Turkey's digital future: Vision for the Broadband Plan

Independent report prepared by Axon Consulting

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AXON

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1. Executive summary

In recent years, international policy makers have been observing the power of broadband networks as enablers of economic and social development, hence promoting their deployment. Public initiatives focused on the development of fixed broadband markets move through successive phases: **Deployment**, **Adoption** and **Integration**. Initially, policy makers tend to focus on the national footprint for broadband network availability. In this first phase, monitoring focuses on broadband network deployment to make services as widely available as possible, using standard indicators of coverage, capacity, take-up and price. The current state of the fixed broadband market in Turkey, as explained in this Report, would be classified under this phase.

In the **Deployment** phase, several technologies exist today that may be considered for delivering broadband connectivity to households (e.g. ADSL 2+, 3G, FTTH/B, WLAN/WIMAX). Among these technologies, FTTH/B is technically the most advanced due to a number of unique characteristics, proving it to be a future-proof technology.

Our study[1] starts with the presumption – and the vision – that expanding FTTH/B coverage to a significantly larger part of the population than its current state should be the goal of Turkey's Broadband Plan. Coupled with a properly designed investment undertaking of a one-time nature, the whole initiative would avail an infrastructure to the nation that will be usable for many decades.

The current consumption profile of fixed broadband users in Turkey indicate demonstrated growth over the recent years. We can observe in general that the Turkish consumers will not be staying behind worldwide usage trends in the years to come. Growth of FTTH/B connections in servicing the growing demand, has however demonstrated a relatively slow growth over the recent years. Turkey stands at a right point in time to consider and realize the vision of expanding FTTH/B coverage to a significantly large part of the population. The challenge of this vision lies in the fact that wide scale FTTH/B expansion projects require significant investments and consequently a careful analysis of the business case for the medium to long-term recovery of those investments.

[1] This study was undertaken by Axon Partners Group Consulting S.L. ('Axon Consulting') to provide an independent report ('Report') regarding the expected Broadband Plan in Turkey. It has been commissioned by Vodafone Telekomunikasyon A.S ('Vodafone').

Expansion of FTTH/B networks in Turkey would imply taking forward the household coverage ratio of this technology from its level of 23% in Q4 2015. The initiative would not only bring the coverage levels at par the levels observed in leading countries, but also would attempt to take it forward to ensure maximum adoption and take-up by the consumers.

We recommend that the deployment of an FTTH/B network through an **open access network (OAN)** scheme will enable the objective of a network with a sufficiently large footprint in Turkey**.** An open access network would cater for the needs of the Turkish market by:

- **Avoiding duplication of resources** through multiple service providers investing in FTTH/B access networks. It would instead enable focusing on the timely expansion of service to reach the widest level of FTTH/B coverage through optimized roll-out and investment plans (hence meeting the supply objective).
- Creating the environment for effective and non-discriminatory access to network elements by multiple retail providers, promoting an environment of **affordable prices** and volume gains by retail policies that **enhance take-up** of FTTH/B services (hence meeting the demand objective).

Our economic analysis on the expansion of FTTH/B coverage in Turkey through an OAN concludes the following:

Conclusion 1: Under the current circumstances, there is a risk that Turkey will miss the opportunity associated to the high growth potential of the Turkish fixed broadband market, with up to 15,16 million households being left without access to FTTH/B networks

According to our study, under the current circumstances, i.e. if no action is taken, only between 5 and 6,50 million households in Turkey will be covered over the next five years by FTTH/B technology. This is an improvement – albeit a small one - from the levels of coverage currently achieved (5 million households).

Our study has shown, however, that the expansion of FTTH/B in Turkey can go up to 11,26 million households by market-driven mechanisms under the right regulatory and market conditions. A first conclusion from our study is therefore that keeping the current course in terms of broadband policy would imply a very high cost for Turkey.

Conclusion 2: Promoting a friendly environment for commercially-driven network roll-out would open up the investment opportunity and could lead to an additional 535 million USD in additional investment and 4,76 million additional households with FTTH/B coverage

The investments required to build a FTTH/B network in Turkey would be reduced by between 31% to 45% in that case that existing civil infrastructure could be reused.

More importantly, introduction of agile and efficient civil infrastructure reutilization measures would result in an *increase* (not a decrease) of investments by private agents in FTTH/B networks. In fact, investments by private operators in FTTH/B networks would increase by up to 535 million USD with the presence of civil infrastructure reuse, leading to an increase in the number of households covered of up to 4,76 million.

Conclusion 3: Moderate financial and regulatory support from the government to an Open Access Network could help boost expansion and provision of FTTH/B networks to all Turkish households living in cities of over 100.000 inhabitants

Under the right conditions, the government could consider some sort of intervention to help expand the current footprint of FTTH/B networks through an OAN. We observe from our economic analysis that this would enable the ambitious yet achievable target to provide coverage, over a 5-year period, to all households in Turkey located in population centres with 100.000 thousand or more inhabitants (i.e. 76% coverage of all households in Turkey).

The above conclusions, point out that, provided the right support, the OAN scheme can enable the pooling of resources and the deployment of an efficient and shared FTTH/B network in Turkey that reaches to 76% of all households. This would put Turkey as a clear leader in the region in terms of FTTH/B coverage and at par with some of the most advanced countries in the world.

2. Introduction

Vodafone Telekomunikasyon A.S ('Vodafone') commissioned Axon Partners Group Consulting S.L. ('Axon Consulting') to provide an independent report ('Report') regarding the expected Broadband Plan in Turkey.

This report, titled "Turkey's digital future: Vision for the Broadband Plan", presents Axon Consulting's independent vision and perspective on this subject.

About Axon Consulting

Axon Consulting (previously known as 'SVP Advisors'), established in 2006 in Madrid (Spain), is an international consulting firm that provides consulting services to an international client base in the broad technology sector, with a strong focus on the Telecommunications, Internet and Media industries.

Axon Consulting has earned a solid reputation as a world-class leader in developing and applying state-of-the-art analytical frameworks for practical problem solving. Axon Consulting's approach combines the disciplines of economics, engineering, marketing, econometrics, accounting, finance, and computer science with which we achieve the strategic thinking required by our clients.

Axon Consulting is the consulting arm of Axon Partners Group, which resulted from a merger between SVP Advisors, an international management consulting firm for the electronic communication industries, and Axon Capital, an investment firm specializing in investments in early-stage technology firms in the telecoms, IT and media sectors.

Within the TMT industry, Axon Consulting offers relevant expertise in the fields of strategy & innovation, regulation & public policy, and profitability & operations. This includes supporting institutional bodies in developing techno-economic and pricing models; setting regulatory policy and competition monitoring; and advising telecom operators on business, commercial and regulatory strategy.

The exhibit below illustrates Axon Consulting's principal areas of expertise.

Exhibit 2.1: Axon Consulting's areas of expertise [Source: Axon Consulting]

Since its foundation, Axon Consulting has worked with top-class clients, including telecoms operators such as Telecom Italia, Telefónica, Vodafone, Saudi Telecom Group, Turkcell, ETB, UNE and Etisalat; media and internet companies such as Babelgum and VirginPlay; telecoms regulators including OUR (Jamaica), SUTEL (Costa Rica), IFT (Mexico), CRC (Colombia), AFTIC (Argentina), OCECPR (Cyprus), TRA (UAE), ANAC (Cape Verde), ARTP (Senegal), EETT (Greece), CNMC (Spain), AGCOM (Italy), ERST (Denmark), CITC (Saudi Arabia) and TRA (Oman); international organizations such as the Inter-American Development Bank and the European Commission; and financial institutions, including Banco Santander and Citigroup.

In total, Axon Consulting has worked on or carried out consulting assignments on approximately 50 countries, as illustrated below:

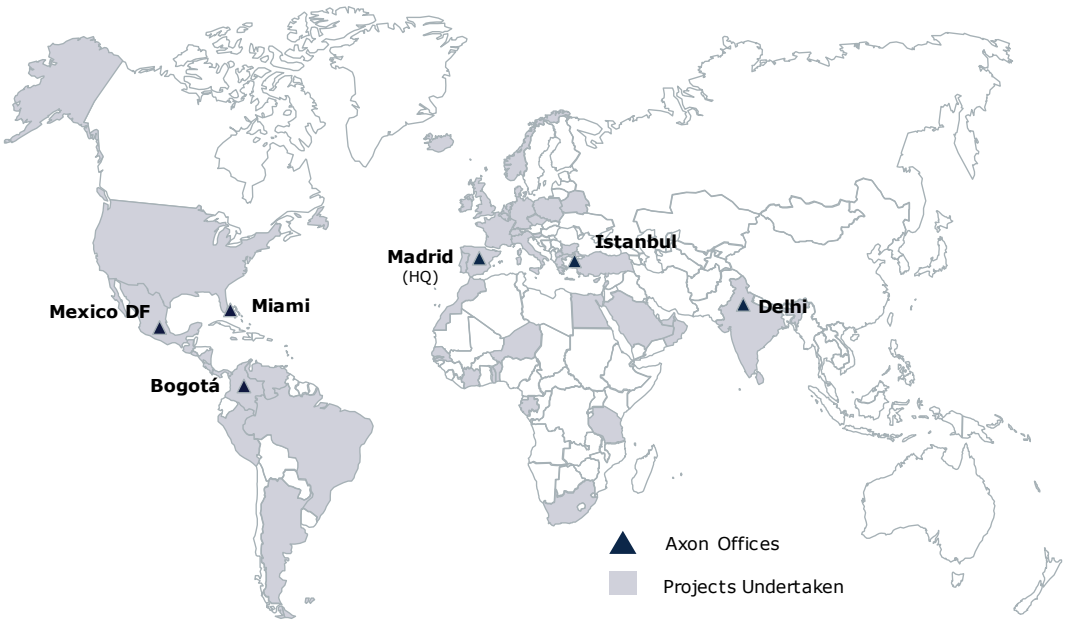

Exhibit 2.2: Axon Consulting's international footprint [Source: Axon Consulting]

Notice from Axon Consulting

In compiling this Report, Axon Consulting has used publicly available information published either by the Information and Communication Technologies Authority ('ICTA') or by third parties. Certain figures pertaining to the year 2016 (including but not limited to the number of fixed broadband subscribers, fixed and mobile broadband consumption) have been forecasted based on actual data available from ICTA for the first three quarters of 2016.

Axon Consulting does not assume any responsibility on the accuracy, robustness and completeness of such information available at the time of writing this Report.

3. Turkey's digital future: Vision for the Broadband Plan in Turkey

3.1. Broadband as a national strategic priority

Broadband access to Internet is an essential pillar of a successful economy. The widespread availability and use of broadband services bring economic and social benefits and are a major driver of global growth and innovation.

"The widespread availability and use of broadband services bring economic and social benefits and are a major driver of global growth and innovation"

In recent years, policy makers have been observing the power of broadband networks as enablers of economic and social development, hence promoting their deployment. Conveniently, available broadband empowers people, nurtures technology and service innovation, and triggers positive change in businesses as well as in the society as a whole.

