



# Creating a brighter future

## **Cost Model – Country Analysis Report (CAR) for Germany**

**Update of the Telecom Broadband Market**

**Cost calculations on future fibre Networks to meet Digital Agenda targets**



**Version 1.0 - August 2013**



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# **1. The FTTH EU Council Cost Model**

## **Introducing the result of last year**

In July 2012 the FTTH Council Europe published the commissioned Cost Model Report, which outlined the Cost of Meeting Europe's Network Needs: The cost of putting in place an infrastructure to meet the Digital Agenda targets for 2020 and beyond. The results of the model indicate that €202 billion would be required to provide a complete overlay of the EU27 countries to meet the DAE targets. This includes 100% homes passed and 50% connected (with 50% of the most remote 5% both passed and connected).

## **Why refining the Cost Model to specific countries?**

The 2012 Cost Model Report has shown a surprising result: delivering fibre to almost all European households will cost just over €200 billion which is less than half of many of the estimates already given! According to the FTTH Council Europe, all countries in Europe should choose future-proof broadband as a driver for economic growth. It is therefore the aim of the Council to bring this message and information about cost levels to each individual country.

Applying the FTTH Council Europe Cost Model to specific individual countries provides them with detailed information regarding the level of investment needed to put in place a future-proof infrastructure accessible by all inhabitants. However, knowing that fiberizing the whole of Europe will cost much less than expected is one thing, but being aware of the lower than expected cost for your own particular country has a much greater impact; all the more if the result is derived from a significantly expanded set of sample areas, amplifying the accuracy of the extrapolation model.

## **Why Germany?**

Germany has the largest population of all the EU countries. Independent research has shown that investments in future-proof infrastructure have a significant positive influence on the growth of the economy. Germany already has the largest economy of the EU, so investment funds are available. During the last 10 years, Germany has invested over €80 billion in telecommunications infrastructure, but as far as ultra high-speed broadband accessibility is concerned, the country is still a sleeping giant. Investments in future-proof infrastructure will not only help Germany to grow out of the current crisis, the slipstream will also aid other EU countries whose economies are partially dependent on the German economy.

## **Introduction to the structure of the report**

The report provides updated general information concerning Germany as well as describing the telecommunications industry and the German broadband market. The methodology used to calculate the estimated costs of future fibre networks to meet Digital Agenda targets is described in detail. Additional background information was given during the webinar on 23 April 2013 and in a presentation at the FTTH Conference 2013 in London. Results for Germany are shown; conclusions drawn and also considerations to reduce the costs further are discussed in the report.

## 2. Germany

### 2.1 Country overview

#### Largest economy in the EU

Having the largest economy in the EU, according to size of population (81.8 million, see Table 1), Germany ranks no. 5 in the world in purchasing power parity. This country is a leading exporter of machinery, vehicles, chemicals and long-duration consumer goods, benefiting from a highly skilled labour force and a high innovation rate as well as having a stable political environment. Foreign trade has resulted in a significant surplus during the last few years. An export all-time high was recorded in 2012, amounting to € 1097.4 billion.

Germany comprises of 16 federal states. In the government framework, with a few exceptions, these federal states and local authorities assume responsibility for infrastructure development.



Figure 1: Map of Germany (Source: Statistisches Bundesamt)

General economics	2008	2009	2010	2011	2012
Population [M]	82.0	81.9	81.8	81.7	81.8
GDP [€ billions]	2,496	2,371	2,372	2,408	2,409
GDP change [%]	1.3	-5.0	1.2	1.5	1.5
Inflation [%]	2.6	0.3	0.6	1.5	2.0
Unemployment rate [%]	8.7	9.1	8.6	7.9	7.6

Table 1: Economic indicators of Germany (Source: Statistisches Bundesamt)

### 2.2 Economic key aspects

With 81.8 million inhabitants (2012) Germany has the largest population throughout Europe, followed by France (65.5 M) and the UK (62.0 M). This population is spread quite evenly across the territory with the larger cities not accounting for a major proportion of the population, a situation which differs with UK and France.

Germany accounts for the sixth highest GDP per capita (€ 28,875 in 2011) in Europe behind Luxembourg, Norway, Austria and Sweden; compared to UK (€ 27,103) and France (€ 26,217). The service sector contributes 71% to the total GDP, industry 28%, and agriculture the remaining 1%. In 2011, Germany was also the greatest net contributor to the EU budget.

Similar to other Western European countries, Germany faces significant demographic challenges. With the German population changing and even decreasing over time, the demographic structure indicates an aging society with an insufficient proportionate number of children and young people.

As a consequence, the steadily growing healthcare market has become one of the cornerstones of the German economy, accounting for 12% of the GDP. In the future it is predicted that health and care needs for a growing number of elderly people will have to involve an increase in health insurance rates and a major transformation of the health care sector; all to be met by a declining number of contributors.

## 2.3 Structure of Population

### Geographical population distribution

The German population is distributed throughout much of the cities and rural areas. Overall, 44% of the total population lives in cities of more than 50,000 inhabitants. Only 16% of the total population is assigned to cities in excess of 500,000 inhabitants; less than 10% covering the top 4 cities (larger than 1 M inhabitants). The remaining 40% is attributed to rural areas.

Though the declining trend in population is apparent, the number of households in Germany is constantly increasing at the benefit of smaller households. In 2011, 74% of the 40.4 M households comprised of one person (16.337 M) or two person households (13.877 M). This leads to an average household size of 2.02 persons, which is almost 13% less than in 1991.<sup>1</sup> The total number of households is expected to reach 41.0 M by 2030, while the population is expected to drop to 77.4 M.<sup>2</sup>

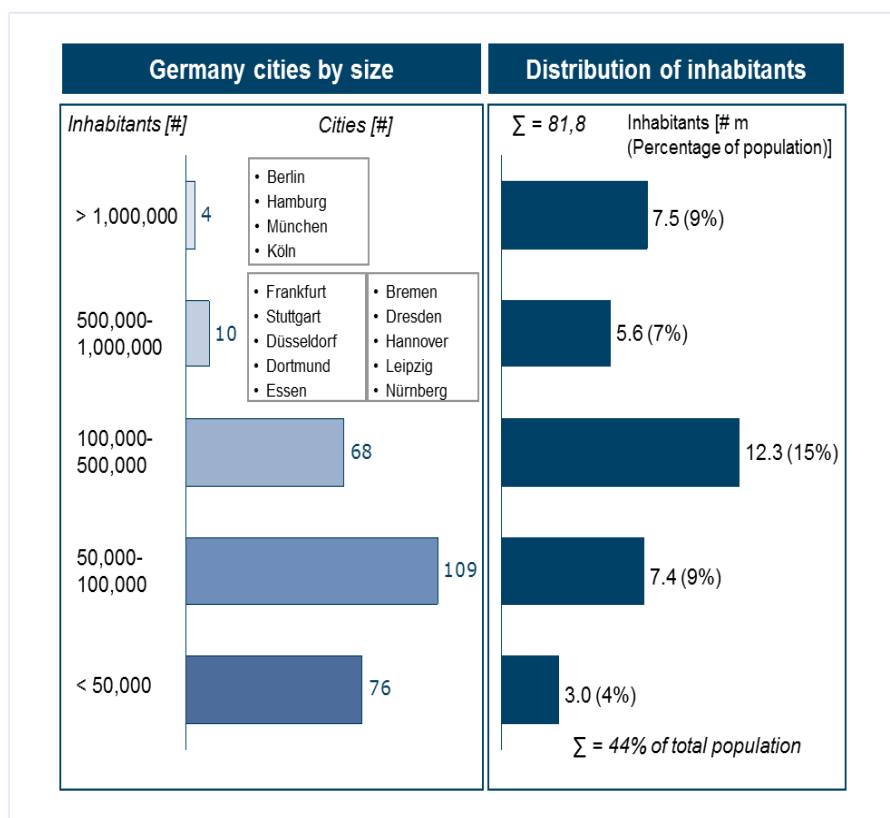


Figure 2: Distribution of inhabitants Germany (Source: Statistisches Bundesamt)

<sup>1</sup> Destatis

<sup>2</sup> Statistisches Bundesamt



## Geographics and soil structure

Covering 357,021 km<sup>2</sup>, Germany is the seventh largest country by area in Europe with an elevation between 2,962 metres above (Zugspitze/Alps) and 3.54 meters below sea level. 11.8 % of the total area is made up of streets and settlements, possessing a density of 229.4 inhabitants per square kilometre. 30.1 % of the total area is covered by woodland and 34% by arable land. The predominant eco-regions are the European-Mediterranean montane mixed forests and Northeast-Atlantic shelf marine.

Land composition comprises of various soil and rock classes (according to the solvability and earthworks technical characteristics - determined by the construction industry).

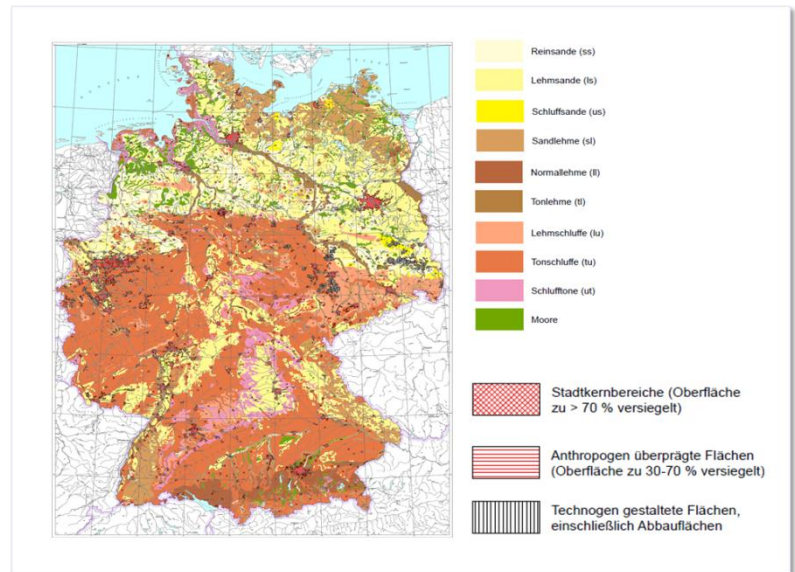


Figure 3: class map Germany (Source: Bundesanstalt für Geowissenschaften und Rohstoffe)

### Excuse: Land composition as cost driver

Land structure will have a direct impact on FTTH trench construction costs which vary depending on its composition. Construction costs differ widely across the country. The Federal Institute for Geosciences and Natural Resources is responsible for soil information and species in Germany. Top-soil structure is illustrated in Figure 3.

## 3 Telecommunications industry in a nutshell

### 3.1 Structure of German telecommunications industry

The overall German telecommunications market comprises of a broad range of different players, many of which offer fairly similar service portfolios (see Figure 5). At present there are a number of major mergers in the pipeline, none of which are completed:

- Vodafone is looking to acquire Kabel Deutschland
- Telefonica has the option to purchase E-Plus

### Mobile Network Operators (MNOs) & MVNOs

In Germany, mobile networks are operated by 4 MNOs, three of which also operate fixed networks in parallel, namely Deutsche Telekom, Vodafone and Telefónica. E-plus is the only MNO that is exclusively focused on mobile services and does not provide a fixed network service.

Most players not operating a mobile network themselves provide mobile services to their clients through MVNO or resell agreements. This is supported by a small number of MVNEs; players that provide mobile services for MVNOs.

There are about 150 MVNOs on the market in total with new ones appearing with offers backed up by one of the 4 MNOs. Of Particular importance in this segment is Mobilcom-Debitel, which holds the 5<sup>th</sup> largest mobile customer base.

## Fixed Network Operators

The fixed network domain is still dominated by the incumbent **Deutsche Telekom (DT)**, which almost exclusively holds the last mile as far as it relates to copper subscriber lines. On the service level and customer interface, DT has lost a major proportion of the market to its competitors due to regulatory efforts. In 2013, DT announced a € 6 Bn invest into VDSL2 /Vectoring. The proposal of the BNetzA has been passed to the EU for consultation.

There is a broad set of national and international Telcos providing services based on their fixed network backbones, most of which are delivered via DT's subscriber lines to customer premises:

- The largest national players are Versatel, EWE TEL and QSC. These are complemented by a large number of regional DSL and voice resellers.
- International players include for example British Telecom, COLT and Verizon Business that focus mainly on the enterprise and wholesale market.
- Besides those classical telco players, municipally owned telecom operators have grown their business significantly. NetCologne and M-net are the avant-garde in this market segment. Here a broad set of players has already established businesses – ranging from smaller cities (e.g., Schwerte, Sindelfingen as lead innovators) to mid-sized cities (Essen, Ingolstadt, Wiesbaden, Konstanz, Lindau). This market segment is characterized by strong dynamics.

