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Drivers and barriers for commercial FTTH wholesale of alternative competitors - a case study-oriented analysis

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Drivers and barriers for commercial FTTH wholesale of alternative competitors - a case study-oriented analysis.

Dr Sebastian Tenbrock, Dr Christian Wernick

1 Introduction

In Europe, alternative network operators have rolled out own FTTH networks in numerous regions. They often realise first mover advantages and thus dispose (at least for some time) of superior infrastructures. In comparison to copper infrastructures of incumbent operators, most alternative networks are not subject to access regulation (as long as they are not subsidised by state-aid programs or the network operator is deemed as SMP operator). Against this backdrop, the decision to offer wholesale products to third parties represents a business decision depending on various factors.

The objective of this paper is to investigate the state of development of the market for alternative FTTH wholesale services in five European countries (Austria, Denmark, Germany, Sweden, and Switzerland). It aims to identify drivers and barriers and to identify common patterns in the countries under observation. Furthermore, we give some recommendations on policy measures which might help to remove existing barriers and further wholesale on alternative networks. We apply a case study approach, which builds on primary and secondary research including interviews with market experts from business and policy.

2 Dimensions of our analysis

Our case studies focus on four aspects, which are deemed most relevant to support/impede commercial wholesale on alternative networks in the respective markets. These are

- the dominating strategies and business models of alternative operators,
- the transaction costs associated with wholebuy/wholesale,
- the strategy and role of the incumbent operators, and
- the state of development of the fibre market.

In the following sections we expand on our understanding of the four dimensions.

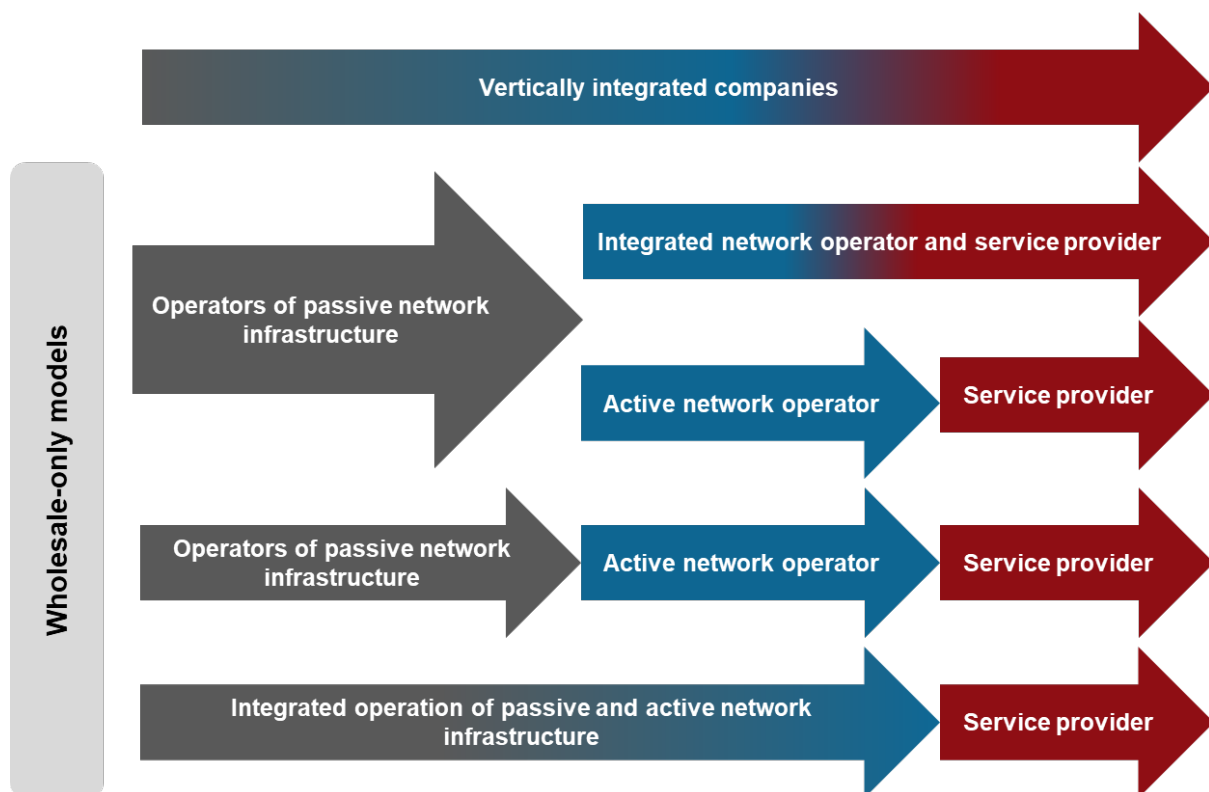
2.1 Business models of alternative FTTH roll-out