According to a study carried out by ITU[2] in 2012, every 10% increase in **broadband coverage** in a country market results in a GDP[3] increase between 0,25% and 1,38%, with the exact impact depending on the country's dynamics. A similar report[4] covering 33 OECD countries by Ericsson concludes that doubling the **broadband speed** in an economy leads to a GDP increase of 0,3%, equivalent to 126 USD billion considering the total GDP of the OECD countries in year 2011, the year covered by the report.

"Every 10% increase in broadband coverage in a country market results in a GDP increase between 0,25% and 1,38%"

Despite the undisputed positive impacts of broadband coverage and speed, the economics of broadband networks typically imply that a compromise needs to be taken between the two. The priority placed on each of these aspects determines the general policy direction in countries and therefore needs to be carefully considered in the light of national strategies.

The economics of broadband networks have typically led to the above factors being viewed by policy makers in a mutually exclusive context – i.e. either to focus on policy initiatives to achieve high

[2] Report 'Impact of broadband on the economy', 2012.
[3] Gross Domestic Product.
[4] Report 'Socioeconomic effects of broadband speed', 2011.

levels of 'social coverage' (affordable and universalized service across the whole population), or to prioritize quality and performance. None of these two approaches has traditionally paid the needed attention to the 'efficiency' of the services, i.e. making a high performance service widely available and at affordable prices.

However, current public initiatives are beginning to consider the efficiency target for their broadband plans as an enabler to boost not only the availability of the services across the whole population, but also the affordability of such services. This phenomenon is illustrated in the Exhibit 3.1 below:

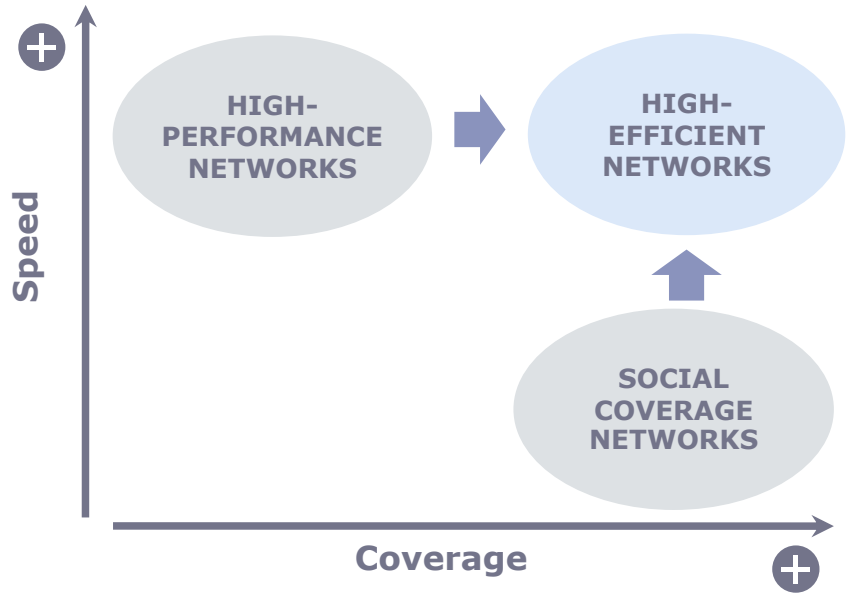

Exhibit 3.1: Economics of broadband networks [Source: Axon Consulting]

"Currently government initiatives focus on delivering high-speed and quality broadband services to all premises in the country, while also ensuring the affordability of such services"

Currently government initiatives focus on delivering high-speed and quality broadband services to all premises in the country, while also ensuring the affordability of such services. As such, specifying technical characteristics alone turns out to be insufficient, if there do not also exist requirements on affordability.

The exhibit below illustrates some example targets of National Broadband Plans (NBP) from international practice in terms of their focus on performance and availability.

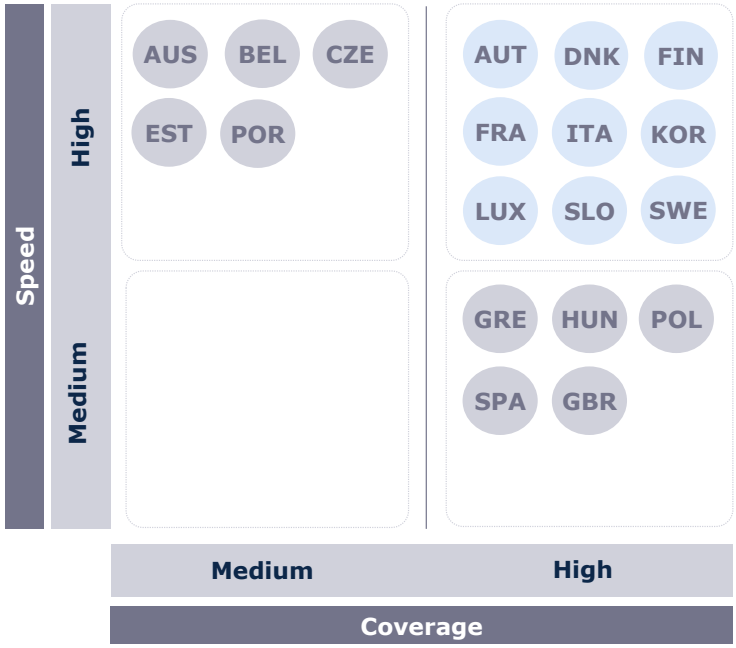

Exhibit 3.2: National Broadband Plan objectives in international examples [Source: Axon Consulting based on information published by Cullen International] Note: Medium coverage: Below 50% / High coverage: 50% or above. Medium speed: Below 70 Mbps / High speed: 70 Mbps or above.

Research conducted by the Broadband Commission suggests that the introduction or adoption of public initiatives oriented to the attainment of high-efficient networks is associated with 2,5% higher fixed broadband penetration.

"Research conducted by the Broadband Commission suggests that the introduction or adoption of public initiatives oriented to the attainment of high-efficient networks is associated with 2,5% higher fixed broadband penetration"

This result is consistent with a broadband line of action focusing efforts across the industry in coordination with policy-makers, emphasizing broadband as a national priority, and signalling national commitment to the roll-out of broadband networks.

As illustrated in the exhibit below, public initiatives focused on the development of fixed broadband markets move through successive phases: Deployment, Adoption and Integration.

"Public initiatives focused on the development of fixed broadband markets move through successive phases: Deployment, Adoption and Integration"

Phase	Focus
PHASE 1: DEPLOYMENT	▸ Broadband network deployment (availability) ▸ Broadband network uptake (affordability)
PHASE 2: ADOPTION	▸ Broadband access and capability building for effective use ▸ Stimulation of digital literacy and community access programs
PHASE 3: INTEGRATION	▸ Broadband integration in economy and society ▸ Integration of multiple ICT services (e-health, e-governance, e-commerce) in a wide range of sectors

Exhibit 3.3: Phases of the application of governmental initiatives [Source: Axon Consulting based on reports published by the ITU]

Initially, governments tend to focus on the national footprint for broadband network availability. In this first phase, monitoring focuses on broadband network deployment to make services as widely available as possible, using standard indicators of coverage, capacity, take-up and price. The current state of the fixed broadband market in Turkey, as explained later, would be classified under this phase.

In their second phase, governmental initiatives include usage or adoption factors such as digital literacy programmes or community access projects. Basic telecom indicators remain important, but the focus expands to include subscription rates, network resilience and quality of the network.

Initiatives in the third phase tend to focus on evaluating the social, economic and institutional uses of broadband underpinning the wider use of ICT services in a range of sectors (including health, government, education, commerce, public information and the media). Indicators of speed, quality and reliability become more important in this phase.

3.2. **Choice of a future-proof technology for Turkey**

Several technologies exist today that may be considered for delivering broadband connectivity to households. These may typically be viewed under two perspectives: connectivity ('Basic' and 'Next generation') and access medium ('Fixed' and 'Wireless'), as summarized in the table below:

		Access medium	
		Fixed	**Wireless**
Connectivity	**Basic**	**ADSL 2+** **DOCSIS 2.0**	**3G (UMTS)** **SATELLITE**
	Next-generation	**FTTH/B** **FTTC/VDSL** **DOCSIS 3.0/HFC**	**WLAN/WIMAX** **LTE/LTE-A**

Exhibit 3.4: Classification of broadband access technologies [Source: Report 'The broadband State aid rules explained']

Consistent with the categorization of fixed broadband in Exhibit 3.4, the European Commission (EC) considers FTTH/B, Cable DOCSIS 3.0, VDSL and other superfast broadband technologies as Next Generation Access (NGA) technologies.

Among these NGA technologies, FTTH/B is technically the most advanced due to a number of unique characteristics:

- Capability to provide very high bandwidths, up to 1Gbps, thereby able to accommodate future redefinitions of the "broadband access" in terms of download speed.
- Lowest possible latency compared to other alternatives.
- Flexibility to upgrade bandwidth capacity over time with minimal investments.
- Long physical lifetime of at least 40 years.
- Relatively lower energy consumption.

"Among the NGA technologies, FTTH/B is technically the most advanced due to a number of unique characteristics"

The above characteristics prove FTTH/B to be a future-proof technology, assigning a truly 'next generation' perspective to the significant initiative of bringing broadband to a large portion of the population. This perspective is achieved not only through the capability to provide high bandwidths, but also through the low latency characteristic of this technology, which becomes increasingly important with applications that require real time interaction with remote servers (e.g. online storage, tele presence, virtual reality).

In Exhibit 3.5 below we provide an overview of the connectivity requirements of an illustrative group of consumer applications and the corresponding technologies that can meet those requirements. Advanced applications such as augmented reality, 4K resolution video streaming, telemedicine, Internet-of-Things based communications such as smart homes, emergency and response systems, smart power grids all have requirements both for high speed and high quality connections. FTTH is the only technology poised to meet both of these requirements, being capable of providing very fast typical speeds (e.g. >1 Gbps) and high connection quality (via ultra-low latencies of less than 1.5ms) simultaneously.