## Cable Network Operators (HFC - Hybrid Fibre Coaxial)

Until 2000 all German cable network was held by DT, which was urged by the European Commission to sell assets in order to open up its monopoly. A set of regionally separated HFC companies/operators was introduced as a result of this measure; the number of which quickly reduced by a rapid consolidation process. Today, the HFC networks are mostly digitalized based on DOCSIS 3.0 with the operators providing TV/video as well as internet and telephony services. Nowadays the download speeds are reaching up to 150 Mbit/s.

The key player cable operators are Kabel Deutschland (recently announced to be under offer by Vodafone), Unity Media Kabel BW (the result of a merger by Unity Media and Kable BW in 2011), TeleColumbus, DTK Deutsche Telekabel plus a large number of purely local players. Most of those are offering triple or quadruple play (enabled by MVNO agreements) to their customers.

## 3.2 Market development

Since 2005, overall revenues in the telecommunications market have been shrinking. Nonetheless, the German telco market is slowly stabilizing (see Figure 4).

While mobile revenues stagnate due to increased competition and price pressure, fixed net revenues are suffering from substitution effects. Opposed to the decline in fixed-net revenues, the market is characterized by a continuous growth of cable revenues, which is still small in scale.

Mobile revenues have been relatively stable in recent years, benefiting from the introduction of mobile broadband. This is partly offset by quite aggressive price actions of some players. E-plus is running

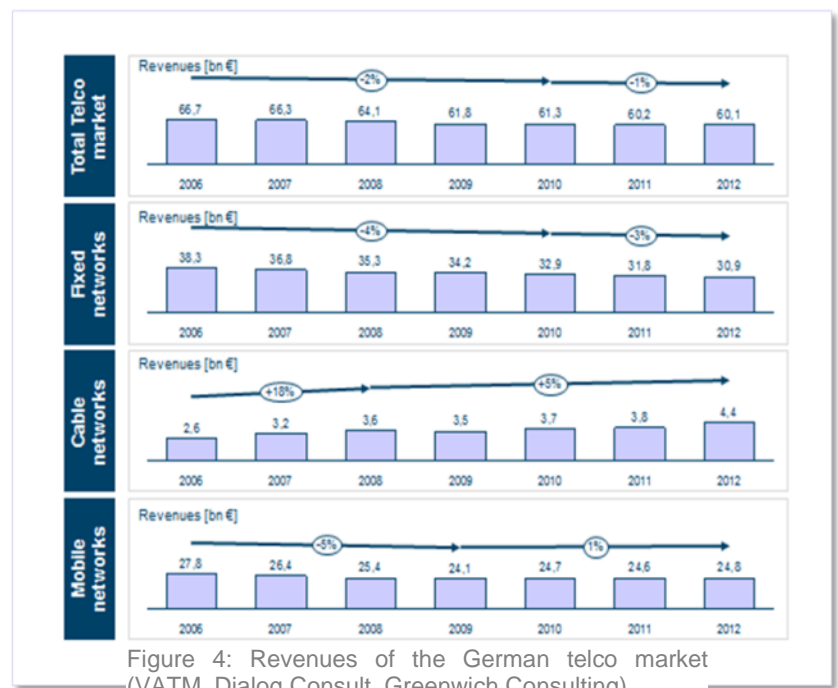


Figure 4: Revenues of the German telco market (VATM, Dialog Consult, Greenwich Consulting)

quite successfully on a 'mobile only' strategy.

The acceptance of convergent services is still delayed in Germany compared to other countries: as an indication, IPTV (e.g. T-Entertain, Vodafone IPTV; Telefónica has stopped promoting its IPTV service) has not yet captured in excess of 5% of the market; but second screen applications are rapidly gaining ground. Converged voice solutions (fixed and mobile voice) have not established relevant market shares so far.

### 3.3 Regulatory regime

Before 1998, most services available on the telecommunications market were fully regulated resulting in a uniform supply; however, they substantially lagged behind other leading countries, offered high prices and low innovation levels. Since 1998, the fixed-net market has been subject to thorough de-regulation measures – fixed net regulation was directed towards deregulation of incumbent services and opening up the networks for competition. Prices rapidly dropped by the deployment of call-by-call and carrier pre-selection (CPS) instruments.

The regulatory authority for telecommunications and other network-based services is the Bundesnetzagentur (BNetzA), which also covers energy and railway regulations. BNetzA is under business and technical supervision of the Federal Ministry of Economics and Technology. The responsibility of the agency is to maintain and promote competition in the above-mentioned network markets. This is ensured by a list of key responsibilities which includes:

- Responsibility for technical regulation in the telecommunications sector
- Review and approval of all rate changes by companies holding a pre-dominant market position on a particular market, affecting only DT in the fixed net segment and all MNOs in the mobile segment
- Participation in standardization organizations to ensure that regulatory objectives are taken into account (e.g. development of open and interoperable standards and interface specifications)
- Allocation of specific resources, e.g. telephone numbers in fixed and mobile telecommunications segment
- Allocation of applicable radio frequencies
- Consumer protection services

As of today, BNetzA has not yet introduced major steps to encourage the broadband cable industry to open up its networks, even though these players are already offering broadband services.

## 4 The German broadband market

### 4.1 Status of development

At present, Germany holds fifth place of the overall broadband penetration in Europe (see Figure 5). Sweden (87%) reported the highest proportion of households based on broadband connection, followed by Denmark and Finland (both 85%), the Netherlands (83%), Germany (82%) and the UK (80%). Though good basic broadband service coverage differs strongly across the country, some areas still remain 'grey spots'.

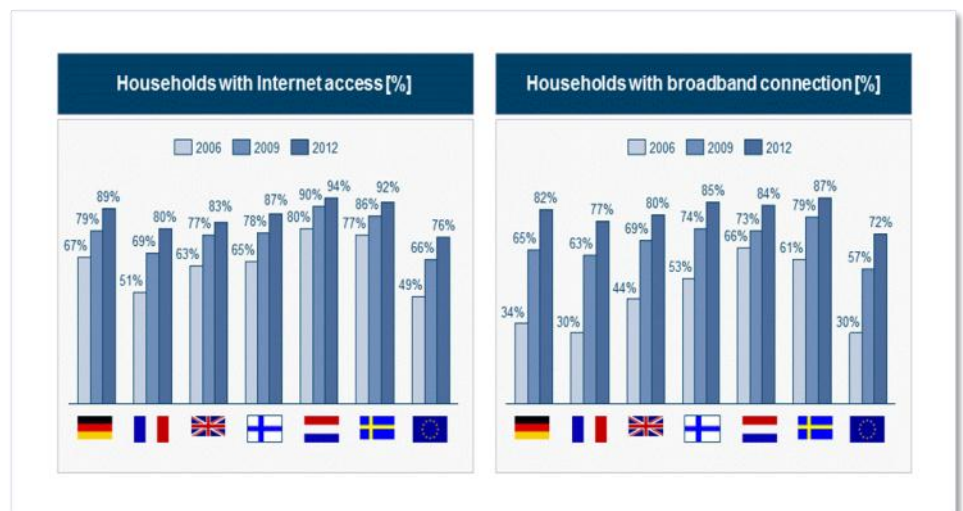


Figure 5: Households with Internet and broadband connection (Source: Eurostat)



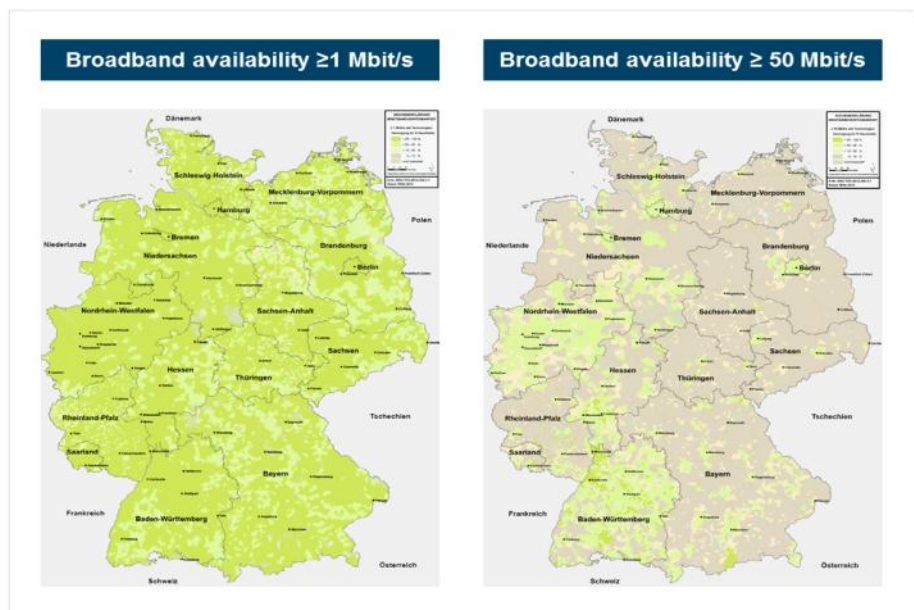


Figure 6: Broadband availability in Germany (Source: BMWI – ‘Breitbandatlas’)

The proportion of FTTH/FTTB connections however is still marginal; availability of a bandwidth above 50 Mbit/s is still showing major potential for improvement. Ultra-speed (>50 Mbit/s) bandwidths are available only in very few areas with many of the major German cities still without this service.

Regarding the split of operators, the market share of alternative network competitors has been shrinking recently. Cable operators and the incumbent operator DT increased their shares.

Though the government’s well-promoted ‘Breitbandstrategie’ has achieved its goals of 2010 to provide the country with broad coverage of 1 Mbit/s services, the country is still behind, behaving like “a diesel engine with a slow start but tremendous stamina”. By the end of 2012 almost 70% of DSL demand was still allocated to ports with a maximum download bandwidth of up to 6 Mbit/s (see Figures 7 and 8).

## 4.2 National political framework

High-speed broadband connections became a focal point of the political discussion when broadband networks were considered an essential base and driver for economic growth and welfare. In terms of international competition, these infrastructure technologies provide economic benefit to the country, if they proceed faster and are more sustainable than others. Conversely, some regions are falling behind, as services of this kind are not being provided (‘Digital divide’).

According to BNetzA, in 2010, services at a bandwidth above 30 Mbit/s have only been available to 5% of all internet users, with 2 - 10 Mbit/s being the average bandwidth. Each 8th household was surfing below 2 Mbit/s. The number of FTTH/FTTB homes passed was only 1,011,000 in 2011, serving 166,400 subscribers.

Nonetheless, general availability of broadband bandwidth up to 1 Mbit/s is very good (see Figure 6) with only a few internet users in limited areas not able to receive this bandwidth based on all the technologies – wired (FTTX and Coax) and wireless. So-called ‘white spots’ have been quite successfully eliminated.

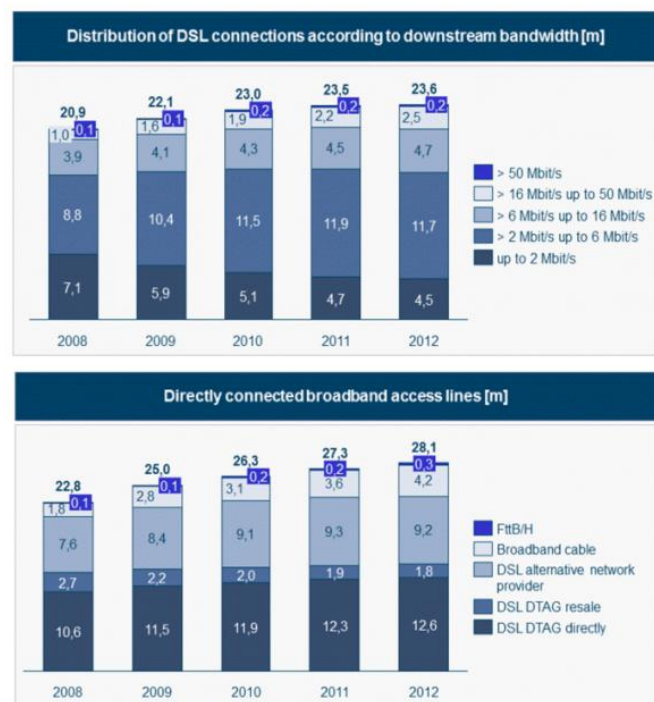


Figure 7: Split of broadband access lines

Figure 8: Distribution of DSL connections (Source: Dialog Consult, VATM)

With the aim of improving the development stage of broadband penetration, the Federal Ministry of Economy and Technology published the first 'Breitbandatlas' in 2005, which became the overarching measure for broadband development (see Figure 9). The Breitbandatlas provides regionally differentiated representation of the availability of broadband internet connections thus making it possible to determine market potential of a city or region. The Atlas is also authoritative for the application of funds for infrastructure development. Since early 2012 a broadband demand atlas has been available.

