

Competition and investment in the Danish broadband market

(Non-confidential version)

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Executive summary

New legislative provisions on “symmetric” access regulation are due to be introduced in Denmark, in the context of the transposition of the 2018 EU Electronic Communications Code.¹ Symmetric access obligations under the Code are obligations that apply to all operators, and not only to operators found to have “Significant Market Power”. While such obligations could cover only access to in-building wiring, the Code makes provision for these obligations to be extended to passive access at concentration points outside the building, and even in some circumstances, active access obligations. The Code also highlights circumstances in which such obligations could be waived.

In this report, we assess the impact that different forms of “symmetric” wholesale access regulation may have on the investment incentives of broadband operators in Denmark, as well as the potential effects on competition and consumer outcomes.

The assessment is based on interviews within the Danish market, as well as four European case studies, and comparative data analysis. The main findings follow.

The Danish broadband market

The main operators in Denmark which are active in the deployment of VHC Connectivity are the so-called fibre utilities. Incumbent TDC, which operates both FTTC/VDSL and cable infrastructure has not historically made significant investments in deploying FTTH but has FTTH coverage due mainly to acquisitions. However, its new shareholders have stated their ambition to complement existing infrastructure to enable Gigabit access nationwide by mid 2020s and have announced plans for more significant fibre roll-out.²

There are some areas within Denmark in which there are two infrastructures capable of Gigabit connectivity (via DOCSIS 3.1 or FTTH) – 16 % in 2018. However, the areas served by a utility fibre network alone may expand, because the fibre utilities are making further investments, while Macquarie has stated that it prefers to avoid duplicate investments.

Although the fibre utilities have stated that they plan to offer wholesale access, and some agreements have been reached, provision of wholesale access is not central to the business case of most fibre utilities, and many report that other challenges need to be addressed first. In the status quo, it seems unlikely that wholesaling on fibre utility networks will expand rapidly in the short to medium term. This may result in demand from access seekers not being satisfied, and in more restricted take-up on utility fibre platforms than if wholesale access were embraced.

1 See <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0453+0+DOC+XML+V0//EN#BKMD-11>.

2 See <https://www.macquarie.com/kr/about/newsroom/2018/approach-to-tdc-as-to-discuss-a-possible-voluntary-takeover-offer/>.

There is limited evidence of excessive charges being levied by fibre utilities, even in areas where they hold a high market share in the regional market. This could be *inter alia* due to their co-operative ownership structure and/or due to pricing constraints from copper and FTTC-based offers. However, if over time, copper-based access offers continue to decline, and customer demand for ultrafast connectivity continues to expand, it is possible that fibre utilities in areas not served with cable might be able to price above the competitive level, and that customer choice in areas where wholesaling is not widespread could be limited. However, fibre utilities have the disadvantage of providing services at a significantly smaller scale than TDC which also may lead to higher prices without this being an indication of no competitive pressure.

Options for the implementation of symmetric regulation in Denmark

The provisions of the EU Electronic Communications Code envisage that symmetric access would normally apply to passive access at connection points close to the end-user – i.e. in-building wiring or access at the first concentration point outside the building. The NRA would determine where this point lies.

The Code does however allow for this interpretation to be expanded in specific circumstances to cover access beyond the first concentration point. Active access (bitstream) can also be mandated “if justified on physical and/or economic grounds”.

The Code also provides for exemptions from access regulation for wholesale only providers or where wholesale access would compromise the viability of network deployment, in particular by small projects. Exemptions may also (at national discretion) be extended to vertically integrated providers which offer access to VHC networks on fair, non-discriminatory and reasonable terms.

Feedback from interviews with Danish stakeholders suggests that there is limited demand for access to in-building wiring or access to the fibre terminating segment, except in the context of access to the infrastructure of housing and antenna associations. Access to passive infrastructure (fibre unbundling) could be of potential interest for TDC and business providers, while active (bitstream) access, could be of interest for alternative operators. The demand for such access is a relevant consideration for policy-makers. However, it is not clear that symmetric obligations under the Code would be appropriate as a tool to address these needs. Symmetric fibre unbundling and/or bitstream obligations would in any event require an assessment to the effect that symmetric obligations for access at the first distribution point as well as obligations under the market analysis process were not sufficient to address high and non-transitory economic or physical barriers to replication, significantly limiting competitive outcomes to end-users.

Interviews with fibre utilities suggest that mandating symmetric access could create concerns for the business case of operators which are still in the process of deploying fibre and have not yet reached sustainability. Moreover, the voluntary wholesaling commitment made by some fibre utilities should be considered. Thus there is a case to consider applying exemptions (i) for small scale operations; and (ii) wholesaling meeting certain standards - in the context of the Danish market.

Findings from literature about the impact of symmetric regulation and wholesaling on regional operators

Available literature which has considered the effects of symmetric regulation has found that in-building wiring can be effective in supporting infrastructure-based competition (duplication) in FTTH in areas where this is viable (primarily dense urban areas), in the presence of willing investors. Our analysis of the Spanish market confirms this, but it is not clear that similar market dynamics exist in Denmark that would support end-to-end infrastructure competition.

Symmetric regulation has also been used to mandate a form of fibre unbundling in France outside “very dense areas”. This form of access has been mandated on both traditional telecom operators, and on regional operators which specialise in providing FTTP-based access with the support of state aid. A key benefit from the French model is that the use of symmetric regulation created common standards for (passive) wholesale access which are used by multiple firms in different regions. Major telecom operators including the incumbent have now signed agreements enabling them to provide services via the wholesale networks of these regional players.

Business model simulations suggest that, irrespective of any regulatory requirements, wholesale access (and wholesale only models) can be positive for the business case for regional operators. In particular, by increasing take-up on the network they help to reduce business risk and support a longer-term ‘utility’ investment model for FTTH. An examination of strategies by regional carriers in Sweden (municipal networks), Germany (City Carriers) and France (public initiative operators) supports the findings from our theoretical models that suggest that active wholesaling policies (including wholesale only networks) can support the business case for fibre deployment by regional operators.

Impact assessment and conclusions

A summary of our assessment concerning the impact of different options on investment, competition and consumer welfare is shown below.

Overview of impact assessment of symmetric regulation for Denmark

	Investment in VHC			Competition		Consumer welfare	
	Incumbent	Energy co.	Altnets	Infra-structure	Service	Price	Quality
Option 1: (base case) asymmetric VHC regulation on TDC alone	+	+	0	0	-	-	--
Option 2: Symmetric regulation (in-building only) ³	+(+)	+	(+)	(+)	- (+)	- (+)	- (+)
Option 3: Symmetric regulation (passive unbundling) ⁴	+	(+)	0	(+)	+	+	++
Option 4: Symmetric regulation (active extensive)	+	(+)	0	0	++	+	+
Exemptions permitted for operators meeting given wholesaling standards	+	+	0	(+)	++	++	++

Source: WIK. + and - imply an increase or decrease in the short to medium term, while 0 indicates stability. Brackets indicate partial or uncertain developments. The lighter colouring in the context of in-building access indicates that the indicated benefits would accrue only in specific cases, further discussed below.

There is a risk under the **status quo** that in time, as customers migrate towards VHC networks, they will experience less choice and potentially higher charges and lower quality in areas where there is only one VHC network, which is unregulated, unless fibre utilities and antenna associations play a more active role in wholesaling. Recent developments suggest that some fibre utilities have taken steps to open their networks. However, other networks remain closed, risking a patchwork in competition. Another potential concern is that even where wholesaling is offered, there is a reluctance to provide passive access. This may limit the degree of differentiation in the services provided by access seekers and may not meet the needs of business service providers or mobile operators seeking high capacity backhaul connections.

Symmetric regulation applying to **in-building wiring only** could be helpful in supporting competitive investment in infrastructure to antenna and housing associations, and in supporting choice, value and quality for residents benefiting from the connection. However, it seems unlikely to be used to duplicate infrastructure already deployed by fibre utilities, with the potential exception of services to large businesses. Thus, significant investment in offering such access by fibre utilities may not be justified.

³ Assumed used for access to antenna and housing association infrastructure. Investments and benefits (shown in grey) are presumed to accrue only for customers of antenna/housing associations and businesses.

⁴ Prices are assumed to be set at levels which allow reasonable cost recovery.

Symmetric regulation applying to **passive unbundling** would not be used by smaller broadband service providers, but could be used by existing larger operators and would support competitive provision for larger businesses and mobile backhaul. It is possible that passive unbundling could enable an existing large-scale provider such as TDC to act as an “aggregator” providing competition in the provision of wholesale bitstream access over FTTP services. This could be beneficial to other service providers and consumers, if the market can support multiple aggregators. However, if this is not the case, there is a risk that TDC could leverage its nationwide coverage to outcompete other platforms and gain market share at the wholesale level. If used on a widespread scale, passive access should benefit fibre utilities through higher take-up and thereby improving their business case. However, significant take-up is not certain (except potentially under the aggregator scenario described) and access obligations would require fibre utilities to establish new wholesale products and associated platforms, which could – especially for smaller players – raise costs and delay deployment plans. Price setting that does not clearly permit costs to be recovered could also undermine the business case.

Symmetric regulation applying to **bitstream access** could accelerate existing wholesaling plans by fibre utilities, leading to additional service competition and choice for customers. However, bitstream may not support significant price and quality differentiation in retail services, and is less suitable than passive access for business provision and mobile backhaul. Applying obligations on fibre utilities could, as described with passive access, divert resources from deployment. Price setting that does not clearly permit costs to be recovered could also undermine the business case.

Providing **exemptions from symmetric obligations** for operators which meet given criteria concerning wholesale access could potentially contribute to increased competition and consumer benefits whilst avoiding concerns that may arise over unduly restrictive regulation. Because it would put the onus on fibre utilities and antenna associations to find a solution, and settle common issues through working groups with access seekers, it could streamline the current patchwork negotiation process and provide greater confidence for alternative fibre operators to continue their investments. A further benefit of this solution is that it would obviate the need to demonstrate that the legal criteria for symmetric regulation are fulfilled in any particular case. The threat of symmetric regulation would, however, remain (and the case for it could be bolstered) if operators fail to adapt their strategies to effectively accommodate wholesaling.

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1 Introduction

New legislative provisions on “symmetric” access regulation are due to be introduced in Denmark, in the context of the transposition of the 2018 EU Electronic Communications Code.⁵ Symmetric access obligations under the Code are obligations that apply to all operators, and not only to operators found to have “Significant Market Power”. While such obligations could cover only access to in-building wiring, the Code makes provision for these obligations to be extended to passive access at concentration points outside the building, and even in some circumstances, active access obligations. The Code also highlights circumstances in which such obligations could be waived.

In this report, we assess the impact that different forms of “symmetric” wholesale access regulation may have on the investment incentives of broadband operators in Denmark, as well as the potential effects on competition and consumer outcomes.

The assessment is based on interviews within the Danish market, as well as four European case studies, and comparative data analysis.

- Chapter 2 discusses developments in the Danish broadband market.
- Chapter 3 considers the options for implementation of symmetric regulation in Denmark.
- Chapter 4 summarises available literature on the impact of symmetric regulation and on different business and wholesaling models applied by regional firms.
- Chapter 5 presents four European case studies and considers their relevance to the Danish market.
- Chapter 6 presents information from confidential interviews with stakeholders.
- Chapter 7 concludes the report with an assessment of the impact of different options for the implementation of symmetric regulation on the Danish market.

⁵ See <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0453+0+DOC+XML+V0//EN#BKMD-11>.

2 Developments in the Danish broadband market

In this chapter we describe the current structure of the broadband market in Denmark and its likely evolution in the absence of symmetric regulation, drawing on data analysis and interviews with stakeholders.

Key conclusions are:

- The main operators in Denmark which are active in the deployment of VHC Connectivity are the so-called fibre utilities. Incumbent TDC, which operates both FTTC/VDSL and cable infrastructure has not historically made significant investments in deploying FTTH but has a FTTH coverage today due mainly to acquisitions. However, its new shareholders have stated their ambition to complement existing infrastructure to enable Gigabit access nationwide by mid 2020s and have announced plans for more significant fibre roll-out.⁶
- There are some areas within Denmark in which there are two infrastructures capable of Gigabit connectivity (via DOCSIS 3.1 or FTTH) – 16 % in 2018. However, the areas served by a utility fibre network alone may expand, because the fibre utilities are making further investments, while Macquarie has stated that it prefers to avoid duplicate investments.
- There is demand or access to utility fibre networks from other operators in Denmark. While unbundled fibre is of interest to TDC and business providers, other access seekers have primarily expressed interest in bitstream access. As broadband providers seek to avoid duplicating networks in the access segment, there is limited interest in access to in-building wiring or to access points aggregating a limited number of end-users i.e. the fibre terminating segment, except for the case of antenna and housing associations, which may otherwise be subject to exclusive agreements.
- Although the fibre utilities have stated that they plan to offer wholesale access, and some agreements have been reached, provision of wholesale access is not central to the business case of most fibre utilities, and many report that other challenges need to be addressed first. In the status quo, it seems unlikely that wholesaling on fibre utility networks will expand rapidly in the short to medium term. This may result in demand from access seekers not being satisfied, and in more restricted take-up on utility fibre platforms than if wholesale access were embraced.
- There is limited evidence of excessive charges being levied by fibre utilities, even in areas where they hold a high market share in the regional market. This could be inter alia due to their co-operative ownership structure and/or due to pricing constraints from copper and FTTC-based offers. However, if over time,

⁶ See <https://www.macquarie.com/kr/about/newsroom/2018/approach-to-tdc-as-to-discuss-a-possible-voluntary-takeover-offer/>.

copper-based access offers continue to decline, and customer demand for ultrafast connectivity continues to expand, it is possible that fibre utilities in areas not served with cable might be able to price above the competitive level, and that customer choice in areas where wholesaling is not widespread could be limited. However, fibre utilities have the disadvantage of providing services at a significantly smaller scale than TDC which also may lead to higher prices without this being an indication of no competitive pressure.

2.1 Main actors in broadband network investment

Mid 2018, there were approximately 144 companies and associations which offered broadband services on the Danish market.⁷ The four largest broadband service providers are the incumbent operator TDC, SE/Stofa, Telenor and Fibia. These companies accounted for approx. 70 % of the fixed broadband connections provided on the Danish retail market in the first half of 2018.⁸ The third and fifth largest providers of fixed broadband services in Denmark, Telenor and Telia including its subsidiaries, do not operate their own fixed access infrastructure, but rely on wholesale access, primarily from the incumbent TDC.

The main actors in broadband network investment are the two largest providers TDC and SE/Stofa as well as a large number of fibre utilities, which operate regional and local networks. Many of the fibre utilities are Danish energy companies which have deployed fibre to deliver fast broadband to private households and businesses in the regions where they supply energy services.

The incumbent TDC delivers broadband services over copper, fibre and cable networks and also operates a mobile network. TDC's copper network reaches 95 % of all households and businesses in Denmark. TDC's fibre network coverage to a certain extent has been expanded through acquisitions of and partnerships with other fibre companies. In 2009 TDC bought DONG Energy's fibre network and in 2013 the TV and broadband services provider ComX. ComX had fibre infrastructure in Copenhagen and

7 The information on the main actors in broadband network investment in Denmark is based on market data provided by the Danish Energy Agency, on information from stakeholder interviews, on a report on regional broadband markets from December 2018 by the Danish Business DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf and on the market analyses of the Danish Business Authority from July 2017 DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf and DBA (2017), Engrosmarkedet for central netadgang på et fast sted, for så vidt angår masseforhandlede produkter (marked 3b) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3b.pdf.

8 Danish Energy Agency (2019), market data provided to WIK, DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

North Zealand and supplied approximately 34.000 households with television, broadband and IP telephony. In 2014 TDC entered a strategic cooperation with TREFOR (now EWII) to be able to provide fibre broadband connections in the Triangle Area.⁹

In addition to its copper and fibre networks TDC also owns the largest cable TV network in Denmark with a network coverage of well over half of the 2,6 million households in 2016.¹⁰ In the first half of 2018, TDC provided services to 1.2 million retail customers.

The second largest supplier of broadband is the company formed by the merger between Syd Energi and Stofa (SE/Stofa) with a stable market share of approximately 12 % since 2013. SE bought Stofa, which is the second largest cable television provider in Denmark, in 2012. After the acquisition of Stofa, SE decided to exit the sales platform it was using, the Waoo!-cooperation, in April 2014 and moved approximately 65.000 retail customers from the Waoo! platform to Stofa. Stofa now operates SE's broadband department. In the context of the merger between SE and Stofa, the companies also began to offer fibre and broadband capacity to business and wholesale customers both within and outside the footprint of SE/Stofa. SE/Stofa primarily supplies broadband based on its own fibre and cable network infrastructure and is the largest provider of broadband based on fibre. SE has invested in fibre networks since 2000 and has a geographic focus in the region of South and North Jutland. The target is to reach 98 % coverage in this region.

In 2015 SE/Stofa entered a strategic partnership with Energy Sydfyns (SEF) which eventually resulted in the transfer of SEF's operational fibre business to SE/Stofa. SEF owns 75 % of the company behind the fibre network, while SE/Stofa owns 25 % and is responsible for the operation of customer relations, content packages and digital services. Furthermore, in the same year, SE/Stofa concluded a strategic cooperation agreement with Verdo Telecommunications, which is a subsidiary of the energy company Verdo. The agreement involved SE/Stofa taking over 25 % of the telecommunications business of Verdo and since early 2016 it became responsible for the operation of Verdo's fibre network and the provision of content packages and digital services combined with fibre broadband access. In May 2016 a merger took place between SE/Stofa and Nyfors and in December 2016 SE/Stofa bought the Digital Terrestrial TV platform Boxer TV from the Swedish Teracom AB group.

In December 2018 SE/Stofa and Eniig announced the merger of the two companies to form a new company called Norlys. The merger has been approved by the Danish

9 DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at:

[https://d8test.w2ltest.dk/sites/default/files/2019-](https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf)

[03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf](https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf).

10 DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf

Competition Authority in June 2019. Norlys covers ca. 42% of Danish households with fibre and cable networks.¹¹

The other approximately 140 actors in the retail market held a combined market share of 30 % in the first half of 2018, and comprise regional and local fibre or aerial network operators as well as broadband providers using TDC's wholesale access to the copper, cable and fibre networks.

Typically, the fibre utilities are organised as cooperatives, where the customers are members of the cooperative and in consequence are indirect owners of the fibre networks. The size of fibre utilities varies significantly, with a few large fibre network operators and a significant number of small scale network operators. Some of the fibre utilities are wholesale-only operators and use a retail platform to sell their services (e.g. the network operators providing services through Altibox). However, unlike in Sweden, where wholesale only operators typically sell services to a range of ISPs, many operators have thus far reached an agreement with a single platform. Several utilities also use the Waoo! platform to market their services. This business model is not a wholesale only model because the Waoo! Platform provides a brand but the subscription is maintained by the network operator.

In September 2010 15 fibre utilities launched the Waoo! platform to provide retail broadband services. Waoo! today operates as a sales and marketing cooperation for a number of energy companies. It provides TV, internet and telephony over fibre networks of utility companies. In addition, Waoo! provides retail services based on TDC's fibre network in Copenhagen and North Zealand. Since 2014 several fibre utilities have opted out of the cooperation. For example, SE migrated its customers to Stofa two years after the merger of SE/Stofa in 2012. Furthermore, SEF (Energy Sydfyns) and Verdo opted out of the Waoo!-cooperation and entered an agreement with SE/Stofa.

For the five smaller West Jutland energy companies (Thy-Mors Energi, Jysk Energi, Midtjysk Elselskab (MES), Grindsted Electric and Heating Plant and Energi Ikast), Altibox operates both the networks and retail offerings. Altibox is owned by the Norwegian energy company Lyse and supplies broadband services on a number of regional fibre networks in Norway, including Lyse's own fiber network. Altibox also took over the customers of MidtVest broadband after its bankruptcy in 2009.

There are also a number of players on the Danish broadband market (e.g. Bolignet Aarhus and Parknet), which specialise in the supply of broadband and other services to associations (e.g. housing associations, antenna associations, aerial associations and colleges) and have their own infrastructure. It is estimated that approximately 650.000 households in Denmark (24 % of households) are members of a housing association,

11 See <https://www.kfst.dk/pressemeddelelser/kfst/2019/20190625-konkurrenceraadet-griber-ind-i-fusion-mellem-se-og-eniig/> and <https://www.se.dk/om-se/presse/presserum-se/repraesentantskaberne-i-se-og-eniig-sagde-ja-til-fusion?vocid=539165127582301&pressPageld=4a0a61aa-512d-4ab3-a577-a5b8adf41057>.

while approximately 684.000 households (25 % of households) are members of an antenna association.¹² It should be taken into account that there can be an overlap between the two numbers. Some of the antenna associations are larger than fibre utilities and provide services to 40.000 households. Other network operators focused on business services include Colt Technology Services SA (Colt) and GlobalConnect. Colt is an international company whose business model is to deliver telecommunications and data traffic to larger organizations, businesses and wholesale customers. Colt provides services in 86 countries, including 28 countries in Europe. Colt uses own infrastructure with a view to the provision of broadband services to its retail and wholesale customers.

GlobalConnect has been on the Danish market since 1998. The company is a nationwide provider of retail and wholesale products to companies, organizations and telecommunications providers in Denmark, Sweden and Northern Germany. GlobalConnect uses its own infrastructure to provide broadband services to retail and wholesale business customers but also relies on third party networks for the provision of services to some smaller customers. In 2018, GlobalConnect acquired Nianet, a network operator which was similar in scope and had been owned by some of the power supply companies in Denmark. GlobalConnect has also merged its operations with Broadnet, a Norwegian network operator, which may provide a platform for GlobalConnect to play a greater role in the consumer segment.

The broadband market in Denmark is very fragmented and the size of broadband network operators varies considerably. As shown in the table below, more than half of the network operators serve less than 10.000 households.

Table 2-1: Size of network operators in Denmark by network coverage in 2018

Network coverage (numbers of covered addresses)	Operators (share in %)
< 10.000	72 %
10.000 – 40.000	11 %
40.000 - 100.000	8 %
> 100.000	8 %

Source: WIK based on DEA

The following table summarises the main operators, their structure and technological focus, as well as the services provided to end-users.

¹² DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf

Table 2-2: Overview of main broadband network operators in Denmark

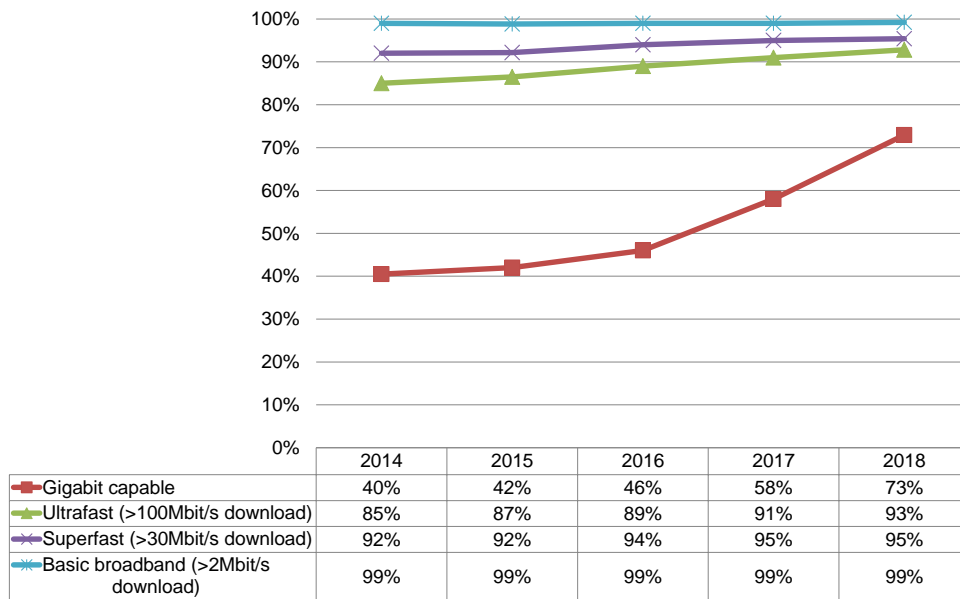
Operator	Type	Structure	Technology	Services provided to residential customers	Customer focus (residential/SME/ large business)
TDC	Incumbent	Vertically integrated operator, has announced structural separation of netco	Copper, FTTC, DOCSIS 3.1, FTTH	Internet, Voice and TV, mobile	Residential/SME/ large business
SE Stofa	Fibre utility merged with cable operator	Vertically integrated network operator	FTTH and coax	Internet, Voice and TV	Residential/SME/ large business
Other fibre utilities	Typically organised as cooperatives	Vertically integrated and wholesale only, e.g. selling services over Waoo!, Altibox or SE/Stofa	FTTH, predominantly PtP, some also deploying PON	Internet, Voice and some also providing TV	Residential/ Business
Aerial associations		Vertically integrated	FWA	Broadband and TV	Collectively organised customers
Other associations		Vertically integrated	FTTH/LAN	Broadband and TV	Collectively organised customers (e.g. housing associations)
Antenna associations	Typically organized as cooperatives	Vertically integrated	coax	Broadband and TV	Collectively organized customers

Source: Websites of the network operators and interviews with stakeholders.

2.2 Ultrafast broadband deployment trends

In Denmark the availability of very high speed connectivity has increased significantly in recent years. In 2018 95 % of households could access a broadband connection with speeds of at least 30 Mbit/s download and 93 % of households had access to connections with at least 100 Mbit/s download. The availability of Gigabit capable connections (considered to be those offered via DOCSIS 3.1 or FTTH) has increased from 40 % in 2014 to 73 % of households in 2018.

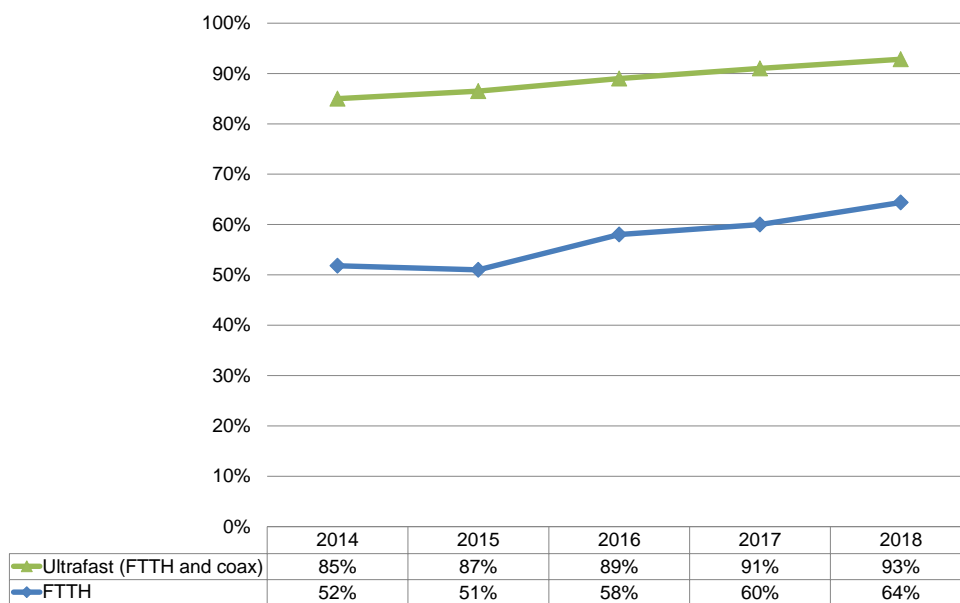
Figure 2-1: Broadband coverage in Denmark (in % of households)



Note: the gigabit capable coverage refers to infrastructure listed as being able to provide 1 Gbps.

Source: WIK based on DEA.

Figure 2-2: FTTH and ultrafast broadband coverage in Denmark



Source: WIK based on DEA.

TDC has a network reach with its copper network of 99 % of households.¹³ Ultrafast broadband connections in Denmark are mainly provided over cable and fibre networks.

TDC is able to supply broadband via the cable television network to well over half of the total 2.6 million households in Denmark.¹⁴ The company completed upgrading the cable networks to DOCSIS 3.1 in 2017. Compared with copper and cable, the network reach of TDC's fibre network is low.¹⁵

Table 2-3: Nationwide broadband coverage per operator and technology
(in % of households)

[confidential]

Source: WIK based on DEA.

2.3 Wholesaling

2.3.1 Wholesale access services of TDC

In Denmark markets 3a and 3b have been defined as national in scope in the DBA (Danish Business Authority) market analyses of 2017. Nevertheless, the regulator has identified geographic differences in the competitive conditions in 56 postal code areas based on the following criteria:

- TDC's market share is < 40 %,
- 75 % of households are covered by 2 alternative infrastructures and
- Postal code areas include more than 25.000 addresses either individually or combined in a cluster of areas

The geographic definition of competitive areas applied in market 3a and 3b is the same.

¹³ DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf

¹⁴ DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf

¹⁵ DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf

The regional differences in the competitive conditions were taken into account by a regional differentiation of remedies. In market 3a, in non-competitive areas, TDC is obliged to provide

- local physical access to the copper and fibre network
- local virtual access to the copper network (FTTC VULA)
- access to transport of traffic from decentralized points of distribution to more centrally placed nodes based on fibre
- access to co-location with the purpose of interconnecting network elements for transport of data traffic

In market 3b, in non-competitive areas TDC has to provide

- central, virtual access to the copper and fibre network
- access to co-location with the purpose of interconnecting network elements for transport of data traffic

In competitive postal code areas the obligations of access to fibre and all associated obligations have been withdrawn.

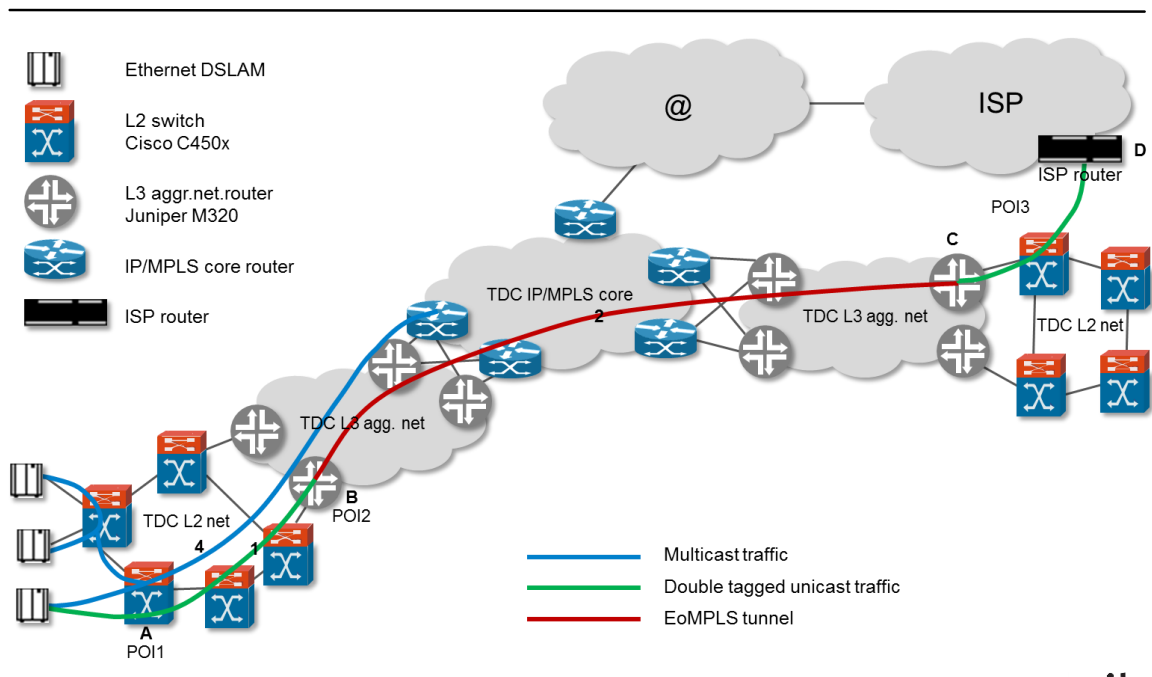
Wholesale access to TDC's fibre network has been regulated since 2010. Cable bitstream access was also subject to regulation in 2009. However, the obligation was withdrawn in the last market analysis on the basis that there was a viable commercial offer available. Due to the technical conditions of TDC's wholesale cable access, demand for this type of access did not develop at first. However, take-up has increased since TDC adapted its offering and improved commercial terms in the first quarter of 2016, although according to alternative operators, the cable bitstream does not currently enable them to provide voice services via the cable bitstream.

2.3.1.1 VULA and Ethernet BSA

FTTC VULA (VULA contended) was introduced in 2012 to ensure an alternative to the ULL in connection to Vectoring and provides speeds up to 150 Mbit/s on TDC's copper networks. VULA can be combined with Ethernet BSA/Raw copper to provide nationwide services.

TDC provides an uncontended VULA product directly at the DSLAM from TDC. The functionality matches that of VULA. Using a standalone DSLAM requires a substantially finer meshed backbone on the wholesale demand side.

Figure 2-3: VULA and Ethernet BSA offer of TDC



Source: TDC.

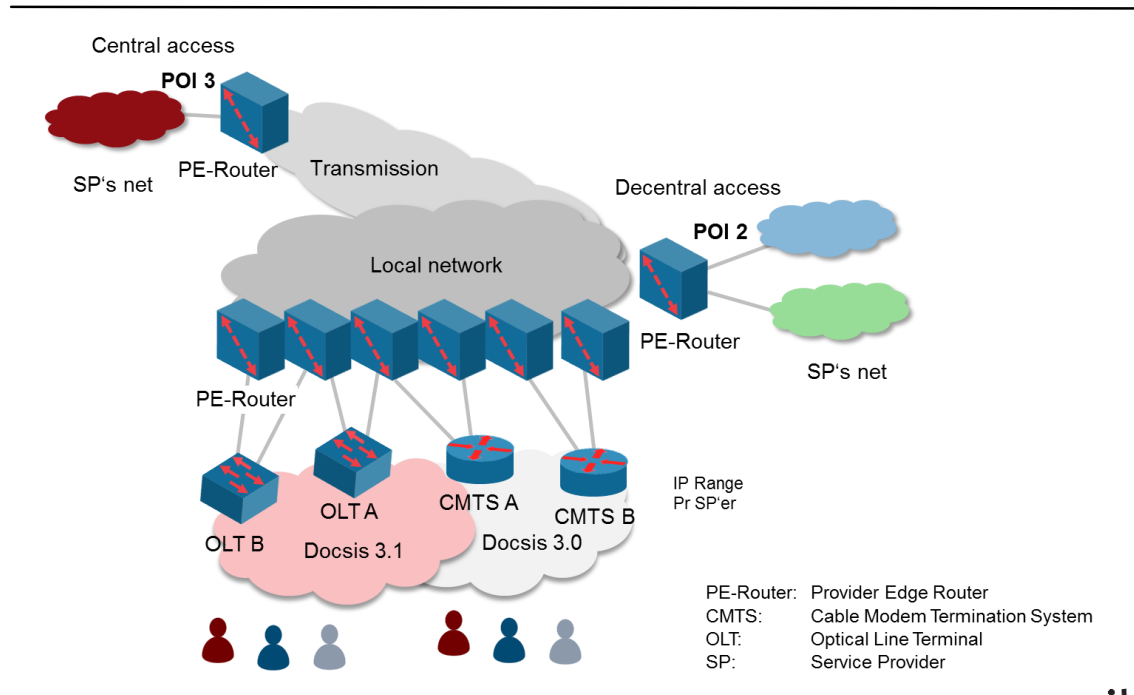
The Ethernet Bitstream Access provides access to all households covered by TDC. It can be purchased at (see also figure above)

- POI1 – at nearest L2 switch/router (in the above exemplified A), the wholesale customer purchases an Ethernet port in the switch/router. There are approximately 1260 L2 switches/router in the network today.
- POI2 – at nearest L3 switch/router, the wholesale customer purchases an Ethernet port in a switch/router in a central where the layer 2 ring is connected to layer 3 (in the above exemplified in B). There are approximately 165 POI2 locations in the current network.
- POI3 – with central termination at one or a limited number of places in the network (in the above exemplified in C). The wholesale customer in this case will be able to provide services with a limited or no infrastructure. POI3 will typically be in e.g. 1-8 locations.