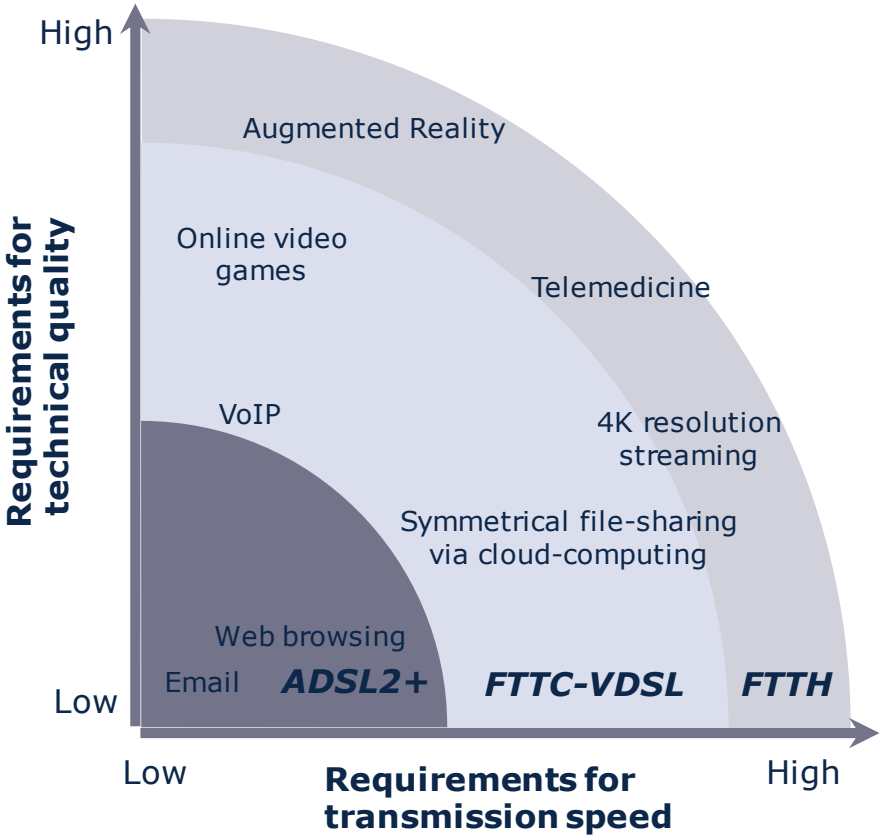

Exhibit 3.5: Quality and speed requirements of different applications and corresponding technologies [Source: Axon Consulting based on recent research by the European Parliament]

"Recent studies carried out by the FTTH Council Europe also confirm that FTTH/B is the only technology with enough bandwidth to handle projected consumer demands in the close future from a reliable and cost-effective perspective"

Recent studies carried out by the FTTH Council Europe[5] also confirm that FTTH/B is the only technology with enough bandwidth to handle projected consumer demands in the close future from a reliable and cost-effective perspective.

The preferential characteristics of FTTH/B are recognized also in Turkey, observable through:

- The deployments of FTTH/B networks in the recent years by the incumbent operator as well as an alternative operator, albeit focused in the densely populated, urban zones and

[5] The FTTH Council Europe is an industry organisation whose mission is to accelerate the availability of fibre-based, ultra-high-speed access networks for the benefit of consumers and businesses. Created in 2004 by five founding members (Alcatel-Lucent, Cisco, Corning, Emtelle and OFS), the FTTH Council Europe now has more than 150 members and a contracted team working to promote the benefits of fibre access across the continent.

green field projects (further discussed in the coming sections).

- Turkey's 2015-2018 Information Society Strategy and Action Plan released by the Ministry of Development, which points out FTTH/B as the only long-term solution to the constantly increasing need for bandwidth and consumption.

A number of countries across the world have been leading the deployment and usage of FTTH/B technologies since quite a few years. Among these Bulgaria, Denmark, Finland, Japan, Norway, Portugal, Romania, Russia, South Korea, Spain and Sweden can be cited as countries with sizable geographic areas. The common factor in all these countries is the fact that deployment of FTTH/B has been the main national target in enhancing fixed broadband offered to consumers.

Our study starts with the presumption – and the vision – that expanding FTTH/B coverage to a significantly larger part of the population than its current state should be the goal of Turkey's Broadband Plan. Coupled with a properly designed investment undertaking of a one-time nature, the whole initiative would avail an infrastructure to the nation that will be usable for many decades.

"Our study departs from the presumption that expanding FTTH/B coverage to a significantly larger part of the population than its current state should be the goal of Turkey's Broadband Plan"

3.3. Turkey's fixed broadband opportunity: a market with high growth potential

Turkey's fixed broadband market has been growing in the recent years in terms of both market size and demand. As can be observed in the exhibit below, as of the end of 2016, the number of fixed broadband connections in Turkey are forecasted to have reached 10,4 million, while the total annual data exchanged over fixed broadband connections are forecasted to have been 8,4 TB[6] million[7].

[6] Terabytes.
[7] The forecasted figures for total fixed broadband connections and annual data exchange have been based on the actual data available from ICTA for the first three quarters of 2016

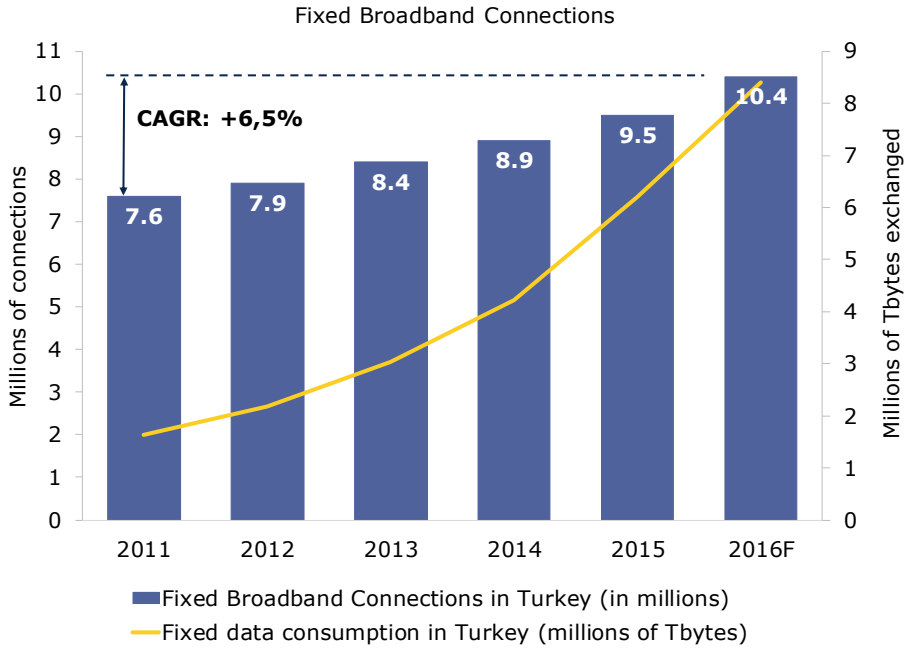

Exhibit 3.6: Evolution of fixed broadband connections and total data exchanged over fixed broadband in Turkey in the period between 2011 and 2016 (forecasted) [Source: ICTA]

"Turkey's fixed broadband market has been growing in the recent years both in terms of market size and demand, implying a 45% take up of fixed broadband services among households covered"

As of Q4 2015, the total fixed broadband connections corresponded to 83% of the 11,5 million fixed line connections in the market[8]. At the same time, the total fixed broadband connections implied a 45% take-up of fixed broadband connections within the households that are covered by broadband services[9].

The annual data exchange through fixed connections increased from 1,6 TB million in 2011 to the forecasted 8,4 TB million for 2016, implying a CAGR[10] of 38,6%, which compares significantly high in relation to the 6,5% CAGR of fixed broadband subscriptions in the same period. The above observation implies that per connection demand for fixed broadband is increasing in Turkey.

"The average monthly data consumption per fixed broadband connection has been growing over the 2011-2016 period"

In fact, as can be seen in the exhibit below, the average monthly data consumption per fixed broadband connection has been growing over the 2011-2016 period.

[8] Source: ICTA, Q4 2015 market indicators report.
[9] As per data from the Turkish Statistical Institute, there were 21,7 million households in Turkey in 2015. As per recent announcements of Turk Telekom, 98% of the households in Turkey are covered with fixed broadband. Hence, the estimated take up percentage of 45% is obtained through dividing 9,5 million fixed broadband connections by 98% of 21,7 million households.
[10] Compound Annual Growth Rate.

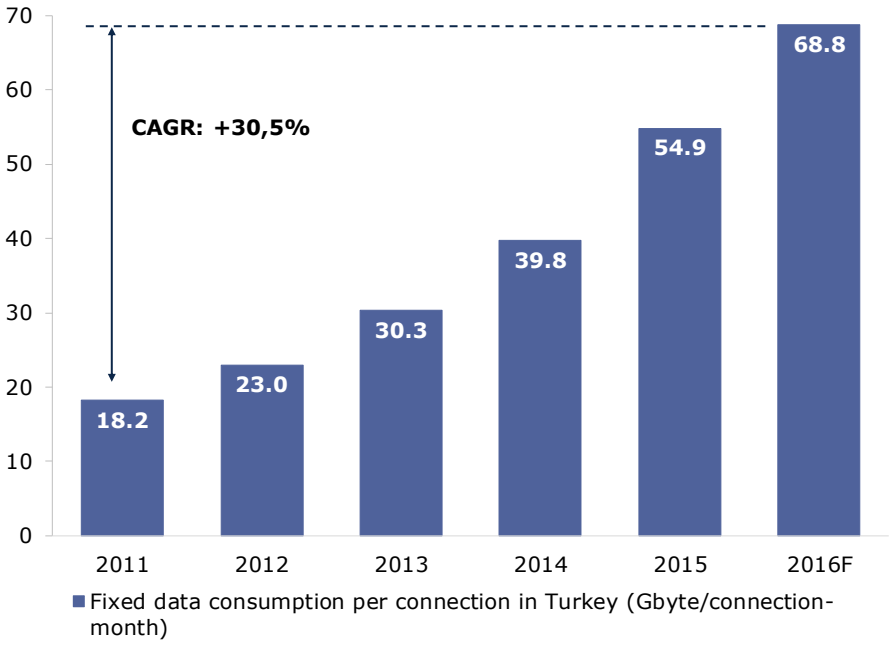

Exhibit 3.7: Evolution of fixed data consumption per connection and annual increase in the period between 2011 and 2016 (forecasted) [Source: ICTA]

Note: Data consumption per connection has been calculated by dividing the total data consumption and the average broadband connections along the year.

The average monthly fixed data per connection has increased at a CAGR of 30,5% between 2011 and 2016. It appears from above that the growth trend observed above will continue into the future.