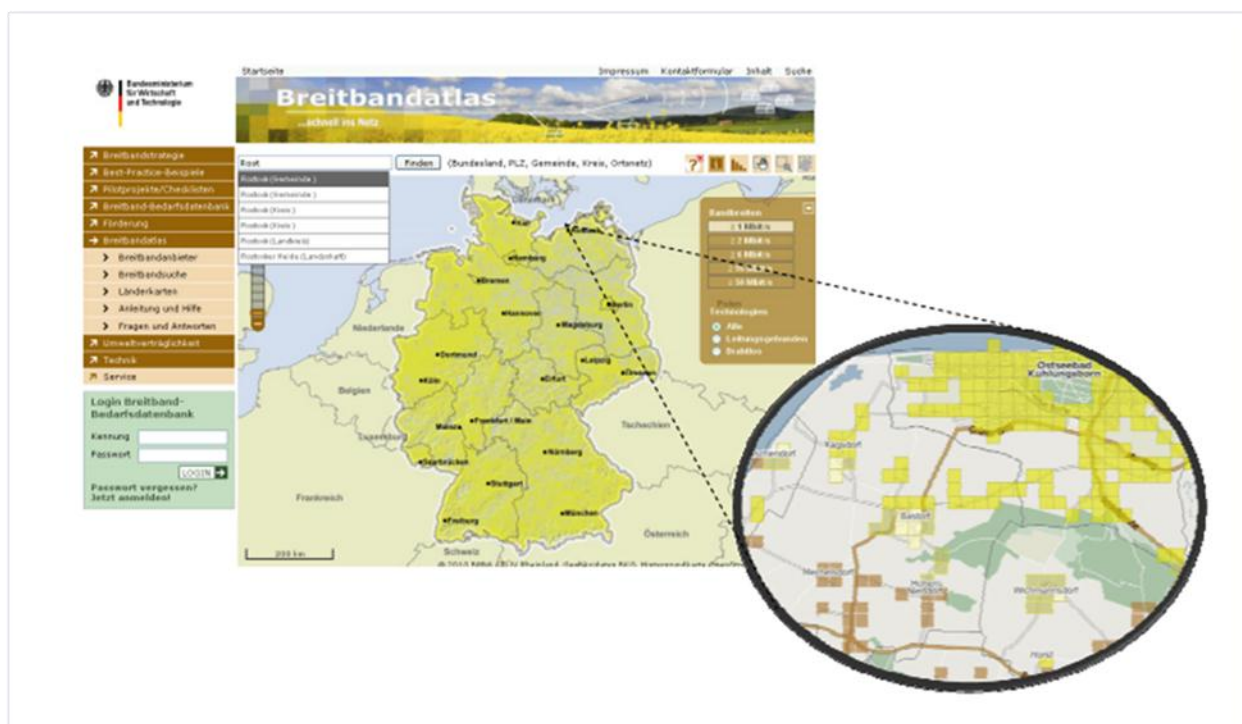


Figure 9: 'Breitbandatlas' (Source BMWI – 'Breitbandatlas')

In February 2009, the government made a commitment to improve broadband availability and launched the "Breitbandstrategie" programme on federal government level to enforce this. The objective of this programme has been to generate additional impetus on the market thus ensuring that all homes and businesses be supplied with high-speed broadband connections as soon as possible.

As a result of intensive discussions within the industry and together with the government, the "Breitbandstrategie" programme outlined several phases:

- **Objective phase 1:** By 2010, all broadband connections (at least 1 Mbit/s) should be available nationwide. This objective is to provide broadband services with at least 1 Mbit/s for 99.5 % to all households.
- **Objective phase 2:** By 2014, bandwidth of at least 50 Mbit/s should be available to 75% of households.
- **Objective phase 3:** By 2018, comprehensive availability of almost 100% of this bandwidth should be provided consistently across the country.

The following **key measures** were defined to contribute to the achievement of the defined objectives (excerpt):

- Action 1: Optimizing the shared use of existing infrastructure and facilities
- Action 2: Establishment of an infrastructure atlas
- Action 3: Development of a construction site database
- Action 4: Demand-driven "co-laying" of ducts and common development of infrastructures
- Action 5: Improvement of in-house broadband distribution

- Action 6: Improved production conditions in the common tasks
- Action 7: Additional funding for infrastructure construction by the municipalities
- Action 8: Establishment of broadband competence centres

These objectives are quite ambitious. As from today's perspective the objective of phase 1 has been well achieved. With respect to the objective stated in phase 2 regarding 2014, some doubt exists on its feasibility. Currently, 51% of all households have access to bandwidths of at least 50 Mbit/s. Thus, the gap to reach 75% technical coverage could only be achieved by a blanket implementation of mobile networks, which are limited to delivering constant and simultaneous large bandwidth capacities to multiple concurrent users.

Through these phases, the "Breitbandstrategie" is contributing to the goals of the 'Digital Agenda of Europe' (DAE). In order to achieve the goals on a European level, the DAE demands the member countries to improve their broadband development performance by setting up operational broadband strategies and targeting public funds (including structural funds) on areas not fully served by private investments. The DAE also requires the establishment of a legal and political framework for co-ordinating public works to reduce costs of fibre rollout.

These goals will form the basis of achieving overall objectives which include the promotion of digital literacy, research and innovation aimed at reinforcing and strengthening Europe's technology expertise in key strategic fields and the creation of a truly single market for online content and services (i.e., borderless and safe services and content markets) at a high level of trust and properly established rights.

Since releasing the "Breitbandstrategie", Germany is on track in a European context (See Figure 10). The goals are competitive and several investment situations have been established on national and federal levels. Promotion programmes are geared to grey or white spots and are, in particular, aimed at developing infrastructure in rural areas. There are also spillover effects on local businesses (energy industry/owner-operated) as well as Telco's.

#### 4.3 Political measures of the states

As Germany comprises of 16 states, the federal programme has spawned several state-level programmes within the last few years. The size and goals of these programmes as well as funding volumes and conditions differs greatly from state to state with some relying solely on national programmes and others contributing large amounts from state household budgets. The latter receiving backing from European (such as ELER or EFRE) or national (e.g. GAK or GRW) funds on e.g. 60/40 basis.

One of the pioneers in this area is the state of Hessen, where several programmes, been backed by European and national funds, have increased since 2010, especially in rural areas in the state. Please refer to Appendix 1.








Country	Area coverage/penetration target	High-Speed target
	1 Mbit/s for 100% of HH by 2010 <input checked="" type="checkbox"/>	By 2014, bandwidth of at least 50 Mbit/s should be available for 75% of HH, coverage as soon as possible
	512 Kbit/s as a universal service by 2012 <input checked="" type="checkbox"/>	---
	2 Mbit/s as a universal service by 2012	---
	1 Mbit/s for 100% of HH by 2010 <input checked="" type="checkbox"/>	100 Mbit/s for 99% of HH by 2015
	≥ 10 Mbit/s with the world's largest broadband penetration rate by 2010 <input checked="" type="checkbox"/>	
	100 Mbit/s for 40% of HH by 2015 and for 90% by 2020	
	Basic supply for all citizens by 2013	≥ 30 Mbit/s for 100% of HH by 2020 ≥ 100 Mbit/s for 50% of HH by 2020

Figure 10: Broadband strategy in European comparison (Source: RB Consult, Greenwich Consulting)



#### 4.4 Regulatory players and associations

The government agency responsible for regulating broadband is BNetzA. However, a broad selection of associations and a number of players from various industries have been invited by BNetzA to participate in the process of developing respective regulatory guidelines that will incorporate detailed specifications. In this way BNetzA has made significant moves to adapt to the changing environment of the fixed-net domain. Where in the past DT, as incumbent operator, had been the main target of various regulatory measures; BNetzA is now very much in favour of providing a game plan by setting only minimal rules.

In this context, two associations and a respective technical specification body can be mentioned:

**BREKO** (Bundesverband Breitbandkommunikation e.V.) is an association comprising of 110 utility providers whose focus is the development of broadband in Germany. BREKO is the official representative of this alternative network towards the legislature, European Commission, BNetzA and the general public. BREKO's key goals are:

- Fair competition in the telecommunications market
- Continuation of the liberalization and deregulation process
- Promotion of the economic activity of its members

**BUGLAS** (Bundesverband Glasfaseranschluss e.V.) is an association consisting of 50 members, which represent glass fibre specialists all over Germany and who are also focused on nationwide broadband development. The key goals of this organisation are:

- Common voice representing the glass fibre industry and member companies regarding submissions associated with regulations, legislation and other consultation procedures
- Technological expertise on policy decisions and network concepts
- Collaboration on product selection and purchase
- Shaping public policy and regulatory framework relating to fibre, such as rules covering network access obligations within their own networks with the aim of establishing incentives for long-term investments

The goal of the **NGA Forum** is the speedy resolution of issues relating to the expansion of broadband. This Forum was founded in 2010 under the guidance of BNetzA and tasked with developing a standard procedure for cooperation. All members of the Forum have agreed to contribute jointly on the resolution of outstanding issues. One example of the work carried out by the Forum involves the specifications of the open access interface 'S/PRI'.

In 2012, '**TKG Novelle**' was implemented. The intention was to adapt the national telecommunications act to the adjusted situation. 'TKG Novelle' has been implementing important elements of the governments' broadband strategy into the telecommunications act. Additional incentives for investment in new high-speed networks and facilities network expansion are also included. The regulation favours an effective and sustainable competition and is to be limited to minimum requirements or even deleted whenever possible.

The principles of TKG Novelle are:

- Right of information access by the BNetzA
- Obligation to provide information on telecommunications network operators (regardless of whether the network is open to the public or to a closed group)
- Obligation to provide information of businesses and legal entities of public law, which have facilities that can be used within the telecommunications industry
- Claim on shared use of infrastructure of the Federal government.

One of the key adjustments is that local authorities can no longer request micro-trenching for a local project. This can, however, be directed to the next higher level.

## 4.5 Role of Tier 1 & 2 Telco's in broadband development

Characterizing the activity level of the major Telco's (fixed network) in Germany is based on a differentiated view, ranging from the incumbent to other Tier 1 players (Vodafone and Telefónica) and the Tier 2 segment (Versatel, EWETEL, QSC) to the local players on Tier 3 level.

### - Tier 1 -

#### **DT as incumbent**

DT's strategy towards the development of FTTH/B networks in Germany has already evolved, however the company has clearly not focused on those large cities where major investments have been conducted into its VDSL network. Furthermore, if cities choose to pursue their own fibre plans, these regions will not be targeted either. DT announced a list of cities for 2012 and 2013 to be included in the 'Giganetz'. Each city on the list has to achieve a minimum threshold of contracts during the pre-sales phase. Not all of the listed 28 cities included in this activity achieved the pre-sales target.

Originally DT pursued a vertically integrated, build-based approach. This changed in 2012 towards a cooperative model that made the local municipalities responsible for investment into the passive infrastructure layer leaving DT with the responsibility of implementing the active network layer and the service layer as well as taking care of sales and service processes.

The cities served in 2012 and planned for 2013 are:

- 2012: Braunschweig, Brühl/Baden, Hannover, Henningsdorf, Kornwestheim, Mettmann, Offenburg, Potsdam, Stade
- 2013: Amberg, Aschaffenburg, Bergneustadt, Friedrichsdorf, Gummersbach, Ingolstadt, Kempten, Kiel, Neu-Isenburg, Rastatt, Bad Homburg, Chemnitz, Frankenthal, Fürstenfeldbruck, Koblenz, Lörrach, Oberursel, Witten
- Failed to achieve pre-sales targets: Münster, Bremerhaven

#### **Telefónica**

Telefónica (operating o2 as B2C brand today) purchased Hansenet a few years ago giving the company access to some minor FTTH installations in Hamburg. With about 60,000 homes passed Telefónica is currently falling behind the slow-starter DT. The company's wholesale team has identified municipal FTTH projects as potential business and launched a white label dual play offer targeting, amongst others, regional energy suppliers. A pilot project has been initiated with com.in in Ingolstadt.

#### **Vodafone**

Vodafone has only a few minor pilots and is fully committed to LTE.