The pricing consists of a payment for the Ethernet Port, the access to the Pol as well as for the Ethernet transport provision when Pol3 solution is used. The price for Ethernet transport depends on the number of layer-2 rings used (nationwide vs. limited number of layer-2 rings used). In addition to the Ethernet transport the customer must pay for the relevant Ethernet capacity between the POI2 location and the POI3. This shall be settled after consumed capacity.

If the customer chooses the POI1 or POI2 solution, the price is paid for the Ethernet transport between the different areas, i.e. the aggregated transport from the POI2 to POI3. This shall be settled after consumed capacity.

Figure 2-4: Cable Coax bitstream access (commercial offer)



Source: TDC.

Bitstream Access Coax (BSA Coax) enables wholesale access seekers to offer fast broadband via TDC's Coax network. With BSA Coax, traffic is delivered to a collocation. Coupled with IP Transmission, the traffic can be delivered at a central location. The wholesale customer handles the subsequent transmission of traffic.

BSA Coax is based on the particular structure and nature of the network. Accordingly, the infrastructure is a shared entity in which all broadband clients in any area share the total capacity. This requires network planning and capacity development within the network.

The pricing is a combination of a payment for transmission capacity (which has to be booked in advance) and a fee paid per connection.

BSA Coax provides access to more than 35 % of households and offers two possible interfaces in the cable TV network:

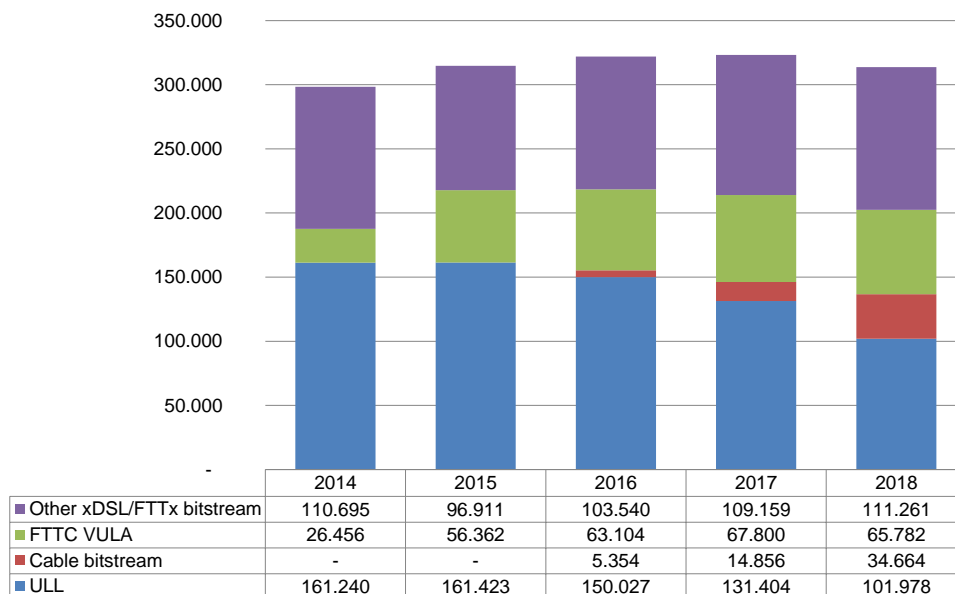
- A decentralised access connected on the POP (TDC PE router) (POI2)
- A central access in one or more central points (TDC PE router) (POI3)

For both solutions, the interface is one or more physical ports on the L3-level (1G or 10G). The BSA Coax can be compounded with other wholesale products.

2.3.1.2 Development of demand for wholesale broadband access provided by TDC

In 2016, copper technology represented 49 % of the wholesale market, but has fallen to 40 % in 2018. In 2016, fibre and coax technologies constituted respectively 22 % and 29 % of the market. But in 2018 represented respectively 26 % and 34 %; as a result, fibre and coax technologies in 2018 on aggregate make up 60 % of the Danish broadband market – an increase from 51 % in 2016.

Figure 2-5: Wholesale broadband access lines provided by TDC



Source: WIK based on DBA.

The development of wholesale broadband access provided by TDC shows the migration of wholesale customers from ULL to VULA and bitstream services. This process is partly the result of the shift towards next generation technologies. However, interviews suggest that many access seekers also prefer access options which require lower capital intensity.

2.3.2 Wholesale offers of alternative operators

Since 2016, the majority of fibre utilities have communicated their intention to open their networks to third parties for the provision of broadband access at retail level.¹⁶ However, notwithstanding statements of intention, the vast majority of fibre networks are still de facto closed networks or in the case of wholesale only network operators, they only provide broadband access to end customers on one retail platform (e.g. Waoo!, Altibox, TDC or Stofa).

Several fibre utilities have entered agreements with OpenNet, a wholesale platform established as an independent company business unit of Eniig. According to Eniig, OpenNet will work as a common wholesale platform for access to fibre networks. The network owners will, via the common platform, offer open access to service providers.

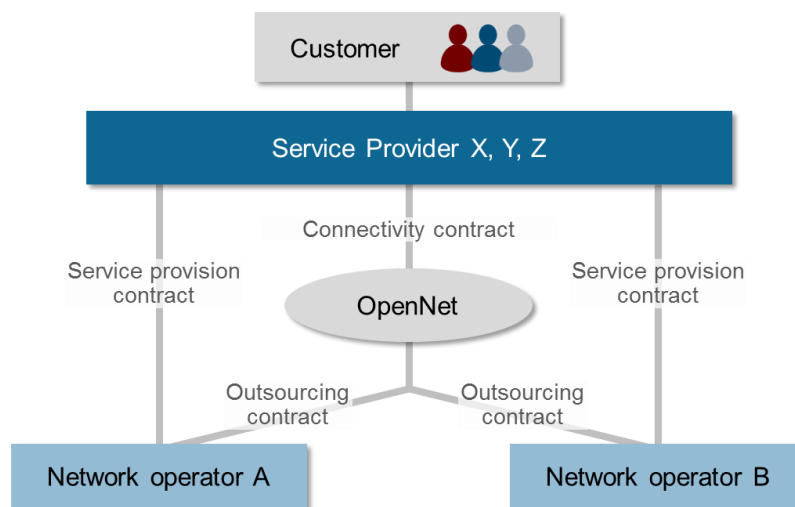
OpenNet's contract structure is illustrated in Figure 2-6 and consists of three agreements:

- 1) Outsourcing agreement: Agreement entered into between OpenNet and the individual network owner. The agreement includes terms and conditions for OpenNet's communication between the network owner and the service provider.
- 2) Service Provider Agreement: Agreement entered into between the individual network owner and the service provider (service provider). The agreement covers the terms of the individual services, including commercial aspects such as prices and SLAs.
- 3) Connection agreement: Agreement whereby OpenNet makes its wholesale platform available to the individual service provider. The agreement is concluded between OpenNet and the service provider to provide access to the network that is included in the OpenNet platform.

It is notable that the structure still requires service providers making use of the OpenNet platform to agree contract terms with individual network owners.

¹⁶ DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Figure 2-6: OpenNet contract structure



Source: DBA (2018).¹⁷

The first agreement entered into by OpenNet (at this time called “Wholesale”) was with TDC in November 2017. The agreement enabled TDC to offer YouSee products on Eniig’s fibre network. Eniig and TDC expected that the first YouSee customers would access Eniig’s fibre network during 2018. However, this has been postponed inter alia due to the need for a number of contractual and system adjustments. The partnership between OpenNet and TDC is also expected to enable TDC to offer services on other companies’ networks associated with OpenNet in the longer term, but this would require TDC to reach agreements with the network owners individually.

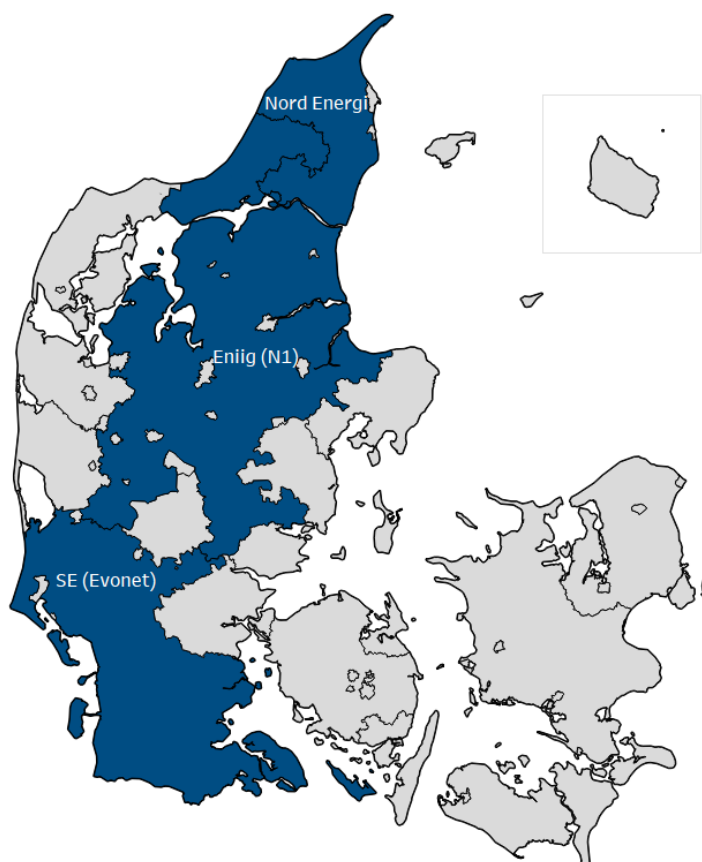
In the Autumn of 2018, Altibox entered into an agreement with OpenNet. Through this collaboration, similar to the TDC agreement, Altibox has the opportunity to provide services to customers over Eniig’s fibre network. Here too, the plan states that Altibox will conclude further agreements with other network owners who join OpenNet.

Nord Energy and SE/Stofa both entered into agreements with OpenNet in May 2018. However, these agreements are not yet implemented.

Based on the above-described agreements with network owners in OpenNet, the figure below illustrates where in Denmark, geographically, agreements have been entered into access to the fibre network via OpenNet’s platform (marked with blue).

¹⁷ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Figure 2-7: Energy companies that have entered into an agreement with OpenNet



Note: The fibre networks are represented on the map by the respective energy companies' electricity networks. There are smaller areas that are not covered by the fibre network.

Source: DBA (2018).¹⁸

Verdo and SEF are not mentioned in connection with OpenNet, but according to the DBA report should be included in this constellation, if they continue to use Stofa as a service provider after the reported merger between SE/Stofa and Eniig.¹⁹

In October 2014, TREFOR (now EWII) left the Wao! cooperation to enter a strategic cooperation with TDC (YouSee) as a service provider. Since the second half of 2015 TDC has access to about 95.000 households via EWII's fibre network. EWII operates the fibre network that covers Kolding, Vejle, Fredericia and Middelfart (the so called Triangle area).

18 Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

19 DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

The agreement between EWII and TDC runs until 2020. TDC has, since 2016, experienced a small increase in the company's market share for fibre-only connections in the Triangle area. EWII also has an agreement with Telia.

SE/Stofa already provides wholesale services for the provision of business communication services as well as white label product for resale to the Service Provider Kviknet. SE/Stofa announced in November 2016 that the company would open its fibre network for service providers in 2018. This schedule, however, has been subsequently postponed.

As previously mentioned, SE and Eniig announced in 2018 that they would merge under the name of Norlys and that they would combine the companies' activities in the broadband area. Norlys will have one overall broadband network (fibre and coax) covering more than one million households, primarily in Jutland. This corresponds to 42 % of all Danish households.²⁰ In connection with the merger notification, the companies officially announced that the opening of the fibre networks will take place within the next year. In the first half of 2019, Telia, Telenor and Altibox have announced that they reached agreements with Eniig (OpenNet).

As shown in the table below (confidential), agreements between OpenNet and network owners until 2018 have not yet resulted in effective wholesale access to utility fibre networks by third parties. In interviews conducted in the context of this study, access seekers stated that they considered that fibre utilities were reluctant to grant access to their networks. On the other hand, the network operators claim that the delivery of third party access has been delayed by the fact that many fibre utilities still are heavily investing in their networks, awaiting merger decisions and/or that the implementation of open access to their fibre networks is linked with challenges still to be solved related to the integration of network- and IT-systems. They state that eventually fibre utilities will have an incentive to provide open access to their networks to increase the penetration of their networks.

Table 2-4: Provision of wholesale broadband connections of fibre utilities

[confidential]

TDC as well as Telenor and Telia have a strong interest in obtaining wholesale access to the fibre and cable networks of the fibre utilities. TDC does not intend to roll-out fibre in areas which already are served with fibre by an alternative operator. Telenor and Telia depend on wholesale access to provide broadband services. The more subscribers migrate to bandwidths above 100 Mbit/s, the more important wholesale access to

²⁰ <https://www.se.dk/om-se/presse/presserum-se/repraesentantskaberne-i-se-og-eniig-sagde-ja-til-fusion?vocid=539165127582301&pressPageld=4a0a61aa-512d-4ab3-a577-a5b8adf41057>.

alternative cable and fibre networks will become. Business service providers such as GlobalConnect are also interested in wholesale access to fibre networks to provide services to those customers which they cannot reach via their own infrastructure.

TDC has expressed an interest in accessing unbundled (dark) fibre. Fibre unbundling may also be relevant for business access and for mobile backhaul. Alternative operators Telia and Telenor are migrating wholesale services to FTTC VULA and cable bitstream to optimise their cost and clearly state that they are interested in bitstream access to fibre networks, but preferably at regional level. Access at this level may be particularly relevant in view of the fact that fibre utilities have strong coverage in rural and suburban areas, for which the number of households aggregated at local level is lower than in urban areas.

The large number of fibre utilities as well as housing and antenna associations suggests that transaction costs of using wholesale access to fibre networks to reach nationwide coverage with ultrafast broadband are very high. The use of the OpenNet platform could reduce these costs to some extent, but this is counteracted by the need to reach agreements (including commercial terms) with each network operator individually. Alternative operators have explained that it would be helpful to have working groups for all operators to agree technical, operational and commercial conditions of wholesale access to fibre and cable networks.²¹

There is no apparent demand for access to in-building wiring from fibre utilities, and the lack of demand for in-building wiring also suggests that in areas where fibre utilities are present, operators would not have an interest in deploying infrastructure deep in the access network to use wholesale access at the first concentration point, as they would prefer to utilise fibre unbundling or bitstream. However, interviews suggest that there could be some interest in obtaining in-building access or access at the first concentration point from the antenna associations.

2.4 Financial performance

Comparison of financial performance of network operators in Denmark shows that there is a significant difference between the financial performance of the incumbent compared with that of alternative investors.

The following chart (confidential) shows trends in fixed broadband revenues, for a sample of the companies investing in very high capacity connectivity. The revenues reflect the fragmented nature of the market, and small scale of the fibre utilities in comparison with TDC. Some fibre utilities are also still in the process of deploying their networks and building a customer base.

²¹ Information from stakeholder interviews.

Figure 2-8: Fixed broadband revenues

[confidential]

Source: WIK based on DEA.

The following table (confidential) shows the capex deployed by TDC and sample fibre utilities as a proportion of revenues. Fibre utilities have made significant investments in their fibre networks in recent years. According to the association representing fibre utilities in Denmark, most fibre utilities have not yet reached their network coverage target and are therefore likely to continue their investment in fibre networks. However, investment by TDC in fibre networks could also increase after the takeover by Macquarie, which has stated its intention to “invest material amounts of capital into network infrastructure” resulting in a significant upgrade of both mobile and broadband network coverage.²²

Table 2-5: Capex/Revenues in Denmark

[confidential]

Source: WIK based on DEA.

[confidential]

Figure 2-9: Fixed broadband ARPU in DKK

[confidential]

Source: WIK based on DEA.

[confidential]

²² <https://www.macquarie.com/kr/about/newsroom/2018/approach-to-tdc-as-to-discuss-a-possible-voluntary-takeover-offer/>.

Table 2-6: EBIT in thousand DKK

[confidential]

Source: WIK based on DEA.

2.5 Market structure and competition

2.5.1 Infrastructure competition

2.5.1.1 Coverage with parallel infrastructure

Since 2015, the proportion of households with coverage of parallel infrastructure has increased and reached 51,3 % of households in 2017. Table 2-6 shows the number of postal code areas with parallel infrastructure. The number of postal codes with at least 75 % parallel infrastructure increased by 42 postal code areas from 180 to 222 (of overall 592 postal code areas). The number of postal code areas with 90 % coverage with parallel infrastructures has also risen since 2015. In 108 post code areas the coverage with parallel infrastructure remains very low (less than 10 %), decreasing however from 134 postal code areas in 2015.

Table 2-7: Share of households with parallel infrastructure, 2015-2017

Year	Total households	Households with parallel infrastructure	Share of households
2015	2.662.652	1.252.052	47,0 %
2016	2.671.755	1.350.231	50,5 %
2017	2.682.077	1.374.589	51,3 %

Note: total number of households includes households which are not covered by any infrastructure.

Source: DBA (2018).²³

²³ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Table 2-8: Postal code areas with parallel infrastructure, 2015-2017

Year	Postal code areas with at least 10 % parallel infrastructure	Postal code areas with at least 75 % parallel infrastructure	Postal code areas with at least 90 % parallel infrastructure
2015	134	180	76
2016	109	216	85
2017	108	222	92

Note: total number of households includes households which are not covered by any infrastructure.

Source: DBA (2018).²⁴

There is less infrastructure competition for Gigabit broadband than for NGA broadband. 16 % of households were served by two gigabit networks in 2018 compared with 43 % of households served with two NGA networks. The share of households with a choice between three gigabit networks is negligible.

Table 2-9: NGA and Gigabit capable infrastructure with 1, 2 or 3 network operators (% of households)

	2015	2016	2017	2018
NGA infrastructure				
% HH served by at least 1 NGA-capable network (FTTC/VDSL and above)	91 %	87 %	90 %	92 %
% HH served by at least 2 NGA-capable networks (FTTC/VDSL and above)	38 %	37 %	39 %	43 %
% households served by at least 3 network operators	5 %	5 %	7 %	6 %
Gigabit infrastructure				
% HH served by at least 1 Gigabit capable network (FTTH and cable)	33 %	35 %	46 %	66 %
% HH served by at least 2 Gigabit capable network (FTTH and cable)	0 %	1 %	9 %	16 %
% households served by at least 3 network operators		1 %	0 %	0 %

Note: NGA is here defined as infrastructure with a reported technologically possible max download capacity ≥ 30 Mbit/s. Gigabit-capable is here defined as coverage listed as being technically able to deliver at least 1 Gbit download. Currently, some fibre networks are only listed as being able to deliver speeds of less than 1 Gbit/s download and are therefore not included as Gigabit infrastructure in this table.

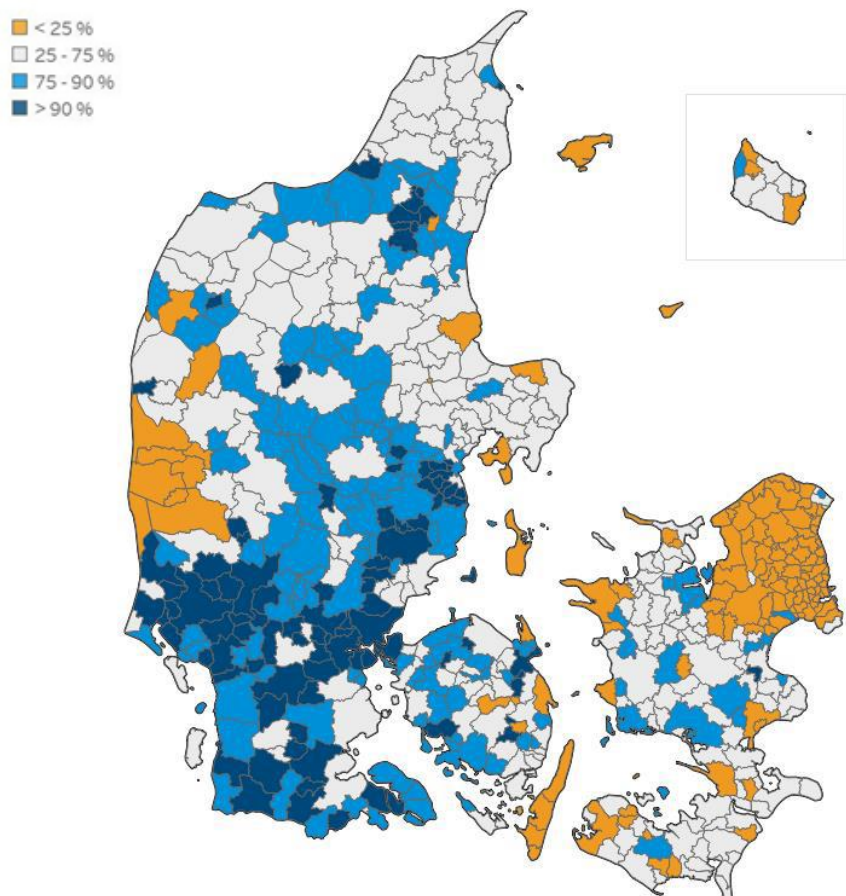
Source: WIK based on DEA.

The coverage of fibre utilities is higher in rural and suburban areas of Denmark while TDC has a strong presence in coax and fibre in urban areas.²⁵

²⁴ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.
²⁵ WIK based on DEA.

The map below shows the coverage with parallel infrastructures in the postal code areas. High coverage with parallel infrastructure mainly occurs in South Jutland, East- and North Jutland. The coverage with parallel infrastructure in West Jutland, on several of the Islands and in the metropolitan area is very low.

Figure 2-10: Coverage with parallel infrastructure in Denmark



Source: DBA (2018).²⁶

2.5.1.2 Market shares of wholesale broadband access

The DBA has published wholesale broadband market shares in its report on regional broadband markets. These market shares include self-supply and supply to exclusive retail partners. Thus to some extent, they reflect the retail market share of fibre utilities (as the provision of wholesale access to unrelated third parties by fibre utilities is limited). Almost 2/3 of wholesale broadband connections on all platforms are based on

²⁶ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

TDC's infrastructure. However, TDC's wholesale broadband market share between 2016 and 2018 declined from 70,9 % to 65,8 % due to the decline of demand for wholesale broadband on the copper network. The wholesale sales based on coax and fibre increased from 21,2% in 2016 to 25,7% in 2018.

Table 2-10: Market shares on the wholesale market (all platforms) (in %)

	2015	2016	2017	2018
TDC	72,6	70,9	68,5	65,8
Company 1	12,9	13,6	14,3	14,3
Company 2	3,8	4,4	4,6	5,9

Source: DBA (2018).²⁷

Both the second and third largest network operators have increased their wholesale market shares, but these remain significantly lower than the share of TDC. This is not surprising considering that TDC is the only network operator with nationwide coverage.

On the copper network, TDC is the only provider of wholesale services and thus has a market share of 100 % when coax and fibre are not included. On coax networks there are two network operators, TDC and SE/Stofa, which account for the greatest part of sales.

Table 2-11: Wholesale market shares (coax) (in %)

	2015	2016	2017	2018
TDC	68,0	68,8	71,0	72,1
Company 1	32,0	29,5	27,1	25,3
Company 2	0,6	0,6	1,9	1,8

Source: DBA (2018).²⁸

Since 2015, TDC has increased its sales on the coax network from 68 % to 72,1 % in 2018. The second largest network operator has experienced a continuous decline of its market share since 2015 from 32 % in 2015 to 25,3 % in 2018. TDC's growth can be partly attributed to the company's growth of subscribers on the coax platform at retail level, but also to an increased demand for coax Bitstream Access at wholesale level.

Fibre networks are characterized by a number of regional and mostly non-overlapping networks. In contrast with copper and coax, TDC does not have the highest market share in the provision of wholesale fibre access. The two largest fibre operators hold a

²⁷ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

²⁸ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

market share of approximately 22 % each while TDC in 2018 was the 5th largest operator with a market share of 5,3 %.

Table 2-12: Wholesale market shares (fibre)

	2015	2016	2017	2018
Company 1	20,3	20,6	19,6	22,7
Company 2	19,4	22,6	24,2	22,4
TDC (company 5)	4,1	4,5	4,7	5,3

Source: DBA (2018).²⁹

The provision of wholesale access services by alternative operators remains limited. The table below (confidential) shows the development of wholesale access provision in terms of number of connections. Fibre utilities from 2014 to 2018 predominantly provided unbundled access and only to a small extent BSA. According to information from interviews with stakeholders there is less demand for unbundled access and service providers on retail markets have a strong interest in purchasing BSA. While the provision of commercial BSA provision is being negotiated fibre utilities already provide unbundled fibre to other network operators for the provision of business services.

Table 2-13: Provision of wholesale broadband connections of fibre utilities

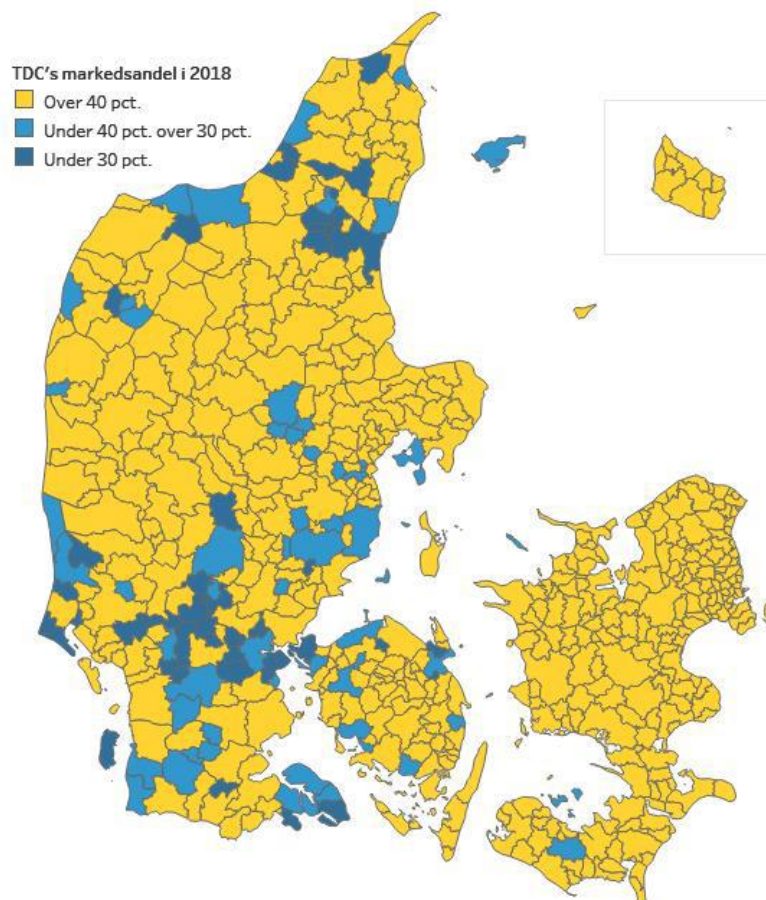
[confidential]

Source: WIK based on DBA.

The geographical analysis of wholesale market shares (incl. self-supply) shows that in 2016, there were 74 postal code areas where TDC had a market share below 40 % (287.371 households). The number of postal code areas where TDC had less than 40 % market share rose to 107 in 2018 which corresponds to 393.558 households (approximately 15 % of total households in Denmark). From 2016 to 2018, a large proportion of the postal code areas, where TDC's market share was below 40 % in 2016, has fallen to under 30 % in 2018. The figure below shows the areas in which the TDC's market share was below 40 % in 2018.

²⁹ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Figure 2-11: TDC's wholesale market shares on postal code level in 2018



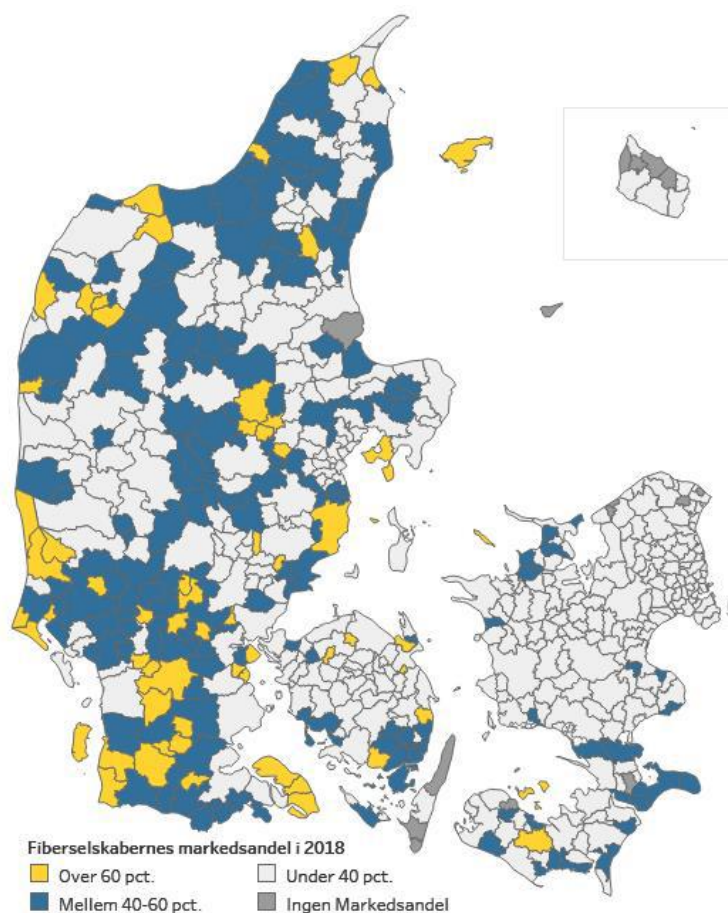
Source: DBA (2018).³⁰

There are still no areas in Zealand, where TDC's wholesale market share is below 40 %. This is particularly the case in the area around Copenhagen and North Zealand, where TDC owns the copper as well as the fibre and coax network, and fibre utilities have not deployed their networks. Here, TDC's market share is approximately 90 % of the wholesale broadband access market.

Fibre utilities have a strong presence with their fibre networks in Jutland. The majority of postal code areas, where fibre network operators' market share is high, is therefore located in Jutland. 52 of the 61 postal code areas where fibre utilities' wholesale market share is over 60 %, and 125 of the 165 postal code areas where fibre utilities' wholesale market share is between 40-60 % are in Jutland. This is illustrated in the figure below.

³⁰ Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Figure 2-12: Wholesale market shares of fibre utilities in 2018



Source: DBA (2018).³¹

2.5.2 Retail competition

In the middle of 2018 there were approximately 144 companies and associations which offered retail broadband services on the Danish market. Only a few companies offer broadband throughout the country, while the majority of the actors operating regional or local networks deliver broadband services in geographically limited areas.

31 Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://d8test.w2ltest.dk/sites/default/files/2019-03/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

Table 2-14: Providers of broadband communications services to end users

Operator	Type	Platform	Services provided to residential customers	Customer focus (residential/SME/large business)
TDC	Nationwide	Copper, FTTC, coax, FTTH	Broadband, Voice, TV, OTT, business services	Residential/business
Telenor	Nationwide based on ULL, VULA and BSA	Copper, FTTC, coax, FTTH	Broadband, Voice, TV, OTT, business services	Residential/business
Telia	Nationwide based on ULL, VULA and BSA	Copper, FTTC, coax, FTTH	Broadband, Voice, TV, OTT, business services	Residential/business
SE Stofa	Regional	FTTH and coax	Broadband, Voice, TV, OTT, business services	Residential/business
Wao!	Regional	FTTH	Broadband, Voice, TV, OTT	Residential/business
Altibox	Regional	FTTH	Broadband, Voice, TV, OTT	Residential/business
Other fibre utilities	Regional	FTTH, predominantly PtP, some also deploying PON	Internet, Voice and some also providing TV	Residential/Business
Aerial associations	Regional	FWA	Broadband and TV	various types of customers
Other associations (e.g. housing and antenna)	Regional	FTTH, coax, LAN	Broadband and TV	Collectively organised customers (e.g. housing associations)
Global Connect	Nationwide	FTTH	Broadband, Voice, Business services	Focus on business, some residential

Source: Websites of the network operators and interviews with stakeholders.

The four largest providers of broadband, TDC, SE/Stofa Telenor and Fibia including its subsidiaries, accounted for around 70 % of the broadband connections on the Danish retail market. TDC is the largest provider in the retail broadband market. Although TDC's market share (including subsidiaries) has been declining since 2012 it still remains on a high level of 51 % of fixed broadband subscriptions in the first half of 2018.³²

The second largest supplier of broadband is SE/Stofa and the company has since 2013 had a stable market share of 12-13 %. SE/Stofa primarily supplies broadband via its own infrastructure, which consists of both fibre and cable-TV networks.

Telenor had in the first half of 2018 a market share of 5 % followed by Fibia with less than 5%. Telenor use TDC's wholesale services (ULL, FTTC VULA and cable

32 See Danish Energy Agency (2019), market data provided to WIK, DBA (2018), Den geografiske udvikling på bredbåndsmarkedet, downloadable at: https://erhvervsstyrelsen.dk/sites/default/files/media/erst_rapport_om_den_geografiske_udvikling_paa_bredbaandsmarkederne_2018.pdf.

bitstream) for the provision of broadband connections to residential and non-residential customers while Fibia is a regional utility company with own fibre network.

The other market players (excl. Telia and its subsidiaries), which predominantly rely on regional and local fibre networks, had a combined market share of 30 % in the first half of 2018.

The Danish retail broadband market on the demand-side is also characterised by collectively organized customers, as e.g. housing associations, colleges and networks. The collectively organised customers typically buy broadband services and TV and some of them provide broadband services over their own infrastructure and only buy TV from an external company (e.g. YouSee, SE/Stofa or Viasat). For network operators it can be attractive to conclude agreements on the supply of broadband services and/or TV to those collectively organised customers. This is partly due to the opportunity to get a high number of customers through one contract and as a result a high penetration on the network. Also, the long duration of such contracts allows for long periods of tying (often over several years), and any decisions to change supplier must as a starting point be adopted in a general assembly. It is estimated that approximately 650.000 households in Denmark (24 % of households) are members of a housing association, while approximately 684.000 households (25 % of households) are members of an antenna association.³³ It should be noted that there can be an overlap between the two numbers but nevertheless it is a significant number of customers who buys broadband through a collective agreement and it will be of relevance for the future development of market shares and prices who provides broadband services to collectively organised customers.