The observed phenomena of increased usage in the fixed broadband market results relevant also against the data usage trends in the mobile market. The following exhibit provides a snapshot of the monthly average data consumption in 2011 and the forecast for 2016 and the CAGR between these years in both markets:

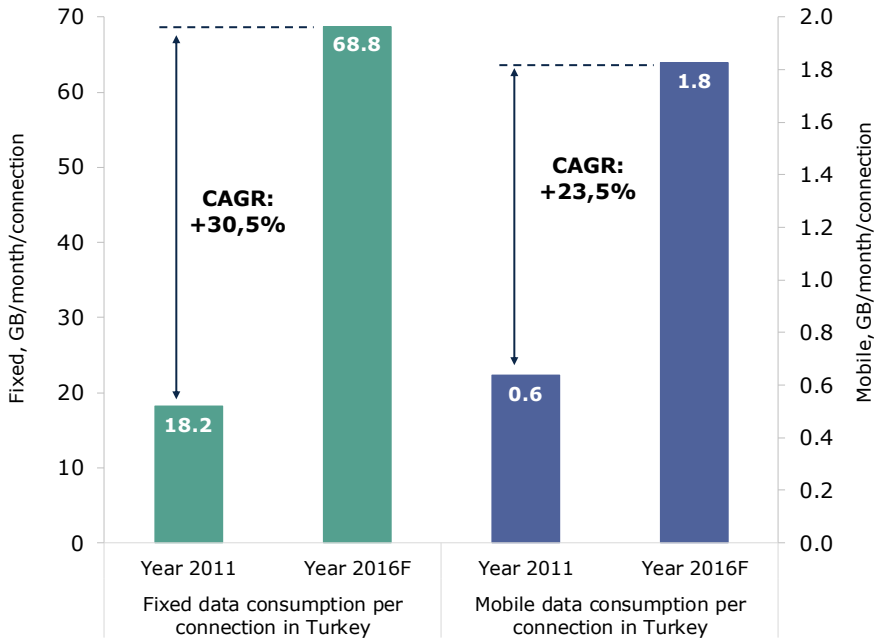

Exhibit 3.8: Evolution of data consumption per connection between the years 2011 and 2016 forecast in the fixed and mobile markets [Source: ICTA] Note: Data consumption per connection has been calculated by dividing the total data consumption and the average broadband connections along the year.

We note the following from the above exhibit:

- The growth in average consumption of fixed broadband data (CAGR of 30,5%) has been substantially higher than the growth in the average consumption of mobile data (CAGR of 23,5%).
- The average consumption of fixed broadband data was about 30 times (18,2 GB fixed data divided by 0,6 GB mobile data) the average consumption of mobile data in 2011, while the same multiple has increased to 38 times in 2016 (68,8 GB fixed data divided by 1,8 GB mobile data).

We observe from the above that historically the appetite of Turkish consumers for data consumption has been much higher for consumption through fixed services compared to consumption through mobile services. This could be attributed to the overall higher speeds and usage quotas of fixed connections[11].

"The appetite of Turkish consumers for data consumption has been much higher for consumption through fixed services compared to consumption through mobile services"

[11] Fixed broadband plans in Turkey usually allow unlimited data usage or usage subject monthly fair usage quotas on volumes of data downloaded. Such volume

The LTE-A[12] services recently launched in Q2 2016 may bridge the gap between the fixed and mobile broadband data consumption, although it is also true that wireless technologies tend to be supplementary technologies compared to fixed technologies for fixed broadband provision.

"The LTE-A services may bridge the gap between the fixed and mobile broadband data consumption, although wireless technologies tend to be supplementary technologies compared to fixed technologies for fixed broadband provision"

We observe that the usage habits of the Internet have been changing dramatically over the recent years. The Internet has evolved from a means for exchange of electronic messages and downloading documents to a channel for a wide suite of applications and services for consumers and businesses including, video media streaming of increasing quality (with multiple simultaneous streaming devices in a household), video conferencing, cloud-based services and peer-to-peer file sharing, among others. Data available from a recent report by Ericsson[13] indicates that the worldwide average monthly data consumption per fixed broadband connection is expected to reach 180 GB/month by the year 2021. Attaining this level of monthly data consumption by the same year in Turkey would imply that the average consumption of 68,8 GB/month forecasted in 2016 needs to increase by a CAGR of 21,2%, as presented in the exhibit below.

"Such a growth seems plausible given the demonstrated growth in consumption over the recent years, as well as the expected changes in the usage habits"

based on quotas are significantly higher than the typical monthly allowances of mobile data plans.

[12] Abbreviation of Long Term Evolution–Advanced. This terminology is currently referred to as the 4.5G technology in the Turkish market.

[13] Report 'Ericsson Mobility', 2015.

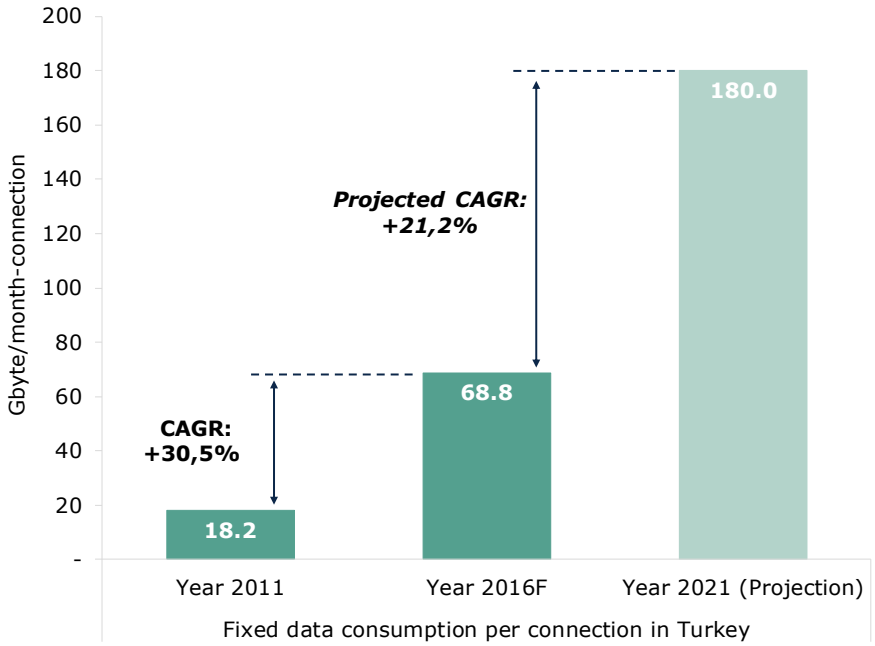

Exhibit 3.9: Projections of data consumption per connection between the years 2016 and 2021 [Source: Ericsson]

Such a growth seems plausible given the demonstrated growth in consumption over the recent years, as well as the expected changes in the usage habits. We can observe in general that the Turkish consumers will not be staying behind worldwide usage trends in the years to come.

3.4. **Understanding Turkey's Broadband Gap**

Subscribers in the Turkish fixed broadband market are served via a number of different access technologies that include xDSL, FTTH/B, cable and satellite. The exhibit below presents the share of these technologies among the fixed broadband connections in Turkey for the period between 2013 and 2016:

"xDSL is still by far the largest access technology in 2016, forecasted to be accounting for 73,9% of the total fixed broadband connections as of Q4 2016"

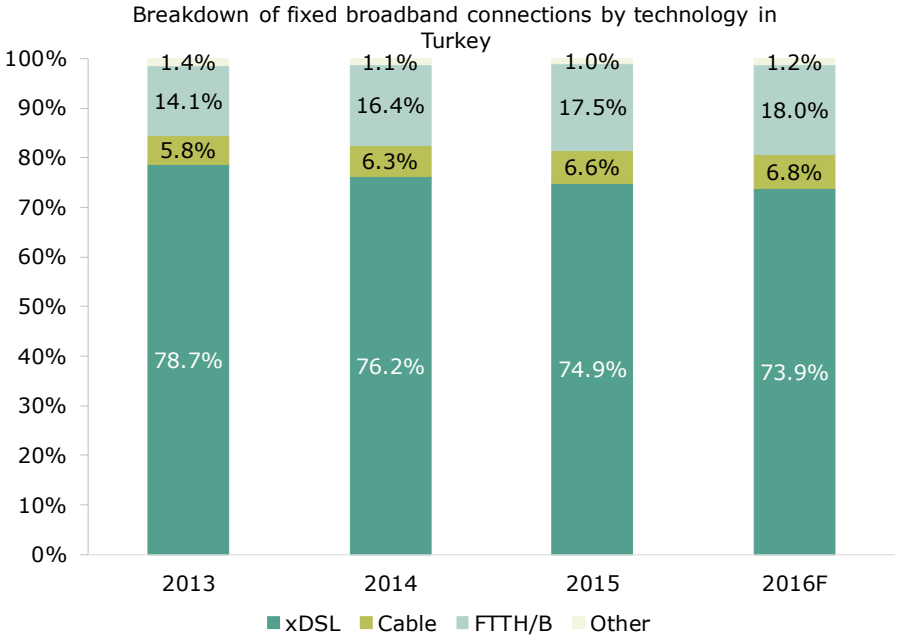

Exhibit 3.10: Breakdown of fixed broadband connections by technology in Turkey [Source: ICTA]

From the exhibit above, we observe that xDSL is still by far the largest access technology in 2016, accounting for around 74% of the total fixed broadband connections. We also observe a moderate decrease of this percentage from its level of 78,7% in 2013, mostly in favour of the FTTH/B and cable access technologies.

In terms of the advertised connection speeds of the connections, we see – as demonstrated in the next exhibit – that there has been a migration towards higher speed connections in the period between 2013 and 2016[14]:

[14] The 2016 figures have been estimated based on the actual data available from ICTA for the first three quarters of the year.

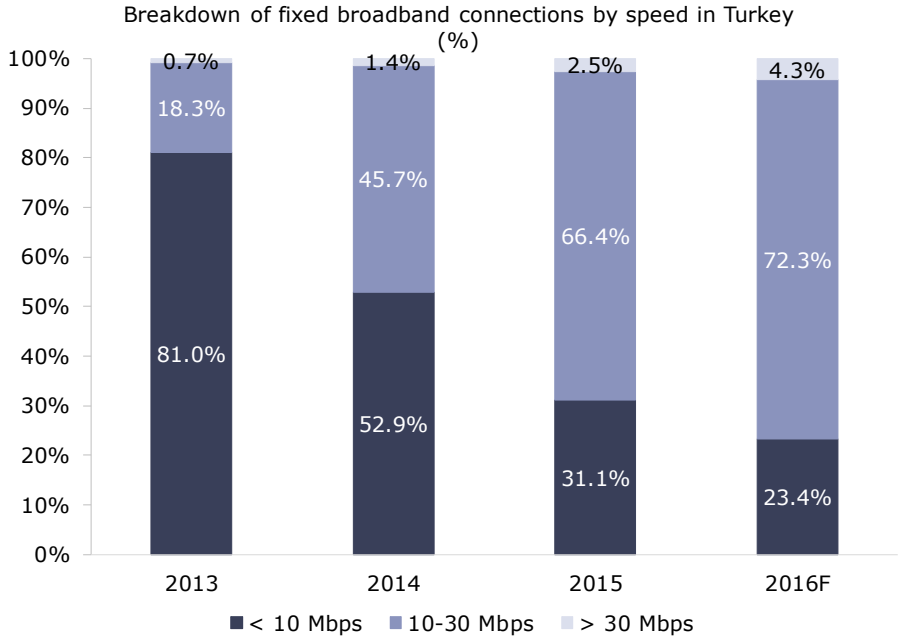

Exhibit 3.11: Breakdown of fixed broadband connections by speed in Turkey [Source: ICTA]

We note that the observed switch from <10 Mbps speeds to 10-30 Mbps speeds has come through a technology upgrade of the existing copper networks, making VDSL technology available to a larger part of the households. In other words, the technology upgrade has still kept xDSL as the major access technology, as viewed also on the previous Exhibit 3.10.