The value creation of a broadband network is provided on 3 Layers. The infrastructure provider on Layer 1 owns the passive network (ducts, cables, etc.) and is responsible for its maintenance (Passive Infrastructure Provider (PIP)). The network provider (NP) on Layer 2 rents unbundled lines and installs and operates active technology components (routers, switches, etc.). Finally, the service provider (SP) on Layer 3 provides digital services (Internet, telephony, etc.) and markets them to retail customers.

These three stages of the value chain are provided by one or more suppliers. On a very general level, it can be distinguished between vertical integration and wholesale-only. Integrated providers cover the entire value chain. In addition, they may offer (deliberately or obliged by regulation or state-aid rules) active and/or passive wholesale products to third parties.

In contrast, providers of wholesale-only networks do not market products on their own. They either concentrate on Layer 1 or integrate Layer 1 and Layer 2. In the first case, the activities on Layer 2 can be taken over by one or more third-party operators, in the latter one or more service providers purchase active wholesale products.

Figure 2-1: Business Models for fibre roll-out



Source: WIK

Within wholesale-only models, three different forms of OAN models can be distinguished depending on the distribution of roles on Layer 1 and Layer 2: These are Active Layer Open (ALOM)¹, Passive Layer Open (PLOM)² and 3-Layer Open (3LOM).³

¹ In the Active Layer Open Model (ALOM) an integrated PIP + NP operates the passive and active network layers jointly. Layer 3 is operated by pure SPs.

² The network owner is only active on the PIP layer (Layer 1). The broadband network is open to all market players at the passive layer. This includes both, integrated NPs + SPs as well as specialised NPs selling connectivity to (pure) SPs.

³ The roles of the PIP, NPs and SPs are strictly separated. In contrast to the PLOM, the role of the NP is only awarded to a single company. It is possible, however, to contract different NPs in different roll-out projects/geographical areas. In order to ensure fair and non-discriminatory conditions for all SPs, the NP itself should not provide services to end customers.

Historically, incumbent operators have been vertically integrated companies. Despite discussions on structural separation in some Member States, vertical integration still represents the business model of the majority of former telecom monopolists. With regard to alternative operators things look different: In some countries, wholesale-only has been the dominating business model in alternative fibre roll-out. In other markets the business model of vertical integration is practiced by most alternative operators.

Given that a successful wholesale business is crucial for wholesale-only operators, one would expect intensive wholesale competition over these networks. Framework conditions (e.g. size, location), technical, procedural and commercial reasons can make their use more difficult, however.

Commercial wholesale may represent a valid strategy for integrated companies as well – in particular if they are unable to achieve high take-up rates with their own retail business or try to expand their customer base. Moreover, the product portfolio (active and/or passive products) and the number and size of alternative operators represent relevant dimensions. Having this mind we study

- the extent and relevance of alternative fibre investments
- the dominating business models of alternative network operators
- the openness of alternative network operators towards third party access and
- the dominating wholesale products, which are offered to third parties.

2.2 Transaction costs

The transaction cost theory provides explanations as to whether activities or transactions should be provided internally (i.e. hierarchy) or purchased externally (i.e. market). Relevant dimensions include the degree of specificity, strategic importance, uncertainty and frequency. The prototypical governance structures between the poles of hierarchy and market include cooperations that, depending on their design, can be more market-oriented or more hierarchy-oriented.

In our set-up, the hierarchy solution would be to roll out a parallel network. A merger or takeover of another FTTB/H network would represent a hierarchy solution, too.

Long-term co-operations with risk sharing elements can be interpreted as a middle way between market and hierarchy. These include joint ventures, IRUs, co-investment models as well as swap models.

In a market solution, a telecommunications company requests wholesale FTTB/H to individual lines.