- Laudert, Kisselbach, Wiebelsheim (in cooperation with RWE)
- Düsseldorf (planned in cooperation with NetCologne)

### - Tier 2 -

#### **EWETEL**

EWETEL has previously conducted a few pilot projects. The roll out for FTTH is currently in the planning stage with the focus set on FTTC in grey spots.

#### **Versatel**

Private-Equity owned Versatel has some city network capabilities in a few cities, but is not yet using it intensively for FTTH networks. Plans for further development have not yet been published.



## QSC

Cologne-based QSC AG has adopted an NGA-aggregator role in terms of aggregating networks and providing an open access platform by aggregation of different areas (e.g. Berlin – joint effort with Vattenfall, Ericsson and 1&1 Internet). Furthermore, QSC is the supplier of FTTH/B access to its resellers; claiming to be able to provide up to 1 M access lines. An excerpt of current QSC projects is listed below:

- Berlin: Project started in September 2011 and completed in July 2012. Subsequent three-year trial period seeking acceptance and experience in the open-access approach.
- Herne: QSC operates an open access fibre network for the “Stadtwerke Herne”, start up February 2012
- Köln: Cooperation on fibre networks and future cooperation on open-access platform, start up September 2012

## 4.6 Role of other local players in dynamic broadband growth

Tier 1 carriers only have a minimal contribution in the FTTH/B development initiatives in Germany. Most of the FTTH expansion is being driven by regional Telco's, cable network operators and municipal service companies who are all encouraged by the low activity level of national Telco's and the political promotional programmes. Most projects, about 140+, are executed by municipality-owned local utility providers in various stages (planning, pilot, operation) and cover mid-sized cities such as Konstanz as well as smaller cities, for example Passau, Itzehoe, etc. Also they are involved in some smaller projects in Oberhausen an der Donau which leaves the bigger cities beyond their scope. This patchwork of cities and municipal utilities is evolving into a “Flickenteppich”: Germany has about 100 cities with more than 100,000 inhabitants. Within the top 10 Düsseldorf and Frankfurt are not covered at all, while Berlin has only a very minor pilot area. NGA-Aggregators providing service platforms on an open access basis are contributing to closing the gaps, but still the “Flickenteppich” remains one of the biggest challenges for German broadband development.

Due to the broad distribution of the population, especially regionally, active utility companies can benefit from certain aspects such as location advantages and partial existing infrastructure. In this regard, the role of municipal utilities and energy concerns like RWE can take various forms.

At present, many of the relevant FTTH networks are deployed, for example, by **NetCologne** (owned by Rheinenergie) in Cologne as well as a number of adjoining regions and also **M-net** (owned

by municipal service companies such as SW München GmbH, SW Augsburg Energie GmbH, N-Ergie AG, infra fürth GmbH, Allgäuer Überlandwerk GmbH, Erlanger SW AG). Both of these players pursue opportunities far beyond their core geographical remit. One example is Munich's involvement since 2012 in the approximately 400km distant Main-Kinzing-Kreis; or NetCologne that a few years ago extended its

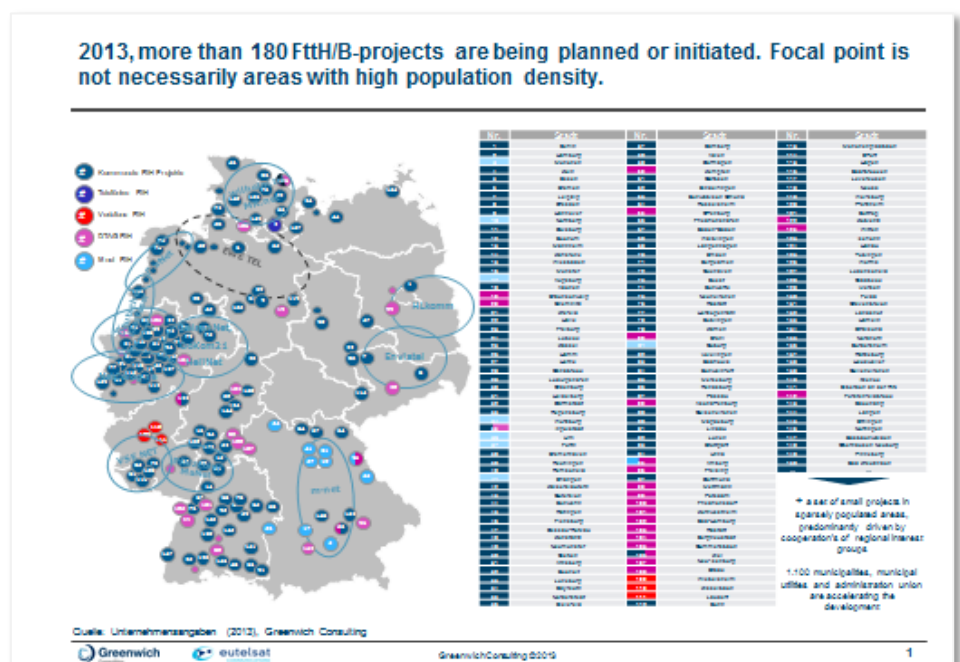


Figure 11: FttH projects in Germany - Status Q4/2012 (Source: Greenwich Consulting)

reach to Bonn and recently moved across the Rhine to Spich or Leverkusen and is still looking to target additional areas.

An excerpt of current municipal and regional FTTH projects is listed below:

- **Deutsche Glasfaser (Reggeborgh Group):** Heinsberg, Borken, Wesel, Steinfurt
- **NetCologne:** Köln, Bonn, Aachen, Neuss, Betzdorf, Siegburg, Niederkassel, Windeck, Leverkusen, Burscheid
- **M-net:** München, Nürnberg, Augsburg, Regensburg, Würzburg, Fürth, Ingolstadt, Ulm, Erlangen
- **EWE Tel:** Oldenburg, Bremen, Oberlangen, Niederlangen, Renkenberge, Fresenburg
- **EVV Essen.net:** Essen, Frohnhausen, Huttrop
- **Stadtwerke Nürtingen GmbH:** Reudern, Raidwangen, Neckarhausen

There is also a broad range of local players that are also getting involved to ensure their market share, e.g. Bornet, Wilhelm.tel, Sindelfingen, Lindau, Essen, Bochum, Regensburg, Konstanz and Herne.

#### 4.7 Evolution of business models in newly emerging markets

Fibre projects receive huge political support due to national and international broadband development goals. Yet, planning and implementation costs of a fibre optic project are high. Most projects, about 180+, are executed by municipally owned local utility providers that are dependent on cost effective and solid business models.

The evolution of the business model is based on three value chain levels: the first is the passive and active distribution network, the second the telecommunications service platform and the third covers sales and customer service. Each of the layers can be processed separately offering different economies of scale

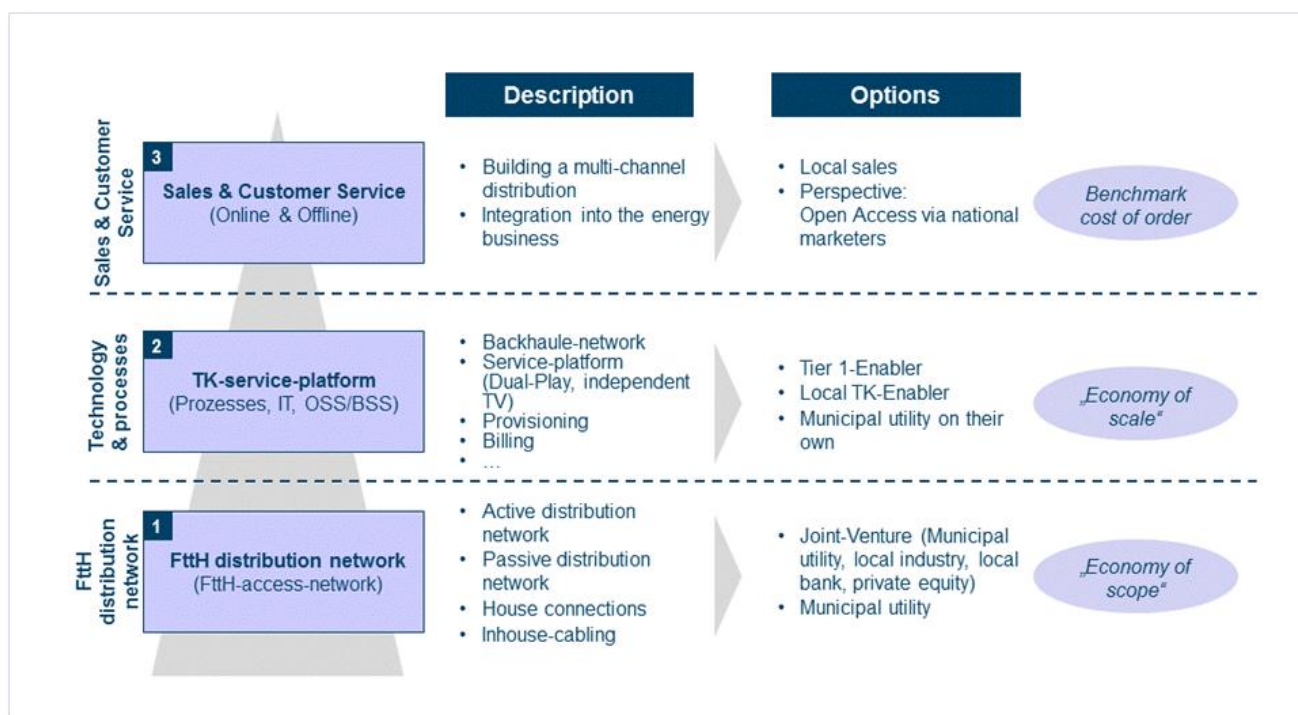


Figure 12: Evolution of FttH business models (Source: Greenwich Consulting)

(see figure 12). Market players might operate on all levels (vertical integration), or on one of the levels (full horizontal separation) or on a combination of all levels. The TK service platform offers the smallest proportion on total revenue though it is highly complex; the second level is frequently operated on a full separation basis (horizontal business model), making economies of scale applicable. Active and passive

sharing models offer great revenue opportunities for network owners and operators with a solid customer base, while full vertical integration models are common for incumbents (DT in Germany).

Vertically integrated models have not proved to be very successful for smaller players, with only DT operating such a model at present. Due to market development, four horizontally separated cooperative business models have been established. The blocks of each business model have different business logics offering cost-optimization approaches (see figure 13). Please refer to Appendix 2 for more details on Open Access Expansion.

#### 4.8 Outlook on broadband evolution

In Germany, the number of connected fibre-households is growing steadily: By the end of 2012 about 800,000 households in Germany were connected to fibre networks at least up to the building. So far only about 43% of these households have taken advantage of this (see figure 14).

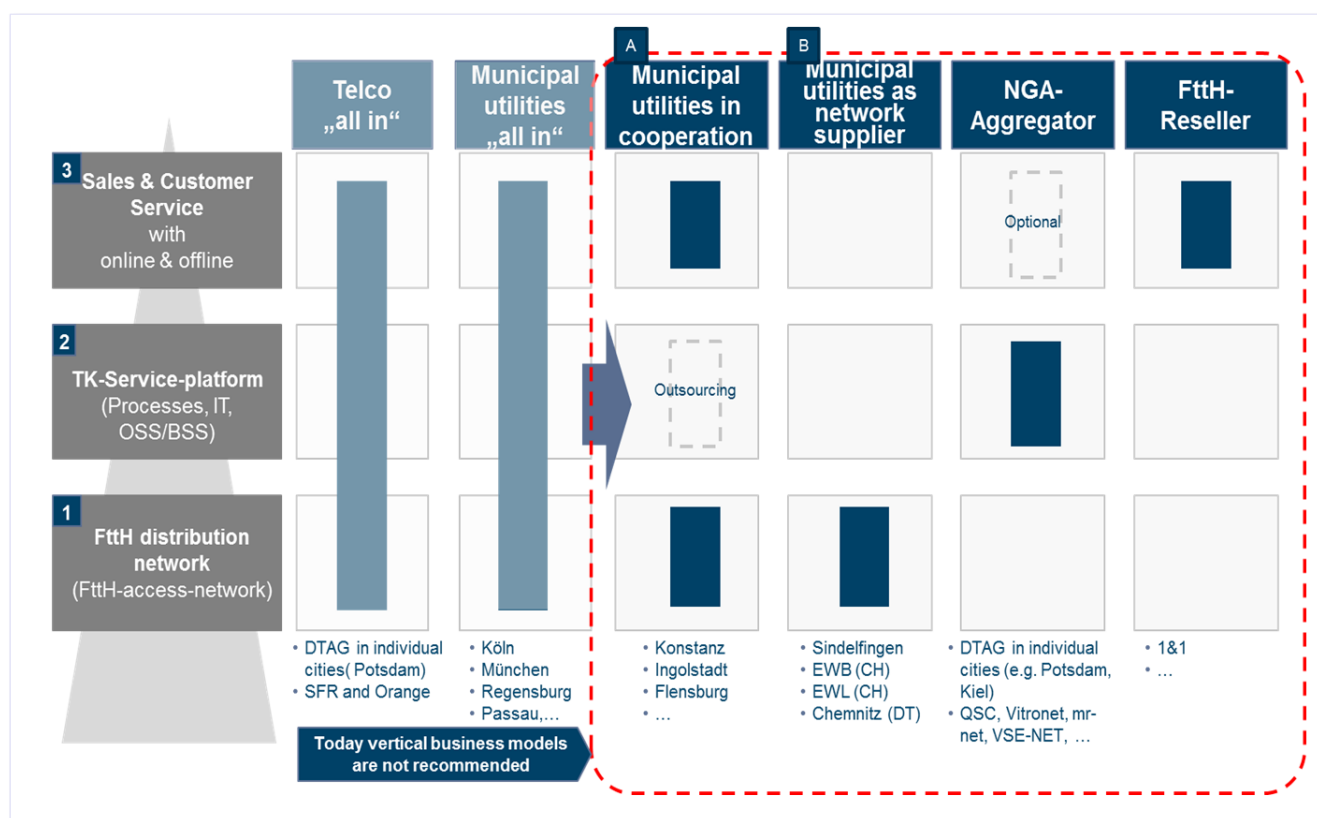


Figure 13: Emerging FttH business models (Source: Greenwich Consulting)