Looking into the future, the expected growth of fixed broadband demand in the coming years (as observed in the previous section) implies that new and more profound upgrades or changes of access technology may be timely and appropriate for Turkey.

The shifts in the habits of consumers, who more and more expect to use high performance communication services, multiple streaming music and video instances, and cloud services in many aspects of daily life (e.g. public e-government services, online storage), point out to the need for high speed, low latency networks with high availability rates.

The above observations justify that setting the objective of the national broadband plan to focus on deploying FTTH/B is both timely and appropriate. Before moving on with our proposed vision for implementing this objective, we find it useful to provide in the coming paragraphs a snapshot of the current FTTH/B deployment,

"The expected growth of fixed broadband demand in the coming years imply that new and more profound upgrades or changes of access technology may be timely and appropriate for Turkey"

prices of FTTH/B services and the competition in the fixed broadband market.

Current FTTH/B coverage and take-up

The levels of FTTH/B coverage[15] and take-up[16] in Turkey (23% and 33% by the end of 2015, respectively) compare significantly low against the average of the leading FTTH/B countries[17] (66% and 41%, respectively).

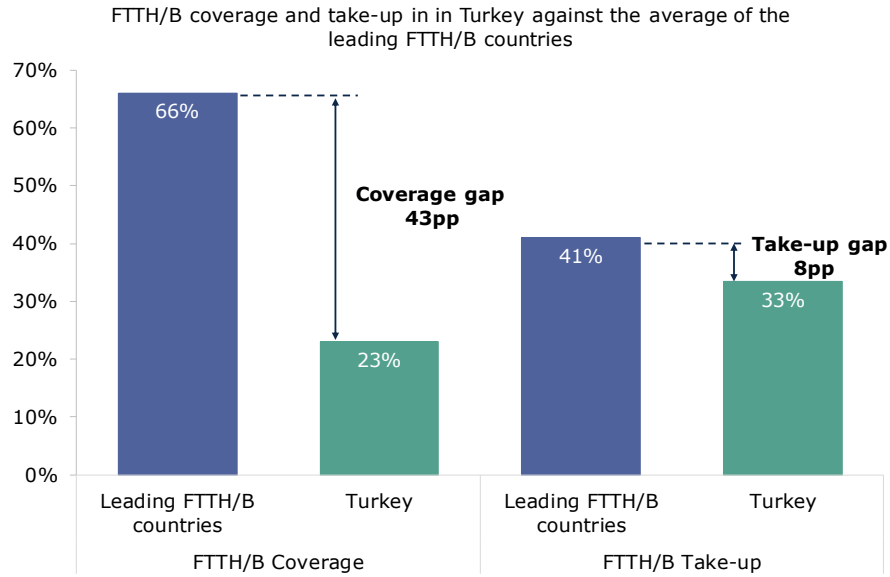

Exhibit 3.12: FTTH/B coverage[15] and take-up[16] gaps in Turkey against the average of the leading FTTH/B countries [Source: European Commission, FTTH Council and the OECD]

Until recently, the FTTH/B deployment in Turkey has been under a regulatory holiday period[18] introduced by the ICTA at the end of 2011. Under these observations, it is not clear whether the regulatory holiday period has been effective in triggering the investments needed for ensuring coverage levels in line with the leading FTTH/B countries.

"The current levels of FTTH/B coverage and take-up in Turkey compare significantly low against the average of the leading FTTH/B countries"

"It is not clear whether the regulatory holiday period introduced by the ICTA at the end of 2011 has been effective in triggering the investments needed for ensuring coverage levels in line with European countries"

[15] Coverage: households passed over total households in the country.
[16] Take-up: households connected over households passed.
[17] We refer to Bulgaria, Denmark, Finland, Japan, Norway, Portugal, Romania, Russia, South Korea, Spain and Sweden as the leading FTTH/B countries as mentioned under Section 3.2.
[18] The regulatory holiday period ensures that neither the newly deployed fibre networks of the incumbent operator nor those of alternative service providers would be subject to market analysis, and hence obligations for wholesale network access arising from a potential designation of significant market power (SMP).

Price levels of FTTH/B services

The exhibit below compares the average purchasing power parity (PPP) adjusted monthly price of a FTTH/B subscription with a download speed of 100 Mbps in Turkey with the average observed in the leading FTTH/B countries in 2015.

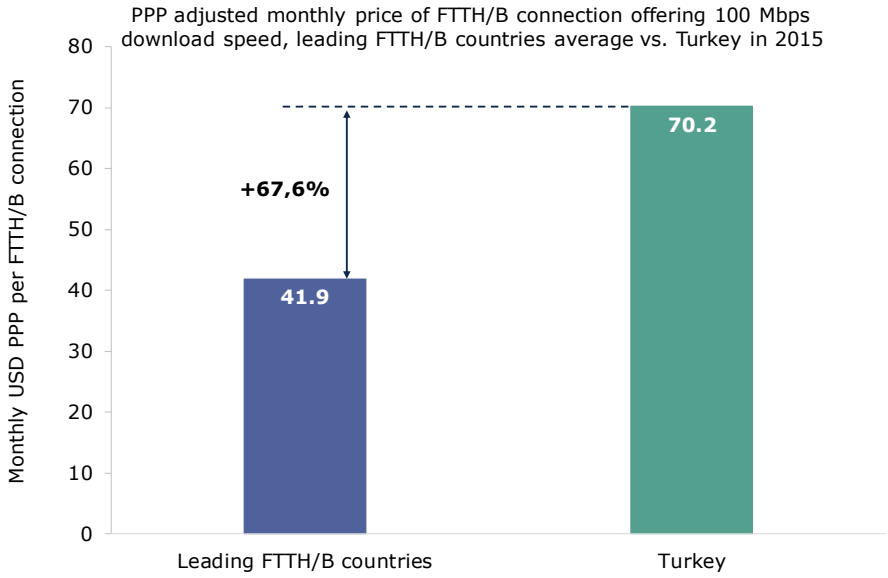

Exhibit 3.13: Price of reference for a FTTH/B connection in Turkey against the average of the leading FTTH/B countries with comparable offers [Source: OECD and information gathered from websites of service providers in the respective countries adjusted for PPP]

"The average price of a FTTH/B subscription in Turkey is 67,6% higher than comparable existing offers in the average of the leading FTTH/B countries"

The observed gap in PPP terms of 67,6% could be attributable to the lower levels of coverage and take-up compared to the leading FTTH/B countries (see Exhibit 3.12).

Competition in the fixed broadband market

In the Turkish fixed broadband market (i.e. broadband connections over xDSL, cable and FTTH/B), the incumbent operator Turk Telekom is the main player. As can be observed in the exhibit below, the significantly high subscribers' market share of Turk Telekom in the market has been in a declining trend over the 2013–2016 period (from 80% by the end of 2013 to a forecasted level of 69% as of the end of 2016).

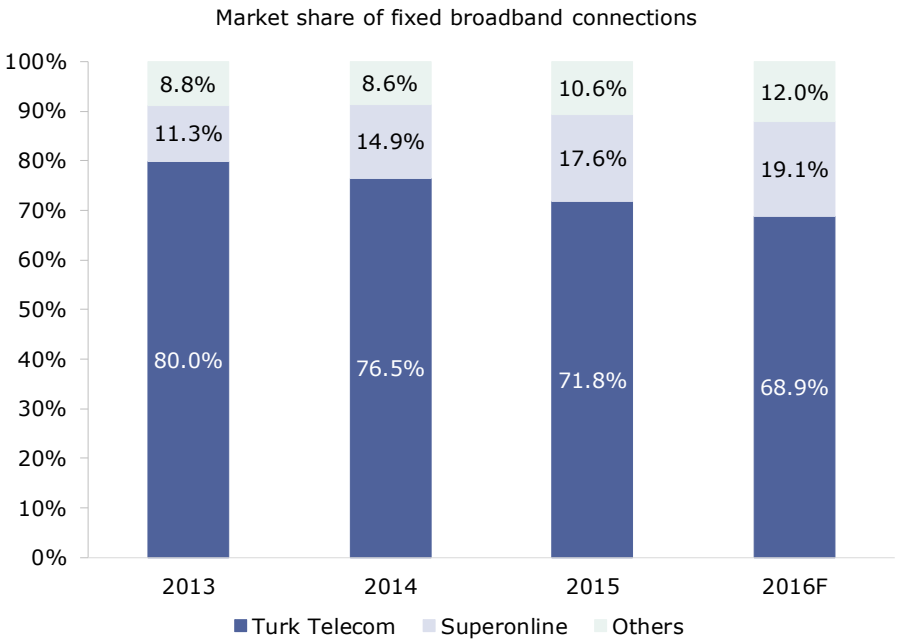

Exhibit 3.14: Market share in the fixed broadband market [Source: ICTA]

Despite a decline in Turk Telekom's market share, it is still high in comparison with international standards, especially when compared with the average of the leading FTTH/B countries where incumbent operators' average market share of fixed broadband connections stands at 40,5%, as presented in the exhibit below.

"Despite a decline in Turk Telekom's market share, it is still high in comparison with international standards, especially when compared with the leading FTTH/B countries"

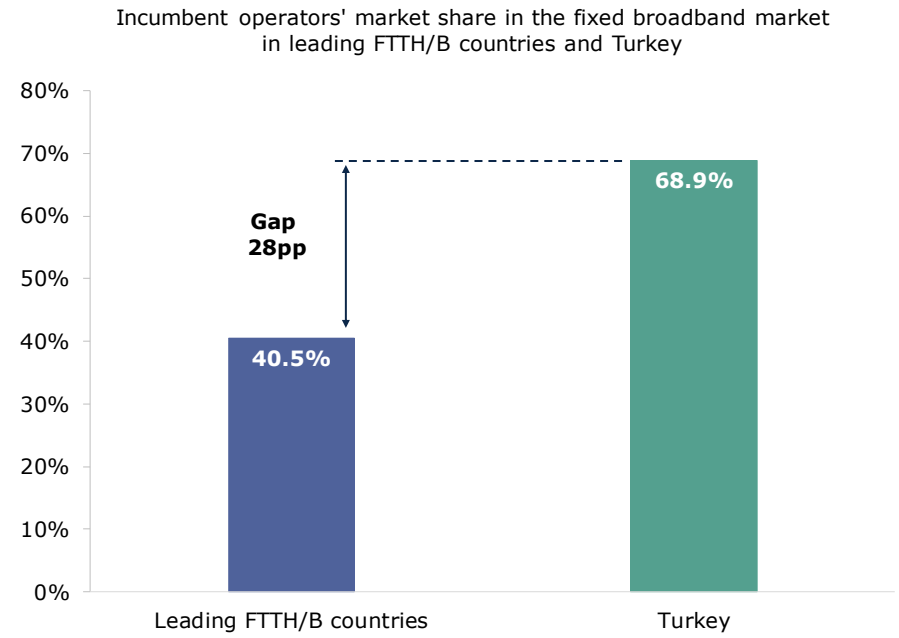

Exhibit 3.15: Incumbent operators' market share in the fixed broadband market in Turkey against the average of the leading FTTH/B countries [Source: ICTA, EU Digital Agenda Scoreboard and other public sources]

3.5. **Crafting a Broadband Plan for Turkey**

In formulating a Broadband Plan, each country needs to consider its conditions and priorities, taking into account the overall national priorities, the socio-economic climate and geography, as well as levels of broadband awareness among key stakeholders (such as government agencies, business and community leaders and the public).