Fibre utilities, antenna associations as well as other service providers have been able to increase their market shares in the last years but although in sum the market share amounts to 30 %, the majority of the network operators behind this sum only have a small subscriber base.

33 DBA (2017), Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf.

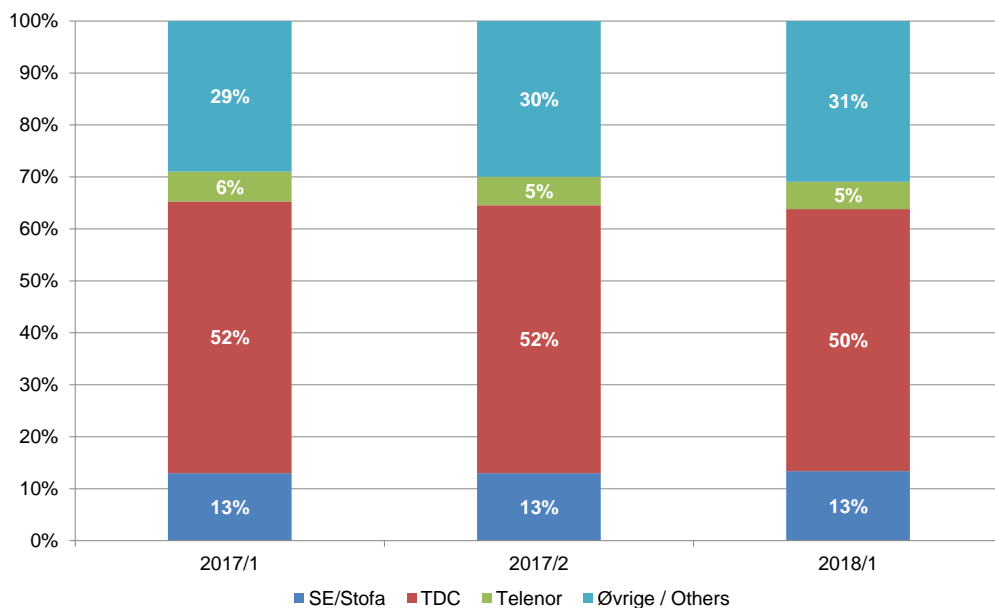
Table 2-15: Subscriber numbers and market shares, fixed broadband market 2011-2018

[confidential]

Notes: TDC after 2012/2013 includes Telmore, Fullrate, YouSee and Dansk Kabel TV, As of the first half of 2012, data from Stofa1 (Canal Digital) is included in Stofa's data. As of the second half of 2014, data from Syd Energi is included in Stofa's data. As of the second half of 2015, data from Stofa Erhverv is included in Stofa's data. From second half of 2016 Stofa is included in SE kommunikation's data. Boxer is from first half of 2017 owned by SE Kommunikation (Stofa).

Source: WIK based on DEA.

Figure 2-13: Retail broadband market shares in Denmark (in % of broadband subscribers)



Source: WIK based on DEA.

Fibre utilities have a strong presence in suburban and rural regions. As they have no fibre coverage in North Zealand and in the metropolitan area, the main competitors of TDC in these areas are Telia and Telenor. TDC has lost market share, particularly in

Jutland. SE/Stofa is the strongest competitor to TDC and is likely to become stronger through the merger with Eniig.

2.6 Retail outcomes

2.6.1 Prices

Prices for higher bandwidths have declined over time. For example, the subscriptions for download speeds above 50 Mbit/s from TDC cost *[confidential]* DKK per month in 2014 and in January 2019 the price had fallen to *[confidential]* DKK per month. Subscribers to Waoo! paid *[confidential]* DKK per month in 2019. The lowest price for a download speed of 50 Mbit/s was *[confidential]* DKK per month from SE/Stofa.

Figure 2-14: Prices for subscriptions to download speeds above 50 Mbit/s (January, in DKK per month)

[confidential]

Source: WIK based on DEA.

The prices for subscriptions to download speeds above 90 Mbit/s have also decreased for all operators. TDC and Waoo! are more expensive than the two competitors SE/Stofa and EWII. They request *[confidential]* DKK per month while SE/Stofa and EWII both have a price of *[confidential]* DKK per month for a subscriptions to a download speed above 90 Mbit/s.

Figure 2-15: Prices for subscriptions to download speeds above 90 Mbit/s (January, in DKK per month)

[confidential]

Source. WIK based on DEA.

The lowest price for download speeds above 250 Mbit/s (*[confidential]* DKK per month) is offered by Waoo! The most expensive service provider is SE/Stofa with *[confidential]* DKK per month. All providers have reduced their prices compared to 2015 (SE/Stofa and Waoo!) or 2017 (TDC).

Figure 2-16: Prices for subscriptions to download speeds above 250 Mbit/s (January, in DKK per month)

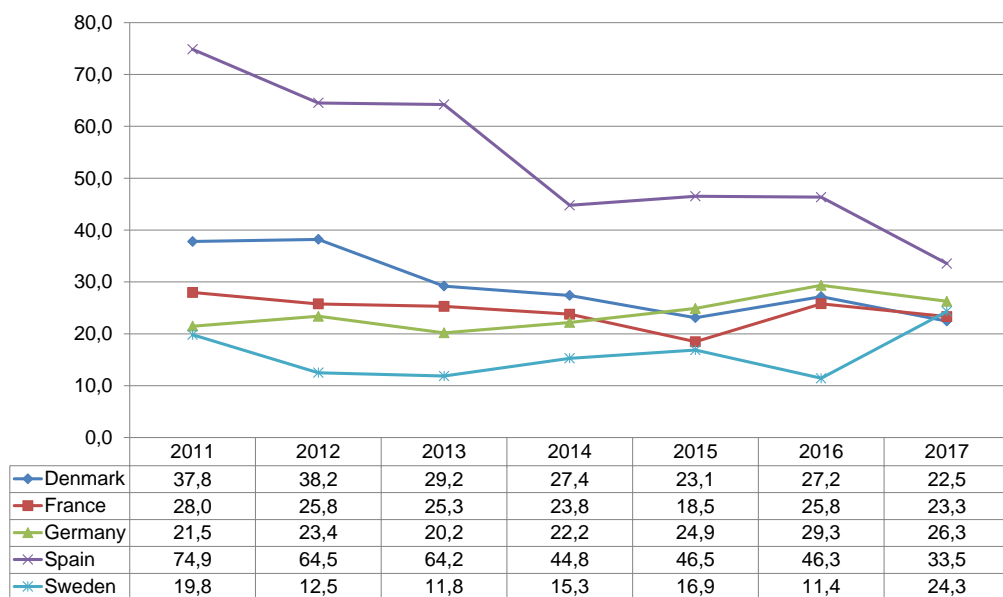
[confidential]

Source: WIK based on DEA.

Gigabit offers are available from TDC on fibre and cable, as well as through Altibox.

An international comparison of prices shows that prices for advertised download speeds above 30 Mbit/s and up to 100 Mbit/s in Denmark were lower than in most of the other countries in 2017. In the years before the price level was similar but sometimes lower and sometimes higher than in other countries.

Figure 2-17: International price benchmark, monthly price of standalone internet access, advertised download speed above 30 Mbit/s and up to 100 Mbit/s (minimum_euro_PPP)

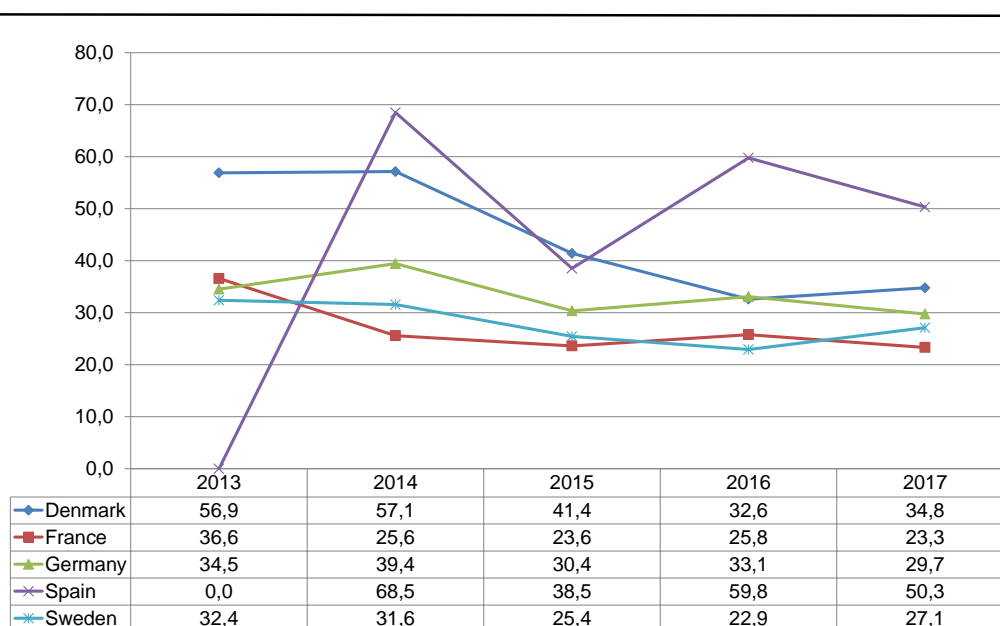


Source: European Commission, Digital Agenda Scoreboard.

The price comparison for advertised download speeds above 100 Mbit/s shows that prices in Denmark are higher than in all countries studied except Spain but that the prices have decreased from 56,9 Euro in 2011 to 34,8 Euro in 2017. In the interviews, some stakeholders suggested that 100 Mbit/s prices in Denmark are likely to be higher as a result of the approach taken towards wholesale price regulation. Although prices at

wholesale level are required to be cost oriented, the difference between high and low bandwidth prices is not cost oriented but rather reflects price differences between different bandwidths which were present in the retail market some years ago. The cost oriented price is calculated for the mean bandwidth delivered which is 50 Mbit/s. Some stakeholders also suggest that the margin squeeze test, which includes a 50 % mark-up on retail cost, may also result in higher prices.³⁴

Figure 2-18: International price benchmark, monthly price of standalone internet access, advertised download speed above 100 Mbit/s (minimum_euro_PPP)



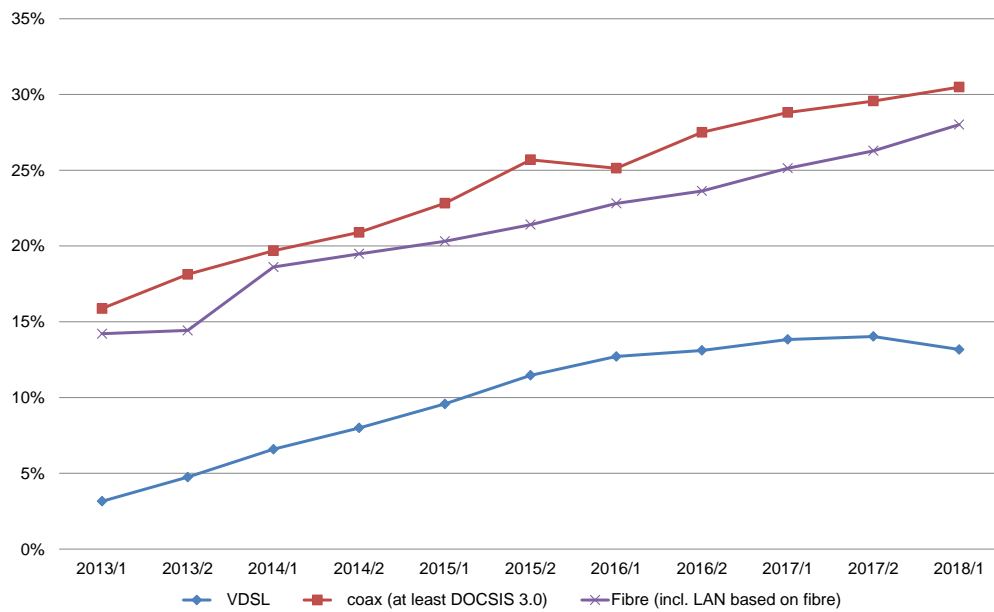
Source: European Commission, Digital Agenda Scoreboard.

2.6.2 Quality

The development of NGA subscriptions by technology in Denmark shows a considerable increase of coax and fibre subscriptions as opposed to the decrease of VDSL connections since 2017.

³⁴ Information from interviews with stakeholders.

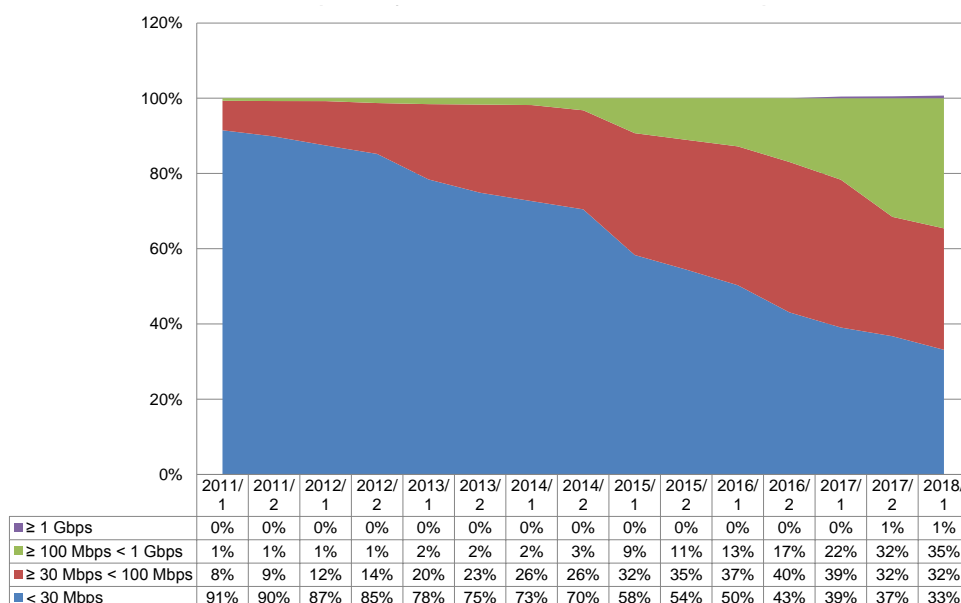
Figure 2-19: NGA subscriptions by technology (in % of households)



Source: WIK based on DEA.

The development of NGA subscriptions is reflected in the demand for bandwidth. While the share of broadband subscriptions below 30 Mbit/s has decreased from 91 % to 33 % (from 2011-2018), the broadband subscriptions with bandwidths above 30 Mbit/s have increased from 9 % to 68 % in the same period.

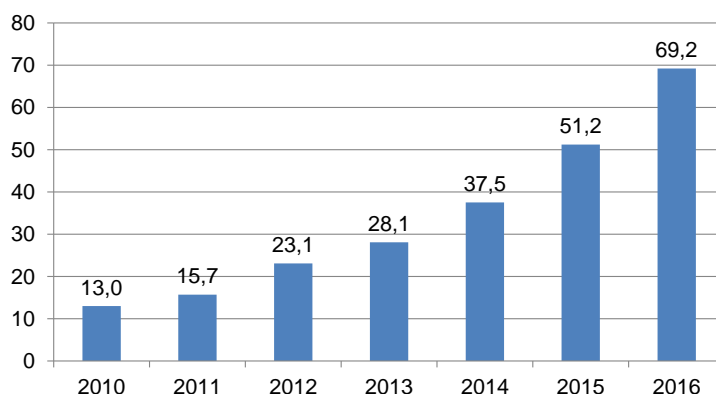
Figure 2-20: Broadband subscriptions by bandwidth (in % of broadband subscriptions)



Source: WIK based on DEA.

The development of traffic volumes in Denmark shows a significant increase of the traffic volume per month and per connection. From 2010 to 2016 the traffic volume quadrupled.

Figure 2-21: Traffic volume on fixed broadband networks in GB/connection/month

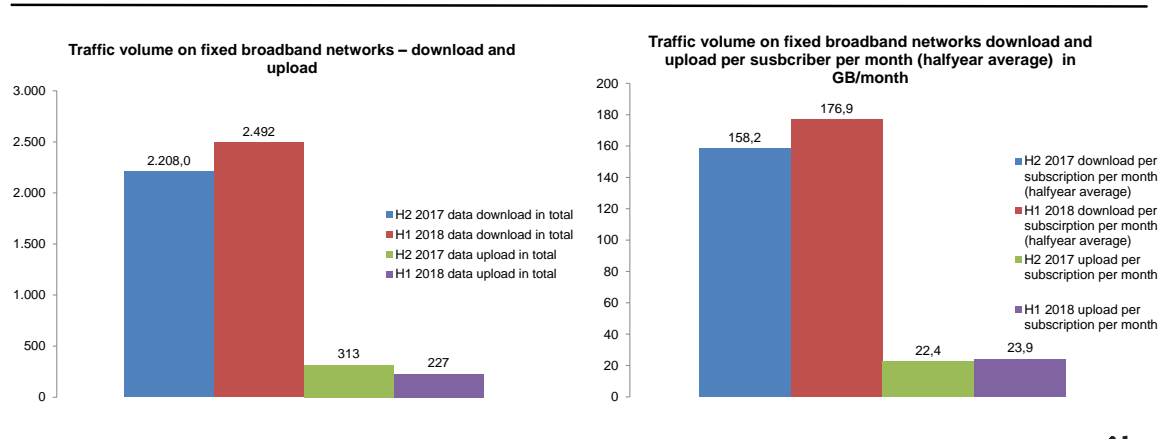


Source: DBA (2017).³⁵

35 Engrosmarkedet for local netadgang på et fast sted (marked 3a) Markedsafgrænsning, markedsanalyse og markedsafgørelse, downloadable at: https://erhvervsstyrelsen.dk/sites/default/files/media/afgoerelse_paa_marked_3a.pdf and DBA (2017).

According to the Telestatistik for first half of 2018 the traffic volume per subscriber and month in 2018 reached 176,9 GB growing by 12 % from 158,2 GB in the second half of 2017.

Figure 2-22: Data download on fixed broadband networks in Terabyte



Source: Danish Energy Agency (2018).³⁶

The development of advertised download speeds in Denmark clearly reflects the trend in increasing demand for and usage of high-speed connections. In 2015 the median download speed increased from 19 to 28 Mbit/s over a three-year period. From 2015 until 2017 the median speed doubled to 60 Mbit/s. The figure below shows the development of median download speeds and the difference both the level and development of the median speeds between the different technologies.³⁷

The median speeds have increased from 70 to 114 Mbit/s on the coax network and from 64 to 93 Mbit/s on fibre network. On the copper network the median speed remained unchanged and only increased from 21 to 22 Mbit/s.³⁸

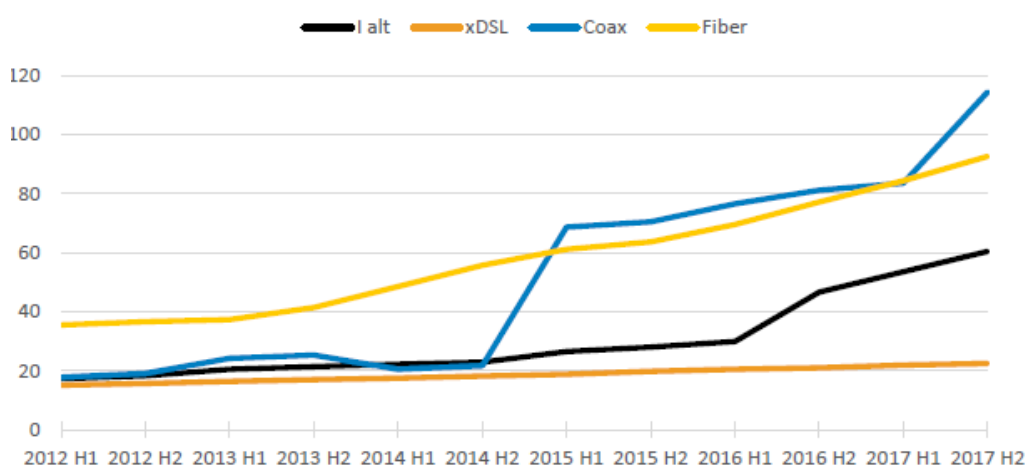
The development of the overall median speed is influenced both by the speeds provided with the individual technologies but also by a shift in sales between technologies.

On the demand side, the median speed increases either when retail customers switch from the copper network to the fibre or coax network, which presumably results in a higher download speed for that customer, or when retail customers choose to upgrade their subscription to a higher rate of the same technology.

36 Telestatistik Første halvår 2018, downloadable at: https://ens.dk/sites/ens.dk/files/Tele/telestatistik_-_foerste_halvaar_2018.pdf.
 37 Danish Energy Agency (2018): Telestatistik Første halvår 2018, downloadable at: https://ens.dk/sites/ens.dk/files/Tele/telestatistik_-_foerste_halvaar_2018.pdf.
 38 Danish Energy Agency (2018): Telestatistik Første halvår 2018, downloadable at: https://ens.dk/sites/ens.dk/files/Tele/telestatistik_-_foerste_halvaar_2018.pdf.

On the supply side, the median speed is influenced by the providers choosing to increase their speeds for existing subscriptions e.g. by changes in the capacity of their network. This is primarily seen on the coax network, where in the first half of 2015 and the second half of 2017 significant increases in the median speed occur. In addition, the providers can also choose to migrate customers' subscriptions from the copper network to the fibre or coax network where these technologies are available. Such a migration typically increases the download speed.

Figure 2-23: Median speeds, download (Mbit/s) 2012-2017



Source: Danish Energy Agency (2018).³⁹

The download speeds of the broadband connections sold in Denmark have increased significantly from 2015 to 2017. Accordingly, the median speed increased from 28 Mbit/s to 60 Mbit/s in the same period.

The median speed of coax connections was 114 Mbit/s, of fibre connections 93 Mbit/s and 22 Mbit/s for copper.⁴⁰

Subscriptions delivered on the copper network typically have a download capacity of 30 Mbit/s or less while subscriptions delivered on the fibre or coax networks have a download capacity of 30 Mbit/s or more.⁴¹

Coax networks account for most of the high-speed connections with download capacity over 100 Mbit/s.

³⁹ Telestatistik Første halvår 2018, downloadable at:

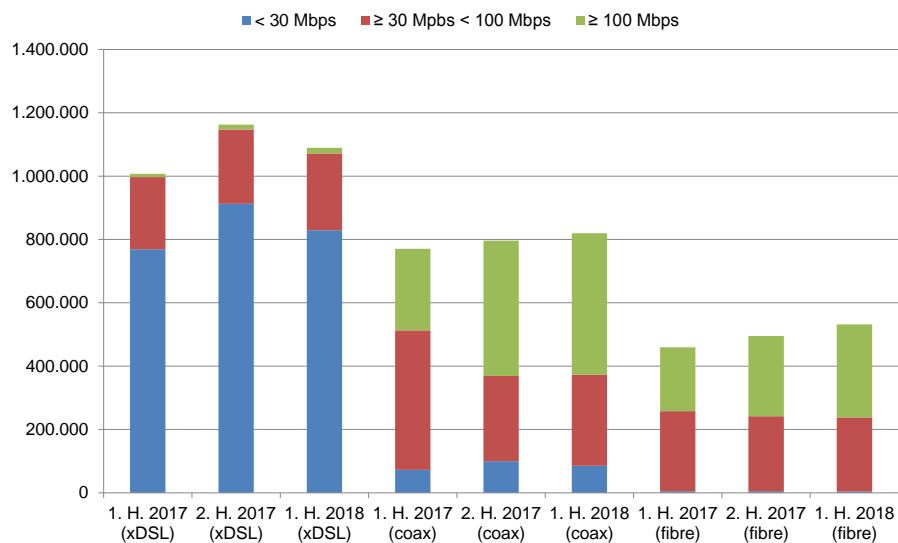
https://ens.dk/sites/ens.dk/files/Tele/telestatistik_-_foerste_halvaar_2018.pdf.

⁴⁰ Danish Energy Agency (2018): Telestatistik Første halvår 2018, downloadable at:

https://ens.dk/sites/ens.dk/files/Tele/telestatistik_-_foerste_halvaar_2018.pdf.

⁴¹ WIK based on DEA.

Figure 2-24: Development of subscriptions to download speeds by technology



Source: WIK based on DEA.

Actual bandwidth speeds from testmy.net⁴² indicate an average download speed in Denmark of 65 Mbit/s. The figure below shows the results for ISPs. The actual bandwidths of fibre utilities on average are higher than the average on copper and cable networks. According to testmy.net the average actual download speed in Copenhagen is 100 Mbit/s which is significantly higher than in other cities and also than the actual download speeds of ISPs. This reflects the coverage in that area with cable and fibre and also is likely to result from the higher demand for high bandwidths in Copenhagen compared to other regions.

Figure 2-25: Actual bandwidth by ISP (31 March 2019)

1	Aura Fiber OE A/S	58.6 Mbps (7.3 MB/s) [66 Mbps / 45 Mbps] 129 clients took 269 speed tests recently
2	Hiper A/S	53.8 Mbps (6.7 MB/s) [60 Mbps / 36 Mbps] 624 clients took 483 speed tests recently
3	FIBIA P/S	47.7 Mbps (6 MB/s) [45 Mbps / 51 Mbps] 649 clients took 1345 speed tests recently
4	Stofa	36.1 Mbps (4.5 MB/s) [39 Mbps / 30 Mbps] 394 clients took 243 speed tests recently
5	TDC Danmark	27.1 Mbps (3.4 MB/s) [36 Mbps / 10 Mbps] 2802 clients took 1855 speed tests recently
6	Telia Company	17.4 Mbps (2.2 MB/s) [22 Mbps / 10 Mbps] 432 clients took 424 speed tests recently
7	Telenor A/S	15.5 Mbps (1.9 MB/s) [18 Mbps / 6 Mbps] 809 clients took 332 speed tests recently

Source: testmy.net (2019).⁴³

42 See <https://testmy.net/country/dk>. The information was downloaded on 31 March 2019.

43 <https://testmy.net/country/dk> (31 March 2019).

2.7 Future trends

2.7.1 Broadband coverage trends and projection of future development

Data from the DEA suggests that as of 2018, 66 % of households were already served with at least one Gigabit (cable or fibre) network.⁴⁴

Available evidence and interviews conducted for this study suggest that further FTTH network expansion is planned, which may serve, at least to some degree, to close the gap for the remaining households.

For example, information gathered from interviews with stakeholders indicates that coverage of fibre utilities will increase in the next years. Fibre utilities are organised as cooperatives and their market potential (in terms of homes passed) is defined by the households covered by their energy network. The roll-out targets of some operators depend on the demand of the households for fibre but in principle most of the network operators target a coverage which enables at least 80 % but often 100 % (full coverage) of their cooperative members to subscribe to fibre connections. While alternative investors initially focused their fibre roll-out on regions without cable coverage, the share of households served by fibre and cable may in the future increase due to the duplication of infrastructure resulting from fibre roll-out in parallel with cable networks.

In addition, statements from Macquarie, the shareholder of TDC, suggest that it intends to invest in network deployment and to collaborate rather than compete with the utility-owned fibre networks with the aim of providing Gigabit broadband to all Danish households by the mid-2020s.⁴⁵

Assuming that TDC does not replace its existing cable network with fibre, at least in the medium term, a full Gigabit coverage could imply that FTTH deployment might expand to around 70 % of households, compared with the 64 % achieved in 2018.

Antenna and housing associations also play an important role in providing coverage for VHC networks, but this is typically limited to infrastructure inside or close to the household.

2.7.2 Market structure at wholesale and retail level

At present, the wholesale market for fibre-based broadband is fragmented, and features a large number of non-overlapping local projects. However, recent developments suggest that the market may consolidate. For example, after the merger of SE/Stofa

44 Gigabit-capable here being defined as coverage listed as being technically able to deliver at least 1 Gbit/s download.

45 See <https://www.macquarie.com/kr/about/newsroom/2018/approach-to-tdc-as-to-discuss-a-possible-voluntary-takeover-offer/>.

and Eniig, Norlys has a fibre coverage of ca. 42% of households⁴⁶, more than 60% of the total fibre footprint in Denmark. Such consolidation may provide economies of scale and simplify the process of providing and using wholesale access on the fibre network. As fibre networks do not overlap, such consolidation is unlikely to affect the number of competitors at the wholesale level.

It could also increase the bargaining power of the consolidated company with respect to content owners, enabling fibre utilities to more effectively compete with the retail offers of the incumbent. However, in the event that consumers move towards Gigabit offers, it could also increase the market power of the network owner with respect to service providers that would need access to compete in retail ultrafast broadband services.

The potential market power of such providers would be greatest in areas where there were no alternative open Gigabit networks available.

The fibre utilities have stated that they plan to open their fibre networks voluntarily to provide wholesale access to third parties. However, thus far, wholesaling volumes have been low, and in interviews conducted in the context of this study, access seekers stated that they considered that fibre utilities were reluctant to grant access to their networks.

In a scenario where wholesaling on the networks of fibre utilities remains low and consumers move towards Gigabit offers, TDC's overall market share is likely to decrease. Service competition would be limited to services provided via TDC's networks, assuming they remain open to competing retail service providers. In areas served by fibre utilities in the absence of an alternative open cable infrastructure, the fibre utilities and/or linked retail providers could increase their market share and market power at the retail level.

On the other hand, if fibre utilities do effectively open their networks on a non-discriminatory basis, they may increase their wholesale market share and network utilisation, but their retail market shares may decline. A key beneficiary would be TDC, which may be able to increase its retail market share in those regions, further supporting relatively high broadband market shares across the country as a whole. Compared with the fibre utilities, TDC has advantages of size in buying content, financing and marketing, which could be further extended. On the other hand, wholesaling by the fibre utilities would benefit Telia and Telenor which may depend on open fibre networks to stabilise or increase their market shares and stop the slight decrease in market shares observed in the last years. More active wholesaling by fibre utilities could also support the deployment of business services and future mobile infrastructure.

⁴⁶ <https://www.se.dk/om-se/presse/presserum-se/repræsentantskaberne-i-se-og-eniig-sagde-ja-til-fusion?vocid=539165127582301&pressPagelId=4a0a61aa-512d-4ab3-a577-a5b8adf41057>

If TDC is granted regulated wholesale access to in-building wiring, retail competition may develop as alternative operators can make use of wholesale access to TDC's network. If access to in-building wiring is granted to alternative investors including fibre utilities and alternative cable operators, service providers would need to reach commercial agreements with these companies to be able to provide services to members of antenna and housing associations. Competition at retail level would depend on the extent to which the networks have been opened.

2.7.3 Market outcome (prices and quality)

If the migration of customers to higher bandwidths which can only be satisfied by fibre or cable networks continues, the competitive constraint from copper networks will decrease in the regions covered only by fibre utilities. Until now there is limited evidence of excessive charges being levied by fibre utilities, even in areas where they hold a high market share in the regional market. This may be a result from their co-operative ownership structure and/or due to pricing constraints from copper and FTTC-based offers. However, with an increasing demand for ultrafast and Gigabit broadband services copper networks lose relevance for the provision of broadband services.

On the one hand there is a risk of fibre utilities demanding prices above the competitive level in areas not served with cable. Further, the lack of competition may result in a limited customer choice and lower quality in areas where wholesaling has not developed and is not widely used.

On the other hand, fibre utilities have the disadvantage of providing services at a significantly smaller scale than TDC which may lead to higher prices without this being an indication of no competitive pressure. As the fibre networks in many cases are owned by their customers there is likely to be a constraint on prices and an incentive to provide high quality resulting from this ownership structure.

3 Options for implementation of symmetric regulation in Denmark

In this chapter we consider which options for the implementation of symmetric regulation are possible under the EU electronic communications Code and might be potentially relevant to the Danish situation.

Key findings are that:

- The provisions of the EU Electronic Communications Code envisage that symmetric access would normally apply to passive access at connection points close to the end-user – i.e. in-building wiring or access at the first concentration point outside the building. The NRA would determine where this point lies.
- The Code does however allow for this interpretation to be expanded in specific circumstances to cover access beyond the first concentration point. Active access (bitstream) can also be mandated “if justified on physical and/or economic grounds”.
- The Code also provides for exemptions from access regulation for wholesale only providers or where wholesale access would compromise the viability of new network deployment, in particular by small projects. Exemptions may also (at national discretion) be extended to vertically integrated providers which offer access to VHC networks on fair, non-discriminatory and reasonable terms.
- Feedback from interviews with Danish stakeholders suggests that there is limited demand for access to in-building wiring or access to the fibre terminating segment, except in the context of access to the infrastructure of housing and antenna associations. Access to passive infrastructure (fibre unbundling) could be of potential interest for TDC and business providers, while active (bitstream) access, could be of interest for alternative operators. The demand for such access is a relevant consideration for policy-makers. However, it is not clear that symmetric obligations under the Code would be appropriate as tool to address these needs. They would in any event require an assessment to the effect that symmetric obligations for access at the first distribution point as well as obligations under the market analysis process were not sufficient to address high and non-transitory economic or physical barriers to replication, significantly limiting competitive outcomes to end-users.
- Interviews with fibre utilities suggest that mandating symmetric access could create concerns for the business case of operators which are still in the process of deploying fibre and have not yet reached sustainability. Moreover, the voluntary wholesaling commitment made by some fibre utilities should be considered. Thus there is a case to consider applying exemptions (i) for small scale operations; and (ii) wholesaling meeting certain standards - in the context of the Danish market.

3.1 Provisions of EU electronic communications code as regards symmetric regulation

In the 2009 revisions to the EU Framework for electronic communications, new provisions were added enabling national regulatory authorities to mandate “sharing of wiring inside buildings or up to the first concentration or distribution point, where located outside the building”... where justified on the grounds that duplication of this infrastructure would be economically inefficient or physically impracticable.⁴⁷

However, use of this provision was limited to a few countries in which there was a regulatory focus on supporting infrastructure-based competition in FTTH. The country which made most use of the provisions was France (see case study at 5.1). Symmetric regulation was also used to mandate access to in-building wiring in Spain (also extending beyond the building), Portugal and Italy.

In the EU Electronic Communications Code,⁴⁸ these provisions were clarified and their scope was extended as follows.

- NRAs may, on reasonable request, impose obligations on providers of e-comms networks or the owners of relevant infrastructure (if not e-comms providers), for access to wiring and cables and associated facilities inside buildings or up to **the first concentration or distribution point as determined by the NRA**, where that point is located outside the building. The NRA must demonstrate that replication of these network elements would be economically inefficient or physically impracticable. Conditions that can be imposed include specific access obligations, as well as rules on transparency, non-discrimination and on apportioning the cost of access, where appropriate adjusted to take into account risk.
- NRAs may, where they conclude that the above obligations (as well as obligations resulting from any relevant market analysis) do not sufficiently address high and non-transitory economic or physical barriers to replication significantly limiting competitive outcomes for end-users, **extend symmetric access obligations “on fair and reasonable terms and conditions” beyond the concentration or distribution point**, to a point that it determines to be the closest to end-users capable of hosting a sufficient number of end-user connections to be commercial viable for efficient access seekers. In doing so, they must take utmost account of BEREC Guidelines to be developed on this subject.
- If justified on technical or economic grounds, **NRAs may impose active or virtual access obligations.**

47 See Article 12 EU Framework for electronic communications.

48 See Article 61(3) EU EECC.

Exemptions to the above obligations are required or permitted in the following cases:

1. The provider is a **wholesale only operator** and makes available a viable and similar alternative means of reaching end-users by providing access to a very high capacity network to any undertaking on fair, non-discriminatory and reasonable terms and conditions (except that access may be permitted in these circumstances where the network is publicly funded). **NRAs may at their discretion extend this exemption to providers other than wholesale only operators offering access to a very high capacity network on fair, non-discriminatory and reasonable terms and conditions;** or
2. The **imposition of obligations would compromise the economic or financial viability of a new network deployment, in particular by small local projects.**

BEREC is required two years after the entry into force of the Code, to produce guidelines setting out the criteria to determine the location of the first concentration or distribution point, as well as the point capable of hosting a sufficient number of end-user connections to overcome replicability barriers. BEREC guidelines will also set out recommendations on which projects can be considered to be small, and which economic or physical barriers could be considered high and non-transitory.