The transaction cost theory suggests choosing a setup, which tends to limit the sum of transaction costs (as a result of the characteristics of the transaction cost dimensions) and production costs (representing the costs of creating products and services).⁴ Having this in

⁴ See Williamson, O. (1985): The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting.

mind, we focus on both, the average roll-out costs and factors, which tend to increase transaction costs. Relevant aspects with impact on the level of transaction costs include

- the number of (small) suppliers, access seekers have to settle contracts with,
- the existence of uniform product specifications and standards, and
- the existence of intermediaries.

2.3 Incumbents

Incumbents represent potential access seekers on alternative fibre networks. Although wholebuy is not an integrative component of an incumbent's DNA, high roll-out costs and limited potentials for second movers, may lead to strategic shifts. Having this in mind, we study (apart from the roll-out costs already mentioned above)

- the technology strategy of the respective incumbents and
- their openness towards co-operations and wholesale relations with competitors.

2.4 State of development of the fibre market

In Europe alternative commercial wholesale is expected to flourish with increasing investments of alternative fibre operators. Historically there have been alternative operators offering bitstream access to third parties based on the unbundled copper loop,⁵ but in light of increasing demand for bandwidths, this business is not future proven. With FTTH new potentials arise. Having this in mind, we study the fibre coverage and take-up, too.

⁵ See Gries, C. / Wernick, C. (2018): Treiber und Hemmnisse für kommerziell verhandelten Zugang zu alternativen FTTB/H-Netzinfrastrukturen, WIK discussion paper no. 428, URL: https://www.wik.org/uploads/media/WIK_Diskussionsbeitrag_Nr_428.pdf

3 Country case studies

3.1 Sweden

Sweden is one of the leading FTTH countries in Europe: FTTH coverage amounts to 77.1%; this is more than twice the EU average (33.5%). With 41.8%, Sweden also disposes of a very high FTTH coverage in rural areas. In sum, FTTH represents the dominant fixed network-based technology.⁶

The FTTH roll-out in Sweden benefits from a high demand and willingness to pay: Fibre represents the most popular broadband technology. FTTH connections account for around 2.8 million out of a total of around 4 million fixed broadband connections.⁷ Many households are open to pay installation fees of EUR 2,000 or more to connect their homes to fibre networks.

The expansion of fibre networks has been largely driven by local city network operators (or municipal networks), which regard the roll-out of high-speed broadband internet as part of the provision of public services. Stokab, the municipal network operator in the Stockholm area, started its FTTH roll-out as early as the mid-1990s. Around 180 out of a total of 290 Swedish municipalities have built fibre networks since the beginning of the 2000s. They reach more than a half of the households connected with FTTH. Many of them are small-sized and focus on rural areas.

The majority of municipal network operators operate as wholesale-only. Some of the larger city network operators have established PLOMs and offer unbundled fibre access. Smaller network operators tend to integrate PIP and NP and offer layer 2 bitstream products. As wholesale-only providers, it is of high interest for them to maximise their network take-up and to enter into wholesale agreements with large wholesale customers. Only a few municipal operators are vertically integrated.

There is a high demand for wholesale products in the Swedish market. In general both, active and passive access products are available. Smaller service providers tend to prefer active wholesale products based on Layer 2, while larger service providers tend to favour (passive) access based on dark fibre.

Due to a relatively low population density, a self-sustaining parallel fibre roll-out is not economically feasible in large parts of the country.

The incumbent Telia has been expanding its own fibre networks, especially in urban areas. For some years now, the company has also been requesting dark fibre wholesale products

⁶ See European Commission (2020): 2020 DESI Report – Electronic communications markets overview per Member State, Telecom Chapter Sweden, URL: <https://ec.europa.eu/digital-single-market/en/news/2020-desi-report-electronic-communications-markets-overview-member-state-telecom-chapters>

⁷ See PTS (2019): The Swedish Telecommunications Market – First half year 2019, URL: https://statistik.pts.se/media/1484/swedish-telecoms-market-en-1h-2019_t.pdf

from various city network operators: Telia has entered into commercial agreements in areas not covered by its own infrastructure.

In light of the high relevance of wholesale-only, there was a great need to create uniform access products and interfaces at an early stage. The market players on the Swedish market have initiated cross-operator cooperations for this purpose. The Local Fibre Alliance, in which almost all municipal operators are organised (290 members), was founded as early as 1998 and dealt with standardisation issues. This included standardised procurement interfaces at wholesale level and technical specifications.