"Turkey stands at a right point in time to consider and realize the vision of expanding FTTH/B coverage to a significantly large part of the population"

Concerning the Turkish fixed broadband market, we can summarize our observations in the previous sub-sections as follows:

- A market with high potential growth in terms of **demand** and adoption of new services over fixed broadband.
- A market that appears to be impacted from low affordability of high download speeds which in reality may be achieved through new technologies and effective competition, and instead basing its **supply** principally on legacy copper networks in the foreseeable future.

These observations justify that Turkey stands at a right point in time to consider and realize the vision of expanding FTTH/B coverage to a significantly large part of the population. The challenge of this vision lies in the fact that wide scale FTTH/B expansion projects require significant investments and consequently a careful analysis of the business case for the medium to long-term recovery of those investments.

"An open access network (OAN) scheme suits well the objective of deploying an FTTH/B network with a sufficiently large footprint in Turkey"

Expansion of FTTH/B networks in Turkey would imply taking forward the household coverage ratio of this technology from its level of 23% in Q4 2015 (as presented in the previous Exhibit 3.12). The initiative would not only bring the coverage levels at par with the levels observed in the leading FTTH/P countries, but also would attempt to take it forward to ensure maximum adoption and take-up by the consumers.

3.5.1. **The Open Access Network (OAN) scheme**

We discuss in this section the so-called **open access network (OAN)** scheme which we believe suits well the objective of deploying an FTTH/B network with a sufficiently large footprint in Turkey**.**

In the international examples of open access networks, a separately founded entity in the market undertakes the deployment of a common passive wholesale FTTH/B access network. This passive network lets third parties – i.e. licensed retail service providers – use the deployed network assets to serve end users in an effective manner. In other words, in an OAN scheme, competing service providers reach end user premises through a common passive network/infrastructure offered at the wholesale level. The service providers attach their active equipment to the passive network to complete the full service to the end user. The end users may choose among multiple service providers who offer ICT services.

The revenue source of an open access network is typically monthly wholesale access fees collected from retail service providers for each retail connection activated by end users. It is a common practice that this access fee is determined on a cost-oriented, affordable and non-discriminatory basis to ensure fair and equal passive access to all players in the market.

An open access network with the above characteristics would cater for the needs of the Turkish market by:

- **Avoiding duplication of resources** through multiple service providers investing in FTTH/B passive access networks. It would instead enable focusing on the timely expansion of service to reach the widest level of FTTH/B coverage through optimized roll-out and investment plans (hence meeting the supply objective).
- Creating the environment for effective and non-discriminatory access to network elements by multiple retail providers, promoting an environment of **affordable prices** and volume gains by retail policies that **enhance take-up** of FTTH/B services (hence meeting the demand objective).

We also note that an open access network enables the utilization of any government support and facilitation in the deployment of FTTH/B networks, since it facilitates the pooling of resources and capital, and efficient expansion. We discuss in Annex A, selected examples of open access networks from the international experience, providing also a perspective on the different levels government support that was provided to such networks.

Bearing in mind the suitability of an open access network for Turkey, we present in the next section an analysis of the likely investment cases for such a network.

3.5.2. Investment needs of the open access network scenarios in Turkey

We present below the results of an investment and business case analysis we have carried out to assess the economic fundamentals of a shared FTTH/B network in Turkey. The calculations behind the presented results are based on a business case model[19] developed for this exercise.

We consider two main scenarios in the business case model:

- **Scenario A (with reutilization of civil infrastructure)**: Roll-out of the FTTH/B network with reutilization of the existing civil infrastructure (in which ducts are rented through a wholesale price) by the open access network entity. Such entity in turn provides wholesale services to retail service providers to make use of the deployed infrastructure.
- **Scenario B (no reutilization of civil infrastructure)**: Roll-out of the FTTH/B network with own deployment of the civil infrastructure (i.e. no reutilization of the existing infrastructure) by the open access entity. Such entity in turn provides wholesale services to third parties to make use of the deployed infrastructure.

We note that under the above Scenario A, we have not assessed the actual feasibility of full reutilization of existing telecommunications ducts in Turkey. However, we are of the opinion that some degree of reutilization should be achievable, given the international experience, and the possibility that ducts constructed not necessarily only for telecommunications networks, but also for other utilities (such as electricity and gas), may also turn out as at disposition under the right conditions.

[19] Further details on the basics and principles of the business case model are presented in Annex B.

We also note that under the above Scenario B, the assumed deployment cost of ducts[20] represent the cost of construction only. Any fees that may be charged by various state entities (such as the municipalities) in the form of rights of way or other descriptions are not included. Therefore, the investment and business case results of Scenario B presented further below should be interpreted as outcomes in the absence of such charges.

Under both scenarios, we evaluate the investments needed to bring the FTTH/B household coverage from its existing level of 23% (see Exhibit 3.12) to higher levels. While explained in further detail in the Annex B of this Report, we summarize below the principal household coverage percentage levels referred in the presentation of our results:

- **23% FTTH/B coverage:** the level of coverage as of Q4 2015 attained by own infrastructure of retail service providers.
- **76% FTTH/B coverage:** The coverage level signifying full coverage of the households located in **urban** areas of Turkey (i.e. cities with more than 100.000 inhabitants).
- **90% FTTH/B coverage:** The coverage level signifying full coverage of the households located in urban and **suburban** population centres in Turkey (i.e. all cities and towns with more than 30.000 inhabitants).
- **100% FTTH/B coverage:** The coverage level signifying full coverage of the households located in urban, suburban and **rural** population centres in Turkey.

The exhibit below summarizes the resulting key performance metrics under both scenarios in terms of FTTH/B coverage and households passed.

[20] Details of cost assumptions are provided in Annex B.

Alternative	FTTH/B coverage	Million HH passed
No action (Status Quo) – Current Situation	**23%**	**5,00**
Coverage of urban areas	76%	16,46
Coverage of urban and suburban population centres	90%	19,49
Coverage of urban, suburban, rural population centres	100%	21,66

Exhibit 3.16: Summary of performance metrics under different coverage targets [Source: Axon Consulting]

The estimated investments needed by the open access network entity for each scenario illustrated above are presented below.

Alternative	Estimated investments by the OAN (USD million)		Diff.
	Scenario A (reutilization of civil infrastr.)	Scenario B (no reutilization of civil infrastr.)	
No action (Status Quo)	-	-	
Coverage of urban areas (>100.000 inhabitants)	1.740	3.167	x1,8
Coverage of urban and suburban population centres (>30.000 inhabitants)	2.757	4.561	x1,7
Coverage of urban, suburban, rural population centres	4.607	6.681	x1,5

Exhibit 3.17: Summary of investments needed for different household coverage percentages under Scenario A and Scenario B [Source: Axon Consulting] Note: Figures in USD millions.

"Under Scenario B, with no reutilization of civil infrastructure, the OAN entity would need to undertake investments that are between 1,5 and 1,8 times more than Scenario A, where instead existing civil infrastructure is reutilized"

As seen above, under Scenario B, with no reutilization of civil infrastructure, depending on target coverage rates, the OAN entity would need to undertake investments that are between 1,5 and 1,8 times more than Scenario A, where instead existing civil infrastructure is reutilized. In other words, the possibility of reutilizing existing civil infrastructure has a significant impact on the investment case.

3.5.3. **Business case analysis of the OAN scenarios**

In this sub-section, we analyse the investment figures presented above against the projected revenue streams foreseen for each Scenario. We present in the remainder of this section an analysis of Scenario A and B under the following assumptions concerning the revenue model of the OAN:

Input	Assumption value
Take-up under Sensitivity Case 1	33%
Take-up under Sensitivity Case 2	45%

Exhibit 3.18: Characteristics of the scenarios considered in the business case analysis [Source: Axon Consulting] Note: Take-up figures are presented in terms of households connected over households passed.

Among the assumptions, the wholesale access fee of the eventual open access network is foreseen at a fee level that approximates the currently regulated wholesale prices of traditional xDSL services in the market. Hence, by setting a similar level, we aim to fulfil the objective that the final service provided to the end users will be priced at affordable levels. We note here, however, that the foreseen wholesale price for this exercise has been chosen for purely illustrative purposes and that once the OAN goes ahead, a detailed analysis would need to be undertaken to determine the right wholesale prices that are cost-oriented, and that ensure affordability and non-discrimination.

Concerning the take-up of FTTH/B lines in the covered zones, the business case analysis considers two sensitivity cases:

- *Sensitivity Case 1* assumes that the retail service providers will convert households covered to connections at the same rate currently observed in the market (33%, as presented in Exhibit 3.12).
- *Sensitivity Case 2* assumes that this rate will reach the level of 45%, i.e. the take-up of fixed broadband in Turkey as of the end of 2015 (as outlined in sub-section 3.3).

We present in the following paragraphs the outcomes of the 4 scenario/sensitivity case combinations that result from the above. Each scenario/case combination is presented in terms of the evolution of:

- Estimated revenues
- Estimated expenditures (comprising operating expenses, depreciation and cost of capital)
- Estimated economic margin (difference between revenues and expenditures)

The above items are presented in net present value (NPV) terms over the projections for the next 5 years and along a continuous scale that represents different FTTH/B coverage levels starting from 23% up to 100%.