3.2 Options for implementation in Danish context

The Code requires NRAs to be given the power to impose obligations to grant access on reasonable request to wiring and cables, with some flexibility over the type and connection point of any access granted and over exemptions in certain cases. As access would normally be based on a “reasonable request”, there is no need to stipulate the form of access within any implementing legislation. However, it seems reasonable to assume, based on the demands of service providers and the network architecture of existing fibre and coax networks, that requests might relate to:

- Access to in-building wiring (specifically in the context of access to the infrastructure of housing and antenna associations); or
- Passive access to the fibre at the ODF or (in the case of PON architecture) passive access at the first distribution point, potentially with a request for backhaul to a point aggregating a sufficient number of lines to enable viability for the access seeker; or
- Active (bitstream) access, potentially at a regional level

In each case the NRA would need to judge the reasonableness of the request based on the criteria laid down in the Code, noting that the burden of proof to mandate access under symmetric regulation increases for each step taken beyond in-building wiring.

It also seems reasonable to assume that fibre utilities would seek exemptions to any obligations that might apply under symmetric regulation. Key questions are:

- At which point (i.e. which relevant scale or other criteria), the obligations could be considered to compromise the economic or financial viability of a new network deployment, in particular by small local projects; and
- Whether exemptions should be granted for vertically integrated fibre utilities providing wholesale access, and if so, what should be the minimum criteria that wholesale access would need to meet in order to exempt providers from symmetric access obligations.

4 Effects of symmetric regulation on competition and investment: findings from literature

In this chapter, we consider available literature concerning the impact of symmetric access regulation and wholesaling (commercial or otherwise) on the business case for alternative investors to deploy fibre networks.

Key findings are:

- Symmetric regulation of in-building wiring has been shown to be effective in supporting infrastructure-based competition (duplication) in FTTH in areas and countries where this is viable, in the presence of willing investors. Symmetric regulation has also been used to mandate a form of fibre unbundling in France outside “very dense areas”. However, in both cases the symmetric regulation regime was established before major investments occurred and was designed inter alia to accommodate the needs of alternative operators who were willing to invest in competition with the incumbent. The situation in Denmark differs.
- Business model simulations suggest that, irrespective of any regulatory requirements, wholesale access (and wholesale only models) can be positive for the business case for regional operators. In particular, by increasing take-up on the network they help to reduce business risk and support a longer-term ‘utility’ investment model for FTTH.

4.1 Impact of symmetric regulation on non-incumbent operators

There is a wide range of literature available on the interaction between regulated access, competition and the deployment of very high capacity networks.⁴⁹ Much has focused on the implications of regulation on the investment incentives of the incumbent, and less has been written about the effects of symmetric regulation specifically.

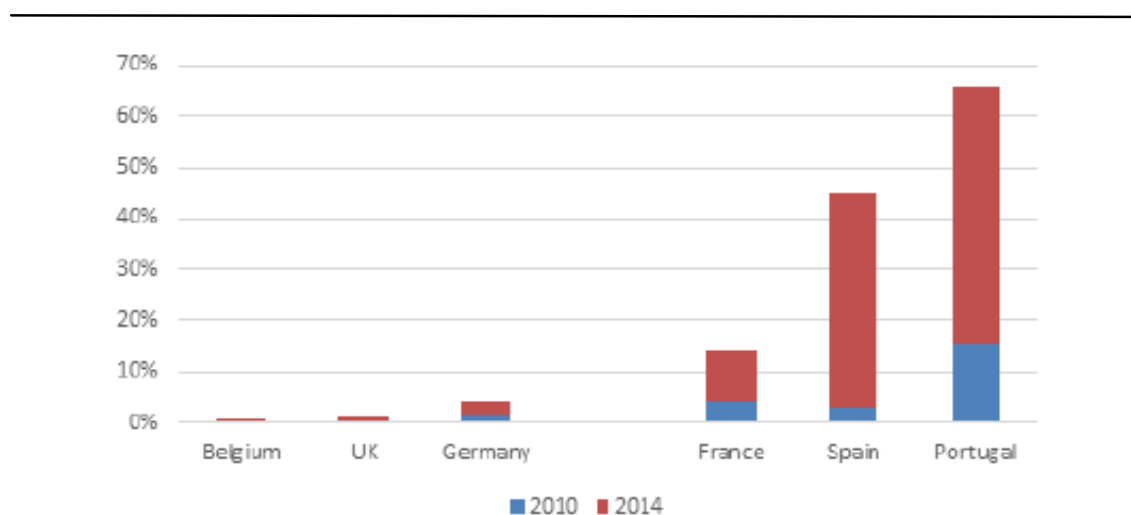
However, WIK-Consult has authored a number of studies which look into developments in competition and investment in markets in which symmetric regulation has been applied instead of or in addition to SMP regulation, and compared the outcomes with markets in which SMP regulation alone has been pursued.

49 For example Briglauer et al. (2016) and Smith et al. (2013) have identified a significant positive relation between inter-platform competition and investment. Regarding intra-platform competition and investment results are inconsistent. A literature survey by Cambini & Jiang (2009) identifies a negative connection, whereas Briglauer et al. (2016) identify no connection. See Briglauer et al. (2016), *The Economic Impacts of Telecommunications Networks and Broadband Internet: A Survey*, ZEW Discussion Paper No. 16-056, Mannheim, downloadable at: <http://ftp.zew.de/pub/zew-docs/dp/dp16056.pdf>; Smith et al. (2013), *The Impact of Intra-Platform Competition on Broadband Prices and Speeds*, *Journal of Information Policy*, Vol. 3 (2013), pp. 601-618, downloadable at: <https://www.jstor.org/stable/10.5325/jinfopoli.3.2013.0601> and Cambini, Carlo & Jiang, Yanyan, 0. "Broadband investment and regulation: A literature review," *Telecommunications Policy*, Elsevier, vol. 33(10-11), pages 559-574, November.

In the 2016 study “Regulatory, in particular access, regimes for network investment in Europe”,⁵⁰ WIK-Consult compared progress in FTTH deployment in three countries which had focused on duct access coupled with symmetric regulation of FTTH (Portugal, Spain and France), with deployment in countries which had focused primarily on SMP access to the incumbent network (Belgium, the UK and Germany).

The study highlighted that the countries with the “deep passive” strategies (Spain, Portugal and France), had achieved a more widespread FTTH deployment than had occurred in Belgium, the UK and Germany (see following figure). The study also noted that a significant proportion of the FTTH deployment in countries such as Spain, Portugal and France, had been driven by alternative operators that had previously relied on unbundled access to the copper loop (LLU).

Figure 4-1: Household coverage FTTH/B – comparing outcomes of ‘duct access/in-building wiring focus with access to incumbent NGA infrastructure



Source: WIK-Consult based on EC data.

In a subsequent 2019 study⁵¹ WIK-Consult looked more deeply into the differences in the type of symmetric (and other access) regulation on FTTH applied in France, Spain and Portugal to understand whether these differences could help to explain different outcomes for deployment and competition in those markets.

50 WIK, IDATE, Deloitte (2016) Regulatory, in particular access, conditions for network investment in Europe, downloadable at: <https://publications.europa.eu/en/publication-detail/-/publication/c0da75d9-9a8c-11e6-9bca-01aa75ed71a1/language-en/format-PDF/source-89105033>.

51 WIK-Consult (2019) Prospective competition and deregulation, An analysis of European approaches to regulating full fibre, downloadable at: https://www.ofcom.org.uk/__data/assets/pdf_file/0020/145046/b-group-wik-report-annex.pdf.

Specifically, the study noted that while in Spain and Portugal, symmetric access obligations applied mainly to in-building wiring, in France, outside very dense zones serving around 10 % of premises, symmetric access regulation had been used to mandate all operators to offer long-term (IRU-based) and short-term (rental-based) access to fibre at locations aggregating 1.000 households.⁵²

Portugal had also forborne from SMP fibre access regulation entirely, while Spain applied forbearance for an initial period of 7 years, before applying fibre access regulation (VULA) in non-competitive areas covering around 65 % of households.

Thus there was a contrast between France which had used symmetric regulation as an alternative or replacement for SMP regulation to apply fibre unbundling obligations on all operators for the majority of households, and Spain and Portugal, which had pursued a largely deregulatory approach to FTTH/ultrafast broadband.

This difference in focus on the broadband ladder of investment between Spain and Portugal, and France – as well as the contrast between those countries and other countries such as Germany and the UK, which focused on fibre VULA or bitstream access to the incumbent - is shown in the following diagram.

Figure 4-2: Regulatory strategies towards NGA⁵³

		Next generation regulatory approaches circa 2010 and today				
		Forbearance	DPA and in-building wiring (FTTH focus)	Dark fibre access focus	Full ladder (initial FTTC focus)	Service competition
Broadband ladder of investment	Own infrastructure	US				
	Duct and pole access		Portugal, Spain (since 2009)	France (2008 on)	Italy, Germany, UK (initial)	
	Subloop/terminating segment					
	Local access	Nearly universal	Spain (non-competitive zones) 2016			
	Regional (bitstream) access	Less focus/in process of full or geographic deregulation				Australia
	Resale	Deregulated				

Source: WIK-Consult.

52 Specific regulations concerning less dense pockets in very dense areas require access to passive fibre access at smaller aggregation levels. Further detail is shown in the French case study.

53 The reference to “dark fibre access” in the context of France, includes the obligation to provide IRUs for fibre access in addition to short term rental of fibre access – at prices that were determined by the regulator during the resolution of disputes.

The 2019 WIK-Consult study suggests that the deregulatory approaches of Spain and Portugal may have been a factor in supporting greater FTTH investments in those countries compared with France, as well as in other countries such as the UK and Germany, where the regulatory regime focused on mandating access to incumbent fibre infrastructure.

However, it also highlights how nationwide *alternative operators* played an active role in FTTH investment in Spain, Portugal and France and were willing and able to deploy their own access networks in certain regions.

In a 2014 study for the DBA,⁵⁴ WIK-Consult noted that the characteristics of the French market were different from that in Denmark. Specifically in France, there was limited FTTH at the time when symmetric regulation was introduced, while in Denmark more than 40 % of homes had been passed at that time. Moreover, the willingness of alternative operators to invest in France and to seek nationwide coverage, contrasted with the situation in Denmark where mass-market alternative operators showed a lack of interest in making significant investments in fibre access infrastructure, while the utilities focused on deploying and offering fibre-based services in specific zones, and did not seek to expand coverage or provide services elsewhere.

The 2014 WIK-Consult study also noted that wholesale access going beyond access to in-building wiring and passive access at deep levels of the network, including bitstream access, had been mandated on operators other than the incumbent in the context of state aid.⁵⁵ WIK-Consult observed that, although access on the basis of state aid was not relevant in most cases for utility fibre networks in Denmark, the utility companies could offer commercial access agreements. The study noted that “while access arrangements can help to expand the broadband market for utilities and increase network utilisation”, this effect was dependent on consumers’ demand and willingness to pay for very high speed symmetrical broadband. Given the uncertainty about demand, utilities might feel that the “time was not yet ripe” to enter into access agreements. A further challenge would be to harmonise access products between fibre utilities and establish a common wholesale platform.

The study concluded that such commercial access agreements, if concluded, could increase competition in the Danish broadband market, and this would clearly be the case if alternative operators or resellers benefited from them. Access to utility networks could also be of interest to TDC. However, in the case of TDC, the study noted there was a risk that relying on access to the utility networks could limit rather than increase infrastructure competition, as TDC might focus on access at the expense of investing in parallel cable and copper infrastructure. WIK-Consult could not draw generalised conclusions on the effects at that time.

54 WIK (2014) Analysis of market structures in the Danish broadband market, downloadable at: https://erhvervsstyrelsen.dk/sites/default/files/media/publikation/bilag_-_analysis_of_market_structures_in_the_danish_broadband_markets_-_august_2014_-_wik.pdf.

55 See Idem. Pages 72 and following.

4.2 Impact of ownership models and wholesaling on the business case for regional players to invest in FTTH

WIK-Consult has also conducted a number of studies looking at the business cases of commercial FTTH roll-out, the business cases of municipalities and affiliated companies and the comparison between vertically integrated operators and wholesale only network operators. These are summarized below highlighting the aspects relevant for this study.

Wernick, C.; Henseler-Unger, I.; Strube Martins, S. (2016): Critical success factors for FTTB/H-rollout

The aim of the study was to identify success factors for FTTB/H expansion in the German market. To this end, hypotheses were developed based on an FTTB/H expansion ecosystem. The following conclusions were reached:

- Quality differentiation and decoupling from price competition are possible in the marketing of optical fibre.
- Profitable expansion projects require the definition of expansion thresholds or penetration rates, which sets a minimum threshold that must be met for fibre roll-out to take place.
- Cost efficiency is of central relevance for a profitable FTTB/H expansion.
- Fibre optic investments are infrastructure projects with a long duration and corresponding depreciation periods, which must be accepted by the investors of such projects.
- Open Access increases the utilization and profitability of FTTB/H investments. An Open Access platform can contribute to the aggregation of demand.
- Not only in the residential customer segment, but also in the business customer segment, there is already demand for Gigabit connections. Due to higher achievable revenues, the connection of commercial customers can increase the profitability of expansion projects.
- A regulatory framework aimed at safeguarding the existence of infrastructure-based competition is a prerequisite for investments in FTTB/H.

Concerning the relevance of open access for FTTH roll-out the study stated that the concept of open access is commonly promoted by all parties and in the case of state aid is required, irrespective of any SMP identified. Nonetheless, the study noted that wholesale markets had not yet effectively emerged in Germany. High process and integration costs could play a role. A further reason could be the success of Telekom Deutschland's BSA wholesaling model.

The study nonetheless concluded that access to alternative networks could still turn out to be a success in the long term, given the right conditions. The study noted that wholesaling offers investing network operators the opportunity to increase the penetration rates and thus the profitability of FTTB/H roll-out, and could be the only possibility for market participants to obtain wholesale services with the characteristics of FTTB/H networks.

From the point of view of potential wholesale customers, the study noted that an essential criterion for minimising transaction costs is the availability of a standardised interface for ordering processes and the management of end customer connections. It would also make sense to create a cross-vendor platform or infrastructure company against the background of the large number of regional players with a manageable footprint. The latter approach has already been addressed by WIK in the past. The basic idea is to create an organisational construct which on the one hand ensures non-discriminatory access to wholesale products for all market participants and on the other hand creates incentives for investment in fibre networks.

Wernick, C.; Queder, F.; Strube Martins, S.; Gries, C. unter Mitwirkung von Holznagel, B. (2017): Ansätze zur Glasfaser-Erschließung unterversorgter Gebiete, Studie im Auftrag des DIHK, Bad Honnef, downloadable at:

https://www.wik.org/fileadmin/Studien/2017/2017_DIHK_Studie.pdf

Using business case modelling, this study demonstrated that investment periods for fibre optic utilities on the basis of wholesale-only networks show shorter payback periods in comparison to vertically integrated operators. It concluded that the wholesale-only model could be used to expand the number of areas accessible for commercial rollout and to reduce the overall need for subsidies.

From a Danish perspective the business case modelling comparing the economics of a vertically integrated and of a wholesale-only network operator is of interest as there are a number of wholesale-only fibre utilities in Denmark currently providing service on one retail platform only (and therefore are following a strategy similar to a vertically integrated operator) while the incentives to open the networks to third parties should be strong.

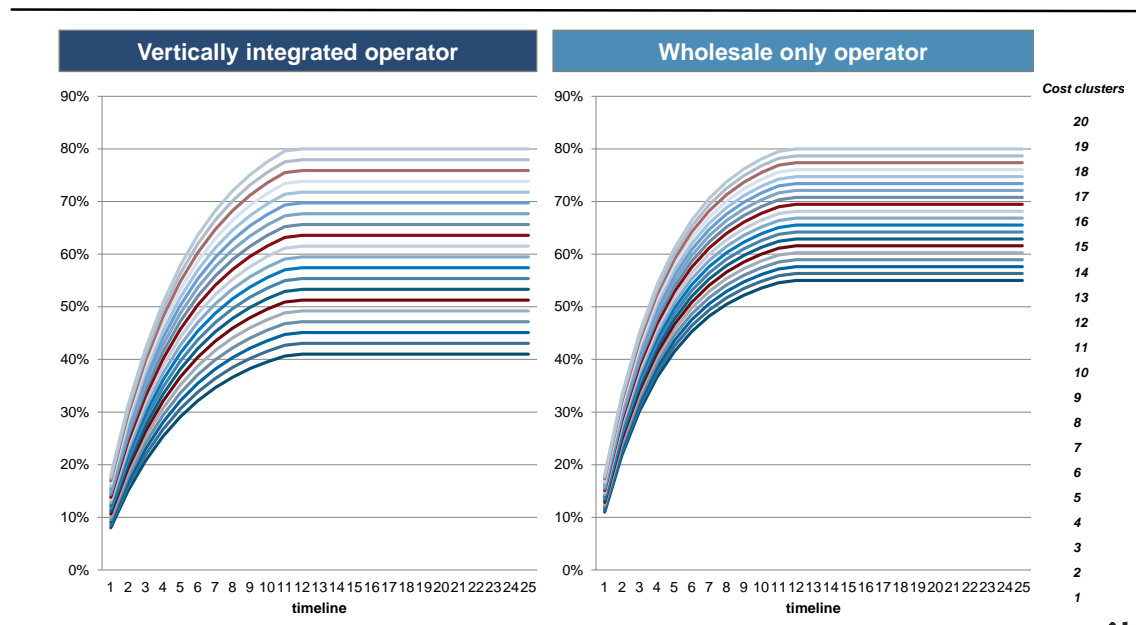
With regard to the profitability analysis of an FTTH rollout, both the cost and revenue categories are essentially the same for vertically integrated and wholesale only providers. On the cost side, costs are incurred for civil engineering, active and passive infrastructure, operating activities and financing. The revenue side, on the other hand, is determined by sales, expressed as the product of the number of customers and ARPU. Despite the same categories, however, on closer examination differences become apparent which are relevant for the profitability analysis.

The average monthly revenue per customer for integrated providers is higher than the ARPU a wholesale only provider can achieve. This follows the different levels of value added of the products marketed. However, revenue per customer is a mixed calculation

for the integrated provider as it has its own end-customer relationships with high ARPU and wholesale contractual relationships that contribute lower ARPU.

Wholesale-only providers incur lower EBITDA-effective costs than integrated providers due to the lower depth of value added per euro of revenue generated. They are therefore in a position to generate significantly higher EBITDA margins than vertically integrated providers. It can also be expected that, following the migration of customers from copper-based networks to FTTH networks and the distribution of end customers between the various providers, the utilisation of the wholesale only network will be higher than would be the case if an integrated provider were to roll out the network.

Figure 4-3: Take-up over time compared



Source: WIK-Consult.

Wholesale-only providers have a lower risk profile in their business activities as the infrastructure market segment is less competitive than the retail market. The effects of regulatory measures also play an important role in determining the cost of capital. Since in some respects there is a congruence of interests with regulation, from the point of view of the providers of capital this has little or no negative impact on the success of the wholesale only network operator in comparison to a vertically integrated provider.

In view of the total costs actually incurred for the provision of FTTH connections, comparative cost advantages can be assumed for vertically integrated providers. It can be assumed that wholesale only providers will incur higher transaction costs due to the potentially high number of business relationships with marketing partners, for example through (re-)negotiations, connections, ongoing processes and declining economies of scale in the backbone network.

The modelling of profitability for both types of provider shows strongly diverging results. In the wholesale only model, the break-even is based on the cumulative cash flows in cost class 1 after 9 years. When looking at 20 years, the cost classes 1 to 18 can be developed economically. A different picture emerges for the vertically integrated provider. Only after 12 years is the break even in the most densely populated cost class reached on the basis of the cumulative cash flows.

Another aspect that can be demonstrated with the help of the model is the increase in profitability by mixing high cost areas with lower cost areas.

The model results indicate that FTTH roll-out investments in a wholesale only model pay for themselves faster than those in a vertically integrated model. Vice versa it allows a wholesale only provider to profitably roll-out a larger area with the same assumed duration. Its profitability limit allows greater (profitable) network coverage.

Wernick, C.; Bender, C. (2017): The Role of Municipalities for Broadband Deployment in Rural Areas in Germany: An Economic Perspective, in: Digiworld Economic Journal, No. 105, 1st Q 2017.

Economic analysis and case study evidence show that municipalities, which engage in broadband roll-out apply different calculations in their investment plans in comparison to commercial players. As a consequence, municipalities or affiliated enterprises are able to realize larger roll-out projects for a given amount of investment. This implies useful policy implications in particular with respect to underserved areas which lay out of scope of commercial broadband roll-out activities and thus cannot enjoy benefits associated with widespread availability of Gigabit connectivity.

This paper provides a discussion of the role of municipalities and affiliated enterprises, their investment and incentive schemes. Furthermore, the potential relevance of these market players for achieving the objective of a nationwide roll-out of high bit rate communications networks is addressed.

From the perspective of the impact symmetric regulation has on the business case of fibre utilities it is interesting that in this paper the authors point out the different approach to fibre roll-out taken by municipalities or affiliated enterprises (such as energy utilities):

Private investment decisions are based on the expected profitability of a project, which in telecommunication is mainly determined by three factors:

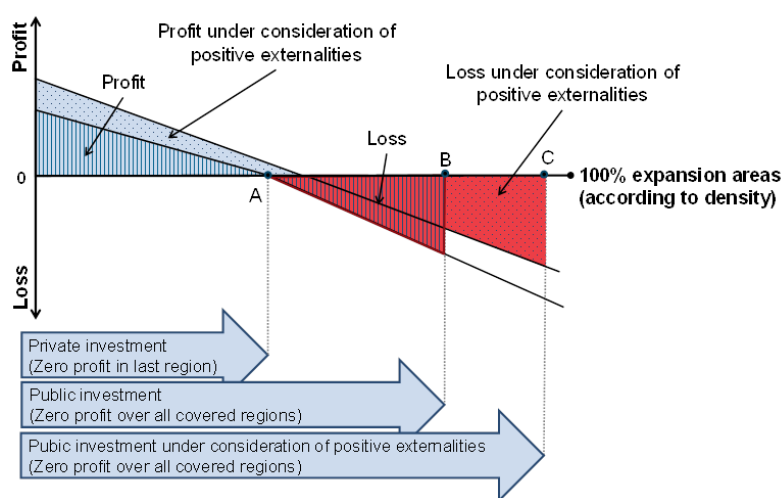
1. The population density.
2. The penetration (utilization rate) that can be realised.
3. The average revenue per user (ARPU).

The investment per potential customer differs significantly between regions depending on the local topography and geographical population density. As a result, a comparable low penetration rate might be sufficient for a given profitability in urban areas, whereas in semi-urban areas much higher penetration rates have to be achieved. In rural areas, commercially viable deployment is often a challenge while sparsely populated areas often do not allow a commercially viable operation at all unless significantly higher ARPUs can be achieved there.

Public policy actors are likely to make significantly different investment decisions than private sector actors, which is illustrated in a stylized way in the figure below. 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 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 4-4, which illustrates that broadband is deployed even in regions with a lower population density (Point C).

Furthermore, private firms do not consider any of the positive overall economic effects 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 4-4, which illustrates that broadband is deployed even in regions with a lower population density (Point C).

Figure 4-4: Investment decision for broadband deployment



Source: WIK based on Inderst et al. (2011).⁵⁶

56 See Inderst et al. (2011): "Ökonomische und rechtliche Rahmenbedingungen zum Ausbau und zur Finanzierung von Breitband-Hochleistungsinfrastrukturen in dünn besiedelten Gebieten", Study for

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.
- 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 roll-out, are well above 20 % and up to 60 % 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; LANGER & TAUBER, 2013). It can be argued that this is due to a higher pronounced local involvement and greater participation of part of the population.
- 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 with external partners. This allows for a higher deployment speed and lower construction costs.

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

5 European case studies

In this chapter, we further investigate the effects on investment, competition and consumer outcomes of different forms of wholesale access regulation and commercial wholesaling strategies applied by non-incumbent operators, by means of case studies focused on France, Germany, Spain and Sweden.

Key findings are:

- Symmetric regulation on in-building wiring in Spain has been effective in supporting infrastructure-based competition in FTTH in very dense areas, while symmetric regulation of fibre terminating segments (similar to unbundling) has enabled competition amongst telecom operators on fibre-based broadband in France. However, the context in which symmetric regulation was imposed in these countries differs from that of Denmark – and there is limited demand for the types of access required under symmetric regulation in France and Spain in Denmark.
- An examination of strategies by regional carriers in Sweden, Germany and France (public initiative areas) supports the findings of theoretical models conducted by WIK (see previous chapter), that suggest that active wholesaling policies (and especially wholesale only networks offering passive access) can support the business case for fibre deployment by regional operators.

Further details are provided for each country below.

5.1 France

5.1.1 Regulatory regime applying to very high capacity networks

The French regulatory regime applying to FTTH was established between 2008-2010. It consists in:

- SMP duct and pole access obligations for fibre roll out applied to the incumbent Orange without any usage restriction under the Wholesale Local Access market; complemented by.
- Symmetric obligations applied through national legislation and Arcep's decisions which require all operators installing fibre in a building to grant access to the fibre terminating segment (the segment up to the first concentration point) either as a "co-investment" offer or line rental.

The symmetric obligations applying to the fibre terminating segment,⁵⁷ require all operators installing fibre in buildings to offer – in a transparent and non-discriminatory manner, and under reasonable technical and economic conditions – passive access to the terminating segment of the fibre (point of mutualisation). Offers should include:

- An offer to participate in the co-financing of FTTH lines for example through a long term right of use (IRU), both from the start of the investment and subsequently.
- An offer of passive access rental.

The location of the access point varies according to whether the connection occurs in very dense or less dense areas.

ARCEP determined in decisions and recommendations made in the period 2009-2014 that the connection point in very dense areas:

- Can be at the base of the building for buildings hosting more than 12 households or offices (or which are connected to a visitable public sewage network through a supply tunnel which is also visitable); or
- Should be at a point aggregating 100 lines for buildings hosting less than 12 households or offices (in accordance with the Jan 2014 ARCEP Recommendation).

The connection point in less dense areas must be:

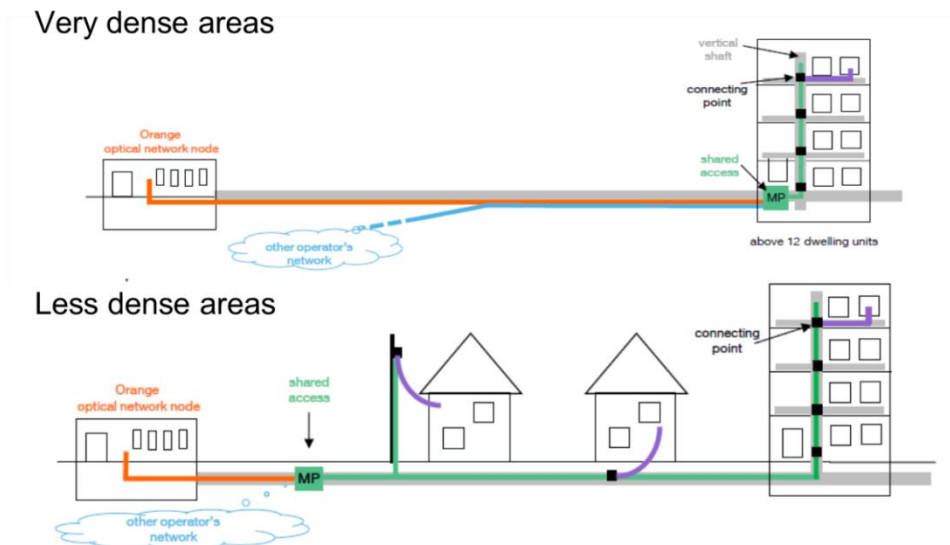
- At a point aggregating at least 1000 lines; or
- At a point aggregating at least 300 lines if backhaul is made available to a point aggregating 1000 lines.

The portion of the fibre network which is shared respectively in very dense and in less dense areas is shown in the diagrams below. If several operators request access to the building in advance of the fibre installation in the high-density areas, up to a maximum of 4 parallel fibres per home can be installed.⁵⁸ Outside these areas one fibre is deemed sufficient, which must be shared by all operators.

57 See ARCEP Decisions ° 2009-1106 et n°2010-1312.

58 Installation d'un réseau en fibre optique dans les constructions neuves à usage d'habitation ou à usage mixte, Guide Pratique – 2016, downloadable at:
<http://www.arcep.fr/fileadmin/reprise/dossiers/fibre/251116-Guide-Immeubles-neufs-BD.pdf>.

Figure 5-1: Very dense areas and less dense areas in France



Source: ARCEP.

The fibre is shared under the following commercial conditions:

Very dense areas (in-building wiring only)

- The fixed fee for a 30 year IRU for the connection from the mutualisation point (MP, inside the building) to the distribution box (PBO) is around €150, which is shared equally amongst co-investors.
- There is a recurrent fee of around € 0.6 per active line per month. This represents the maintenance fee for the drop cable.
- In a given area, the co-investment operators commit to co-invest in all buildings equipped during a given year.

Less dense areas (terminating segment aggregating at least 1.000 households)

- The co-investing operator “invests” (pays an up-front fee) in increments of 5 % lines within a dedicated investment zone (equivalent to one city and its suburbs). The investment gives the operator the right to serve 5 % of lines within that area.
- The fixed fee for a 20 year IRU is around €500 per line. Renewal costs € 1 for another 20 years.
- For co-investing operators, there is a recurrent fee of around € 5 per active line per month (for access to the mutualisation point at a location gathering 300 lines). This fee reflects the financing of uncofinanced shares for the building operator as well as maintenance, service and access to civil infrastructures.

Rental of the fibre terminating segment must also be offered. Typical charges are €13.2 per line per month.

5.1.2 Main alternative investors in FTTH

In its 2011 plan for ultrafast broadband,⁵⁹ the French Government distinguished regions of France where it expected that commercial deployment of FTTH would be viable (private initiative zones covering 57% of the population), from regions in which it considered that wide scale deployment would only be possible with the aid of public funding (public initiative zones covering 43% of the population).

Although there are some overlaps, there are different investors with different business models in the private and public initiative zones.

Private initiative zones

Besides the incumbent Orange, the main FTTH investors in the private initiative zones are the alternative operators Altice/SFR (which also operates the cable network in France, previously Numericable), and to a lesser extent Iliad/Free.

The alternative operators have a vertically integrated business model, in which they are active in service provision (triple play bundled offers including TV, Internet and voice are prevalent in France), as well as in the deployment of core networks and, in some regional areas, FTTH access networks.

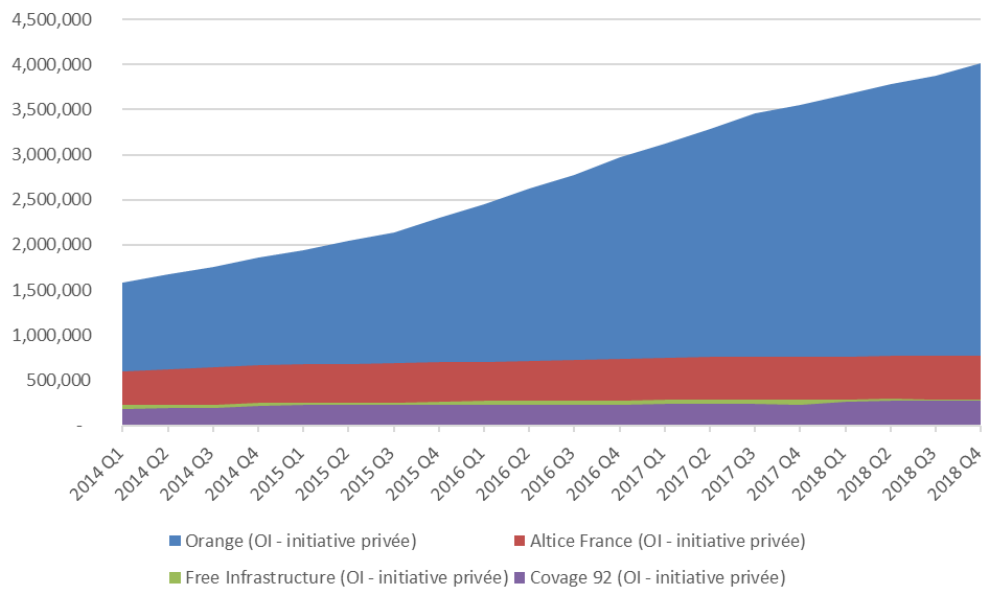
The alternative operators aim to offer nationwide very high capacity broadband retail services.

These offers are based on a combination of their own FTTH infrastructure (in the limited areas in which they have deployed – see figure below) and regulated wholesale passive access to the infrastructure of other companies deploying FTTH access networks, including Orange (in private initiative zones as well as some public initiative zones) and specialised public initiative operators (see below).

The figure below shows the degree to which alternative network operators have deployed their own FTTH infrastructure in commercial zones within France. At the end of 2018, the incumbent Orange had constructed 80 % of the FTTH access lines deployed in these areas, while the largest alternative network investor Altice/SFR had constructed 13 % of the lines.

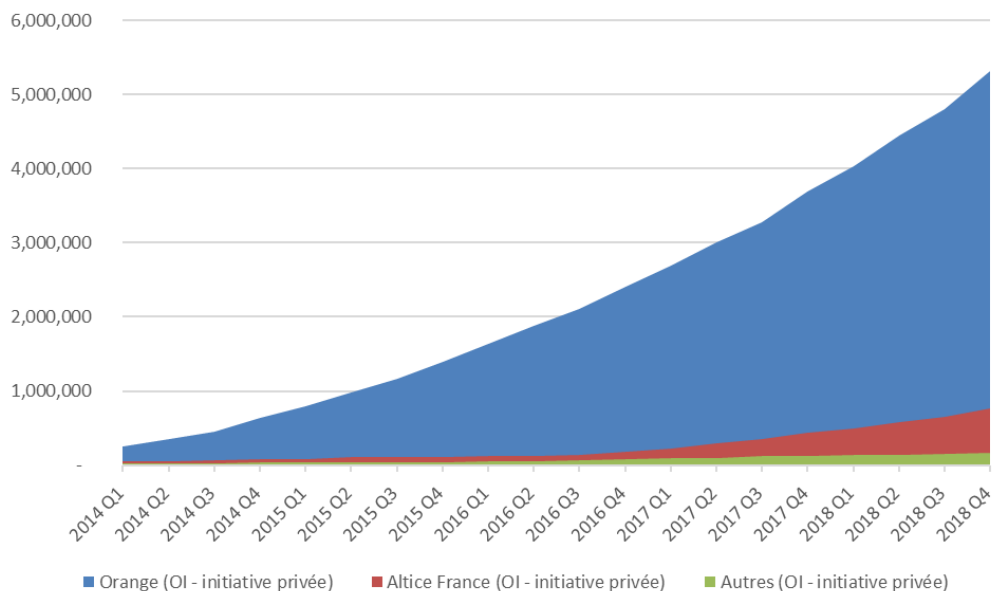
59 See <https://agencedunumerique.gouv.fr/en/the-french-high-speed-broadcast-plan/>.