On the whole, the development stage of German broadband supply is still behind other European countries. Though basic supply is about to reach maturity, high-speed internet is falling behind (see figure 15). Some success factors in broadband development are derived from the leader's model (Sweden; see figure 16).

Additional broadband development follows slightly different trends in urban and rural areas; to meet the individual needs of rural and urban customers as well as providers' strategies.

## 4.9 Trends regarding network technology:

To deliver fibre directly into homes and businesses, two different technologies are applied:

1. Point to point (P2P) technology connects one strand of fibre directly into the premises all the way from the main exchange, or alternatively from a mini exchange in the street which includes active electronic equipment. This method allows for up to 100 premises to be connected, gating up to 32 or 64 houses. P2P networks are usually applied in smaller cities (e.g. Lindau, Herne, Ingostadt).

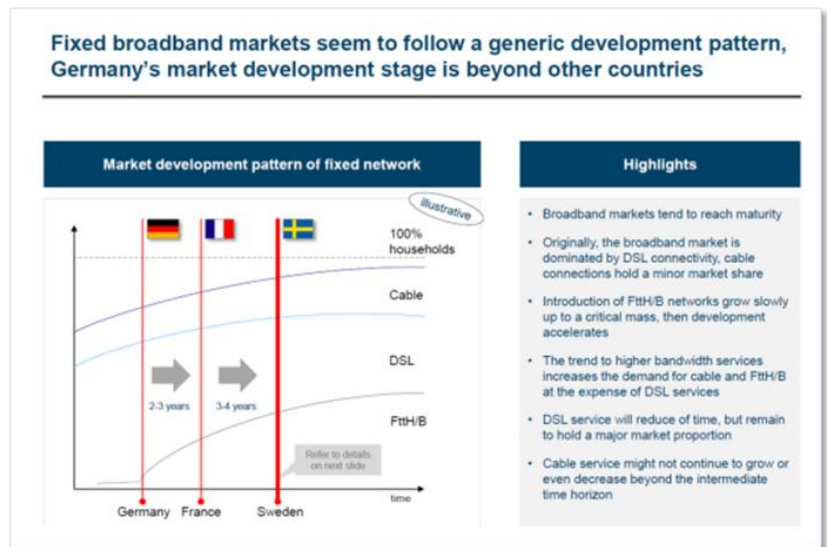


Figure 14: Fiber connected households in Germany (Source: VATM)

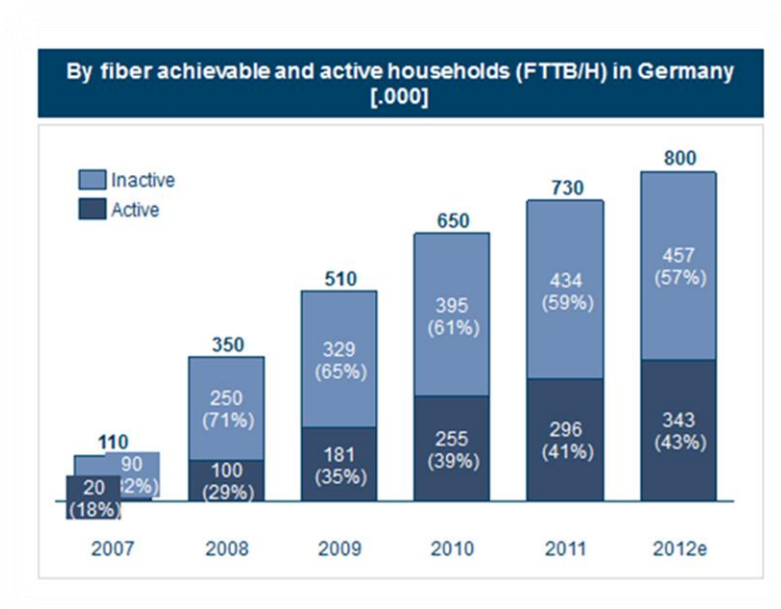


Figure 15: Germany's FttH market development stage (Source: Greenwich Consulting)

2. Passive Optical Network (PON) on the other hand, connects one fibre to a distribution point, which then splits the light out to single fibres each connected directly into homes. Nonetheless, most of those networks are built on an P2P OSP (outside plant network) architecture, which ensures an upgrade to P2P without enhancements on passive network infrastructure.

Furthermore, in some cities, Active Ethernet has been selected as the preferred technology (e.g. NetCologne, Stadtwerke Konstanz).

50% of the networks are based PON technology today – mainly applied in the bigger cities (e.g. M-Net) or built by Deutsche Telekom. An exception is Cologne here, which is providing FttB services via a Active Ethernet network. Hansenet (Telefónica Deutschland) as well as R-KOM (Regensburger



Telekommunikationsgesellschaft) in Regensburg (fibre-rich network architecture) are also PON players. German fibre projects generally involve GPON with a few exceptions, such as Inglostadt and Herne are examples for P2P networks.

At present, there are more FTTB networks being built (80%) than FTTH networks (20%) in Germany.

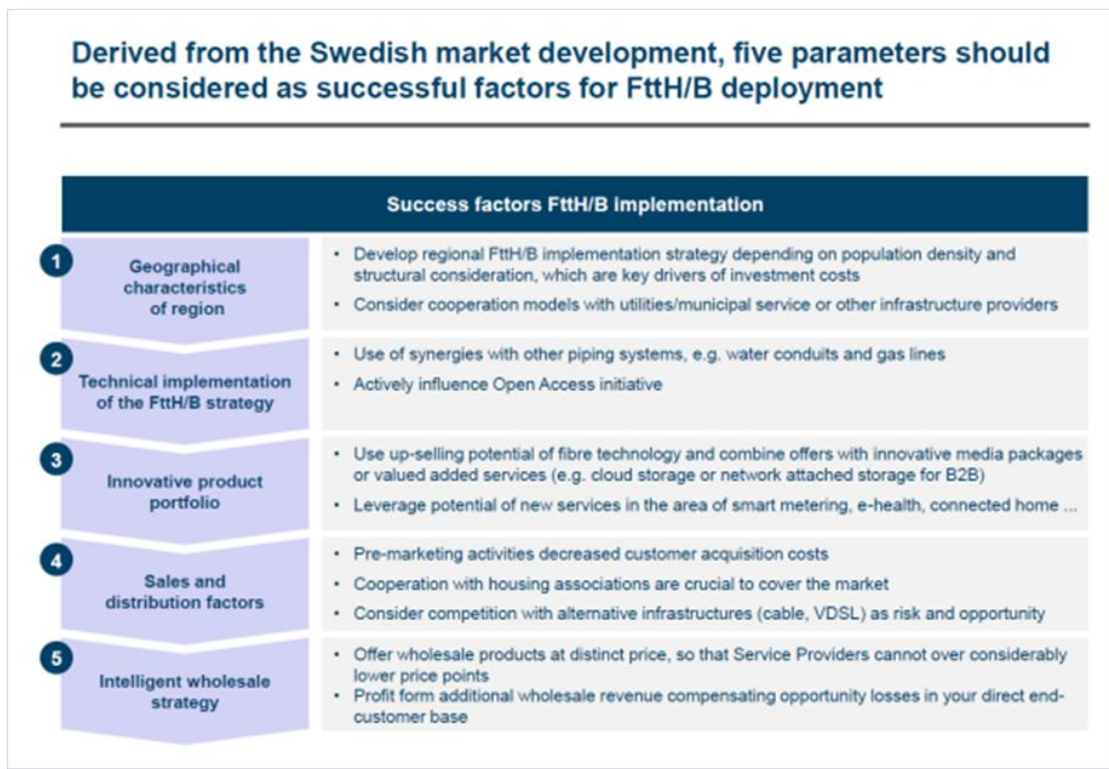


Figure 16: Success factors FTTH/B implementation (Source: Greenwich Consulting)

## 5 Cost Calculations on future fibre Networks meeting the Digital Agenda targets

The main objective of the calculations is to provide an estimate of the total investment needed in order to accomplish the broadband targets set for 2020 in Germany by fibre optic networks, as defined by the European Commission. In summary these targets are:

1. 50% of European households should be subscribed to a bandwidth of at least 100 Mbit/s
2. 100% of European households should be able to subscribe to a bandwidth of 30 Mbit/s

Fulfilling the first objective of a network that covers Germany with only 50% of the households connected will automatically fulfil the second objective.

In order to accomplish these targets, current telecom networks need to be upgraded. This is particularly so when considering a symmetrical 100 Mbit/s bandwidth. Legacy networks, even if already based on VDSL/"Fibre to the Cabinet" (FTTC) or DOCSIS3.0/"Fibre to the Node" (FTTN), are considered insufficient by many people.

It is clear that with a "Fibre to the Home" (FTTH), or "Fibre to the Building" (FTTB), there is no discussion concerning the possibility of achieving the targeted bandwidths, even bi-directional. That is why this type of network has been selected, on which to base calculations, as the best technological choice, although in general it does require higher investments than FTTC or FTTN.



For this study, the costs of such a full fibre network have been calculated based on a greenfield situation. Already existing fibre networks will not be taken into account and existing infrastructure (e.g. pipes), which could reduce the costs, will also not be considered. These assumptions ensure that the worst case scenario is reported, the option with the highest cost.

## 5.1 Modelling the costs of a nationwide rollout

The most accurate approach to calculate the costs of fiberizing Germany is to simulate a full fibre rollout: connecting each building in Germany and calculating the equipment and labour needed to install such a network. The result is then summarized in a 'bill of material' and the total investment would be known.

However, this model would require the exact geographical location of all buildings and streets in German and would also involve a huge amount of calculation power to simulate a rollout using automated and optimized FTTx network design tools. This type of modelling would be the most accurate however both time and difficulty precludes its use.