Scenario A – Sensitivity Case 1

The economics implied by **Scenario A - Sensitivity Case 1 (Reutilization of civil infrastructure and take-up of 33%)** are presented in the exhibit below:

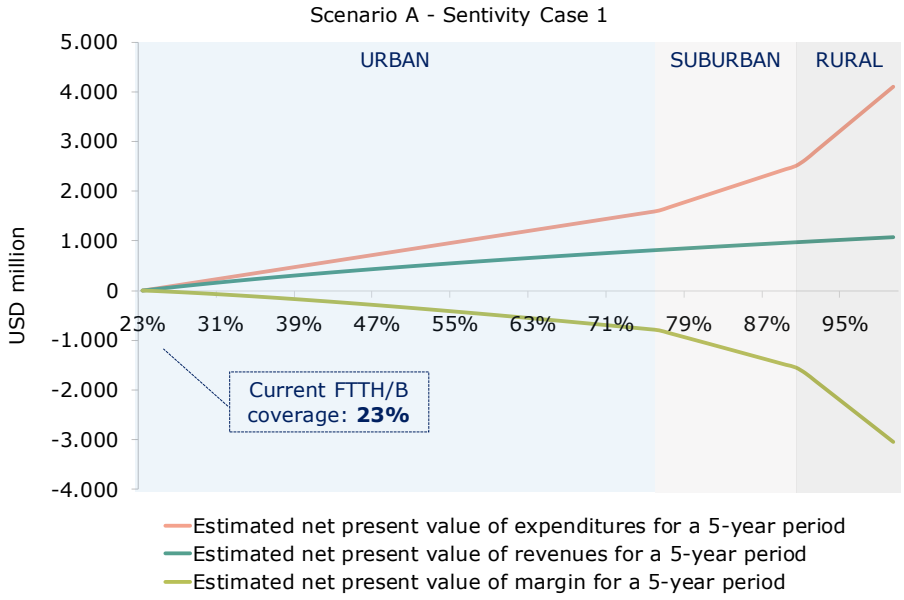

Exhibit 3.19: Economics of an open access network under Scenario A and Sensitivity Case 1 in a 5-year period [Source: Axon Consulting]

We observe from above that in all coverage expansion points above 23%, Scenario A – Case 1 does not produce positive economic margins for the open access network.

Scenario A – Sensitivity Case 2

The economics behind the **Scenario A - Sensitivity Case 2 (Reutilization of civil infrastructure and take-up of 45%)** are presented in the exhibit below:

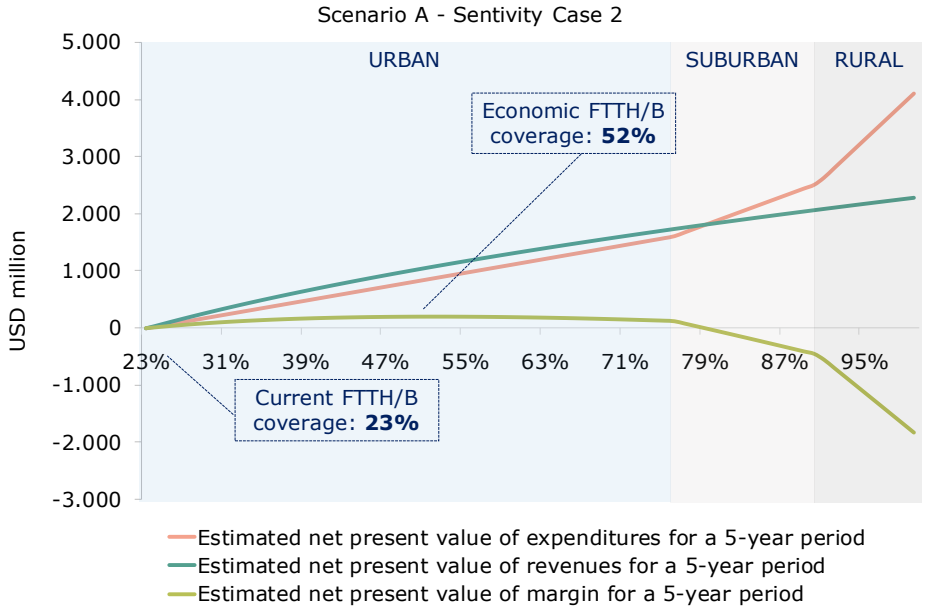

Exhibit 3.20: Economics of an open access network under Scenario A and Sensitivity Case 2 in a 5-year period [Source: Axon Consulting]

We observe above that under Scenario A – Case 2, the improved take-up percentage assumption enables the open access network to have positive and efficient economic margins for coverage levels up to 52%. After this level of coverage, further expansion would imply deteriorating margins compared to 52% coverage level.

In other words, the above economics suggest that the open access network would be able to increase the FTTH/B coverage in the country up to 52% (implying 11,26 million households covered) in an economically efficient manner.

Scenario B – Sensitivity Case 1

The economics behind the **Scenario B - Sensitivity Case 1 (No reutilization of civil infrastructure and take-up of 33%)** are presented in the exhibit below:

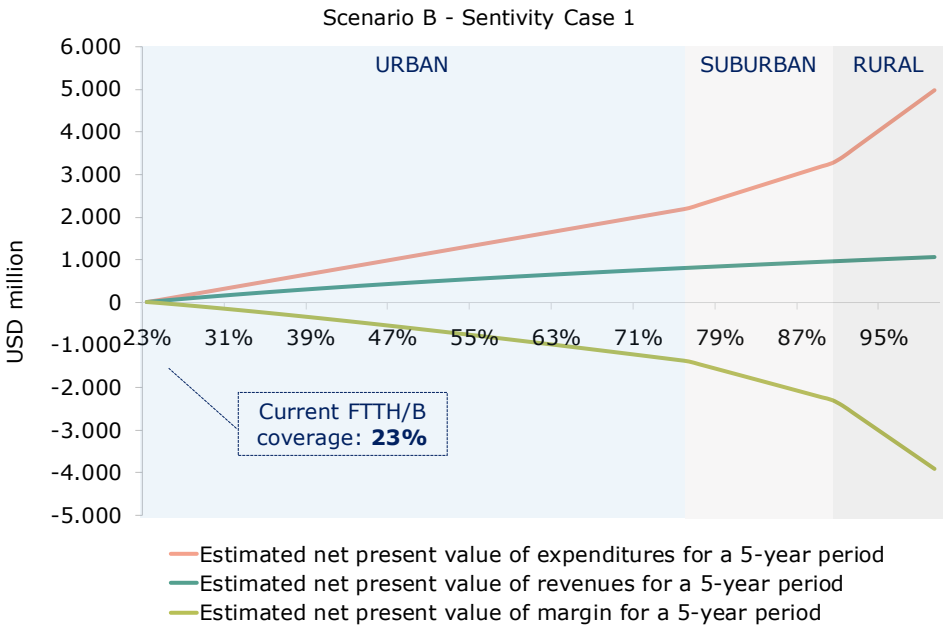

Exhibit 3.21: Economics of an open access network under Scenario B and Sensitivity Case 1 in a 5-year period [Source: Axon Consulting]

We observe from above that in all coverage expansion points above 23%, Scenario B – Case 1 does not produce positive economic margins for the open access network.

Scenario B – Sensitivity Case 2

The economics behind the **Scenario B - Sensitivity Case 2 (No reutilization of civil infrastructure and take-up of 45%)** are presented in the exhibit below:

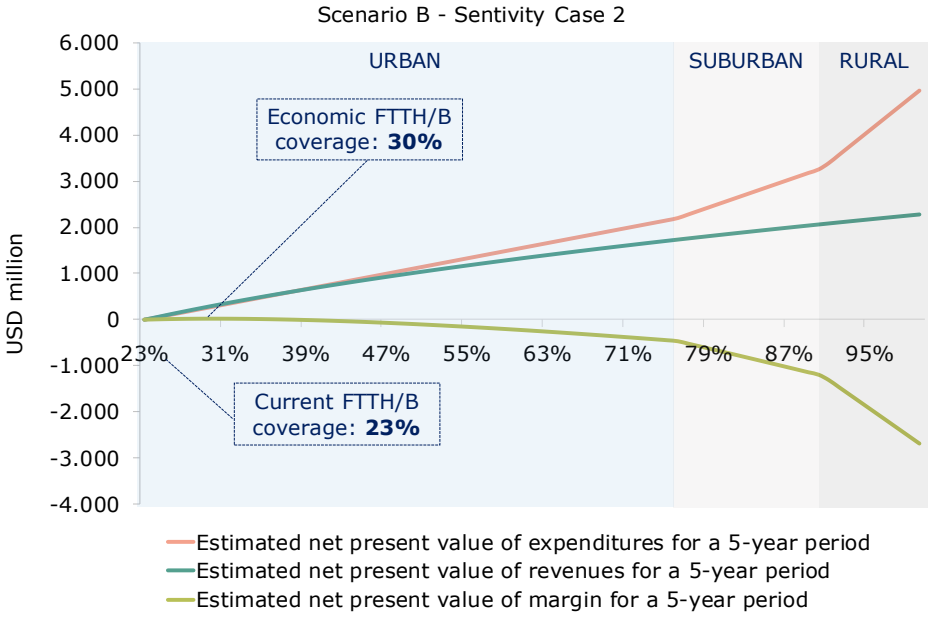

Exhibit 3.22: Economics of an open access network under Scenario B and Sensitivity Case 2 in a 5-year period [Source: Axon Consulting]

We observe above that under Scenario B – Case 2, the improved take-up percentage assumption enables the open access network to have positive and efficient economic margins for coverage levels up to 30%. After this level of coverage, further expansion would imply deteriorating margins compared to 30% coverage level. These economic outcomes suggest that the OAN would be able to increase the FTTH/B coverage in the country up to 30% (implying 6,50 million households covered) in an economically efficient manner.

Economic implications of the 4 'scenario–case' combinations

As mentioned in the previous paragraphs, we note that in some of the 'scenario–case' combinations the OAN may avoid negative economic margins by limiting the FTTH/B deployment at economically viable levels.

The table below summarizes these coverage levels, and the relevant economic indicators:

Scenario-Case	Economic FTTH/B coverage of the country	HH reached with FTTH/B (millions)	Estimated investments by the OAN (USD millions)	NPV of economic margin in a 5-year period (USD millions)
Scenario A (with reutilization of civil infrastructure)				
Sensitivity Case 1 (33% take-up)	23%	5,00	-	-
Sensitivity Case 2 (45% take-up)	52%	11,26	948	202
Scenario B (without reutilization of civil infrastructure)				
Sensitivity Case 1 (33% take-up)	23%	5,00	-	-
Sensitivity Case 2 (45% take-up)	30%	6,50	413	21

Exhibit 3.23: Coverage and relevant economic indicators at economically viable levels of FTTH/B coverage [Source: Axon Consulting]

We observe from above that the Sensitivity Case 1, i.e. preserving the current FTTH/B take-up level of 33%, does not yield positive economic margins for the OAN under any scenario. On the other hand, under an increased take-up case, it appears that the OAN would be able to undertake economic investments up to 52% coverage (implying 11,26 million households covered) in the case of reutilization of existing infrastructure, and 30% coverage (implying 6,50 million households covered) in the case of digging own ducts.

Summary and assessment of the scenario outcomes

The exhibit below provides a comparative summary view of the outcomes of the different 'scenario-case' combinations presented above. Particularly the exhibit presents:

- The total foreseen households reached in Turkey (including the households covered with own infrastructure of retail service providers as of Q4 2015).
- The foreseen network investments by the OAN entity.
- The foreseen NPV of the impact on economic profit[21] in a 5-year period of the household coverage percentage under each case.