Figure 5-2: FTTH deployment in France, very dense areas



Source: ARCEP data.⁶⁰

Figure 5-3: FTTH deployment in France, less dense areas (commercial zones)



Source: ARCEP data.⁶¹

60 <https://www.data.gouv.fr/fr/datasets/le-marche-du-haut-et-tres-haut-debit-fixe-deploiements/>.

In cases where they are not the first to deploy FTTH infrastructure, in line with the regulatory regime applying to passive access to fibre networks, in very dense areas, alternative operators in France deploy their own networks to the base of the building and share only the in-building wiring. In less dense areas, they lease passive access to FTTH networks at connection points which aggregate around 1.000 households, which tend to be located at a upper level within a former MDF or nearby, where operators tend to have a backhaul network inherited from LLU. The main alternative operators in France have built up significant market shares in broadband retail services (originally via LLU). These significant market shares enable them to make use of long-term agreements (based on IRU) for access to FTTH infrastructure, rather than relying on short term rental.

Data from ARCEP indicates that at the end of 2018 wholesale access to FTTH networks in France was overwhelmingly provided via passive symmetric access (2.2m lines) compared with only 94.000 FTTH lines which were provided via active wholesale access.

Public initiative zones

A number of specialised infrastructure investors are targeting public initiative zones within France. These investors pursue FTTH deployment as a “utility” investment,⁶² and construct FTTH networks based on a “wholesale only” model and with the participation or support of public bodies (public private partnership). Investments by the private operators may be supported by public financing e.g. national and in some cases national and/or EU funds (i.e. state aid). The state-owned Caisse des Depots is also traditionally active in PPPs following the principle of the efficient investor in the market economy.

The main specialised infrastructure operators in public initiative zones are Axione, Altitude Infrastructure and Covage, while TDF Fibre is a recent entrant in this segment.

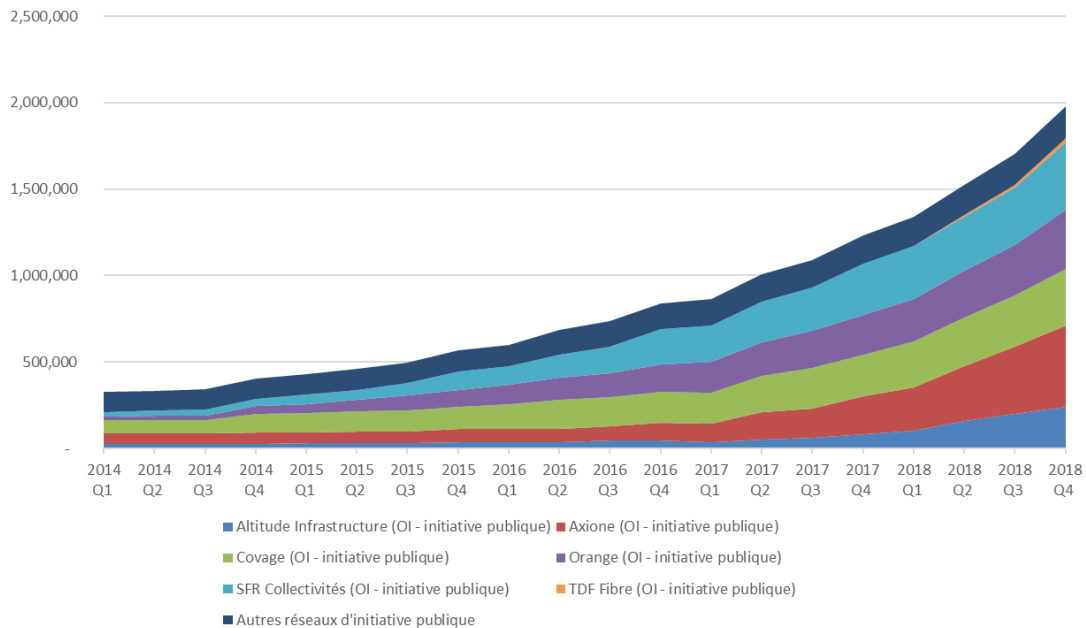
The telecom operators Orange and SFR also operate some concessions within public initiative zones. In these cases they continue to pursue a vertically integrated model, but comply with additional wholesaling rules applying to projects in receipt of state aid (for example legal separation where mandated by national law). The symmetric obligations to offer passive access at locations aggregating at least 1.000 households also apply, in the same way as in commercial “less dense area”.

Deployments in FTTH in public initiative areas are shown in following chart.

61 <https://www.data.gouv.fr/fr/datasets/le-marche-du-haut-et-tres-haut-debit-fixe-deploiements/>.

62 Investments in fibre as a utility focus on investment in infrastructure rather than services, typically with a longer payback period and lower cost of capital than applies to investments made by vertically integrated telecom operators. This business model is described inter alia in the 2016 study by WIK “Regulatory, in particular access, regimes for network investment in Europe”.

Figure 5-4: Public initiative FTTH deployments by operator



Source: ARCEP data.⁶³

The specialist operators have a *de facto* monopoly on very high capacity fibre in specific regions and many of the deployments are relatively small scale.

Examples of projects operated by TDF, including the target number of connections, associated capex per line (including and excluding subsidies), are shown below.

Table 5-1: Examples of TDF fibre projects

Region	Project size	Total capex per line €	Capex per line net of subsidies	Roll-out period
Val d'Oise	84000	1071	893	3 years
Yveline	110000	1091	1091	4 years
Val de Loire	306000	1667	1503	5 years
Maine et Loire	220000	1455	1295	5 years

Source: WIK-Consult based on TDF Infrastructure 2017 Annual results.

Notwithstanding the fact that these deployments have a high capital intensity, are focused on wholesale only and subject to regulation including wholesale tariffs and technical specifications that are controlled by ARCEP, TDF notes that they present strong opportunities to generate returns, and have an expected payback period of 8-12 years (see below).

⁶³ <https://www.data.gouv.fr/fr/datasets/le-marche-du-haut-et-tres-haut-debit-fixe-deploiements/>.

Table 5-2: TDF infrastructure 2017

Economic criteria	Applicability to TDF FTTH projects	Key supporting features
Infrastructure ownership	Yes	⇒ Build, own, operate & transfer after 25 years for 610k plugs (3 PIN) ⇒ Build, own & operate (no transfer) for 110k plugs (Yvelines)
Regulation	Yes	⇒ Regulated business with wholesale tariffs and technical specifications controlled by ARCEP
Competition	Low	⇒ Quasi (de facto) local monopolies in low density areas + high barriers to entry (subsidies)
Technology risk	Low	⇒ No obsolescence risk and no theoretical bandwidth limitation of FTTH passive networks ⇒ Complementarity with mobile networks (radio frequencies to saturate with mobile usages)
Client profile	High	⇒ Blue chip customers, with ca. 90% of revenue from the 4 main ISP/MNOs in France (all TDF telecom site hosting clients) – mostly wholesale (not enterprise) clients
Contract duration	Very long	⇒ Ca. 50% of revenue to be contracted over 20 years (IRU)
Customer churn	Low	⇒ Wholesale business, indifferent to end users churn from A to B (both customers of the fiber infrastructure)
Capital intensity	High	⇒ Substantial capex of which 25-30% variable, net of subsidies
Payback	Progressive & secured	⇒ From 8 to 12 years depending on project but <<< concession duration ⇒ Low volatility (contract driven revenues, supply of a critical infrastructure/service) and high proportion of upfront revenues (IRU)
Profitability	Strong	⇒ High EBITDA margin and strong cash generation during operating phase
Synergies	Yes	⇒ Cross-sell + insourcing opportunities in backbone, connected towers and future needs (small cells, ...) ⇒ Leveraging of our existing Network Operations Center in Romainville

Source: TDF Infrastructure 2017 Annual results

Due to the aggregated reporting of other firms investing in FTTH in France, there is limited information available about returns on other local FTTH projects.

Public initiative projects in France are subject to the same symmetric access obligations as apply to private initiative areas. Thus, operators deploying access in public initiative areas must construct their networks in a manner which permits passive access to the fibre terminating segment at a location aggregating at least 1.000 households (see section 5.1.1). Regulated fibre backhaul connectivity (LFO) to these locations is in turn available through SMP regulation applied to the incumbent Orange.

The access price for passive unbundled access to PIN networks is typically set at the same level as for private initiative networks – on the understanding that state aid addresses the funding “gap” between the cost of serving public initiative areas compared with those in the rest of the country. The up-front investment (IRU) for rights to access 300 households is typically set at € 500 per household, with an ongoing payment of € 5 per month per active line.

There are no exemptions or exclusions to the symmetric access obligations in France based on the size of operators. However, this may be linked to the fact that fibre deployment is considered to be a scale industry and there are few or no very small scale initiatives in the country. The scale of deployment is affected by the fact that concession zones for public subsidies are designed to achieve coverage at least at the department level (complementary to private initiatives). Furthermore, private companies bidding for these subsidies have sought to achieve a minimum scale by acquiring concessions for multiple areas.

There are no active access (*bitstream*) obligations applied on public initiative operator networks either under SMP regulation or through access obligations linked to state aid⁶⁴. Symmetric access obligations do could in theory extend to active access but this has not as of now been deemed reasonable. Some public initiative networks offer bitstream access on a commercial basis. However, the take-up of bitstream is thought to be low.

5.1.3 Competition in altnet FTTH zones

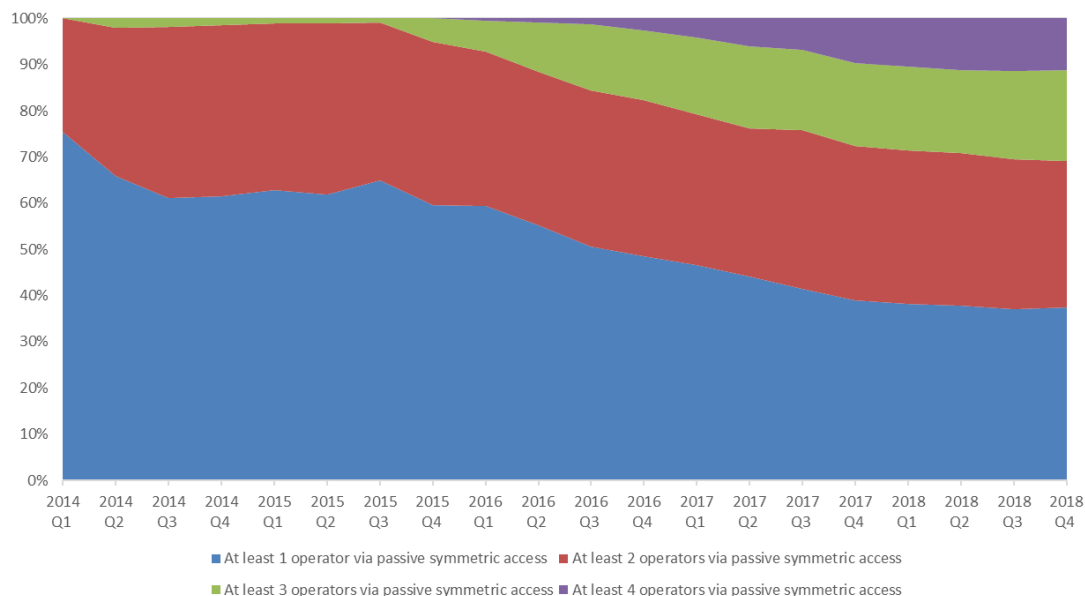
Competition in areas of altnet FTTH deployment

In the very dense zones in which alternative operators have invested in FTTH in France, there may be two or more other very high capacity broadband networks (cable and FTTH). These are zones in which there is significant infrastructure-based competition.

In the less dense zones, there is typically only a single very high capacity (FTTH) network, alongside the legacy copper network of the incumbent. Thus there is limited infrastructure-based competition, although cable is present in some areas. However, due to the passive access that alternative operators are required to provide under the symmetric regulatory regime applying to FTTH, there can be a minimum of 3-4 retail service providers (typically the largest telecom operators Orange, Altice/SFR, Iliad/Free and Bouygues) offering very high capacity broadband services. As shown in the diagram below as of the end of 2018, more than 50 % of end-users served by fibre in less dense commercial zones had a choice of three or more retail offers based on FTTH.

⁶⁴ France's State Aid scheme indeed allows for not providing bitstream access ab initio but only on reasonable demands if no comparable wholesale bitstream access offer is available, whereas the EU guidelines mandate it.

Figure 5-5: % of customers having a choice of FTTH retail provider: less dense zones (private initiatives)



Source: ARCEP data.⁶⁵

Competition in areas of regional FTTH deployment (public initiative zones)

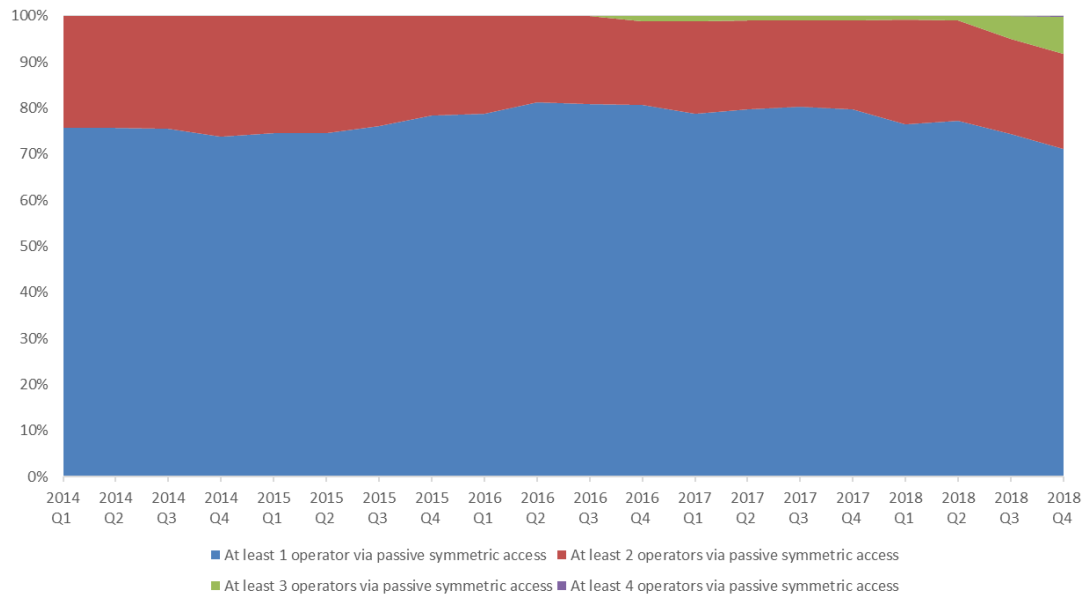
In the “public initiative” zones in which infrastructure specialists have invested in FTTH in France, there is generally only one (copper) infrastructure alongside the FTTH network, and the quality available over copper might be limited.

However, networks in these areas are often designed to accommodate multiple retail service providers, mostly through a wholesale only business model.

In practice, data from ARCEP suggests that the choice of retail fibre provider in public initiative areas is limited (see chart below), with different options in these areas than in “private initiative” deployments. However, it is also important to note that subsidised deployments began more recently than commercial deployments, and there are signs that the degree of choice may be increasing with the arrival of nationwide commercial operators, which will be using passive access.

⁶⁵ <https://www.data.gouv.fr/fr/datasets/le-marche-du-haut-et-tres-haut-debit-fixe-deploiements/>.

Figure 5-6: % of customers having a choice of FTTH retail provider: less dense zones (public initiative)



Source: ARCEP data.⁶⁶

For example, as of July 2018, Axione reported that there were 7 ISPs offering service on its THD42 network in the Loire department. These include the nationwide operators SFR and Bouygues, alongside other smaller and specialist providers.⁶⁷ The choice of service provider on public initiative networks is set to expand to include the incumbent Orange, as it announced its intention in March 2019 to expand its FTTH offering via PINs.⁶⁸ Over time, the result may be a degree of choice that approaches or even exceeds that in private initiative zones.

The ability of commercial ISPs to offer services across multiple local and regional public initiative networks is supported by a common technical and regulatory system for passive access to the FTTH network and guidelines for access pricing developed by ARCEP.⁶⁹

⁶⁶ <https://www.data.gouv.fr/fr/datasets/le-marche-du-haut-et-tres-haut-debit-fixe-deploiements/>.

⁶⁷ See <http://www.axione.fr/en/sfr-joins-isps-offering-services-thd42-public-high-speed-broadband-network>.

⁶⁸ See <https://www.thefastmode.com/technology-solutions/14397-orange-to-expand-ftth-offering-via-public-initiative-networks>.

⁶⁹ See ARCEP 2015 guidelines on pricing on PIN networks https://www.arcep.fr/uploads/tx_gspublication/lignes-dir-ARCEP-tarification-RIP-dec2015.pdf.

5.1.4 Retail outcomes in altnet FTTH zones

Retail prices

The nationwide telecom providers typically offer a uniform price for FTTH-based broadband services in areas where these services are available via their own infrastructure or through symmetric access to the fibre terminating segment.

For example, incumbent Orange offers fibre-based triple play at download speeds of up to 1 Gbit/s for € 28.99 per month for 12 months and thereafter € 47.99 per month.⁷⁰ Alternative operator Bouygues Telecom offers fibre-based triple play packages at download speeds of up to 1 Gbit/s at a price of € 17.99 per month for 12 months, and thereafter € 32.99 per month.⁷¹

Competitive fibre-based offers are also available over the wholesale only “public initiative” networks. For example, Coriolis Telecom, which markets services over the THD42 network in the Loire department offers Internet and telephony at speeds of up to 1 Gbit/s at a price of € 29.99 per month for the first 6 months, with a charge of € 33.99 per month thereafter. Unlimited telephony is available for an additional € 3 per month.⁷² Triple play offers from Coriolis over fibre are available for € 35.99 per month for the first 6 months and € 39.99 per month thereafter.

Nordnet, which also offers services over the THD42 network, offers a “very high speed” fibre-based connection together with a mobile and fixed telephone subscription for € 19.90 per month for the first 12 months and € 32.90 thereafter.⁷³

Implications for quality

Data on average actual download speeds drawn from “testmy.net”⁷⁴ coupled with records of fibre deployment by department⁷⁵ show that although many of the French cities recording the highest average download speeds (>50 Mbit/s) were in areas served by the incumbent Orange, some amongst them are served by wholesale only fibre networks including Pau and Cysoing (Axione), Rueil-Malmaison and Fontenay-aux-roses (Covage). For comparison Paris, served by the vertically integrated major telecom providers, achieved average speeds of around 34Mbit/s.

70 See https://boutique.orange.fr/internet/offres-fibre?_ga=2.204850707.2088752464.1553115307-1309687209.1553115307.

71 See <https://www.bouyguestelecom.fr/offres-internet/fibre-ftth>.

72 See <http://www.coriolis.com/forfait-internet/fibre>.

73 See <https://www.nordnet.com/connexion-internet/internet-fibre/eligibilite>.

74 See <https://testmy.net/country/fr>.

75 Sourced from <http://www.zoneadsl.com/>.

5.1.5 Conclusions and relevance to Denmark

The French case illustrates that extensive symmetric access regulation which results in passive fibre unbundling obligations being applied to all operators in the market (commercial and publicly funded) can be conducted apparently without deterring investment by specialist regional players and could lead to competition in retail provision of very high capacity services and positive outcomes for consumers in areas which would otherwise be dominated by regional players.

However, it should be stressed that the investments in French rural areas were made in full knowledge of the access regime that would be applied, and this may have affected the subsidies requested. Moreover, the French regime was designed to respond to clear demand from market players for passive access to fibre infrastructure similar to fibre unbundling (and supported by regulated access to fibre backhaul).

Another point of difference compared with the Danish market is that at least two of the traditional telecom operators requesting access including Orange and Altice (and also Iliad to a lesser extent), were also building access in certain areas. Thus there is an element of “reciprocity” that is not present in Denmark, where it seems unlikely that the fibre utilities would wish to use access to offer retail services beyond the footprint of their network.

5.2 Germany

5.2.1 Regulatory regime applying to very high capacity networks

SMP regulation on FTTH

Since the market analysis of 2010, the incumbent Deutsche Telekom has been required to offer access on reasonable request to its NGA network. The access obligation is technologically neutral and thus in theory applies to FTTH. However, as the focus of DT’s investment was on FTTC, FTTH access remedies were not elaborated.

The Wholesale Local Access (market 3a) was defined as national while the wholesale central access markets (market 3b) in 20 cities were regarded to be competitive. No SMP regulation has been applied to operators other than the incumbent.

Symmetric regulation based on the DigiNetzG

There is no symmetric access regulation on FTTH networks in practice in Germany. However, there has been debate around how such rules should be applied to regional carriers.

The background is that the DigiNetzG law⁷⁶ sets out rules regarding symmetric access to in-building wiring and passive infrastructure (shared use of existing and evolving physical infrastructure).

All reasonable requests by owners or operators of public communications networks to share the building's internal infrastructure, literally referred to as "internal components of public telecommunications networks or internal passive network infrastructures", must be granted if duplication of the network infrastructures is technically impossible or economically inefficient (Art. 77k Par. 2 and 3 TKG). Access must be provided on "fair and non-discriminatory terms and conditions, including shared usage fees". However, the implementation of symmetric access to in-building wiring has been delayed by unsolved issues related to the ownership, technical standardisation, point of interconnection and pricing of access to in-building infrastructure.

The DigiNetzG also stipulates the shared use of existing and emerging public transport (i.e. telecommunications, electricity, gas, water, district heating, road and rail) networks by telecommunication network operators. In principle, public transport operators must make it possible for owners or operators of public telecommunications networks to share the use of passive network elements already installed in the past, such as for the installation of FTTB/H network components. However, dark fibre is explicitly excluded from this shared use obligation.

The DigiNetzG contains a list of exemptions that entitle public transport operators to reject an application for shared use. This includes offering suitable wholesale products for telecommunications services "on fair and reasonable terms".

Following complaints about the uncertainty linked with the pricing of shared use of passive infrastructure in the context of DigiNetzG,⁷⁷ the Bundesnetzagentur published a consultation on pricing issues in February 2018.⁷⁸

76 The 2014 Cost Reduction Directive (CRD) was implemented in German law in November 2016, through the the DigiNetz Gesetz (law). The provisions are contained in TKG § 77 (Telecommunication law).

77 <https://www.vku.de/themen/digitalisierung/ein-jahr-diginetzg-zentrale-rolle-der-bnetza/>; BREKO (2018): BREKO Positionspapier: Novellierung des Gesetzes zur Erleichterung des Ausbaus digitaler Hochgeschwindigkeitsnetze (DigiNetzG), downloadable at: https://www.bvmw.de/fileadmin/03-Themen/Mittelstandsallianz/Dateien/BREKO_Positionspapier_Reformbedarf_DigiNetzGesetz__002_.pdf; VATM (2015): Stellungnahme zum Referentenentwurf für ein Gesetz zur Erleichterung des Ausbaus digitaler Hochgeschwindigkeitsnetze (DigiNetzG), downloadable at: https://www.vatm.de/wp-content/uploads/2018/08/2015-10-09_VATM-Stellungnahme_DigiNetzGesetz.pdf.

78 BNetzA (2018): Konsultationsdokument Fragen der Entgeltbestimmung im Hinblick auf die Mitnutzung öffentlicher Versorgungsnetze und die Koordinierung von Bauarbeiten auf Grundlage des DigiNetzG, downloadable at: https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Breitband/Entgeltmassstaebe_DigiNetzG/Konsultationsdokument_Entgeltmassstaebe_DigiNetzG.pdf?__blob=publicationFile&v=6.

Provisions related to the shared use of physical infrastructure have also raised criticism because, according to the alternative network operators, the DiginetzG incentivises the duplication of network infrastructure where alternative operators/utilities have started the commercial or subsidised roll-out of fibre (and as a result has a significant impact on the business case of those operators) but it does not as intended incentivise the roll-out of additional coverage.⁷⁹

The government has issued a revision of the telecommunication law⁸⁰ that aims to deter the deployment of parallel infrastructure in areas where the state is subsidising the network deployment. According to the revision of the law, the deployment of very high capacity networks with state aid can be exempted from the obligation to provide access to physical infrastructure. In this context, there has also been discussion on whether commercial roll-out by public utilities should be included in this exemption. The hearing on the draft law revision took place in February 2019.⁸¹

State aid

Germany's poor record in FTTP deployment has led to political efforts to support fibre investment through state aid. In the 2018 coalition agreement signed between the CDU, CSU and SPD, the governing parties stated that they plan to implement gigabit download speeds by 2025 by bringing fibre "to every municipality, if possible directly to the houses".

For the current legislative period the parties proposed investment of 10-12 billion Euros that would be provided to foster broadband upgrades in rural areas through proceeds from the UMTS and 5G auctions as well as subsidies.

Non-incumbent operators receiving state aid to deploy very high capacity networks have to provide wholesale access to third parties on fair and non-discriminatory terms.

5.2.2 Main alternative investors in FTTH

Deployment of FTTH in Germany reached 7,3 % in 2017, considerably below the EU28 average of 28 %. A key reason for the low FTTH coverage has been the focus by the incumbent DT on deploying FTTC/VDSL, which now covers 70 % of German households.

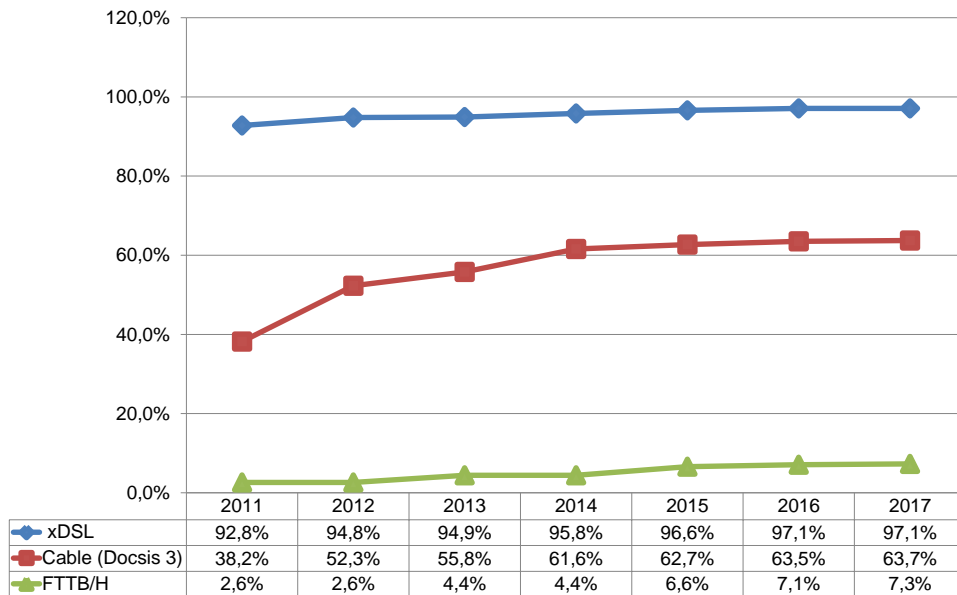
The footprint of cable and DOCSIS 3.1 technology is also relatively high, covering two thirds of German households.

79 See https://www.wik.org/uploads/media/WIK-Newsletter_114_Webversion.pdf.

80 Entwurf eines Fünften Gesetzes zur Änderung des Telekommunikationsgesetzes (5. TKG-Änderungsgesetz 5. TKGÄndG, downloadable at: <http://dipbt.bundestag.de/dip21/brd/2018/0506-18.pdf>.

81 See https://www.wik.org/uploads/media/WIK-Newsletter_114_Webversion.pdf.

Figure 5-7: Fixed broadband coverage in Germany (in % of households)



Source: European Commission, Digital Agenda Scoreboard.

Alternative operators are responsible for 76 % of fibre roll-out in Germany (2018). In total they reached 2,6 million households in 2018 compared to 827.000 FTTH connections of Deutsche Telekom.

Regional operators have played a significant role in the deployment of the limited FTTH installed thus far. This applies in particular for rural areas, which were neglected by large operators such as DTAG.

The table below shows the number of homes passed and homes connected of the leading fibre network operators in Germany in September 2017 (in terms of connections). There may be regional network operators achieving a high coverage and penetration in their region with a lower number of connections.

Table 5-3: Leading fibre network operators (September 2017)

	Homes Passed	Homes Connected
NetCologne	470.000	230.000
Deutsche Telekom	515.000	120.000
Mnet	360.000	110.000
Deutsche Glasfaser	235.000	70.000

Source: IDATE.⁸²

The group of regional operators is very heterogeneous with respect to their business model, shareholder structure, size and product portfolio. Several larger regional operators are owned by public utilities (e.g. NetCologne, M-net), or in cases where no private operator was willing to invest, communities have established associations such as the “Zweckverband High-Speed-Netz-Rhein-Neckar”, which are responsible for the deployment of fibre networks.⁸³

A comparison of the investment of BREKO⁸⁴ members with the investment of Deutsche Telekom AG⁸⁵ shows that since 2009 the capex/revenues ratio of BREKO members has increased, which could reflect increased attention to FTTH deployment.

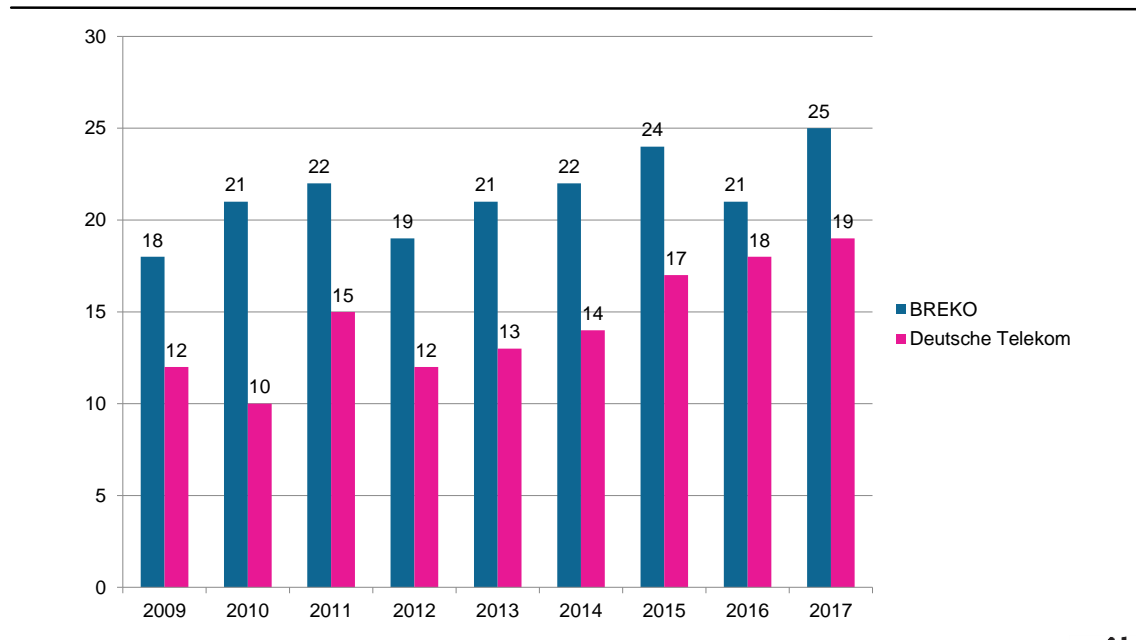
82 IDATE, quoted after <https://www.golem.de/news/ftth-b-wer-in-deutschland-die-meisten-glasfaserkunden-hat-1702-126203.html>.

83 AVR (2015): "Zweckverband High-Speed-Netz Rhein-Neckar - Gemeinsam die Infrastruktur der Zukunft aufbauen", downloadable at: https://www.avr-umweltservice.de/de/Unternehmen/Die_AVR-Gruppe/Fibernet-RN.php.

84 The German Broadband Association.

85 180 regional network operators are members of BREKO (Bundesverband Breitbandkommunikation e.V.). The association claims to represent 80 % of broadband network operators in Germany. Some of these operators have invested in FTTH, although many are also or alternatively focused on deploying FTTC/VDSL, with the aid of subloop unbundling from DT. Other associations representing alternative operators are VATM and BUGLAS.

Figure 5-8: Capex/revenues of BREKO members compared with Deutsche Telekom (in %, 2009 – 2017)



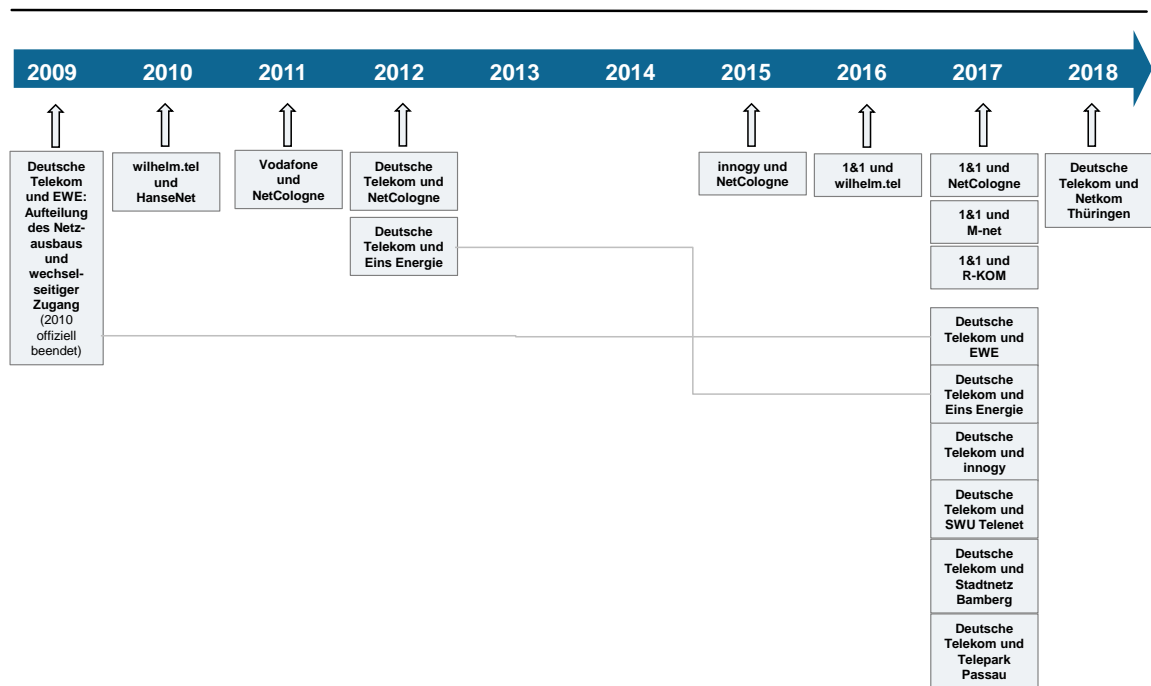
Source: BREKO (2018).