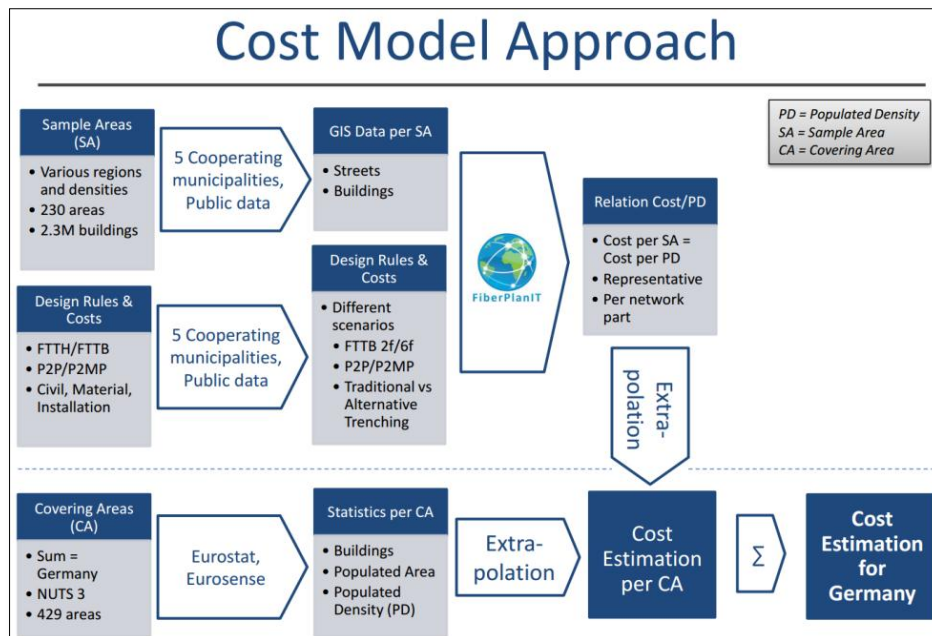


Figure 17: The Cost Model Approach consists of two sections: (1) using simulations to calculate the relation between cost and PD (2) German statistics (Source: Comsof)

A less accurate approach, but much easier to calculate, is the use of a full extrapolation model. Using statistics covering the number of families and buildings, city densities and rural areas and then combining them with rough figures of 'cost per home passed' and 'cost per home connected' it is possible to determine an approximate estimate for the total investment. These kinds of estimations are referred to as 'spreadsheet calculations'. However this approach uses many approximations and relies on important assumptions such as cost per HP and HC, with the result that the accuracy is rather low.

A combination of both approaches has been used in order to achieve a more accurate figure and provide more insight than the 'full extrapolation model' offers. This method requires less geographical data of buildings and streets with the result that less calculation power is needed. Figure 17 visualizes the different steps used in this model; the following subsections dig deeper into the details of this model. The first part of the model is about establishing a relation between costs and populated density by simulating FTTx rollouts. This information will then be combined with the second part of the model - the area statistics of Germany - to extrapolate the costs for the whole of Germany.

### 5.1.1 The relation between populated density and cost of FTTx

The first part of the approach consists of simulating the costs of FTTx networks. In order to achieve this accurate geographical information regarding building locations and street lines need to be collated (*Sample Areas*) and a specific FTTx technology chosen. In addition, all relevant costs need to be assigned (*Design Rules & Costs*). Automated and optimized FTTx network design software can be used to combine these elements and simulate the rollout: all cables, ducts, splices, splitters, etc. will be located on street-sides. The volumes calculated and summarized in a detailed bill of material (see figure 18 for clarification). For this study, the FiberPlanIT tool (<http://www.fiberplanit.com>) has been used to simulate FTTx fully automated and optimized rollouts resulting in an FTTx network representation in GIS files that can be summarized in a bill of material.

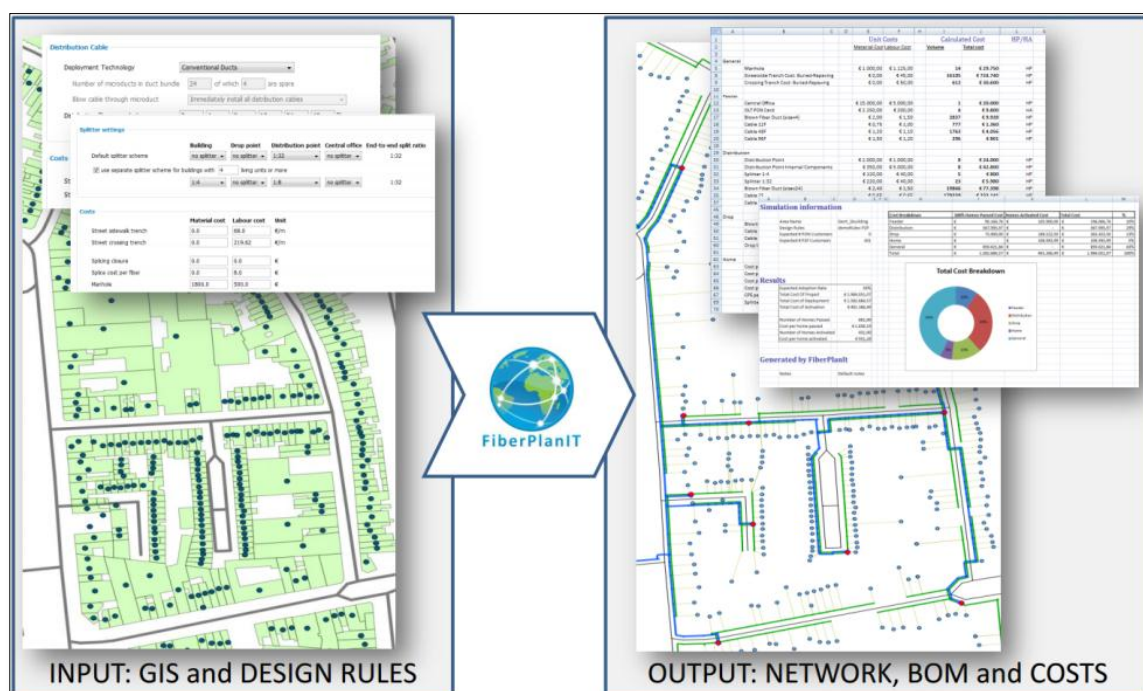


Figure 18: GIS data and design rules are used by FiberPlanIT to calculate an FTTx network, associated Bill Of Material and costs. (Source: Comsof)

#### 5.1.1.1 Sample Areas

For this study, German GIS datasets have been used in order to represent the typical building profile in Germany. Five cooperating municipalities (Troisdorf, Wiesbaden, Ingolstadt, München and Konstanz) shared their GIS data of buildings and streets. Other public sources, such as OpenStreetMap, have also been used to provide data of more than 230 sample areas containing in excess of 2.3 million buildings (see Figure 18 for an overview). This huge set of sample areas covers dense urban areas as well as very rural districts and everything in between.

Using such a large set of sample areas amplifies the accuracy of the extrapolation model; the calculations used are not reliant on a few simulations instead incorporate 2.3 million buildings.

#### 5.1.1.2 Design Rules & Costs



Figure 19: Sample GIS datasets of more than 230 areas and five cooperating municipalities. (Source: Comsof)

This study focuses on a typical German FTTx network. A questionnaire was constructed and sent out to various operators of municipal networks. This document asked for detailed information relating to choice of design chosen by the operator in the fibre network ('Design Rules'). While the typical German design is very important, the cost of all equipment used is equally important. Using the FTTH Council EU member companies, the pricing of all equipment was verified against the German standards, ensuring that the right costs were used for all network elements such as cables, splitters, distribution points, OLT cards, CPEs, etc. In total, more than 30 network equipment types were considered.

The FTTB design, rather than FTTH, was selected for the calculations as the FTTB design is most widely used in Germany. In addition, in order to calculate the FTTH scenario accurately, detailed information of each building is needed to estimate the in-house costs. This information is not available for Germany. The FTTB network is compliant with the EU 2020 broadband objectives.

The results of the questionnaire were summarized into two different network designs that were then used to simulate the sample areas with an FTTx rollout. Figure 20 visualizes the network topology.

The first network resembles the most common design in Germany: 4 active and 2 spare fibres to each building in a P2P connection. Although this design is common practice, it is also expensive and exceeds the broadband objectives of 100 Mbit/s per household. As the goal of the study was to ascertain the costs associated with meeting the objectives (not exceeding them), a second design was introduced.

Simulation Information		Cost Breakdown				
Area Name	xxx	Homes Passed Cost	Homes Activated Cost	Total Cost	%	
Design Rules	yyy	Public Trenching	€ 101.312.443	€ 0	€ 101.312.443	22%
Number of Homes Activated	189525	Home	€ 0	€ 46.433.625	€ 46.433.625	10%
Number of Homes Passed	189525	Drop	€ 18.952.500	€ 40.869.229	€ 59.821.729	13%
Overall Adoption Rate	100%	Distribution	€ 94.307.564	€ 0	€ 94.307.564	20%
Expected # PON Customers	0	Feeder	€ 47.409.035	€ 110.166.400	€ 157.575.435	34%
Expected # P2P Customers	189525	BackBone	€ 5.227.176	€ 0	€ 5.227.176	1%

The second design involved a P2MP network, connecting each building with only 2 fibres, with 1:32 splitters in the Distribution Point. This second design lowers the cable count in the feeder connection as well as reducing the speeds. For multi-dwelling units,

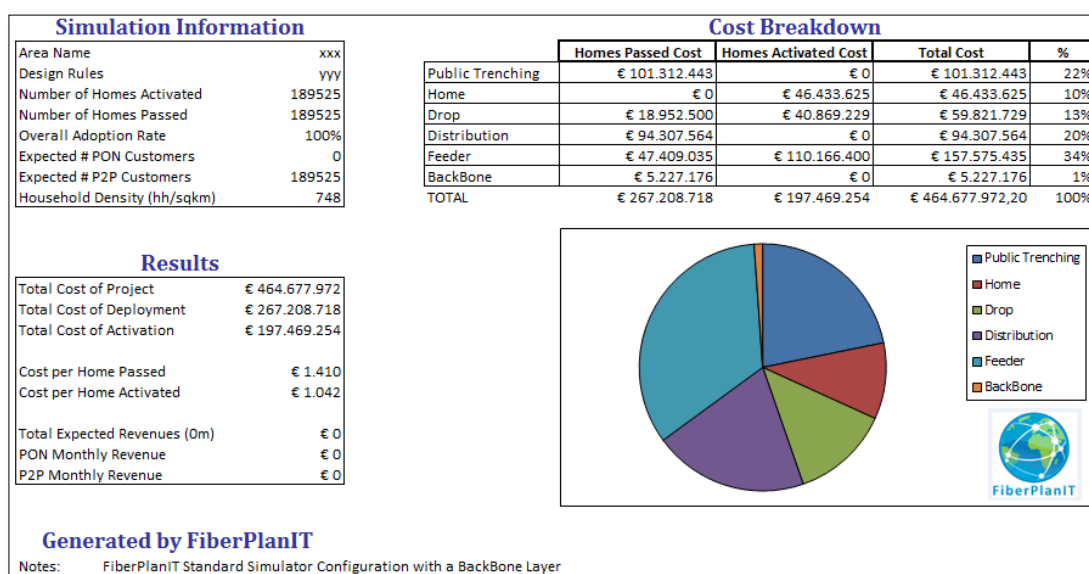


Figure 20: Typical cost overview of the bill of material of a simulation. (Source: Comsol)



this design would not be able to deliver sufficient bandwidth to all residents.

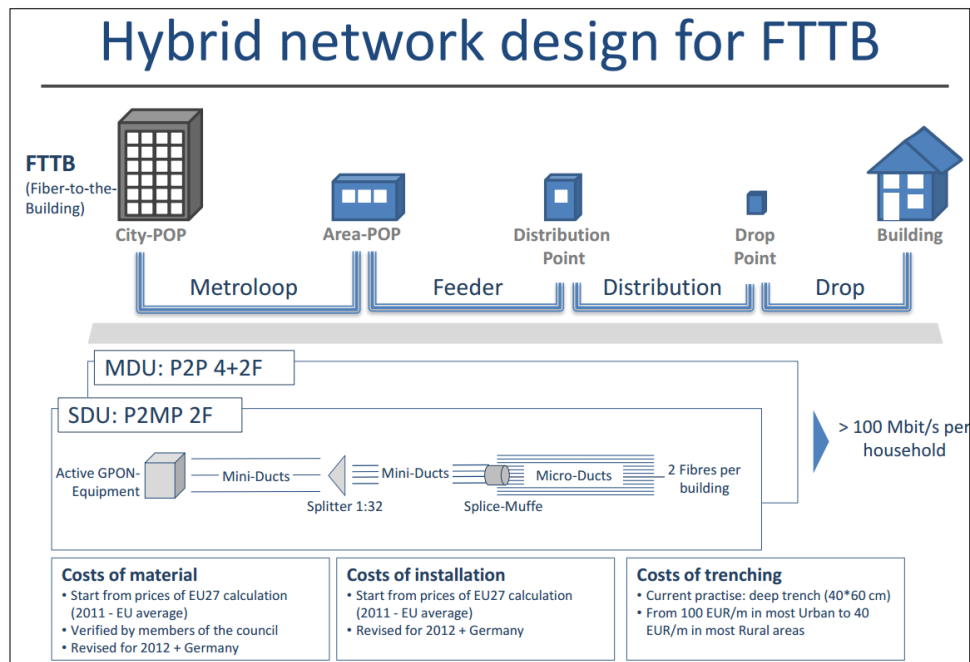


Figure 21: Structural overview of the German network designs, used in the simulations.  
(Source: Comsof)

When simulating both designs, the maximum cost of the first design exceeds the broadband objectives while the second design (with minimum cost) does not achieve broadband objectives. By combining the results, a 'Hybrid' network design was introduced (not to be confused with the HFC - Hybrid Fibre Coaxial network): a P2P connection to all multi-dwelling units and a P2MP connection to all single-dwelling units.