Within the framework of the Local Fibre Alliance, the service and contract agreement CESAR was also established. CESAR was initially conceived in 2005 as a common model contract for dark fibre connections. It has been continuously refined and was relaunched as CESAR 2 in 2014. CESAR 2 includes product and process specifications as well as SLAs and access conditions and is supported by (city) network operators and service providers throughout the country.

CESAR or CESAR 2 was set up as an interface primarily for smaller market players and is primarily used by them. Larger city network operators such as Stokab have established their own platforms and do not use the CESAR interface.

A special characteristic of the Swedish market are the "Communications Operators" (CO), which play an important role for the Swedish market in wholesale services (B2B) as well as in retail business (B2C): As active network operators (Layer 2), COs enable cooperation between Layer 1 and Layer 3 providers. In addition, the COs also provide portals for end customers (private and business customers), through which they can find out which products and services are available at their respective location. Thus offers and products of the service providers can be compared with each other, and individual services can be selected, compiled and ordered.⁸

Conclusively, several success factors facilitated the development of the Swedish alternative fibre wholesale market. The lack of viability of infrastructure duplication in rural areas and a high market relevance of wholesale-only by municipality networks were key factors. Moreover, the high degree of standardisation and the special role of the COs also furthered the spread of fibre wholesale agreements.

3.2 Denmark

Denmark is another country in Europe with an advanced fibre roll-out. FTTH coverage (homes passed) sums up to 66.9%, which is around twice the EU average (33.5%). The country also has the second highest FTTH coverage in rural areas in Europe.⁹

⁸ See SSNF (2014): Swedens Local Fibre Networks creating competition and providing consumers and operators with freedom of choice, URL: <https://www.ssnf.org/globalassets/in-english/facts-and-statistics/sweden-local-fibre-networks-2014.pdf>

⁹ See European Commission (2020): 2020 DESI Report – Electronic communications markets overview per Member State, Telecom Chapter Denmark, URL: <https://ec.europa.eu/digital-single->

FTTH disposes of a technology market share of just below 30% among the fixed broadband technologies, with a steady increase in recent years.¹⁰

Similar to Sweden, the FTTH roll-out in Denmark has been driven mainly by regional and local city network operators. In comparison to Sweden, these companies are usually vertically integrated, however. Many of them hold high market shares within their footprints which are furthered by co-operative models integrating the public. The focus of the municipal networks is on rural areas. However, the overall market is small-scale and fragmented, despite some consolidation processes in recent years.

In mid-2016, some fibre network operators jointly announced a commercial opening of their respective networks for competing service providers. In practice, however, the implementation was rather slow and the number of commercial agreements increased significantly only recently. This was influenced by the foreseeable development towards regional market definitions and corresponding regulatory access obligations for several large alternative network operators. The planned self-commitments of regional SMP operators should give momentum to the wholesale business in Denmark.¹¹

In contrast, the incumbent TDC has been rather reluctant to invest in FTTH. Instead, TDC was focussing on a mixed cable and FTTC strategy. In 2018, TDC was acquired by Macquarie and three Danish pension funds. They restructured the company and introduced separate business units. For the future, TDC has announced its intention to connect one million households with fibre technology by 2025.¹²

As parallel FTTH networks are not economically feasible in relevant parts of the country, TDC has concluded geographically limited wholesale agreements with alternative competitors such as Norlys, Fibia, and EWII covering rural regions. Wholesale access is provided on Layer 2 bitstream. Beyond that, approximately 40 further commercial agreements were concluded between network operators and service providers.

With regard to the standardisation of interfaces and processes, the public sector in Denmark has not played an active role. National comprehensive agreements with uniform interfaces and standards do not exist in the Danish market.

In addition to the incumbent's platform, three proprietary wholesale platforms (OpenNet (Norlys), Fibia und EWII) have evolved that are active in complementary geographic areas. Even if the incumbent appears as a buyer on all platforms, this result is not efficient from an

[market/en/news/2020-desi-report-electronic-communications-markets-overview-member-state-telecom-chapters](https://ec.europa.eu/digital-single-market/en/news/2020-desi-report-electronic-communications-markets-overview-member-state-telecom-chapters)

¹⁰ See <https://ens.dk/ansvarsomraader/telepolitik/tal-paa-teleomraadet>

¹¹ Such commitments are the subject of Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 on the European Electronic Communications Code (recast), URL: <https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32018L1972&from=EN>