5.2.3 Wholesale access to non-incumbent fibre networks

Although they are for the most part vertically integrated, regional carriers in Germany have reached wholesale agreements with other market players. Wholesaling initiatives by these carriers began in 2010 with an agreement between Wilhelm.tel and Hansenet as well as between 1&1 and HL-Komm. NetCologne, a regional network operator in Cologne, entered an agreement with Vodafone in 2011 providing access to its FTTH network. In 2012 NetCologne reached a reciprocal agreement with the Deutsche Telekom (DT).

There have been further wholesale agreements concluded since 2016 between TDG and 1&1 and a number of regional carriers (as well as Innogy), which are in the implementation phase (see figure below).

Figure 5-9: Commercial wholesale agreements in Germany



Source: WIK (2018).⁸⁶

Wilhelm.tel’s cooperations with several alternative competitors, as well as the agreements concluded in 2017, show that it is possible, despite this difficult initial situation, to reach commercially negotiated contracts. In theory, this should achieve take-up rates that enable a more large-scale, commercially driven FTTB/H expansion than if a company were to expand on its own.

However, overall, the number of agreements with regional and local fibre network operators and of wholesale FTTH connections used has remained small.

This may be due to the low level of development of FTTH/B in Germany. A number of agreements often still refer to or include FTTC, even if the focus is to be on FTTB/H connections in the future. Access is typically via IP bitstream products. Take-up of FTTH/B is also low – in 2018 only 2,2 % of households subscribed to FTTH connections.

Furthermore, operators have reported challenges in addressing technical and operational issues linked with the provision of wholesale access to fibre networks.⁸⁷

86 See Gries, C., Wernick, C. (2018): Treiber und Hemmnisse für kommerziell verhandelten Zugang zu alternativen FTTB/H-Netzinfrastrukturen, WIK Diskussionsbeitrag 428, Bad Honnef.

87 See Gries, C., Wernick, C. (2018): Treiber und Hemmnisse für kommerziell verhandelten Zugang zu alternativen FTTB/H-Netzinfrastrukturen, WIK Diskussionsbeitrag 428, Bad Honnef.

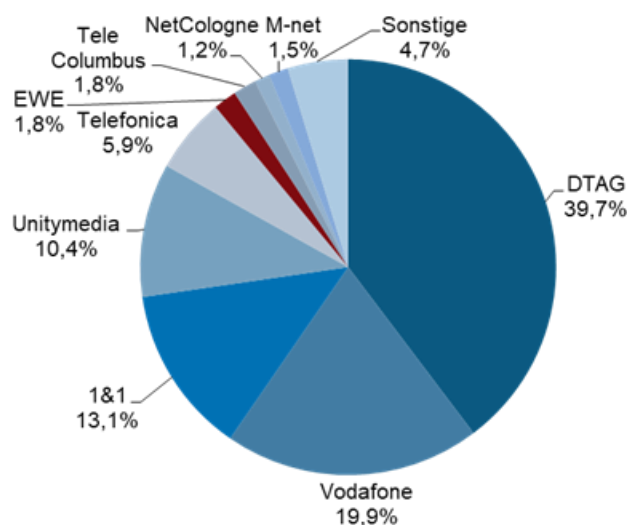
Similarly to Denmark, platforms have been developed to resolve these issues and to lower the transaction costs of the provision of wholesale access services in a highly fragmented market and some of the agreements will be implemented using platforms (e.g. EWE and Telekom with vitroconnect).⁸⁸

5.2.4 Competition in altnet FTTH zones

The level of very high capacity broadband competition in zones in which alternative investors have deployed FTTH varies. In some cases, e.g. Hamburg, fibre has been installed alongside a cable network (while DT remains with FTTC/VDSL). In other, more rural areas, the alternative FTTH network is the only very high capacity network available.

The figure below includes the national retail market shares of some of the regional network operators deploying FTTH networks. The retail market shares of these operators in the national market are limited, but this reflects their limited geographic scope.

Figure 5-10: Market shares (referring to number of broadband customers, 30.06.2018)



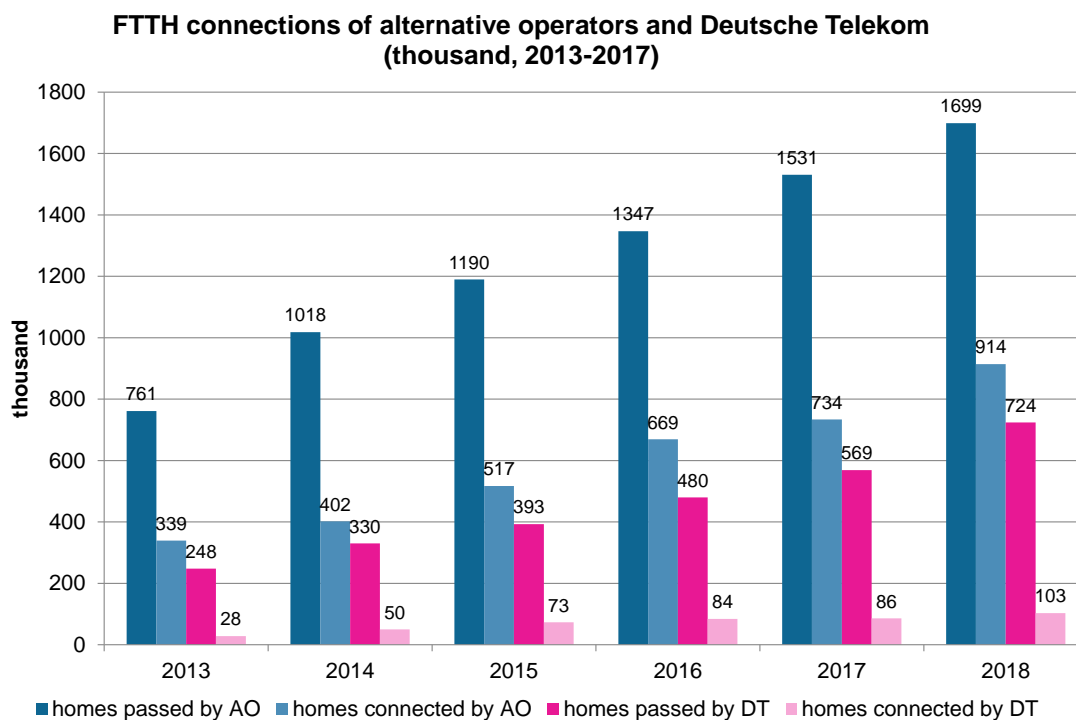
Source: WIK based on data from VATM/Dialog Consult (2018).⁸⁹

88 See EWE (2017): vitroconnect vermarktet jetzt auch EWE VDSL Bitstrom-Produkte, Pressemitteilung vom 04.10.2017, downloadable at: <https://www.vitroconnect.de/Home/Presse/~vitroconnect-vermarktet-jetzt-auch-EWE-VDSL-Bitstrom-Produkte~.html>.

89 See VATM/Dialog Consult (2018): 20. TK-Marktanalyse Deutschland 2018, Oktober 2018, downloadable at: https://ims-files-cdn.net/27576/VATM/2018/Downloads/VATM_TK-Marktstudie%202018_091018_f.pdf.

As is shown in the figure below alternative fibre network operators have a significantly higher take-up rate as a proportion of homes served than Deutsche Telekom.

Figure 5-11: FTTH connections of alternative operators and Deutsche Telekom (thousand, 2013 - 2017)



Source: WIK based on Dialog consult/VATM.⁹⁰

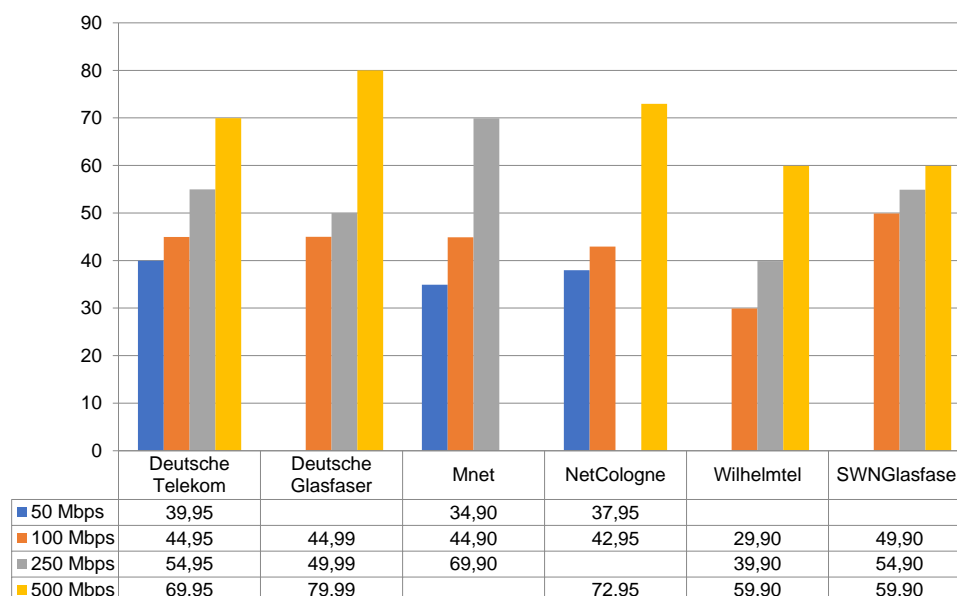
5.2.5 Retail outcomes in altnet FTTH zones

Retail prices

A comparison of prices for fixed broadband access providers in Germany show that the price level of the fibre network operators is comparable to or lower than Deutsche Telekom in some cases. 250 Mbit/s can be obtained at relatively competitive price levels. However, almost all operators do not offer, or demand a significant mark-up for bandwidths above 500 Mbit/s. Gigabit broadband is not yet widely offered.

⁹⁰ See VATM/Dialog Consult (2018): 20. TK-Marktanalyse Deutschland 2018, Oktober 2018, downloadable at: https://ims-files-cdn.net/27576/VATM/2018/Downloads/VATM_TK-Marktstudie%202018_091018_f.pdf.

Figure 5-12: Monthly prices in Germany by bandwidth in euro (March 2018)

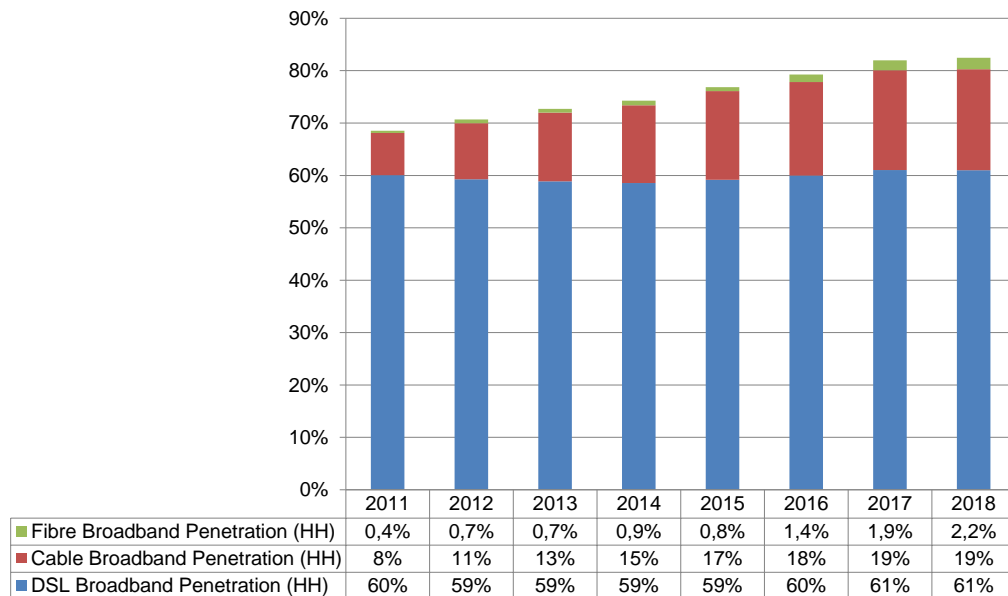


Source: WIK based on websites of operators.

Quality

The figure below shows the shares of technology in terms of end user subscriptions. As indicated, DSL (which also includes VDSL) is the dominant technology in the retail market with almost 61 % of households using this type of access. The penetration rate of cable was 19 % in 2018 and is considerably higher than the FTTB/H penetration with only 2,2 % in 2018.

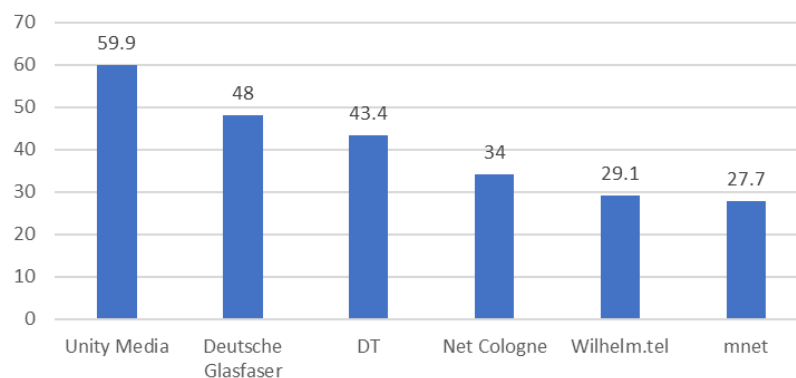
Figure 5-13: Fixed broadband penetration in Germany
(in % of households, 2011-2018)



Source: WIK based on European Commission, Digital Agenda Scoreboard.

The nationwide average download according to testmy.net in 2018 was 44,2 Mbit/s. The figure below shows speeds measured by testmy.net for a selection of regional carriers alongside the incumbent Deutsche Telekom and cable operator Unitymedia.

Figure 5-14: Actual average download speeds in Mbit/s (2018)



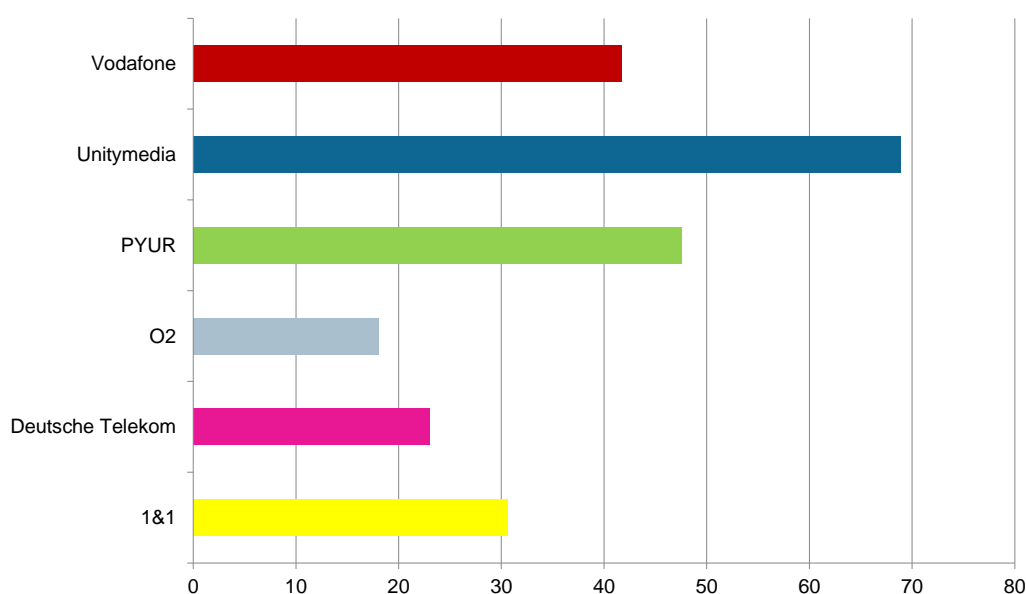
Source: testmy.net (2018).⁹¹

⁹¹ See <https://testmy.net/country/de>.

These figures, if accurate could suggest that notwithstanding the availability of fibre networks in the cities served by carriers such as mnet and Wilhelm.tel, customers may have continued to purchase lower bandwidth technologies offered by these operators or lower bandwidth offers.

The figure below shows the average download bitrates of selected operators according to the nperf report. It clearly shows that the cable operators Vodafone and Unitymedia outperformed the major operators offering services based on DSL/FTTx. However, speeds offered by the city carriers are not reflected.

Figure 5-15: Download bitrates averages per operator in 2018 (in Mbit/s)



Source: nperf (2019).⁹²

5.2.6 Relevance for Denmark

The deployment of fibre by City Carriers in Germany bears some similarities to the fibre deployment by Danish utilities. The wholesale strategies of the City Carriers are also similar (bitstream, but as a secondary strategy to direct retailing). Although fibre deployment by the German City Carriers is significantly less advanced than those of the Danish utilities, greater progress seems to have been made in securing wholesale agreements in Germany. However, they have reportedly been subject to some technical and operational challenges. As in Denmark, platforms have evolved to provide a solution to the market fragmentation.

⁹² See nperf (2019): Barometer von festen Internet-Verbindungen in Deutschland für das Jahr 2018.

It is too soon to tell what the effect will be of the more recent wholesaling arrangements concluded in Germany. Similar to Denmark, a concern may be that the wholesaling agreements might not permit retail providers to differentiate their services significantly from that of their host, and evidence of the offers from City Carriers themselves, suggest that, in contrast with countries such as France and Sweden, where passive access (dark fibre) is available, they have retained tiered pricing levels that may limit the take-up of very high capacity services.

5.3 Spain

5.3.1 Regulatory regime applying to very high capacity networks

CNMC's primary focus in NGA wholesale access regulation since the WLA market analysis of 2009⁹³ has been to foster infrastructure-based competition in NGA (primarily FTTH in practice).

Access to FTTH networks in Spain is regulated through SMP obligations applied to the incumbent Telefonica (only in non-competitive zones) and symmetric obligations based on national legislation, which focus mostly on access to in-building wiring.

SMP regulations

In its initial 2009 review of markets relating to Next Generation Access, the Spanish NRA mandated access to ducts and poles but decided not to mandate wholesale access to the incumbent Telefonica's FTTH network at speeds above 30 Mbit/s, on the basis that fibre deployments were not yet widespread, and that regulation could deter investment and distort competition.

In its 2016 market analysis CNMC decided to introduce a VULA obligation for FTTH on market 3a (NEBA local), without any bandwidth restrictions. CNMC's justification for introducing access obligations on FTTH which were not limited in speed was that – unlike the situation in 2009 – ultrafast broadband services were more widely deployed, and had increased in penetration. However, based on a prospective analysis of competitive conditions, CNMC exempted Telefonica from this regulatory obligation in 66 municipalities covering around 35 % of population.

93 CNMC (2009): Resolución por la cual se aprueba la definición y análisis del Mercado de acceso (físico) al por mayor a infraestructura de red (incluido el acceso compartido o completamente desagregado) en una ubicación fija y el mercado de acceso de banda ancha al por mayor, la designación de operador con poder significativo de mercado y la imposición de obligaciones específicas y se acuerda su notificación a la comisión europea, downloadable at: https://www.cnmc.es/sites/default/files/1048373_6.pdf.

Symmetric regulation

In-building infrastructure in Spain has been governed by legislation since 1998, which has been adapted over time.

Since 2015 in-building wiring is governed by a royal decree which defines operators' rights and obligations regarding access to buildings, obtaining authorization from owners (through notification), sharing rules (technical and economic), responsibilities of first operator deploying the infrastructure vs. following operators, and procedures to provide information on new in-building deployments. Furthermore, the royal decree stipulates the sharing rules and deployment preferences according to the different scenarios that can be found in a building.⁹⁴

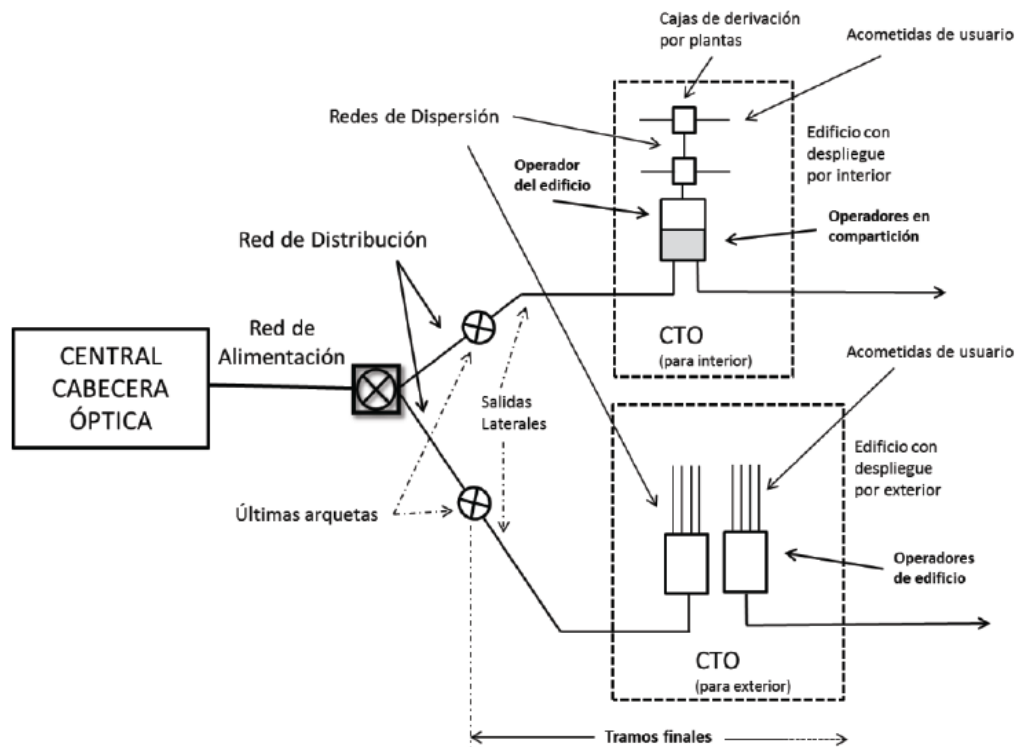
The royal decree issued in 2015 states that the terminating segments of a fibre network to be shared are those between the CTOs (Optical terminating box - "Caja terminal óptica") and the customer connections (inhouse network) and the ducts and conduits of the optical distribution network sections. The CTOs, as a connecting element between operators' distribution networks and the in-house network, are also included in the sharing, with the exception of external CTOs, which can be used exclusively by an operator. The scope of sharing will be extended to the fibre cables of the distribution network in case two or more parallel networks cannot be deployed to the first CTO of the corresponding branch due to the physical impossibility of installing more than one cable due to lack of space in existing ducts. In sections, where this problem does not exist, each operator will deploy its own distribution network.⁹⁵

The figure below shows the reference architecture for FTTH network and the zone of sharing as defined in the decree:

94 Ministerio de Energía, Turismo y Agenda Digital (2015) : Proyecto de Real Decreto por el que se aprueba el Reglamento Regulator de la Instalación de Tramos Finales de Redes Fijas de Comunicaciones Electrónicas de Acceso Ultrarrápido, downloadable at:
https://servicios.mpr.es/seacyp/search_def_asp.aspx?crypt=xh%8A%8Aw%98%85d%A2%B0%8DNs%90%8C%8An%87%A2%7F%8B%99uk%88sf%A3%91.

95 Ministerio de Energía, Turismo y Agenda Digital (2015) : Proyecto de Real Decreto por el que se aprueba el Reglamento Regulator de la Instalación de Tramos Finales de Redes Fijas de Comunicaciones Electrónicas de Acceso Ultrarrápido, downloadable at:
https://servicios.mpr.es/seacyp/search_def_asp.aspx?crypt=xh%8A%8Aw%98%85d%A2%B0%8DNs%90%8C%8An%87%A2%7F%8B%99uk%88sf%A3%91.

Figure 5-16: FTTH reference architecture and sharing zone



Definitions:

- Red de Alimentación: Feeder network
- Red de Distribución: Distribution network
- Red de Dispersión: Inhouse net
- Acometida de usuario: subscriber line
- Arqueta: handhole
- CTO: Optical terminating box
- Salidas Lateral: lead-in segments

Source: Ministerio de Energía, Turismo y Agenda Digital (2015).⁹⁶

The prices of access to the in-building wiring are subject to commercial agreement, but the NRA can (and has) intervened to settle disputes.

The cost of the items to be installed and the activities to be performed by the building operator can be passed on to the sharing operators which use its network.

⁹⁶ Proyecto de Real Decreto por el que se aprueba el Reglamento Regulator de la Instalación de Tramos Finales de Redes Fijas de Comunicaciones Electrónicas de Acceso Ultrarrápido, downloadable at: https://servicios.mpr.es/seacyp/search_def_aspx?crypt=xh%8A%8Aw%98%85d%A2%B0%8DNs%90%8C%8An%87%A2%7F%8B%99uk%88sf%A3%91.

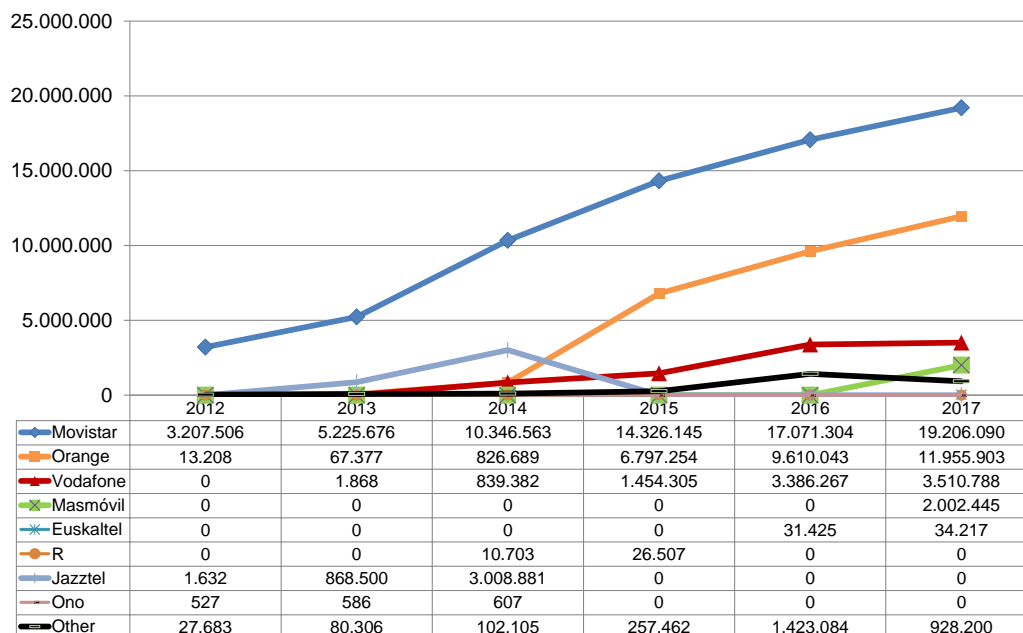
5.3.2 Main alternative investors in FTTH

At 71 % in 2017, Spain has one of the highest levels of FTTH coverage in Europe. According to information of CNMC FTTH coverage lied above 80 % in the beginning of 2018.

The main actors on the Spanish broadband market are the incumbent Movistar (Telefonica) and the alternative operators Vodafone, Orange and MASMÓV! Group (Masmóvil). Movistar, Vodafone and Orange are fixed mobile converged players. Vodafone, Orange and Masmóvil have heavily invested in FTTH networks but also use wholesale broadband access to the fibre and copper network of Telefonica to provide fixed broadband services. Furthermore, in 2017 and 2018 the operators reached commercial wholesale agreements which have enabled them to increase their coverage with FTTH considerably.

SMP duct access has been extensively used to support the construction of FTTH by alternative operators. Around 90 % of the requests for duct access are attributable to the three operators Orange, Jazztel (acquired by Orange in 2015) and Vodafone.

Figure 5-17: FTTH coverage by operator in Spain (2012-2017, access lines)

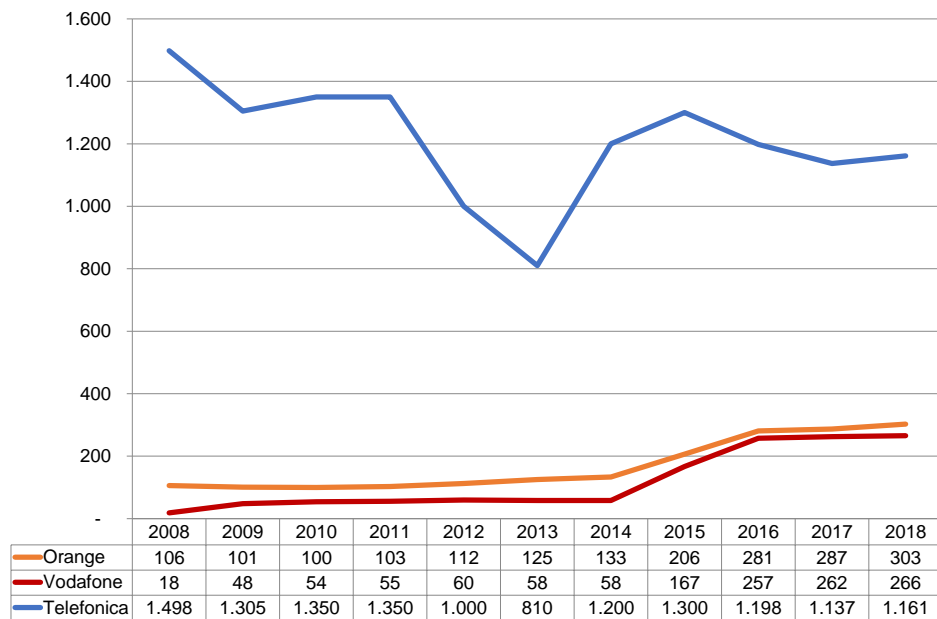


Source: CNMC statistics.⁹⁷

⁹⁷ http://data.cnmc.es/datagraph/jsp/inf_anual.jsp.

The capex of Vodafone and Orange reflects the investment in FTTH networks and has increased, especially since 2014. Telefonica’s investment suffered under the financial crisis but from 2013 to 2015 the company invested heavily in FTTH as a reaction to the loss of market share.

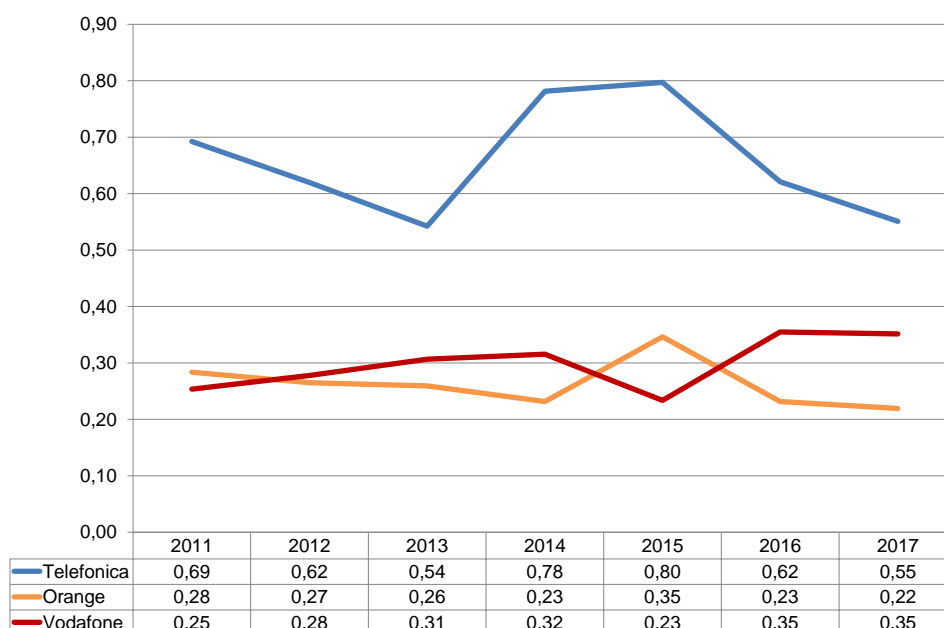
Figure 5-18: Fixed capex of largest operators in Spain (million euro)



Source: WIK based on Newstreet Research (2019).

The relatively high capex levels of Telefonica can also be seen in the capex as a ratio of revenues (see figure below). The lower capex ratios of the alternative operators may reflect the fact that they remain, at least in part, reliant on wholesale access, which is less capital intensive than fibre deployment, and have also engaged in infrastructure swaps to limit the degree to which they duplicate fibre deployment (see section below).

Figure 5-19: Capex/revenues in Spain (2011-2017)



Source: WIK based on CNMA statistics⁹⁸ and Newstreet Research (2019).

5.3.3 Wholesale agreements (access swaps and wholesale access to Telefonica's network)

In the absence of regulated access to ultrafast broadband, the largest operators in the broadband market concluded co-investment agreements on the basis of 'access swaps'.

In October 2012 a co-investment agreement was concluded between Telefonica and Jazztel. The aim of the agreement was to develop and share in-house cabling and connections for 3 million households. Under the agreement, the two companies provide each other with access to in-house cabling for 1,5 million households, including some households, which had already been connected by Telefonica at the time of the agreement. Access is usually provided in the basement of the building. IRUs are used for access to in-house cabling (vertical). Jazztel was acquired by Orange in 2015, but the co-investment agreement with Telefonica remained in place.⁹⁹

⁹⁸ http://data.cnm.es/datagraph/jsp/inf_anual.jsp.

⁹⁹ See http://www.eldiario.es/economia/Telefonica-Jazztel-acuerdo-comparticion-coinversion_0_55994754.html sowie CNMC (2016): Resolución por la cual se aprueba la definición y análisis del mercado de acceso local al por mayor facilitado en una ubicación fija y los mercados de acceso de banda ancha al por mayor, la designación de operadores con poder significativo de mercado y la imposición de obligaciones específicas, y se acuerda su notificación a la comisión europea y al organismo de reguladores europeos de comunicaciones electrónicas (ORECE)

In addition, the two main competitors with the highest market shares (Vodafone and Orange Spain) agreed a co-investment 'swap' deal in March 2013. The companies planned to expand the FTTH network to cover a total of 3 million building units (households, offices, smaller companies) in 50 major cities in the country within 4 years. Each company planned to develop 1,5 million building units; the total costs for the expansion were expected to amount to one billion euros. Under the arrangement, each company would expand their coverage in geographically complementary areas (avoiding over-build), and provide access to each other.

Under the deal, if Vodafone or Orange Spain did not deploy their own network in a given area, but instead obtained access through their partner, they were obliged to pay the other company a one-off fee for an IRU over 50 years. In addition, monthly fees per active user for operating the network infrastructure must be paid to the company constructing the network.