The simulation calculates all equipment needed to realize the FTTB connection between the building and the City-POP. This includes the calculation of the following equipment layers:

- Building: the cost to enter the building, the cost of active basement equipment.
- Drop: the connection of the building to the street side.
- Distribution: the connection of drop points to a first aggregation point: the distribution point.
- Feeder: the connection of distribution points to a second aggregation point: the Area-POP.
- Metro-loop: the connection of Area-POP's to a City-POP. The cost of the City-POP (building) is not included in the calculation.

For each equipment layer, the exact number of splices, closures, cables, ducts, microducts, etc. is calculated and reported in a bill of material.

The "Design Rules & Costs" are very detailed, however the most important cost driver is that covering trenching.

For this study, a varying trenching cost was used: in the densest cities, trenching costs were estimated to be €100/m and in the most rural areas the trenching costs were estimated at €40/m.

### 5.1.1.3 Relation Cost – population density

By combining the "Sample Areas" and the "Design Rules & Costs", the networks were then simulated using the two designs. For each design, a bill of material was derived and summarized covering the following network layers: building, drop layer, distribution layer, feeder layer, Area-POP and metro loop.

The resulting derivative for each simulation produced not one but two cost estimates: an indication of the investment needed to deploy and activate the whole network and in addition the cost for each of the

aforementioned network layers. As each area is characterized by its population density (see 5.1.1), the relation between the cost of a network layer and population can be investigated.

One could query why the populated density was chosen to characterize each area, the answer is very simple: one particular characteristic needs to be established which can then be used as a good indicator for the cost. While evaluating many different relationships, the populated density has the clearest relation in terms of cost per network layer.

The figure below visualizes the relation between density and cost of the distribution layer. Each dot in the figure represents the cost of the distribution layer per home for a specific sample area. On the horizontal axis, a wide variety of sample areas have been used, ranging from low to high-populated density.

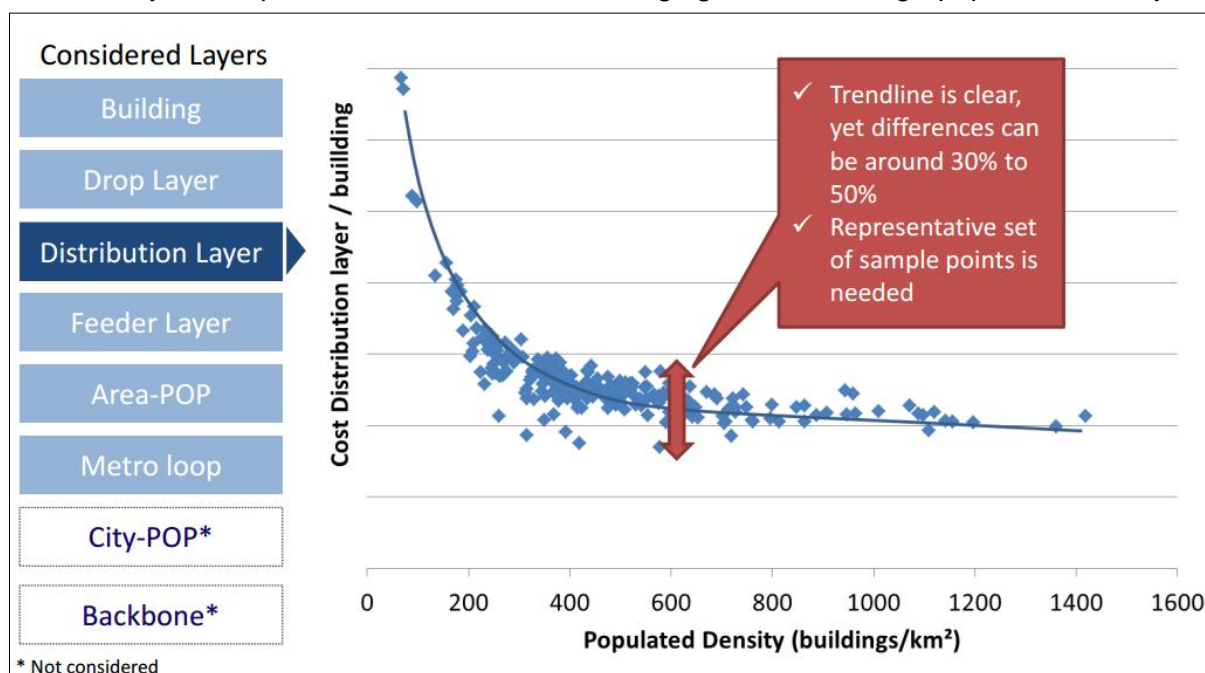


Figure 22: Relationships between populated density and the cost per network layer per building. (Source: Comsof)

For this particular distribution layer, the trendline (the blue line in the figure) is clear and can be represented by a mathematical formula. For each of the network layers, a similar graph is created, a trendline derived and the mathematical formula calculated. These mathematical formulae enable us to calculate the cost/building of each network layer for a particular area with a certain populated density.

As can be seen in the graph, the trendline is clear but the variation is high: differences in costs between two sample areas for a certain populated density can be up to 50%. Clearly, it would not be sufficient to estimate the cost of a single sample area using this trendline, as this value could vary by 50%. However, by introducing a high number of sample points, a representative trendline has been created. The result is a clear relation between costs and populated density. Therefore, to complete the model, Germany needs to be characterized into different 'covering areas' this would allow for a more accurate calculation of the cost of each network layer for these 'covering areas' to be ascertained.

### 5.1.2 German statistics

In order to apply the trendline to calculate the total cost for Germany, the whole country needs to be divided into 'covering areas'. This division can be achieved in many ways, however the following information is needed over each covering area:

1. accurate statistical information regarding the number of buildings
2. the 'populated area surface' can then be calculated

To fulfil these criteria, it was agreed that the official NUTS3 classification as used by Eurostat (the statistical bureau of the European Union) would be adopted. Click on the following link for more information about the



NUTS classification: [http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts\\_nomenclature/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction). For Germany, the classification along NUTS3 borders, divides the country into 429 districts.

The first criterion was met by using the freely available data from Eurostat and the “Regionaldatenbank” Deutschland, which is the statistical bureau of Germany. Information relating to the number of buildings within each NUTS3 area has been obtained from these sources.

A company specialising in airborne data acquisition and treatment provided information for the second criterion. An explanation outlining the reason the populated area surface has been used will be given.

### 5.1.2.1 Population density as basis for extrapolation

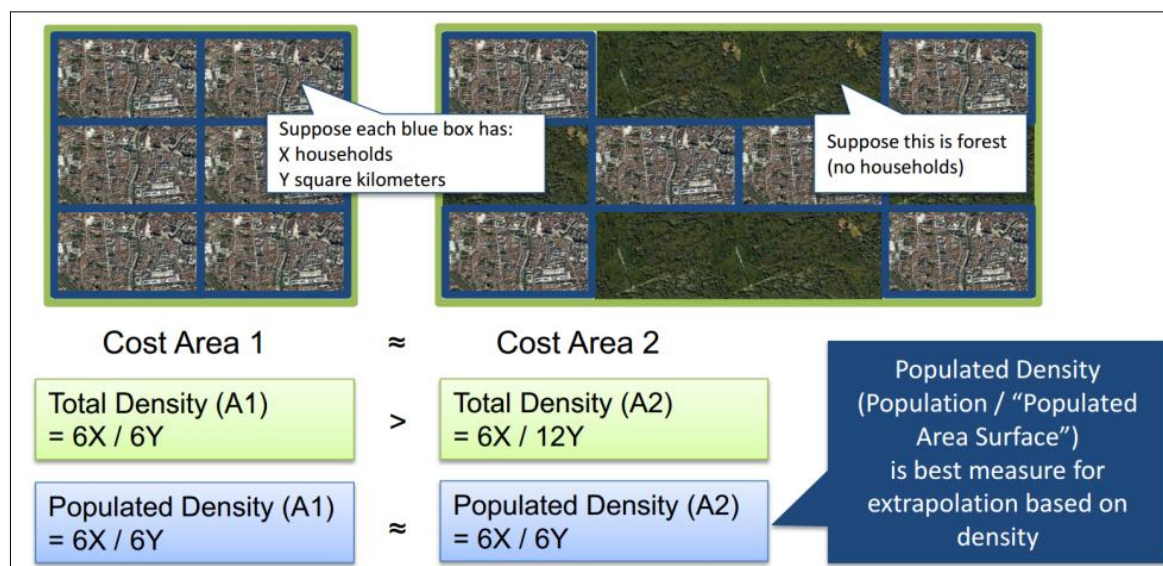


Figure 23: Why populated density is used as a cost driver, instead of population density. (Source: Comsof)

As described previously, it was not population density that was employed to characterize each sample area, instead 'populated density' was chosen. Figure 23 clarifies the use of populated density as a cost driver rather than the population density. The two Cost Areas, 1 to the left, and 2 to the right have a totally different population density; the total surface size of Area 2 is larger. However, it is not the total surface area that is a cost driver, rather the total surface area where households are located: the "populated area surface". Using this "populated area surface" concept, the "populated density" can be calculated, which provides a figure that is a good indication of costs.

For the 230+ sample areas, it has been very straightforward to calculate the 'populated area surface' as the exact GIS data of the buildings and streets are available.

### 5.1.2.2 Populated area surface for the 'covering areas'

However, the populated area surface for each covering area also has to be calculated without having access to detailed GIS data of buildings and streets. Eurosense, a Belgian company specializing in airborne data acquisition and treatment, was employed as support to characterize accurately the percentage of each NUTS3 area that was considered populated. The result is that for each NUTS3 area exact characterization of populated area surface is now available. Figure 24 is an extract of the detailed characterization of Germany: the green areas represent 'populated area surface'.



Figure 24: The light green areas indicate 'populated' areas on the smallest possible grid size. This data is used as base data to further ascertain the 'populated area surface' of each NUTS3 area. (Source: Comsof)

## 5.2 Results for Germany

Combining the results from the 'relation of population density and the costs of FTTx' with the 'German Statistics', it is now possible to calculate the cost for the individual network layers for each NUTS3 area of Germany.

Deploying a network for the whole country based on the typical present-day German system (a P2P FTTB with 4 active and 2 spare fibres per building using underground ducts in deep trenches) the cost would be in the region of **€ 67.1 Bn**. The type of network proposed will exceed the broadband objectives: with 100% connected homes and will deliver bandwidths that are faster than 100 Mbit/s.

The figure of **€ 67.1 Bn** is relatively high, however as it exceeds broadband objectives, alternatives have to be considered to lower the investment.

First of all, only 50% of the homes should be connected to the network. This does not mean that 50% of the costs related to activating the homes can be left out; an FTTB network is considered to include both single dwelling units as well as multi-dwelling units. Using the right calculations, the investment needed to cover this type of network is **€58.5 Bn**.