¹² See European Commission (2020): 2020 DESI Report – Electronic communications markets overview per Member State, Telecom Chapter Denmark, URL: <https://ec.europa.eu/digital-single-market/en/news/2020-desi-report-electronic-communications-markets-overview-member-state-telecom-chapters>

economic point of view. It remains to be seen whether a market consolidation in this area may occur in the future.¹³

In summary, fibre wholesale competition on alternative networks is not well developed. The vertically integrated business models, the reluctance of many network operators towards wholesale and the lack of standardisation have proven as main barriers. However, recently the number of commercial agreements on alternative fibre wholesale platforms has increased – mainly as a reaction to the threat of regulatory access obligations.

3.3 Austria

At 13.8%, the availability of Austria's fibre networks is significantly below the European average. In addition, there is a comparatively low demand for fixed broadband connections in Austria, which can be traced back to the strong presence and acceptance of mobile broadband as a substitute for stationary use.¹⁴

FTTH roll-out is mainly driven by regional network operators in sparsely populated regions on a wholesale-only base. This led to a highly heterogeneous and fragmented market structure with a large variety of solutions. Many of the network operators use federal and state funding; commercial fibre roll-out does not take place on a large scale.

The best-known regional (open) access network (OAN) is nöGIG in Lower Austria, which was founded in 2015 as the first public infrastructure company. nöGIG was set up as a classic 3LOM model. After the pilot phase, nöGIG attracted a financial investor, the Allianz Group, for the planned expansion to a total of 140,000 homes passed. With the entry of the Allianz group, the original 3LOM model was de facto changed into an ALOM model, with an SP controlled by the financial investor. FIS is another prominent 3LOM model, which is applied in Upper Austria. In comparison to nöGIG, the model is open for access seekers, who integrate NP + SP, too. Similar models have been implemented in Styria and Carinthia.

A substantially different approach is practised in the province of Tyrol. Here, municipalities build out their own individual local fibre networks and act as PIP in PLOM models. Unbundled access to these fibre networks is open to all (national or regional) access seekers. Uniform access and contract conditions are supported through the specifications of the Broadband Service Agency Tyrol, which have become a uniform standard accepted by most municipalities.

The incumbent A1 Telekom Austria is currently concentrating on its FTTC roll-out. Its activities in fibre roll-out are primarily limited to new housing developments and commercial areas. However, Telekom A1 is open minded towards wholebuy and practices fibre wholebuy

¹³ See Wernick, C. et al. (2020): Der deutsche Telekommunikationsmarkt im internationalen Vergleich, study for the Bundesministerium für Wirtschaft und Energie, Bad Honnef, URL: https://www.wik.org/fileadmin/Studien/2020/Der_deutsche_TK-Markt_im_internationalen_Vergleich.pdf

¹⁴ See European Commission (2020): 2020 DESI Report – Electronic communications markets overview per Member State, Telecom Chapter Austria, URL: <https://ec.europa.eu/digital-single-market/en/news/2020-desi-report-electronic-communications-markets-overview-member-state-telecom-chapters>

in different setups and regions. It is noteworthy, that A1 applies regionally differentiated prices and products responding to the different active wholesale products offered by the OANs.

It has turned out that the Tyrolean model is preferred by the large national providers. A1 and Magenta offer retail products in this model in a large number of municipalities. On the other hand, the 3LOM models of nÖGIG and others are preferred by regional and local operators.

As of yet, we observe no common standards reflecting the requirements of all market participants. The existing wholesale interface of A1 is used by many market participants, but there are no ambitions (as far as can be seen) on the part of A1 or on the part of other market participants to implement it as a market solution. There are no intermediaries, too. An industry group who seeks to create common standards has been setup by industry organisations VAT and CMG. This group represents only parts of the market, however; in particular, A1 and Magenta are not involved yet.

In sum, there are several drivers and barriers for alternative fibre wholesale in Austria. Key drivers are the prevalence of OAN and the high proportion of subsidised FTTB/H rollout. The lack of parallel fibre roll-out due to the topological nature is also beneficial. On the contrary, the relatively slow fibre rollout, the lack of standardisation and the high relevance of cubes may inhibit further fibre wholesale agreements.