The agreement between Vodafone and Orange was adjusted following two acquisitions. ONO had already connected about 1 million cable households at the time of Vodafone's acquisition in 2014; access to these households became part of the co-investment agreement; Vodafone/ONO offers Orange access to these households on a bitstream basis. At the time of the acquisition by Orange, Jazztel had already connected around 1 million households, which were also included in the co-investment. The other households (i.e. about 0,5 million by both co-investors) would be connected via new construction.¹⁰⁰

Prior to the conclusion of the co-investment, both parties had also entered into a commercial agreement with Incumbent Telefonica providing for reciprocal access to in-house infrastructure. This referred to the 66 municipalities in Spain which were classified as competitive in the 2016 market review of markets 3a and 3b. In these areas, Telefonica grants Orange and Vodafone access to in-house cabling in certain larger buildings (the so-called Block Towers). In return, Telefónica will have access to Orange and Vodafone in-house cabling in areas where it does not have its own FTTH network.¹⁰¹

A third co-investment agreement was signed in 2016 between Orange Spain and MasMovil. The agreement can be seen as a consequence of the acquisition of Jazztel by Orange. To safeguard competition, Orange was obliged by the European

(ANME/DTSA/2154/14/MERCADOS 3a 3b 4), p. 86 f., downloadable at: <https://www.cnmc.es/file/170783/download>.

100 See http://www.elconfidencial.com/tecnologia/2013-02-21/los-bandos-de-la-fibra-optica-jazztel-y-movistar-contra-orange-y-vodafone_768004/ sowie CNMC (2016): Resolución por la cual se aprueba la definición y análisis del mercado de acceso local al por mayor facilitado en una ubicación fija y los mercados de acceso de banda ancha al por mayor, la designación de operadores con poder significativo de mercado y la imposición de obligaciones específicas, y se acuerda su notificación a la comisión europea y al organismo de reguladores europeos de comunicaciones electrónicas (ORECE) (ANME/DTSA/2154/14/MERCADOS 3a 3b 4), p. 86 f., downloadable at: <https://www.cnmc.es/file/170783/download>.

101 See BEREC (2016): Challenges and drivers of NGA rollout and infrastructure competition, downloadable at: http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/6488-berec-report-challenges-and-drivers-of-nga-rollout-and-infrastructure-competition.

Commission to divest a fibre optic network covering more than 700.000 lines. This requirement was met by the sale of an FTTH network with 720.000 connections to MasMovil. In return, however, Orange received the "protected right" to use up to 40 % of the capacity of the sold network for 35 years to continue serving its own customers.¹⁰²

In a further step, the two companies announced their intention to expand this agreement in October 2016. The addendum provides for an additional 2 million households to be connected, with Orange targeting 1,25 million households in more urban areas and MasMovil 750.000 households in more rural areas. In both agreements, IRUs are used.¹⁰³

The swap agreements by Orange Spain give it access to more than 3,5 million ultrafast lines in operation or due to be constructed, in addition to the 10 million lines it had constructed by the end of 2016.

5.3.4 Competition in alternative network FTTH zones

The degree to which there is duplication of ultrafast networks in Spain is not reported by the NRA. Areas with cable coverage have at least two ultrafast networks, and in very dense areas, three networks may operate in parallel.

The choice available to end-users is however, increased by the presence of infrastructure swaps (described above), commercial and regulated wholesale agreements.

For example, at least 7 million individual subscribers (38 % households) are believed to have a choice of three or more ultrafast broadband providers based on infrastructure shared between Orange and Vodafone, alongside Telefonica's extensive deployment. As these figures exclude premises for which Orange Spain and Vodafone and Telefonica have each deployed parallel infrastructure (alongside Telefonica), the true proportion of households with access to three or more offers could be even higher.

In addition to the choice available via parallel deployments and reciprocal access agreements, a choice of at least three retail ultrafast providers in Spain has also been assured across the whole footprint of Telefonica's FTTH deployment through wholesale access offers. The introduction by CNMC in 2016 of regulated FTTH VULA in non-competitive areas has enabled a choice of at least three operators based on access-based competition in areas covering around 65 % of the population, and access has been extended to areas not subject to FTTH regulation through the signature in 2017 of a commercial FTTH wholesaling agreement between Telefonica and Vodafone as well

102 See Europäische Kommission (2015): Fusionskontrolle: Kommission genehmigt Übernahme von Jazztel durch Orange unter Auflagen – weitere Einzelheiten, downloadable at: http://europa.eu/rapid/press-release_MEMO-15-4998_de.htm.

103 See https://economia.elpais.com/economia/2016/10/10/actualidad/1476097156_500492.html.

as Orange Spain (in 2018), based on long-term guaranteed sales (i.e. effectively a risk sharing arrangement).¹⁰⁴

The table below shows the increasing demand for the NEBA FTTH product provided by Telefonica and the decrease of ULL and line sharing. Also, wholesale broadband access lines provided by other operators has increased from 12.742 in 2015 to 528.950 in 2017.

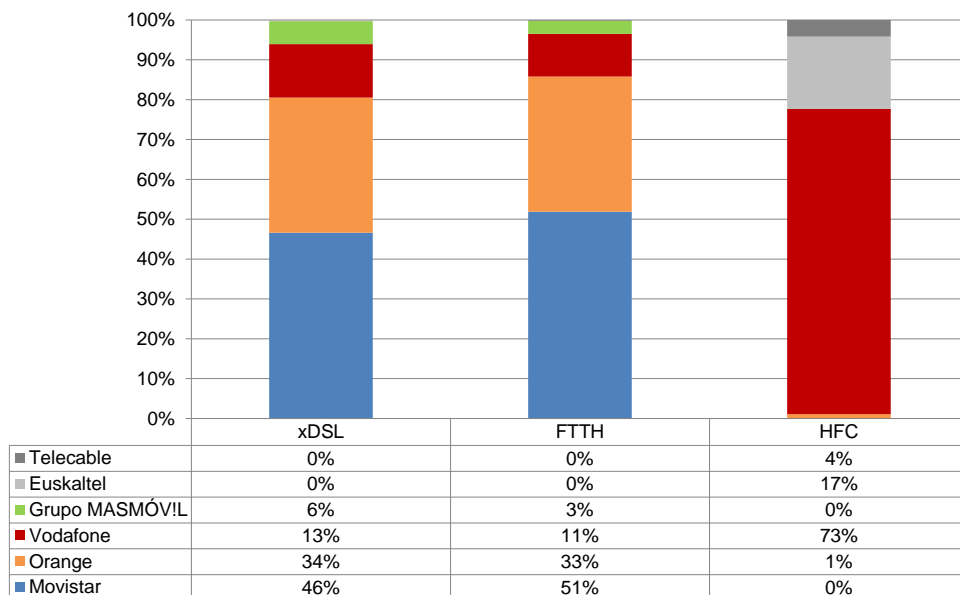
Table 5-4: Wholesale broadband access in Spain (connections 2015-2017)

	2015		2016		2017	
	Telefónica de España	Others	Telefónica de España	Others	Telefónica de España	Others
ULL	3.569.255	0	2.955.881	0	2.311.714	0
line sharing	77.913	0	66.822	0	42.722	0
NEBA FTTH	144.553	0	324.475	0	849.396	0
NEBA copper	33.281	0	66.075	0	94.516	0
Concentration ATM/IP	634.269	12.742	560.567	100.668	427.451	528.950
Resale	2.720	47.147	2.342	55.155	1.614	10.040
Total	4.461.991	59.889	3.976.162	155.823	3.727.413	538.990

Source: CNMC statistics.

At the retail level, there is further competition based on copper unbundling. Retail market shares by technology and operator in 2017 are shown below. It can be seen that while the xDSL market share of the incumbent Movistar was below 50 %, its market share in FTTH was 51 %.

Figure 5-20: Broadband access lines by technology and operator in 2017



104 See <https://www.telefonica.com/en/web/press-office/-/telefonica-and-orange-sign-a-commercial-wholesale-agreement-for-fiber-optic-network>.

Source: CNMC (2018).¹⁰⁵

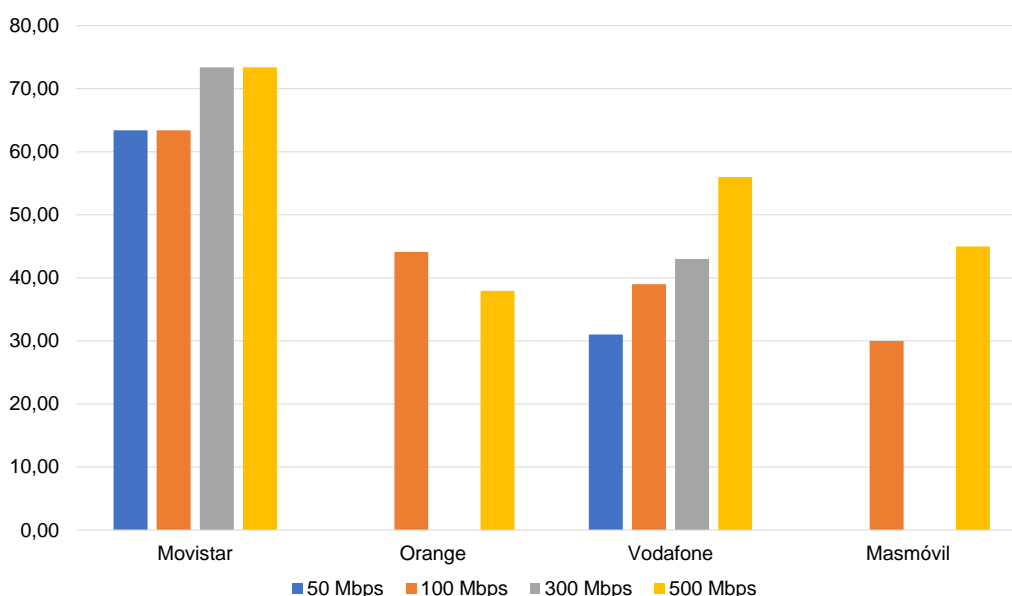
5.3.5 Retail outcomes in altnet FTTH zones

Retail prices

In Spain the pricing strategy followed by the network operators consisted in offering the same price for low entry fibre products as for xDSL to incentivise migration. For FTTH bundles (product with 300 Mbit/s symmetric), however, operators demanded a mark-up of € 10-12 compared with xDSL.

The comparison of prices between operators shows that Telefonica has a higher monthly price than its competitors and that the prices for 50 and 100 Mbit/s and 300 Mbit/s and 500 Mbit/s respectively are the same. The other operators demand a mark-up for higher bandwidths.

Figure 5-21: FTTH broadband retail pricing in Spain Q1 2019: Average price of operators based on 2 years contract excl. VAT (symmetric bandwidths)



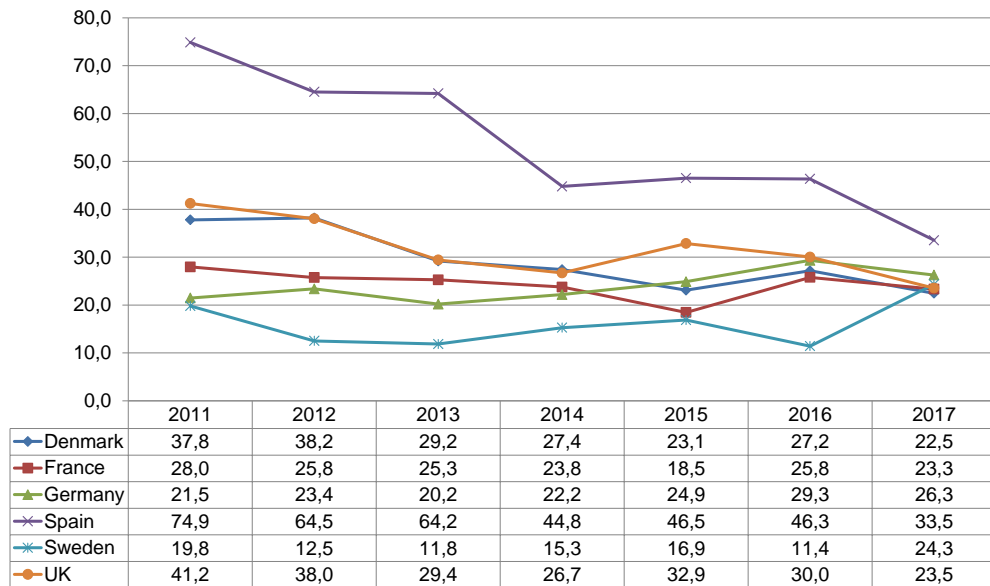
Note: The price of Vodafone for 500 Mbit/s is the price for 1 Gbit/s

Source: WIK based on websites of operators.

¹⁰⁵ Based on CNMC data downloaded at http://data.cnmc.es/datagraph/jsp/inf_anual.jsp.

The international benchmark shows that the prices for bandwidths above 30 Mbit/s have decreased considerable since 2011 but still are at a higher level than in other European countries.

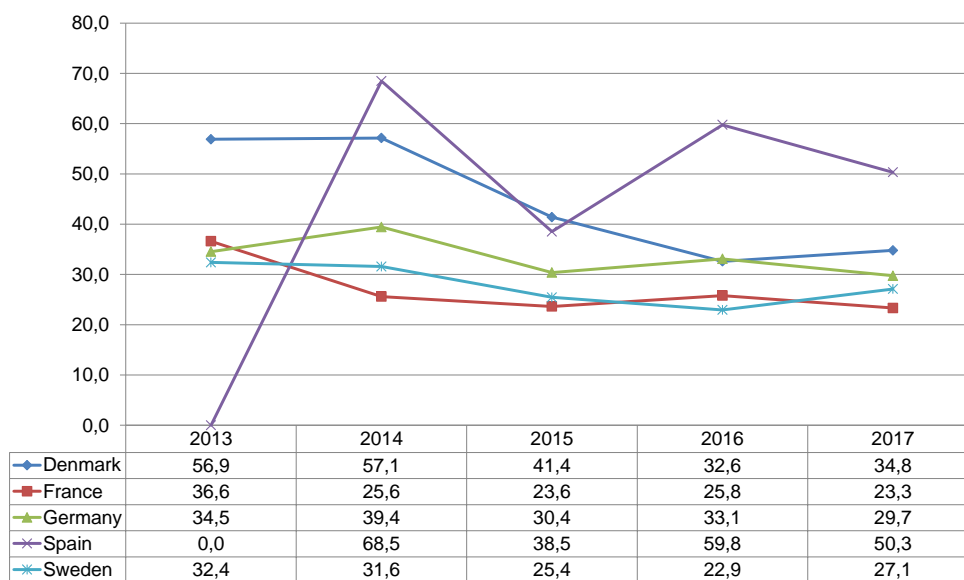
Figure 5-22: Monthly price of standalone internet access, advertised download speed above 30 and up to 100 Mbit/s (minimum_euro_PPP)



Source: European Commission, Digital Agenda Scoreboard.

The prices for bandwidths above 100 Mbit/s are comparatively high.

Figure 5-23: Monthly price of standalone internet access, Advertised download speed above 100 Mbit/s (minimum_euro_PPP)

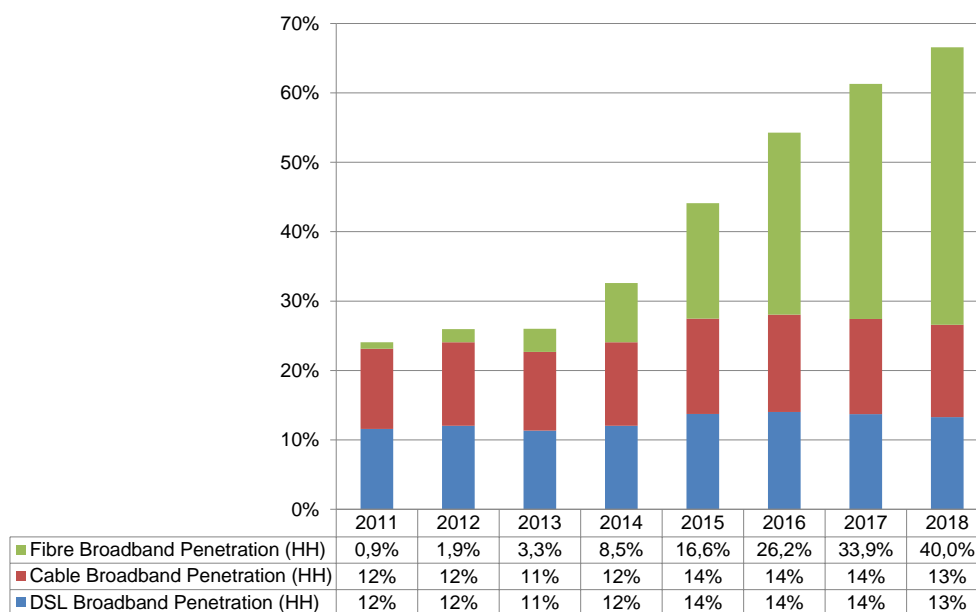


Source: European Commission, Digital Agenda Scoreboard.

Quality

The take-up of FTTH has accelerated, and stood at 40 % of broadband connections in 2018.

Figure 5-24: Evolution of Broadband access lines by technology (in % of households, 2011 – 2018)



Source: European Commission, Digital Scoreboard.

In 2017, the number of active fibre accesses of Movistar, Orange and Vodafone surpassed the number of xDSL accesses. In this way, FTTH has become the main mode of access for these operators who, in recent years, have carried out an intense deployment of FTTH and have migrated their accesses based on the copper pair to NGA accesses.

Data on average actual download speeds drawn from testmy.net show that Orange and Vodafone achieve an average download of 50 and 19 Mbit/s respectively compared with 52 Mbit/s of Telefonica in Spain. In Madrid the average download was 75,1 Mbit/s and average upload of 37 Mbit/s.¹⁰⁶

Data on average actual download speeds drawn from speedtest.net show a higher average download for Spain in 2017 of 61 Mbit/s and average upload of 46 Mbit/s. The results of the nationwide speed score indicates Orange as speed score leader with 80 followed by Movistar and Vodafone with 65 and 44 respectively.¹⁰⁷

106 See <https://testmy.net/list?q=Spain> and <https://testmy.net/list?q=Madrid>.

107 See <https://www.speedtest.net/reports/spain/>.

5.3.6 Conclusions and relevance for Denmark

Symmetric access to in-building infrastructure has been extensively used in Spain. However, there are significant differences between the context of the Spanish market and that of Denmark.

Symmetric access in Spain has been used – especially in very dense urban areas - to support the development of end-to-end infrastructure competition in FTTH amongst the incumbent (and main operator deploying FTTH) and large-scale alternative operators, who are present in the retail broadband market.

In contrast, in Denmark fibre has predominantly been deployed by regional fibre utilities, with limited duplication of the fibre infrastructure or apparent interest in doing so by alternative operators or by TDC itself.

As such, while Spain provides a model as to how standards for in-building infrastructure and associated access obligations could be elaborated, it does not provide an indication as regards the potential take-up of this kind of access in the Danish market.

5.4 Sweden

5.4.1 Regulatory regime applying to very high capacity networks

In Sweden, access to FTTH networks has been mandated since 2010 on the incumbent operator alone, via remedies imposed under the asymmetric (SMP) regime. Access was originally mandated to FTTH unbundling and bitstream at cost-oriented rates which did not include any risk premium – although an uplift on the cost was allowed for single-dwelling units. However, in the last (2015) market analysis decision, PTS took into account the competitive dynamics from cable and municipal deployments by (i) lifting the obligation on TeliaSonera to provide bitstream access (previously under market 5/3b); ¹⁰⁸ and (ii) permitting flexibility in the pricing of fibre unbundling,¹⁰⁹ subject to enhanced measures to ensure non-discrimination including Equivalence of Input and economic replicability (margin squeeze) tests.

In 2018, PTS launched a public consultation in connection with its latest analysis of the Wholesale Local Access market.¹¹⁰ One of its key provisional conclusions was that – on a forward-looking basis – copper and fibre were no longer in the same relevant product market, and that two markets should therefore be defined at retail level involving respectively (i) broadband delivered over fibre and cable; and (ii) broadband

108 PTS (2015), Beslut om fastställande av företag med betydande inflytande på marknaden för centralt tillträde till nätinfrastuktur (marknad 3b), 2015-02-19.

109 PTS (2015), Beslut om fastställande av företag med betydande inflytande på marknaden för lokalt tillträde till nätinfrastuktur (marknad 3a), 2015-02-19.

110 See <https://pts.se/en/news/internet/2018/pts-inleder-samrad-kring-marknaden-for-lokalt-tilltrade/>.

delivered over copper. PTS concluded that at the wholesale level two markets could be defined: namely local access to fibre-based networks, and local access to copper-based networks. Both were considered to be national, and Telia was found to have SMP on both wholesale submarkets. PTS continued to find that no operator had SMP on the wholesale central access (bitstream) market, and that this market was functioning well.

No fibre access obligations have been formally imposed based on symmetric regulation. Thus, only the incumbent is subject to fibre access obligations in Sweden.

5.4.2 Main alternative investors in FTTH

72 % of households and 67 % of businesses had access to fibre-based broadband services at the end of 2017 in Sweden. Coverage of fibre access networks in Sweden is shown in the diagram below.

Figure 5-25: Coverage of FTTP networks in Sweden



Source: PTS.

The majority of fibre infrastructure in Sweden has been deployed by local city networks, such as Stokab, the municipal network serving the Stockholm area. Around 175 from 290 municipalities in Sweden have deployed fiber-optic networks in the past ten to fifteen years, representing more than 50 % of the local fibre coverage.¹¹¹ Most municipal networks offer passive access to fibre (fibre unbundling) and operate a wholesale only business model.

In contrast, although it stepped up its fibre deployments in recent years, incumbent Telia's fibre-based access network has a more limited reach serving around 1,7 million of the approximately 5,7 million households and business premises in Sweden (~30 %). Telia provides regulated fibre unbundling services. From 2008 until 2017, regulated wholesale services were provided via Telia's structurally separated (but wholly owned) subsidiary Skanova. However, in 2018 Skanova was reintegrated into Telia as part of a larger wholesale unit "Telia Infra".

Another private operator that has been engaged in fibre deployment is IP only. IP only has deployed its own backbone network across the Nordic region. It makes use of municipal fibre and has also completed a number of fibre deployment projects, many involving municipalities, across Sweden. IP only states that it has the ambition to invest 15 billion SEK (€ 1.4bln) up to 2020 including 7 billion SEK in sparsely populated and rural areas.¹¹²

Financial data is not available for all city networks. However, published accounts show that the wholesale only Stockholm city network Stokab invested an average of more than 250 million SEK (approx. € 25 million) per year, to total of 5,4 billion SEK (€ 540 million) from its inception up to 2012.¹¹³ The first phase of the network deployment was funded using loans, but customer revenues soon provided the funds necessary to expand the network. Stokab started generating positive cash flows in 1998 until 2003, overextension in network deployment combined with a contraction in demand resulted in a first loss. Following a write-off of € 50 million, positive cash flows returned after 2003 and profits in 2008. In 2017 the turnover was 784 million SEK (approximately € 77 million) and profits amounted to 234 million SEK (€ 23 million).

The financial position of other municipal networks has also been positive – for the most part – with 65% of municipal network companies showing positive results after 10 years and 10% balanced, with less than 25 % of them currently showing negative results.¹¹⁴

111 WIK Consult (2016) based on Swedish Local Fibre Alliance (Svenska Stadsnåts Föreningen) <http://www.ssnf.org/Global/Bilder/Rapporter%20och%20informationsmaterial/EU/Dokument/Local%20fibre%20networks%20in%20Sweden.pdf>. Retrieved: 2016-01-06.

112 <https://www.ip-only.se/kommun/>.

113 WIK Consult (2016), Regulatory, in particular access, regimes for network investment models in Europe, final report, prepared for the EU-Commission, p. 565.

114 See SVENSKA STADSNÅTSFÖRENINGENS, MARKNADSRAPPORT 2012, Stockholm 2012.

Experience of fibre deployment in Sweden shows that, in general, companies that only provide passive infrastructure and contract out network management, tend to have a leaner organization, an easier business case, and a better medium and long-term financial situation.¹¹⁵ However, at the same time, because of its regional focus, the layered model poses some challenges in attracting service providers wishing to target a nationwide footprint. In order to attract service providers and facilitate access, especially in the smaller and more remote municipalities, several municipality networks have recently formed regional associations to interconnect the different local networks. The resulting regional networks provide greater scale, visibility and a single-interface towards the service provider market.¹¹⁶

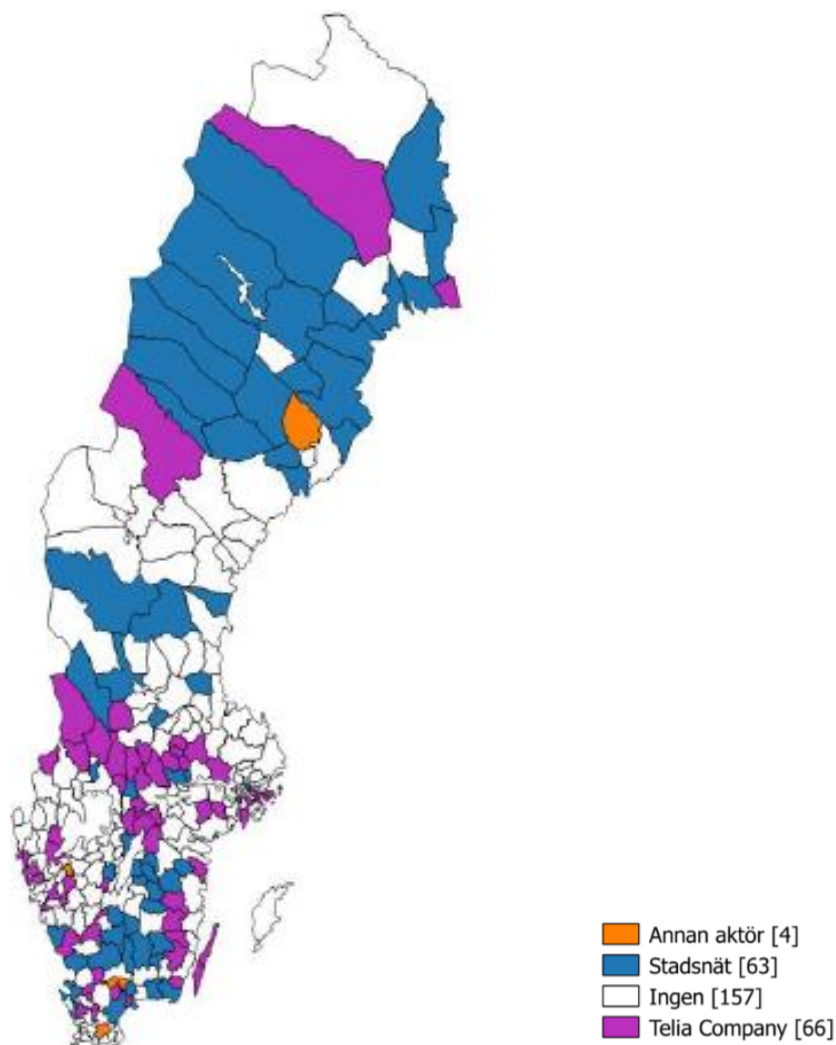
5.4.3 Competition in altnet FTTH zones

Although three very high capacity networks are present across much of the capital Stockholm (Stokab, Telia and the cable operator Comhem), elsewhere in the country, infrastructure-based competition in very high capacity networks is limited. PTS reports that in 133 of the 290 municipalities, there is a network owner with more than 80 % of the total number of wholesale very high capacity connections. This operator is Telia in 66 of the municipalities (shown in purple in the following chart) and the local city networks (blue) in 63 municipalities. In municipalities in which there is not a single network owner with more than 80 % of the connections (shown in white), it is most common that Telia and the local city network together own the majority of the connections.

115 Lemstra, W. and W. H. Melody (Eds). The dynamics of broadband markets in Europe: Realizing the 2020 Digital Agenda. Cambridge: Cambridge University Press. p. 145.

116 Ibid.

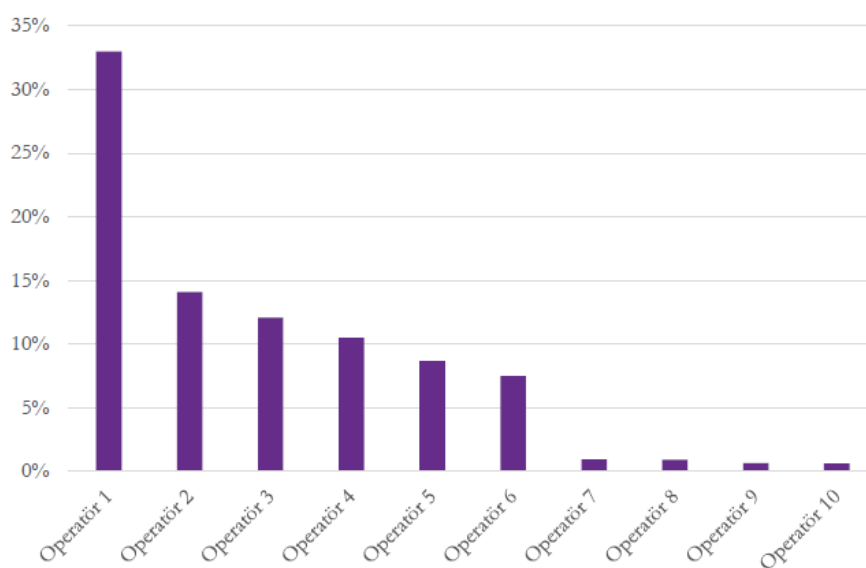
Figure 5-26: Municipalities where a network owner has over 80 % of the number of connections



Source: PTS Building Database.

Notwithstanding the limited degree of infrastructure competition, there is significant retail competition in very high capacity broadband across much of Sweden. At the retail level, as of the end of 2017, PTS reports that there were 139 retail operators providing services via cable and fibre networks to apartment blocks. The largest operator had a 33 % market share, with the next two largest operators having a market share of 14 % and 12 % respectively (see below). Retail competition in very high capacity connectivity is facilitated by the fact that the municipal fibre networks are mostly operated on a wholesale only basis, while Telia provides regulated and commercial wholesale services over fibre. 132 retail operators, largely local urban networks, had a national market share of below 1 %.

Figure 5-27: Retail market shares in very high capacity broadband in Sweden 2017



Source: PTS.

5.4.4 Wholesale pricing by municipal networks

In its latest (2018) draft market analysis, PTS noted that there are 42 smaller municipalities where Telia currently has no established fibre market areas, and where, in the case of fibre networks, the market concentration is significantly higher than in the municipalities where Telia has fibre infrastructure.

In order to assess the potential for excessive pricing at the municipal level, PTS collected prices for dark fibre (fibre unbundling) between September 2016 and January 2017. 252 operators were asked, of which 119 were both network owners and operators, 86 only network owners and 47 only operators. There were significant variations in pricing between different municipalities. According to PTS, the lowest rents lay at approx. 500 SEK per month while the highest were around 4.000 SEK per month. The average value of all municipalities was approx. 1.700 SEK, while the range between the 25th and 75th percentile, within which 50 per cent of the prices lie was 1.150 – 1.900 SEK. However, PTS did not observe any statistically significant correlation between city network prices and their local market shares, and postulated that some price differences could result from differences in the business model (e.g. a tendency amongst operators offering active access to promote such access rather than passive access) rather than being due to competitive dynamics.¹¹⁷

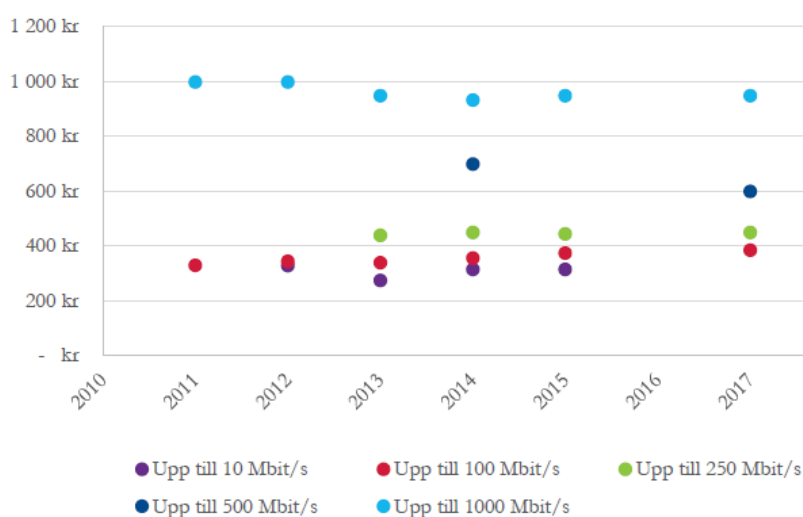
¹¹⁷ Page 81 PTS consultation on draft market 3a analysis.

PTS's investigation also indicated that Telia's application of different price levels in different areas shows a low degree of correlation with the presence of competing urban networks in the different areas.

5.4.5 Retail outcomes in areas served by municipal networks

PTS notes that prices for fibre subscriptions have gradually declined in recent years (between 2-5 %), with the exception of the "entry-level" service at 100 Mbit/s. Gigabit subscriptions remained the most expensive on the market and ranged from an offer of 999 SEK per month from the incumbent Telia to an offer of 899 SEK per month from Bredbandsbolaget (owned by Telenor).¹¹⁸

Figure 5-28: Fixed broadband via fibre, price development over time for different speeds



Source: PTS based on data from Strategy Analytics Teligen.

In a more granular 2017 analysis by WIK-Consult of prices offered by operators using the wholesale network of Stokab,¹¹⁹ Gigabit connectivity was provided at a monthly price of between 827 SEK (Bredband 2) and 899 SEK (All Tele).

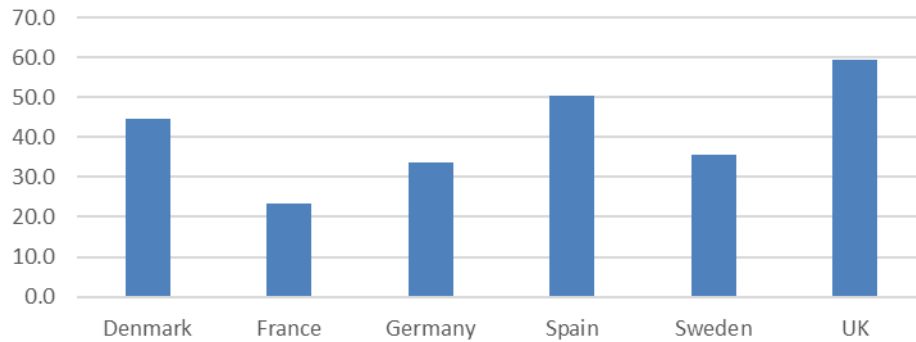
Prices for fast broadband (at speeds of above 100 Mbit/s) are higher than in France and Germany, according to data collected for the European Commission.¹²⁰ However, fibre is also considerably more widespread in Sweden than those countries, making like for like comparisons challenging.

¹¹⁸ Page 36 PTS consultation on draft market 3a analysis.

¹¹⁹ WIK (2017) The implications of broadband business models on choice, price and quality.

¹²⁰ Fixed Broadband Prices in Europe 2016/2017.