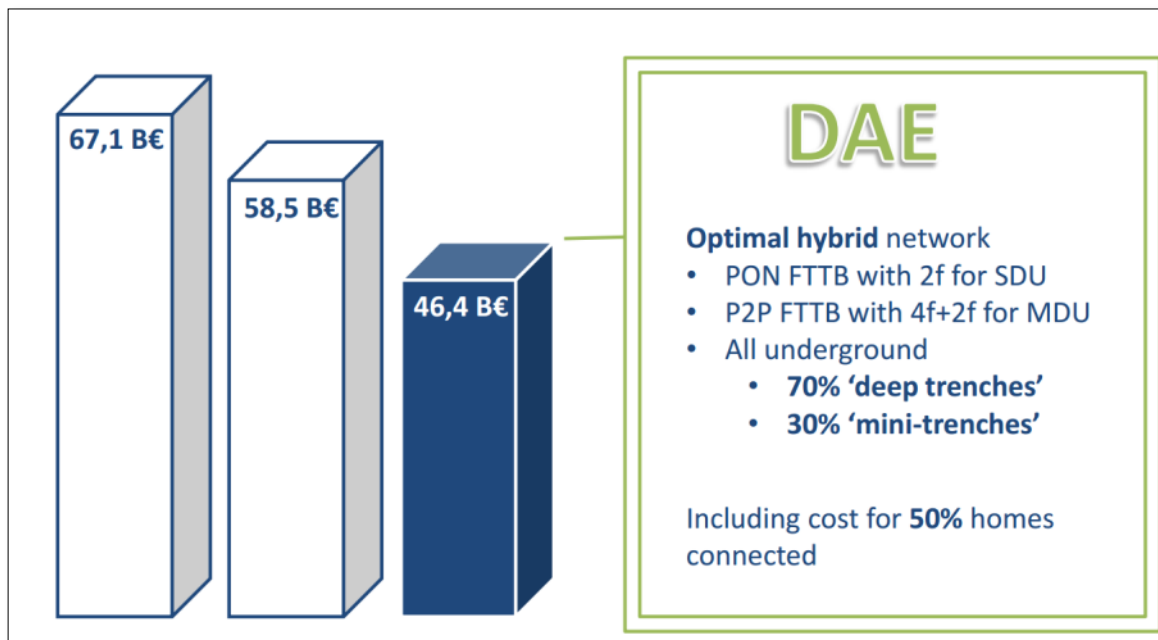


Figure 25: Summary of the results for the cost of fiberizing Germany (Source: Comsof)

Secondly, the bandwidth provided exceeds the objectives. In order to solve this issue, the hybrid network would be an FTTB P2P connection with 6 fibres to each multi-dwelling unit and an FTTB P2MP connection with 2 fibres to each single dwelling unit. Also in this situation only 50% of the homes are activated. Using this type of hybrid a 50% activated network requires an investment of **€ 52.6 Bn.**

Thirdly, there are a number of alternatives that would lower the costs even further, for example: alternative trenching methods. By applying these cost reduction techniques, the total investment could decrease to only **€ 32.6 Bn.**

It should be remembered however, that this figure is only a theoretical example and not realistic to execute. Therefore in reality, 70% deep trenches and 30% mini trenches need to be considered as a valid cost reduction. In conclusion, a realistic total investment needed would be **€ 46.4 Bn.** These results are summarized in Figure 25.

### 5.3 Conclusions

A digital agenda compliant fibre-based network can be built in Germany for an investment of € 46.4 billion, which could, theoretically be lowered to € 33 Bn. There is huge potential in reducing this investment by using alternative trenching methods.

The cost model approach is solid, as it uses a combination of a full FTTx rollout simulation over Germany and an extrapolation model. In order to calculate the cost of covering Germany, 230 real German sample areas have been used (a representative set of 2.3 million buildings). German network topology was simulated incorporating prices of equipment in Germany, which resulted in accurate bills of materials from each simulation. Using the concept of 'populated density' and datasets from well-known statistical companies, Germany can be divided into 429 covering areas for which accurate statistical information is available. Combining the statistics of the 429 areas with simulation results of the 230 sample areas, the German nationwide fibre rollout has been accurately calculated.

## Appendix 1: Broadband development in the state of Hessen

Launched in 2006 by the state government of Hessen, the initiative “Mehr Breitband in Hessen” (*Transl.: More broadband in Hessen*) focused on the development of broadband availability in mainly rural areas. High implementation costs, short periods of recovery, a low utilization related to low population density makes broadband investments not-too-appealing to private investors. This situation was understood and the challenge accepted by Hessen at an early stage. In 2009, an evaluation on a municipal level revealed that some 242,000 households received less than 1 Mbit/s download speed. Consequently, a new project, which today is acknowledged as the “Hessen Model”, was initiated in 2010 with 2 clearly defined objectives:

- State-wide access to at least 1 Mbit/s bandwidth by end 2011
- 75% coverage of Next Generation Access with bandwidth of at least 50 Mbit/s by 2014

Basic service availability (1 Mbit/s) has been successfully achieved for 99.5 % of the households by end of 2011. In 170 projects, 460 provincial towns and districts have been linked to high-speed internet connections and 220 districts have been equipped with LTE. The development of NGA networks is also moving forward quickly: due to the projects in Odenwaldkreis and Fulda, a full coverage of NGA has been realized. The districts of Gießen and Kassel will follow soon. According to the “Breitbandatlas”, Hessen has a 50 % coverage of at least 50 Mbit/s bandwidth and is even expected to meet the 75% goal of the national “Breitbandstrategie” by 2014.

The core of the “Hessen Model” is the co-operative concept, aiming to involve all relevant players. The model involves state-level governmental agencies, municipalities, banks and institutions as well as suppliers of energy and telecommunications services. It provides well-defined role and responsibility concepts and fixed due-dates. A € 200 M loan and surety programme as well as promotional programmes for feasibility studies and ductwork installation is part of the “Hessen Model”.

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## Appendix 2: Open Access Expansion by NGA-Breitband-Forum

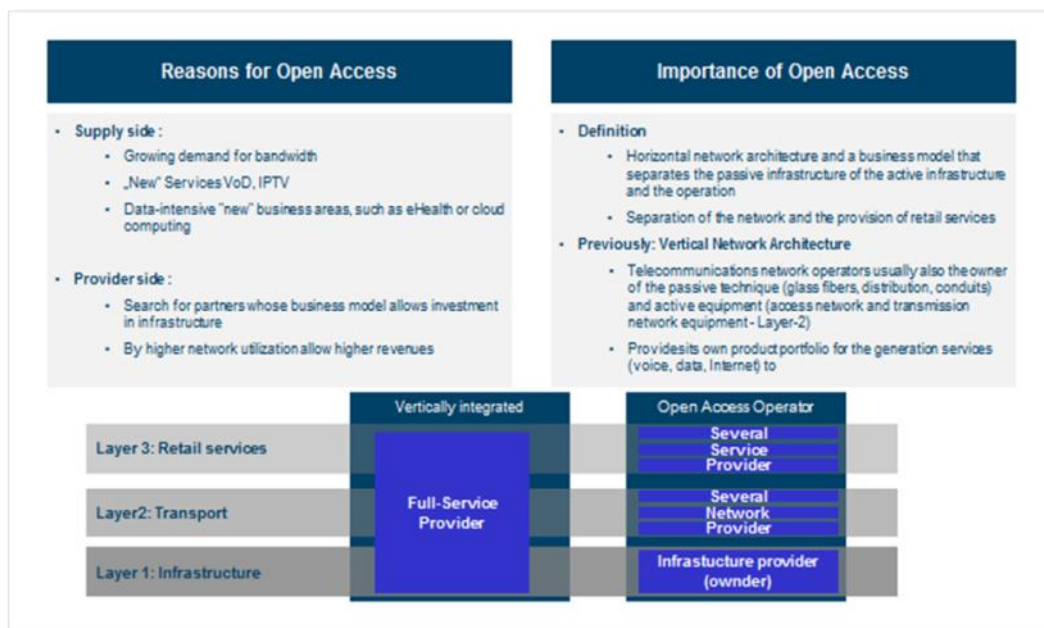


Figure A2: Overview of the "Open Access" Technology (Source: VATM, BNetzA, Greenwich Consulting)

The Open Access model has proved very successful in other countries, e.g. Sweden (Stokab), Netherlands (Reggefiber), Austria (Blizz-net) and Denmark (Wao!).

Open Access offers several benefits for user and suppliers as it goes beyond the classical bundle packages and provides trans-sectoral services (e.g. e-health) while ensuring the evolution of new businesses. New business and public transactions, governmental services, smarter energy, environment and transportation are emerging, making activities more efficient.

The model is defined by usage of a network from the supply process on (building and operating of networks). In this way, the infrastructure provider has a higher utilization of networks through the parallel commercialization of the existing resources. Public-private partnerships (PPP) are adding efficiency through risk sharing.

This model is especially attractive in rural areas with low population density as it improves the basic condition for economic development of networks, making the Open Access Model especially suitable for municipal fibre networks.

### The role of the NGA forum and S/PRI

To coordinate the processes of the companies and unify the variety of network operators in NGA network, joint planning and implementation is required. Standardization of interfaces is one important step towards a proper development of the Open Access. To prevent expensive system procedures and to unify a variety of interfaces, the universal interface S/PRI has been set up by a working group within the NGA Forum in cooperation with the BREKO association. The interface ensures a high automation of processes in the form of web services to all participating providers and will by this drive Open Access.



### Appendix 3: Trenching cost as major cost driver

On an international level, trenching is the most important cost driver in FTTH-business cases. Overall, trenching and civil works can amount to 60 % - 80 % of total project cost. In Germany trenching costs per meter is particularly high, pushing the cost proportion in the business case to > 50% (see also Chapter 1.2). As earth ("Muttererde") is subject to environmental protection in Germany, several legal requirements underlay trenching. Methods to reduce those costs are essential for further broadband development. Several methods to reduce trenching cost are currently being discussed:

- Reduced trench sizes
- Micro- and Minitrenching.
- Y-Connection from EWE NETZ
- Fastopticon
- Undeep methods / deployed by DTAG
- Horizontal drilling + earth rockets cross the streets over a length of 10/15 m from the building

Currently cost reduction methods are available both for indoor as well as outside plant infrastructure installation.

Countries with high labour costs, such as Germany, are the most interesting countries for reuse of infra, one of the easiest cost reduction methods. Micro trenching is applied as a niche application. Recently the government released a new 'Verordnung' on this method.

#### Alternative building connections Feed through Gas pipes



Disadvantage: Building entry still needs to be divided

#### Alternative building connections Feed through water pipes

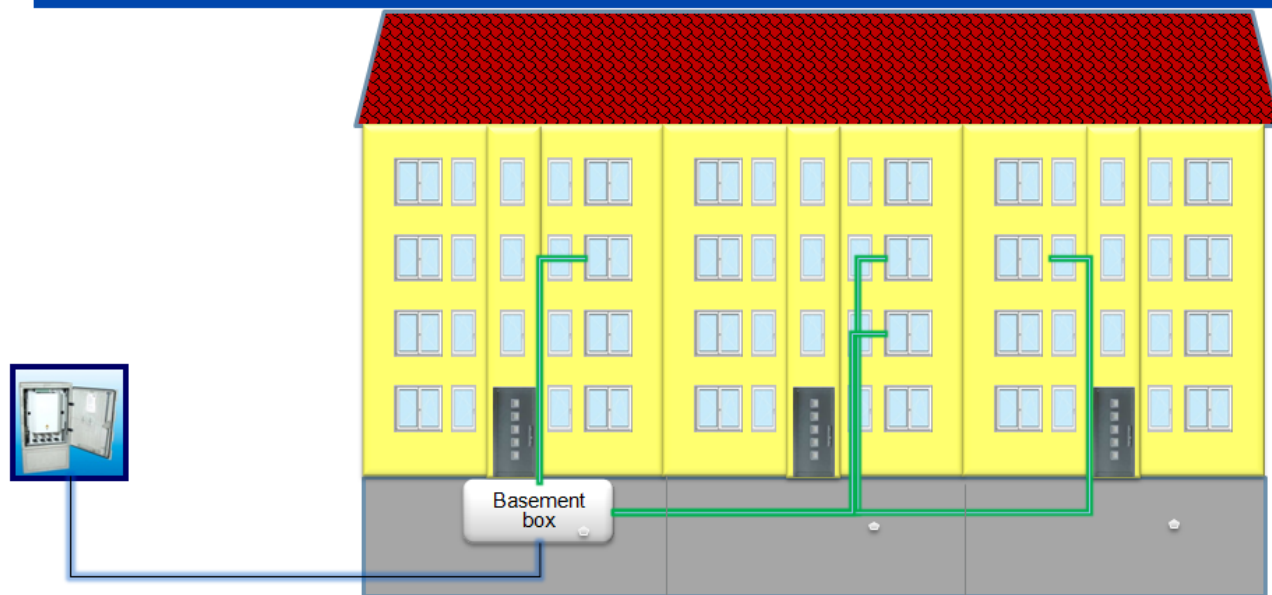


Advantage: Reuse of existing building connection

## Basement distribution in building blocks

### Centralize basement distribution point & direct drop

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#### Savings:

- One building connection & one basement box only
- Distribution thru the basement. Easy on wall distribution
- Direct drop: pay as you grow

#### **Appendix 4: Cost Model – German CAR Project Team**

This work would not have been possible without the support of the members of the project team (*in alphabetical order*):

Luc De Heyn	<b>Comsof</b>
Albert Grooten	<b>Grooten FTTH Consultancy</b>
Chris Holden	<b>Corning</b>
Patrick Jung	<b>Greenwich Consulting</b>
Xenia Abrosimowa	<b>Greenwich Consulting</b>
Raf Meersman	<b>Comsof</b>
Tony Shortall	<b>Telage</b>
Hartwig Tauber	<b>FTTH Council Europe</b>
José Van Ooteghem	<b>Comsof</b>

The Council would also like to thank other members of the FTTH Council and outside parties who have provided real life data and feedback.