3.4 Germany

Fibre coverage (homes passed) amounts to 12.3% of all households, which is below the European average. The take-up currently achieves 37%.¹⁵ Fibre development has gained momentum in the last two years on both the supply and demand side. Despite the considerable public funds for FTTH roll-out, commercial network expansions dominate: approximately three quarters of the connections built were commercially rolled out (without funds) while only one quarter resorted to public subsidies.¹⁶ Small and medium-sized regional operators represent important drivers of FTTH roll-out, especially in rural areas.

In the past, Deutsche Telekom (TDG) has invested predominantly in vectoring and supervectoring technology. A strategic switch to FTTH has been announced only recently. As TDG has focused on upgrading its copper networks and succeeded to attract large parts of the German wholesale business over its contingency contracts, its FTTH wholesale business is quantitatively still in its infancy. In this context, a pilot agreement was concluded in mid-2020 with Deutsche Glasfaser, the largest private fibre-optic network operator in Germany.¹⁷

¹⁵ See Dialog Consult/VATM (2020): 22. TK-Marktanalyse Deutschland 2020, Köln, URL:

https://www.vatm.de/wp-content/uploads/2020/10/VATM_TK-Marktstudie-2020_061020_a.pdf

¹⁶ See Böcker, J. (2020): BREKO Marktanalyse20, URL: <https://brekoverband.de/themen/breko-research/marktanalyse>

¹⁷ See Tenbrock, S.; Wernick, C. (2020): Incumbents als Nachfrager von Vorleistungen auf FTTB/H-Netzen, WIK discussion paper no 464, URL:

https://www.wik.org/uploads/media/WIK_Diskussionsbeitrag_Nr_464.pdf

Very recently another wholebuy agreement with M-Net, a large municipal network operator based in Munich, has been announced.¹⁸

In general, the wholesale market for fibre access products is not yet fully developed. This is not due to a lack of uniformly specified product descriptions and process interfaces. These are available (in principle). Standardization initiatives emerged relatively early in the context of an industry forum (NGA Forum) initiated and steered by the German NRA BNetzA. However, not all market participants have implemented the relevant interfaces jointly developed by the relevant parties. This applies in particular to the incumbent TDG, but also to many small access providers.

The demand for wholesale on small FTTH networks has only developed to a limited extent yet. This is due to high transaction costs which occur in the interplay between large access seekers and a fragmented supply side. The intermediary market solution of Vitroconnect GmbH (Vitroconnect) represents a successful business model which supports business between these antithetical actors.

In light of the high roll-out costs there are indications that TDG might become more open in the nearer future. For a nationwide gigabit offer, which is competitive with the cable network of Vodafone, cooperative relationships seem inevitable. Especially in places with already two gigabit-capable infrastructures in place (DOCSIS 3.1, alternative fibre networks), the roll-out of a third infrastructure seems unlikely.

Conclusively, alternative fibre wholesale in Germany is still in its infancy: Coverage and take-up are comparably low yet. The lack of wholesale-only models and a fragmented landscape limit the scope of fibre wholesale. In light of the high roll-out costs and the existence of a uniform standard and a widely used intermediary, a large potential for fibre wholesale exists, however.

3.5 Switzerland

Switzerland disposes of a high coverage of ultra-fast broadband connections. DOCSIS 3.0 and FTTP cover 88.4% of households.¹⁹ Take-up rates achieve around 50%.

The roll-out of fibre networks in Switzerland began in 2008. The vast majority of FTTH networks were built as part of cooperation models between Swisscom and municipal utilities: Fibre networks covering about 30% of households have been built in the 20 largest (and some medium-sized) cities. It was decided to waive access regulation for FTTH networks and to roll-out fibre in a cooperation of incumbent Swisscom and local utility operators instead (the so-called 4-fibre-model): Four fibres were deployed in each household, enabling infrastructure competition between up to four SPs.

¹⁸https://www.golem.de/news/ftth-telekom-steigt-massiv-in-muenchens-glasfaserausbau-ein-2106-157218.html?utm_source=nl.2021-06-11.html&utm_medium=e-mail&utm_campaign=golem.de-newsletter

¹⁹<https://www.swisscom.ch/de/about/netz/netzausbau-karte-glasfaser.html>

In comparison to Swisscom, municipal operators decided to apply a wholesale-only approach and to offer passive unbundled access to dark fibre. Initially, they had problems to attract large service providers as their wholesale customers. This changed after some time with the foundation of the joint venture Swiss Fibre Net (SFN). The role of this intermediary was to create a uniform ordering, delivery and fault clearance platform. This enabled access seekers to reach FTTH connections in almost all municipal utilities via a single standardised interface. SFN's platform represented a breakthrough for a competitive wholesale fibre market in Switzerland.