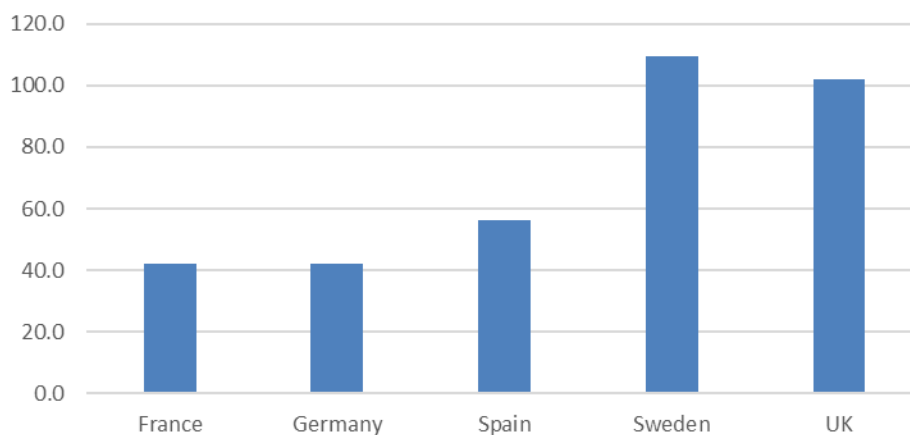
Figure 5-29: Monthly price of fixed broadband internet access offers including fixed telephony, Advertised download speed above 100 Mbit/s (minimum euro PPP) 2017



Source: European Commission, Digital Agenda Scoreboard.

Reflecting the high availability and take-up of fibre, supported by municipal offers, Sweden had the highest average connection speeds for fixed broadband connections in 2017 as reported by Akamai of the six countries we reviewed (22,5 Mbit/s compared with 20,1 Mbit/s in Denmark and 10,8 Mbit/s in France). Bandwidth usage was also higher in Sweden than in the other countries studied (see below).

Figure 5-30: Fixed data: MB per subscriber (monthly traffic in GB) 2017



Source: WIK, based on CISCO, VNI Forecast Widget.

5.4.6 Conclusions and relevance to Denmark

As in Denmark, the majority of fibre deployment in Sweden has been carried out by alternative local investors – in this case municipalities. Unlike in Denmark, however, the business model pursued by these investors was mostly wholesale only, and focused on the supply of passive wholesale access (fibre unbundling).

The wholesale only model pursued in Sweden has supported a wide range of retail service providers, and the widespread provision of ultrafast speed broadband (including broadband at Gigabit speeds) at prices which are competitive compared with Danish offers.

Evidence suggests that the business models of municipal providers have mostly (although not all) proved to be sustainable over a 10 year period.

These outcomes have been achieved in the absence of regulated access to the networks of municipal networks. Due to their wholesale only character, many of these networks would in any event be excluded from symmetric regulation under the exemptions provided for in the EU electronic communications Code.

PTS did not find evidence demonstrating excessive pricing amongst municipal networks in areas that were not served by other ultrafast (fibre or cable) broadband networks. It did however find wide variations in the charges amongst the carriers, which may have been influenced by the degree to which they had an interest in marketing passive access vs downstream active services that some of the municipal networks offer.

5.5 Lessons from case studies

A summary of the business models applied by alternative investors as well as details of regulation and wholesaling in the four case study countries compared with Denmark is shown in the following table.

Table 5-5: Overview of case studies I

	Alternative FTTH investors	Typical scale/ coverage	Business model	Altnet FTTH subject to access obligations?	Regulated FTTH access type/ aggregation level /take-up	Commercial FTTH access type / take-up
Denmark	Utilities/co-operatives	Local scale projects, but ranging in size	Vertically integrated, or wholesale only with single retailer	No	N/A	Bitstream / limited
France (commercial zones - less dense areas)	Alternative telecom operators	Large - nationwide retail provision	Vertically integrated	Yes - symmetric obligations on FTTH terminating segment	Passive access (unbundling) 1.000 households / high take-up	
France (public initiative "state aid" zones)	Specialist infrastructure investors	Local scale projects e.g. 200.000 lines, but investors engage in multiple projects	Wholesale only	Yes - symmetric obligations on FTTH terminating segment	Passive access (unbundling) 1.000 households / high take-up	Bitstream / limited
Germany	Utility-owned city-carriers	Local scale projects, but ranging in size	Vertically integrated	No	N/A	Bitstream / expanding from low base
Spain	Alternative telecom operators	Large - nationwide retail provision	Vertically integrated	Yes - symmetric obligations for in-building wiring access	In-building wiring for MDU, or access to small groups of SDU / high take-up in very dense areas	Exclusive regional access swap agreements prevail, some commercial wholesaling - based on bitstream
Sweden	Municipal networks	Local scale projects, but ranging in size	Wholesale only	No	N/A	Passive access (unbundling) + bitstream in some cases / high take-up

Source: WIK.

The case studies cover two examples of countries which apply symmetric fibre access regulation on alternative operators (France and Spain), respectively at the level of “fibre unbundling” (aggregating 1.000 lines in less dense areas) and access to in-building wiring (with extension beyond in some cases); and two examples of countries which have not applied symmetric access obligations on alternative operators or investors in fibre, Germany and Sweden, but where commercial offers have been made available in some cases.

The case studies provide useful insights on both the *relevance* of symmetric access obligations for the Danish market and the *impact of wholesaling* (whether regulated or commercial) for non-incumbent operators on investment, competition and consumer outcomes.

5.5.1 Relevance of symmetric regulation to the Danish context

A first point of interest is the context in which symmetric regulation was mandated. In Spain and France, symmetric regulation was mandated in the period between 2008-2010, *before* the widespread deployment of FTTH. In both countries the aim was to provide a framework for *new* fibre investments. Thus, fibre investments were made by all parties in full knowledge of the access regime that would be applied.

In Spain and in France (commercial areas) a key aim was to enable *infrastructure-based* competition amongst traditional vertically integrated telecom operators investing in fibre, on the expectation that “alternative operators” which had previously invested in copper unbundling, would climb the ladder of investment (either by deploying to households directly or by “co-investing” in fibre through IRU). There is an element of reciprocity in these cases, in that operators invest in different zones and provide access to other investors on similar terms, enabling the development of homogenous retail offers for very high capacity broadband.

In France (public initiative areas), there are specialist providers, which are not typically present on the retail market. In these zones, the symmetric regime had the added objective of ensuring a common architecture, and wholesale offering/pricing model amongst different regional infrastructure providers, to facilitate the take-up of wholesale access in these areas and support the homogenous retail offers of major broadband service providers.

In the Danish situation, fibre has already been widely deployed by alternative investors, and thus, if symmetric regulation were applied now, it would be applied after deployment in most cases, and therefore its impact could not have been taken into account by the investors. Moreover, as we know from interviews, TDC and alternative operators are not interested in deploying fibre into homes that have already been served by fibre utilities or co-operatives, and fibre utilities are in general not interested in retailing services beyond their coverage area, the objective (in commercially viable

areas) of “promoting infrastructure competition” and ensuring “reciprocal access” amongst vertically integrated providers of broadband services would not be relevant in the Danish case.

The specific case of the French “public initiative areas” does have more parallels with the Danish situation, in that symmetric obligations applied to different regional players could provide a set of common standards for wholesale access supporting retail service provision across areas served by regional players. Recent developments under which the incumbent has declared its intention to serve public initiative areas in France alongside the presence in many of these areas of alternative operators such as Bouygues – serve to highlight the potential effectiveness of this approach.

However, it should again be noted that investments in these public initiative areas in France were made in the knowledge of the regulatory regime that would be applied, and – in most cases – with the support of state aid, which is associated with “open access” obligations. Moreover, by designating concessions zones of a given size, the state aid regime was designed to ensure that projects achieved a certain minimum scale. Thus the expectations and ability of French regional carriers to support wholesale access regulation could be considered different from that applying in Denmark.

5.5.2 Impact of wholesaling for non-incumbent fibre operators

Aside from the relevance of symmetric regulation to the Danish situation, case studies can provide insights on the impact of wholesaling on the business case of smaller non-incumbent regional fibre operators.

Provision of wholesale access by such operators is present in France (public initiative zones), as well as in Germany (utility-owned “city carriers”) and in Sweden (municipal networks).

In France, the PIN networks are subject to symmetric access regulation, and offer fibre unbundling at aggregation points of 1.000 (the same as in commercial zones).

In the countries where alternative investors have not been regulated (Sweden and Germany), wholesale offers have been voluntarily made available. However, there are significant differences between the approaches taken by the operators. In Germany (like in Denmark), local utility-owned operators have offered bitstream access as a secondary strategy, with limited take-up, while in Sweden, the municipally owned networks have typically pursued a “wholesale only” strategy – offering fibre unbundling, alongside in some cases, bitstream.

The table below shows the regulated or commercial wholesale access offered alongside deployment by alternative investors, levels of competition, wholesale and retail offers in the market.

Table 5-6: Overview of case studies II

	Regulated FTTH access type / aggregation level / take-up	Commercial FTTH access type / take-up	Deployment by non-incumbent FTTH investors	Profitability	VHC infrastructure competition in alternative investor zone	VHC retail competition in alternative investor zone	Wholesale pricing by alternative investors	Retail pricing in alternative FTTH investment zones
Denmark		Bitstream / limited	[confidential] households nationwide. Nearly all of the installed FTTH, expanding	Negative EBIT margins in several cases, although some now making returns	None or cable, in some cases	Limited, where no cable	Not known	Fibre utilities offer similar prices to other operators for fibre-based access in zone.
France (commercial zones - less dense areas)	Passive access (unbundling) 1.000 households / high take-up		~20 % total FTTH deployment in these zones. Expanding - SFR planning 1 million homes p.a for 4 years	FTTH business case not separately disclosed	None or cable, in limited cases	2-4 offers via passive access	Regulated € 500 per line for IRU + € 5 per month for activated passive fibre lines	Same offers as other areas
France (public initiative zones)	Passive access (unbundling) 1.000 households / high take-up	Bitstream / limited	63 % of total FTTH deployment in these zones. Expanding	FTTH business case not separately disclosed. However TDF expects payback period of 8-12 years	None	1-2 offers via passive access, but varies (10+ in some cases)	Regulated € 500 per line for IRU + € 5 per month for activated passive fibre lines	Same offers exist, but some specialist retailers
Germany		Bitstream / expanding from low base	Alternative investors account for 76 % FTTH deployment, but volumes are limited	FTTH business case not separately disclosed	None or cable	Some, on the basis of bitstream		Competitive prices offered, but limited Gigabit offers
Spain	In-building wiring for MDU, or access to small groups of SDU / high take-up in very dense areas	Exclusive regional access swap agreements prevail, some commercial wholesaling - based on bitstream	Alternative investors account for 49 % of total FTTH deployment (but with overlap)	FTTH business case not separately disclosed	1 or 2 competing networks including Incumbent FTTH, also cable in some zones	4+ offers via swap arrangements and/or commercial wholesaling		Similar offers as elsewhere
Sweden		Passive access (unbundling) + bitstream in some cases / high take-up	Alternative investors account for more than 50 % of total FTTH coverage	65 % municipal networks positive results after 10 years, 10 % balanced. <25 % negative	None, 1 (incumbent) or 2 (incumbent + cable) competing networks, depending on area	Significant number of ISPs	Highly variable wholesale prices, but not correlated with market share	Gigabit offers widely available. Competitive retail offers can be available (dependent on wholesale price)

Source: WIK.

Available evidence suggests that strategies focused on wholesaling – such as those pursued by many of the municipal networks in Sweden, have been associated with reasonable commercial outcomes for most operators, and have also delivered positive outcomes at the retail level in terms of choice for customers in very high capacity broadband offers and competitive prices.

Commercial outcomes for the wholesale only French public initiative networks are not clear, and the commercial success of these ventures may have been affected by the provision of state aid as well as the nature of state aid concession areas, which tends to favour a minimum scale of deployment. However, reporting by TDF suggests expected payback periods of 8-12 years, and these initiatives have received significant backing from commercial operators as well as investors. Retail competition in areas served by French public initiative areas has been limited, but is expanding, with the expectation that at least two major operators will soon have fibre-based offers available, alongside other specialist ISPs.

Wholesaling in Sweden has been supported by the basic nature of the access (fibre unbundling is typically offered, alongside bitstream in some cases) as well as the emergence of commercial intermediary platforms. Wholesaling on French regional networks has been supported by common regulated standards for wholesale offers, terms and pricing.

In contrast FTTH deployment and access-based competition has been more limited amongst the vertically integrated regional fibre investors in Germany.

While not definitive, these cases are suggestive that, at least for the larger scale regional Danish fibre utilities, a more active wholesaling policy, could make a positive contribution to the business case. Standardisation of the offers and the provision of a “one-stop-shop” for wholesale offers (as provided by intermediaries in Sweden) could also be positive for take-up and competition on Danish fibre utility networks.

6 Interviews with Danish stakeholders

Following the presentation of the interim report at the Danish Energy Agency in April 2019, WIK conducted on-site interviews with Danish stakeholders including the incumbent TDC, SE/Stofa, other alternative fibre investors represented by Dansk Energi, and alternative operators (such as Telenor Denmark and Telia).

- A summary of the main points follows: A significant number of fibre utilities are small scale and have a limited number of employees. Fibre utilities claim that this affects their ability to roll-out wholesale solutions. Most remain unprofitable due to high capex during the deployment phase. Insufficient take-up is also a challenge, and fibre utilities are aiming to increase the take-up on their networks.
- Duplication of existing fibre networks is considered not to be viable, except for larger business customers.
- Larger providers and business access providers have an interest in obtaining fibre unbundling from fibre utilities, but except in some specific cases, access seekers have found fibre utilities reluctant to provide passive access.
- Smaller broadband service providers prefer to rely on bitstream, which is the standard offer for fibre utilities currently providing access.
- There is a perceived difference in the openness of different fibre utilities in providing access. While some, such as Eniig and EWII are considered to be more open to providing access, and have recently signed access arrangements, there is a common perception that SE/Stofa is more reluctant to do so. There are concerns that a merger between SE/Stofa and Eniig could influence the incentives of OpenNet to voluntarily provide access, and ISPs have called for any merger to be subject to wholesale access remedies.
- Wholesale pricing by fibre utilities is seen as being higher than that offered by TDC. A key concern for service providers is the risk of margin squeeze by vertically integrated players.
- Passive access to the networks of housing associations (in-building wiring) is also of interest for some players.
- Service providers note the importance of adopting common standards and data formats for access provided by different fibre utilities. They would find it helpful to establish working groups to agree common standards. Standards are also needed to facilitate switching between broadband platforms, which is said to take 2-3 weeks.

More detailed points from the interviews follow.

6.1 Fibre utilities

[Confidential]

6.2 Incumbent – TDC

[Confidential]

6.3 Alternative operators

[Confidential]

6.4 Business providers

[Confidential]

7 Impact assessment for Denmark

This chapter assesses the impact of different options for the application of symmetric access regulation in Denmark, in view of the evidence provided in previous chapters.

We consider four main options, namely:

- Option 1 (base case), asymmetric VHC regulation only (no symmetric regulation)
- Option 2: In-building wiring subject to symmetric regulation
- Option 3: Passive access (fibre unbundling) subject to symmetric regulation
- Option 4: Active access (bitstream) subject to symmetric regulation

Options 3 and/or 4 could in theory be applied in addition to option 2, if SMP regulation coupled with in-building wiring access was deemed to be insufficient to address enduring competition problems in the market.

We also consider the impact on competition and investment of exempting certain categories of operators from symmetric access obligations.

7.1 Option 1 (base case), asymmetric VHC regulation:

The impact of the base case scenario among others depends on whether

- market definition excludes technologies providing lower bandwidths and
- broadband markets are differentiated geographically in the market definition so that alternative operators may be found to have SMP at wholesale level in regions where they are the only network operator with a VHC network coverage
- VHC network operators (such as fibre utilities and housing/antenna associations) voluntarily provide wholesale access to their networks when they are not subject to asymmetric regulation

The issues linked with asymmetric VHC regulation are out of the scope of this study and therefore are not discussed in detail. However, the future decisions of the regulator on SMP regulation are highly relevant, particularly considering that alternative operators clearly have a preference for the provision of wholesale bitstream access at regional/central level which is typically provided in the context of SMP regulation rather than symmetric regulation (see discussion in section 3.1).

For the purposes of the base case scenario, we assume that the geographic scope of the market remains unchanged i.e. national, and thus wholesale access obligations are applied on TDC alone.

7.1.1 Impact on investment

Under the status quo, it seems likely that **TDC** will pursue its announced strategy of deploying fibre in those regions where there is no fibre coverage, and avoiding infrastructure duplication for residential broadband in areas served by fibre utilities due to the lack of a sound business case. We understand from interviews that **fibre utilities** are planning to expand fibre deployment in the areas they serve.

Service providers using wholesale access services to provide mass-market broadband services at retail level are not expected to invest in VHC networks, independently of whether they are granted wholesale access based on SMP regulation or not. Their investment will consist of the investment necessary to use wholesale access services, as well as investment in any services provided on top. Under the status quo, any additional investment in new platforms and VHC services is likely to depend on the degree to which fibre utilities voluntarily open their networks, and the ease of switching customers to the new VHC networks.

Business providers are expected to invest in fibre access connections to major corporate sites, but are likely to rely on wholesale access for smaller business sites or more remote areas.

7.1.2 Impact on competition

As described in section 2.7, the competitive outcomes for VHC broadband under the status quo depend on the conduct of fibre utilities concerning the provision of wholesale access on a voluntary basis and the development of standards which support the conclusion of contracts with and switching to multiple small providers.

Volumes of wholesale access by fibre utilities are currently low. Fragmented standards are a key concern. Interviews also suggest willingness on the part of some actors, but not others regarding wholesale provision, and a reluctance by most to provide passive access (fibre unbundling). Concerns have been raised about the implications for voluntary wholesaling and non-discrimination of the merger between Eniig and SE/Stofa, although, if such concerns are valid, the competition authority has the power to address them through merger remedies.

More generally, in a scenario where wholesaling on the networks of fibre utilities remains low (or limited to specific regions) and consumers move towards Gigabit offers, TDC's overall market share is likely to decrease. Service competition would be limited to services provided via TDC's networks, assuming they remain open to competing retail service providers. In areas served by fibre utilities in the absence of an alternative open cable infrastructure, the fibre utilities and/or linked retail providers could increase their market share and market power at the retail level.

On the other hand, if fibre utilities do effectively open their networks on a non-discriminatory basis, they may increase their wholesale market share and network utilisation, but their retail market shares may decline. A key beneficiary would be TDC, which may be able to increase its retail market share in those regions, further supporting relatively high broadband market shares across the country as a whole. Compared with the fibre utilities, TDC has advantages of size in buying content, financing and marketing, which could be further extended. On the other hand, wholesaling by the fibre utilities would benefit Telia and Telenor which may depend on open fibre networks to stabilise or increase their market shares and stop the slight decrease in market shares observed in the last years. More active wholesaling by fibre utilities could also support the deployment of business services and future mobile infrastructure.

It should be noted however, that even if fibre utilities open their networks voluntarily and achieve significant take-up by other parties, if wholesale access is limited to bitstream, the degree of differentiation in both price and quality will be limited, and its usefulness for business access and mobile backhaul would be restricted.

7.1.3 Impact on consumer welfare

As discussed in section 2.7, there is a reasonable likelihood that customers will continue to migrate to higher bandwidth services, and in this case, the pricing constraints that currently exist between copper vs cable and fibre networks might reduce.

In this case, there could be a risk of fibre utilities denying access or demanding prices above the competitive level, especially, in areas not served with cable. On the other hand, fibre utilities have the disadvantage of providing services at a significantly smaller scale than TDC which may lead to higher prices without this being an indication of no competitive pressure. As the fibre networks in many cases are owned by their customers it is possible that this might provide a constraint on prices.

However, regardless of price effects, experience from other countries (and past experience with the effect of copper unbundling in comparison with bitstream) suggests that the absence of passive access offers, may result in limited customer choice and lower quality in areas where wholesaling has not developed and is not widely used. A lack of widespread fibre available on an open access basis could also delay or render more expensive, the deployment of next generation mobile networks which will be more reliant on fibre backhaul.

7.2 Option 2 (symmetric regulation – in-building wiring only)

7.2.1 Impact on investment

Access to in-building wiring entails significant complementary investment in fibre access on the part of the access seeker. Because duplication in the access network is considered unviable, with the possible exception of deployment to major business premises, a detailed obligation to provide access to in-building wiring is unlikely to result in significant additional investment by network operators.

However, in-building wiring access could support competition to business premises and the provision of competing services to premises served by antenna or housing associations, in cases where in-building wiring (or access to wiring at the first concentration point) would provide access to a significant number of end-users.

7.2.2 Impact on competition

Due to the limited cases in which investment on the basis of in-building wiring is likely to be viable, it is unlikely to have a significant impact on competition. For example, in France, in-building wiring or access to wiring aggregating only a few households, supports competition to between 10-17 % of households (see case study in section 5.15.1.3). However, these households are mainly in the very densely populated Paris district, and access has also been supported by effective duct and sewer access, and willing investors.

In-building wiring access or access at the first distribution point could however support competition in the provision of services to some antenna or housing associations or to large business premises.

7.2.3 Impact on consumer welfare

The impact of in-building wiring access for end-users is likely to be limited to the specific cases referred to above (some antenna customers and businesses). However, as in-building wiring is offered on the basis of passive access, in cases where in-building wiring access does stimulate infrastructure competition, the potential for price and quality differentiation could be significant.

7.3 Option 3 (symmetric regulation – passive access)

This option is of interest for TDC and business service providers such as GlobalConnect and Colt, but not smaller broadband service providers. However, interviews conducted for this report suggests that most fibre utilities are reluctant to

offer passive access, and are unlikely to supply it in the absence of regulatory obligations or other incentives.

It should be noted that, as discussed in section 3.1, using symmetric access regulation to mandate passive access on all operators would be justified only in the event that other measures including SMP regulation, duct access and in-building wiring prove insufficient to support competitive outcomes in the market.

It is nonetheless worth considering the potential impact of passive access (fibre unbundling) on investment, competition and consumer outcomes.

7.3.1 Impact on investment

The case study of Sweden (see section 5.4) suggests that a sound business case can be made on the basis of wholesaling passive fibre access. However, the Swedish municipal fibre companies are not subject to regulation, and the prices they offer vary significantly. Operators specialising in providing access in rural areas in France also seem to have made a successful business based on offering passive access on regulated terms. However, these operators are typically larger in scale than Danish fibre utilities and are in receipt of state aid.

It seems reasonable to assume that in the Danish context, symmetric regulation of passive access might not have a negative impact on the investment case for fibre utilities (most of which operate point to point fibre networks, which are capable of unbundling). By opening marketing of the network to a wider set of service providers and increasing take-up (which is currently considered insufficient),¹²¹ passive access could even support the business case for fibre deployment by regional players, and thereby enable a greater degree of viable roll-out.

However, given the uncertainties over the business model and early stage in the investment, this is likely to be the case only if access pricing is left flexible, or properly reflects the cost structure of the different firms. In addition, it is possible that, especially for smaller firms, the process of introducing fibre unbundling could divert resources away from network deployment, at least in the short term. Attention would therefore be needed to making any obligation proportionate to the scale of the operators concerned, and to setting realistic timeframes for its introduction.

Symmetric regulation at the level of passive access (fibre unbundling) could support complementary investment, in core networks and services, for operators making use of it. If available in a form that is useful for mobile operators, it might reduce the investment needs of those operators in deploying new backhaul and fronthaul infrastructure, potentially enabling them to divert investments to more productive uses, such as expanding mobile coverage.

¹²¹ Take-up on the networks of Swedish wholesale only municipal networks appears in many cases to be higher than that for Danish fibre utilities.

7.3.2 Impact on competition

There are a limited number of operators with the required scale or high value customers to make use of fibre unbundling – i.e. TDC, business providers and mobile operators (for backhaul).

One potential effect of requiring symmetric regulation for unbundled fibre access would be to open the potential for an alternative active wholesaling platform to emerge to compete with OpenNet. Such an offering would require extensive core infrastructure, and could potentially be provided by an existing operator e.g. TDC in the context of its plans for a netco.

This would mirror developments in Sweden, where intermediaries have emerged to facilitate smaller players obtaining access to local and regional fibre networks across the country (see case study at section 5.4). If such intermediary platforms are developed, it could increase competition in the provision of VHC wholesale bitstream services, and encourage players such as OpenNet to respond.

However, the potential for passive access to deliver a positive impact on competition in the provision of wholesale bitstream access is only likely to be realised in Denmark if there is scope for two or more wholesaling platforms of this kind to co-exist. There is a risk on the other hand, that TDC could leverage its existing strength in areas in which fibre utilities are not present and the nationwide coverage that it could achieve through accessing utility networks to increase its market power in this area.

Ensuring availability of dark fibre on a widespread basis could also support competition in the provision of next generation mobile services, as observed in the context of 4G deployment in Sweden where the Tele2/Telenor JV net4mobility made extensive use of municipal fibre to support mobile backhaul.¹²² The development of small cells in a 5G context may further increase the reliance of mobile operators on fibre.

7.3.3 Impact on consumer welfare

Passive access permits extensive differentiation on price and quality,¹²³ and could improve the range and price of VHC bitstream offers and increased choice for consumers and businesses. The potential for physical unbundling by regional operators

122 See for example the WIK (2017) report: A tale of five cities: The implications of broadband business models on choice, price and quality, downloadable at: <https://www.stokab.se/Documents/Nyheter%20bilagor/A%20tale%20of%20five%20cities.pdf>.

123 See for example in relation to passive access to copper, the 2015 study by Nardotto, Valletti and Verboven “Unbundling the incumbent: evidence from UK broadband”, in: Journal of the European Economic Association, Volume 13, Issue 2, 1 April 2015, Pages 330–362, downloadable at: <https://doi.org/10.1111/jeea.12127>.

to support competitive Gigabit offers is discussed in the case studies concerning France and Sweden in this report and is also explored in a 2017 WIK study.¹²⁴

7.4 Option 4 (symmetric regulation – active extensive)

As interviews conducted for this exercise show, there is a strong interest in regional bitstream access, especially from smaller alternative operators. There appears to be interest from many fibre utilities in supplying bitstream access on a voluntary basis, although concerns have been expressed about the potential reluctance of SE/Stofa in particular, and the implications for the Eniig SE/Stofa merger on wholesaling.

As discussed in section 3.1, significant justification would be needed to justify the application of active access obligations in the context of symmetric regulation. We nonetheless consider its potential impact on investment, competition and consumer welfare.

7.4.1 Impact on investment

As many fibre utilities are in the process of establishing wholesale bitstream offers, the impact of an obligation to do so is unlikely to be significant for fibre investment plans, unless it is associated with stringent obligations concerning cost-orientation and/or conditions concerning non-discrimination and/or margin squeeze tests which have the effect of significantly reducing wholesale charges.

A bitstream access obligation on fibre utilities might stimulate TDC and alternative operators to switch more of their existing services from the TDC platform to fibre utilities. Costs may be incurred in this switching process. However, as regional bitstream includes active equipment, there are not expected to be significant additional investments by access seekers, apart from expansion of their core network infrastructure to support the higher bandwidths made possible through fibre, and the potential development of services.

7.4.2 Impact on competition

The imposition of bitstream access obligations on fibre utilities could accelerate the conclusion of wholesale agreements and support service competition in VHC broadband.

¹²⁴ WIK (2017) report: A tale of five cities: The implications of broadband business models on choice, price and quality, downloadable at: <https://www.stokab.se/Documents/Nyheter%20bilagor/A%20tale%20of%20five%20cities.pdf>.

On the other hand, the characteristics of bitstream access may mean that the price and quality of the retail services offered by competitors are tied to the wholesale offer, and allow limited differentiation in the retail market.

Bitstream may also be less suitable for business communications, especially where high QoS guarantees are required, and is unlikely to be suitable for mobile backhaul, for which dark fibre is typically preferred.¹²⁵

7.4.3 Impact on consumer welfare

Consumers are likely to benefit from additional choice in VHC broadband offers, especially in areas where there is only one VHC network available. However, as described above, the degree of differentiation between offers is likely to be limited.

There would also be more limited benefits available to business and mobile customers from this option compared with option 3.

7.5 Exemptions for operators meeting certain wholesaling conditions

Fibre utilities, antenna and housing associations in Denmark do not generally meet the criteria for wholesale only provision that would automatically justify an exemption from symmetric access obligations under the Code. However, the Code provides the option for national regulatory authorities to grant exemptions to symmetric obligations to other types of operators where they consider that those operators offer access to a very high capacity network on fair, non-discriminatory and reasonable terms and conditions.

A key question is what the impact of such an exemption might be in the Danish market, if permitted.

Firstly, it should be noted that, in order to have any appreciable effect, compared with the status quo, the exemption would need to set a higher bar regarding the definition and terms of access to VHC networks than the current voluntary provision of access by regional players.

Drawing on feedback from interviews with Danish stakeholders, stipulations that could be considered in this context might include for example:

- the requirement to make reference offers available by a particular date
- The provision of access on standardised terms and conditions, and to the extent practicable, standard procedures, agreed through an industry forum established for this purpose, involving the NRA
- a long term commitment to provide access to provide certainty to the market

¹²⁵ Interviews with mobile operators conducted by WIK.

- the provision of passive access where technically feasible, in addition to bitstream access
- Fair and reasonable pricing, taking due account of investments and associated risks, as well as any cost differences arising from the scale or business model pursued.
- The requirement to ensure that the same conditions and prices offered to third parties are applied to any downstream arm or associated partner of the provider

It is possible that the granting of an exemption in these cases might serve to clarify expectations of what would be considered fair and reasonable access provision, bring players together to discuss common issues, and incentivise regional investors to adapt their wholesaling strategy.

In turn, our expectation, based on experience in other markets, such as France and Sweden, is that a clear wholesaling strategy coupled with standardisation could ultimately support increased take-up on regional networks and thereby boost the business case and VHC investment potential by regional investors. It should also foster increased competition in VHC services – and if passive access is offered, support increased quality in residential and business services as well as facilitating competitive mobile broadband services and the deployment of small cells.

7.6 Exemptions for subscale operators

The EU electronic communications Code provides for an exemption from symmetric obligations in cases where the imposition of obligations would compromise the economic or financial viability of a new network deployment, in particular by small local projects.

It is not possible to reach a definitive conclusion on the basis of the information received at which scale an operator might be undermined by the imposition of access obligations. Indeed feedback from one of the business providers suggests that certain small scale operators had been open to providing access. In theory, if small providers provide access in a manner that is compatible with other access offers in other regions, and if aggregators emerge, wholesaling should be possible and positive, even for small players. However, we understand that where projects have not been established with wholesaling in mind, and where there are a limited number of employees, there may be a burden, both in terms of capital and personnel associated with setting up a wholesaling platform.

A limit set at too low a size could potentially jeopardise the viability of small players just starting their deployment, while a limit set at too high a level could leave pockets in which access is not available, and undermine the business case for any aggregator of access or provider of services to multi-site corporations.

We understand that there are [confidential] fibre utilities with less than 10,000 subscribers, [confidential] with between 10-40.000 subscribers and [confidential] with more than 70.000 subscribers. The numbers of homes passed should also be taken into consideration.

Bearing in mind that our research suggests that wholesaling can be positive, even for small providers (if based on a standardised platform), another solution could be to give more time for providers below a certain size, or still in early deployment to make wholesale access available.

7.7 Overview and conclusions on the impact of symmetric regulation on VHC networks in the Danish market

A summary of our assessment concerning the impact of different options on investment, competition and consumer welfare, is shown below.

Table 7-1: Overview of impact assessment of symmetric regulation for residential broadband markets in Denmark

	Investment in VHC			Competition		Consumer welfare	
	Incumbent	Energy co.	Altnets	Infra-structure	Service	Price	Quality
Option 1: (base case) asymmetric VHC regulation on TDC alone	+	+	0	0	-	-	--
Option 2: Symmetric regulation (in-building only) ¹²⁶	+(+)	+	(+)	(+)	- (+)	- (+)	- (+)
Option 3: Symmetric regulation (passive unbundling) ¹²⁷	+	(+)	0	(+)	+	+	++
Option 4: Symmetric regulation (active extensive)	+	(+)	0	0	++	+	+
Exemptions permitted for operators meeting given wholesaling standards	+	+	0	(+)	++	++	++

Source: WIK. + and - imply an increase or decrease in the short to medium term, while 0 indicates stability. Brackets indicate partial or uncertain developments. The lighter colouring in the context of in-building access indicates that the indicated benefits would accrue only in specific cases, further discussed below.

With respect to business markets and mobile backhaul, symmetric regulation with passive unbundling is likely to have a stronger positive impact on competition as these players depend on the flexibility offered by passive infrastructure to adapt their services and be competitive. In the context of residential markets, interviews suggest that service providers tend to demand wholesale active services.

¹²⁶ Assumed used for access to antenna and housing association infrastructure. Investments and benefits (shown in grey) are presumed to accrue only for customers of antenna/housing associations and businesses.

¹²⁷ Prices are assumed to be set at levels which allow reasonable cost recovery.

In conclusion:

There is a risk under the **status quo**, that in time, as customers migrate towards VHC networks, they will experience less choice and potentially higher charges and lower quality in areas where there is only one VHC network, which is unregulated, unless fibre utilities and antenna associations play a more active role in wholesaling. Recent developments suggest that some fibre utilities have taken steps to open their networks. However, other networks remain closed, risking a patchwork in competition. Another potential concern is that even where wholesaling is offered, there is a reluctance to provide passive access. This may limit the degree of differentiation in the services provided by access seekers and may not meet the needs of business service providers or mobile operators seeking high capacity backhaul connections.

Symmetric regulation applying to **in-building wiring only** could be helpful in supporting competitive investment in infrastructure to antenna and housing associations, and in supporting choice, value and quality for residents benefiting from the connection. However, it seems unlikely to be used to duplicate infrastructure already deployed by fibre utilities, with the potential exception of services to large businesses. Thus, significant investment in offering such access by fibre utilities may not be justified.

Symmetric regulation applying to **passive unbundling** would not be used by smaller broadband service providers, but could be used by existing larger operators and would support competitive provision for larger businesses and mobile backhaul. It is possible that passive unbundling could enable an existing large-scale provider such as TDC to act as an “aggregator” providing competition in the provision of wholesale bitstream access over FTTP services. This could be beneficial to other service providers and consumers, if the market can support multiple such aggregators. However, if this is not the case, there is a risk that TDC could leverage its nationwide coverage to outcompete other platforms and gain market share at the wholesale level. If used on a widespread scale, passive access should benefit fibre utilities through higher take-up, improving their business case. However, significant take-up is not certain (except potentially under the aggregator scenario described) and access obligations would require fibre utilities to establish new wholesale products and associated platforms, which could – especially for smaller players – raise costs and delay deployment plans. Price setting that does not clearly permit costs to be recovered could also undermine the business case.

Symmetric regulation applying to **bitstream access** could accelerate existing wholesaling plans by fibre utilities, leading to additional service competition and choice for customers. However, bitstream may not support significant price and quality differentiation in retail services, and is less suitable than passive access for business provision and mobile backhaul. Applying obligations on fibre utilities could, as described with passive access, divert resources from deployment. Price setting that does not clearly permit costs to be recovered could also undermine the business case.

Providing **exemptions from symmetric obligations** for operators which meet given criteria concerning wholesale access could potentially contribute to increased competition and consumer benefits, whilst avoiding concerns that may arise over unduly restrictive regulation. Because it would put the onus on fibre utilities and antenna associations to find a solution and settle common issues through working groups with access seekers, it could streamline the current patchwork negotiation process and provide greater confidence for alternative fibre operators to continue their investments. A further benefit of this solution is that it would obviate the need to demonstrate that the legal criteria for symmetric regulation are fulfilled in any particular case. The threat of symmetric regulation would however remain (and the case for it could be bolstered) if operators fail to adapt their strategies to effectively accommodate wholesaling.

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