture of promoting broadband deployment: the stimulus and additional investment incentives in rural areas can potentially reduce the need for public subsidies for the nationwide deployment.

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WIK Wissenschaftliches Institut für
Infrastruktur und Kommunikationsdienste GmbH
Rhöndorfer Str. 68
53604 Bad Honnef
Germany
Phone: +49 2224 9225-0
Fax: +49 2224 9225-63
eMail: info(at)wik.org
www.wik.org

Person authorised to sign on behalf of the organisation

General Manager and Director	Dr. Iris Henseler-Unger
Director Head of Department Postal Services, Logistics, and Transport	Alex Kalevi Dieke
Authorized Signatory Head of Department Cost Modelling and Internet Economics	Dr. Thomas Plückebaum
Director Head of Department Regulation and Competition	Dr. Ulrich Stumpf
Authorized Signatory Head of Administration	Karl-Hubert Strüver
Chairman of the Supervisory Board	Winfried Ulmen
Registered at	Amtsgericht Siegburg, HRB 7225
Tax No.	222/5751/0722
VAT-ID	DE 123 383 795