As of yet, alternative operators (SFN network partners, service providers) have not been able to catch up with Swisscom's lead in the Swiss fibre market. In the last 18 months, however, Salt and Sunrise have acquired more fibre customers than Swisscom and have thus increased their market shares. The efficiency of the SFN trading platform was a prerequisite for this. Swisscom, vice versa, does not play a relevant role as access seeker on alternative networks.

In summary, the lively alternative fibre wholesale market in Switzerland has been enabled and furthered by the initiation of SFN. The platform solution of SFN represents an attractive solution for access seekers as it limits the occurring transaction costs significantly.

4 Findings

Our country case studies reveal several major drivers for commercial wholesale on alternative networks: The first is the role of standards and intermediaries: In a fragmented and heterogeneous wholesale provider landscape, the effort of a technical and procedural implementation of interfaces, processes and products is especially high when proprietary systems are used and wholesale services are not or only to a small extent standardized. A company wishing to offer FTTH connections to end customers will compare the costs of a parallel FTTH roll-out with the costs of procuring FTTH wholesale services. While the production costs, i.e. the costs of a parallel rollout, are more or less fix (under the assumption that saving potentials e.g. by using existing ducts or cost effective deployments are realised), transaction costs of procuring wholesale FTTH services can be significantly reduced through the standardization of interfaces or the use of intermediaries.

The second driver is the role of incumbent operators. Besides the reasoning outlined above, the main argument against purchasing third-party wholesale services is that it is more profitable to supply their retail customers over existing (inferior) legacy infrastructure and to maintain take-up and profitability on a stable level. Moreover, purchasing wholesale products from third parties represents a paradigm shift for companies, which are used to decide and act independently. The case studies show that incumbent operators tend to carry out parallel roll-out of own FTTH infrastructure as second movers whenever this is economically viable in the area concerned. This is not the dominating case in most countries studied here, however.

Where the roll-out costs are high and alternative providers - in particular wholesale-only providers - are ahead of the incumbent, a more intensive use of wholebuy can be observed.

A related argument applies for the role of alternative operators. With the exception of wholesale-only providers, where wholesale offers for third parties represent the core of their business model, many integrated network operators have found it difficult to open up their network for access seekers – especially those, who are commercially successful and financially strong. In most cases the opening, which is a prerequisite for the emergence of the market, took place either because the company's own sales force was not sufficient to achieve the necessary take-up rates or because it was ordered due to subsidy requirements. A potential threat of intrusive access obligations represents another stimulus.

In sum, the level of production costs represents the most important driver. Focussing on the make-or-buy decision, our findings indicate that production costs are of much greater relevance than the transaction costs in the case of fibre roll-out, which is why, in practice, intermediate inputs are used more frequently than would be expected against the background of the high specificity.

The development of the fibre market and the willingness to pay for fibre services show no clear cause and effect relationships, however: The case studies point out that roll-out costs, individual strategies and competitive conditions are more conducive for wholesale fibre than the general maturity of the FTTB/H market.

5 Policy recommendations

Against this backdrop, the question arises as to what options are available to regulation or policy makers to stimulate the development of alternative fibre wholesale, if this is deemed as necessary and beneficial.

The standardization of interfaces, processes and products is a key success factor in the countries observed. If market players do not reach sufficient market driven standards, public authorities may initiate and convene industry forums for that task. However, it is imperative for the authorities to be restrained in the industry discussion process and not to prescribe (technical) details. Instead these details should be defined by the industry itself and only accompanied and supervised by the regulators and other policy makers.

Even if the industry agrees on appropriate standards, they may not be implemented by all market participants involved as seen in Germany. In case, the standards are not implemented (or only by a few market participants), regulatory authorities and policy makers may ensure compliance with the standards by state-aid schemes and regulation.

In the case of state aid, policy makers can enforce receivers of public funding to use defined interfaces and standards. This would create incentives or remove burdens for the use of wholesale-only in subsidised roll-out projects and accelerate commercial agreements.

Finally, if alternative competitors are found to be (regionally) dominant, self-commitments or access obligations can be another (intrusive) remedy to obtain network access for third parties.

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