[21] Difference between the NPV of the estimated margin for a certain level of FTTH/B coverage and the NPV of the estimated margin obtained under the economical FTTH/B coverage.

	HH reached with FTTH/B (millions)	Estimated investments by the OAN	NPV of variation on economic profit in a 5-year period	
			Sensitivity Case 1	Sensitivity Case 2
Scenario A (with reutilization)				
Economic coverage under *sensitivity case 1*	5,00	-	-	-
Economic coverage under *sensitivity case 2*	11,26	948	-	-
Coverage of urban areas	16,46	1.740	-801	-81
Coverage of urban and suburban areas	19,49	2.757	-1.547	-653
Coverage of urban, suburban, rural areas	21,66	4.607	-3.043	-2.033
Scenario B (without reutilization)				
Economic coverage under *sensitivity case 1*	5,00	-	-	-
Economic coverage under *sensitivity case 2*	6,50	413	-	-
Coverage of urban areas	16,46	3.167	-1.391	-489
Coverage of urban and suburban areas	19,49	4.561	-2.293	-1.217
Coverage of urban, suburban, rural areas	21,66	6.681	-3.900	-2.709

Exhibit 3.24: Summary of performance metrics under Scenario A and Scenario B [Source: Axon Consulting] Note: Figures in USD millions.

We can observe the following from above summary:

- The reutilization of civil infrastructure would lead the OAN to undertake higher investments and reach more households. Specifically, we observe that under a scenario with no reutilization of civil infrastructure, the OAN would undertake an investment amount of 413 million USD and increase coverage of FTTH/B infrastructure from 5 million households to 6,50 million households. The same figures would be 948 million USD and 11,26 million households under the scenario of reutilization of the civil infrastructure.
- The reutilization of civil infrastructure would also enable the OAN to reach to a larger coverage. For instance, while under Scenario B (no reutilization), the OAN would need to invest 3,16 billion USD to cover all the households in urban areas (population centres with more than 100.000 inhabitants), by investing a substantially lower amount of 2,76 billion USD under Scenario A (reutilization), the OAN would be able to cover both urban and suburban areas (population centres with more than 30.000 inhabitants).
- Under the reutilization scenario, the NPV of variation on economic profit of the OAN to cover all urban areas varies between -81 million USD and -801 million USD, depending on

the take-up rate of FTTH/B services. The magnitude of this range suggests that with adequate levels of government support, the coverage of all urban areas under the OAN scheme is a viable and potentially realizable outcome.

All the above observations indicate that with adequate and timely support, the OAN scheme can realistically cover all population centres over 100.000 habitants in Turkey. Implying 76% of the households, this would be an excellent result, bringing a state-of-the-art and future-proof technology to the majority of the country, and potentially contributing to the competitiveness of Turkey in the international arena.

"Given the social and economic implications of an FTTH/B network with wide coverage, a key question that needs answering is the role of the government"

Government support to enable such a desirable outcome would primarily need to focus on:

- Measures for the promotion of a friendly regulatory environment in which it is enabled the reutilization of existing civil infrastructure, e.g. the facilitation or removal of rights of way or other fees currently charged by various state entities such as the municipalities.
- Moderate financial support followed by a careful assessment of the business performance of the OAN and potentially providing grants of a relatively minor magnitude based on the take-up of the FTTH/B services.

3.5.4. **Role of the government to the expansion of FTTH/B networks in Turkey**

Given the social and economic implications of an FTTH/B network with wide coverage, a key question that needs answering is the role of the government and the extent of any eventual government support in such an initiative. Government support to the deployment of next generation broadband networks is a widely encountered phenomenon in the international experience.

"Government support to broadband deployment initiatives would be justified if certain social and economic principles were met"

Government support may be in the form of facilitations (such as rights of way), support in-kind, as well as outright financial aids. The European Commission, for example, has a clear set of guidelines

targeted at the rapid deployment of broadband networks[22] in member countries. These guidelines define proper mechanisms for the Commission to receive, evaluate and approve European aid requests from member states or their jurisdictions (e.g. individual regions, cities) for the deployment of next generation broadband networks.

The guiding principles of the EC guidelines as well as the underlying motivations of interventions encountered in other international markets point out that government support to broadband deployment initiatives would be justified if certain social and economic principles were met. Such principles may be summarized as in the exhibit below:

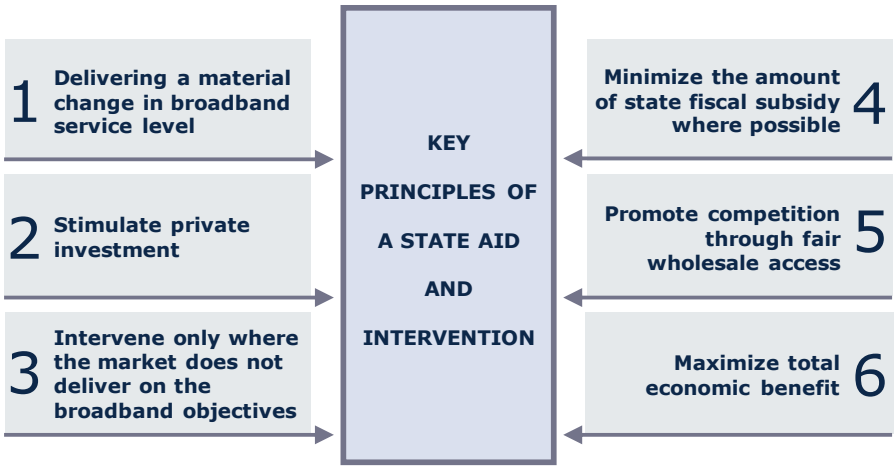

Exhibit 3.25: Key principles pursued by government interventions [Source: Axon Consulting based on international practice]

We briefly explain below each of the above principles:

Principle 1: Delivering a material change in broadband service level

A crucial point for justifying government intervention is whether the relevant initiative is able to ensure a 'step change' in terms of broadband availability. Such a step change would imply significant new investments regarding infrastructure and significant new capabilities to the market in terms of service characteristics.

[22] 'EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks', 2013.

Principle 2. Stimulate private investment

Government intervention should be designed in a way to incentivize the private sector to undertake the major part or the entirety of the investment needed to reach the national broadband objectives. Measures such as the facilitation or removal of rights of way or other fees currently charged by various state entities to the operators could, for example, become effective forms of intervention in this direction.

Principle 3: Intervene only where the market does not deliver on the broadband objectives

The government intervention should only be limited to areas where the market either has failed to deliver service or does not deliver service in line with the policy objectives.

Principle 4: Minimize the amount of state fiscal subsidy where possible

In order to maximize value for money in the use of public funds, government intervention should take place in the form of financial aids only if such aids are absolutely necessary for reaching the objectives of the intervention.

Principle 5: Promote competition through fair wholesale access

Effective competition brings about a wide range of benefits. In recognition of this, government intervention should aim at promoting competition. In other words, all retail service providers should be able to offer service under reasonable and equivalent terms and conditions.

Principle 6: Maximize total economic benefit

Government support should take place with the recognition that wide availability latest broadband technologies will yield numerous benefits to the society and the wider economy.

The following exhibit provides an assessment of which conditions an FTTH/B network in Turkey and its undertaking would qualify for government support in the light of the above principles:

Principle	Assessment of the Turkish case and the proposed FTTH/B deployment	Principle justified?
Principle 1: Delivering a material change in broadband service level	In those regions that are only covered by basic broadband technologies (e.g. ADSL and ADSL+), the widespread deployment of FTTH/B is expected to bridge the connectivity gap and provide a significant 'step change'. In regions where there are next generation technologies (e.g. FTTC/VDSL), deployment of FTTH/B will still bring material improvements in terms of competition, quality service and future proofing of the needs of the consumers.	**Yes**
Principle 2. Stimulate private investment	The national broadband initiative crafted for Turkey should be based primarily on investment by private parties, who may be existing players in the local market or new players looking to enter the market.	**Yes, with the right investment structure**
Principle 3: Intervene only where the market does not deliver on the broadband objectives	The proposed deployment is directed at bringing FTTH/B to areas that are currently not covered with this technology.	**Yes**
Principle 4: Minimize the amount of state fiscal subsidy where possible	FTTH/B deployment should have the necessary transparency to permit timely and continuous assessment of network and business performance and determine the right amount of government support needed, if at all, through changing market conditions.	**Yes, through a sufficiently transparent undertaking**
Principle 5: Promote competition through fair wholesale access	The deployed FTTH/B network should be available to all retail service providers at equal and suitable conditions.	**Yes, through ensuring equal and fair access**
Principle 6: Maximize total economic benefit	The proposed undertaking should make possible the existence of multiple competitors at the retail level, leading in time to product innovations. This, for example, could come through a pooling of resources at the wholesale level.	**Yes, under a resource pooling approach at the wholesale level**

Exhibit 3.26: Justification of the key principles of government intervention in Turkey [Source: Axon Consulting]

It can be observed from the above assessment that an initiative to deploy an FTTH/B network would need to be complemented by the following elements in order to qualify for an eventual government support:

- An ownership structure consisting of private investors who undertake the primary investment and the risk of the initiative.
- A transparent governance structure, permitting continuous monitoring of its technical and business performance and timely adjustments to the support that the undertaking receives from the government.
- Service provision at the wholesale level, through regulated access prices and services equally available to all licensed retail service providers.

- Pooling of individual funds and promoting sharing of infrastructure in order to maximize the economic benefits that would be passed to the consumers.

The proposed OAN scheme for deploying FTTH/B infrastructure in Turkey would qualify for government support as deemed appropriate since it would:

- Have a private ownership structure composed of one or more parties who commit to provide the main funding of the common passive wholesale network and undertake the business risk.
- Be a separate undertaking offering access at the wholesale level only, and ensuring a setup with a governance structure of maximum transparency.
- Provide wholesale service through regulated access prices.
- Enable the pooling of individual investors interested in network deployment in Turkey, and ensure that funds are spent economically.

4. Conclusions

We present below our conclusions and relevant recommendations from our previous analyses:

Conclusion 1: Under the current circumstances, there is a risk that Turkey will miss the opportunity associated to the high growth potential of the Turkish fixed broadband market, with up to 15,16 million households being left without access to FTTH/B networks

The Turkish fixed broadband market is growing both in terms of consumption per connection and in terms of the number of connections. Consumers are increasingly adapting to the services available over fast broadband speeds, and are on track to match the expected worldwide consumption trends.

This environment of growing demand represents an excellent background for the extension of future-proof FTTH/B technologies to serve a large percentage of the population in Turkey.

According to our study, however, under the current circumstances, we expect that only up to an additional 1,50 million households in Turkey will be covered over the next five years by FTTH/B technology, bringing the total number to 6,50 million households. This is an improvement – albeit a small one - from the levels of coverage currently achieved (5 million households).

This implies that up to 15,16 million households in Turkey would remain without access to FTTH/B technologies and would have to wait for the next technology-change cycle to obtain such access.

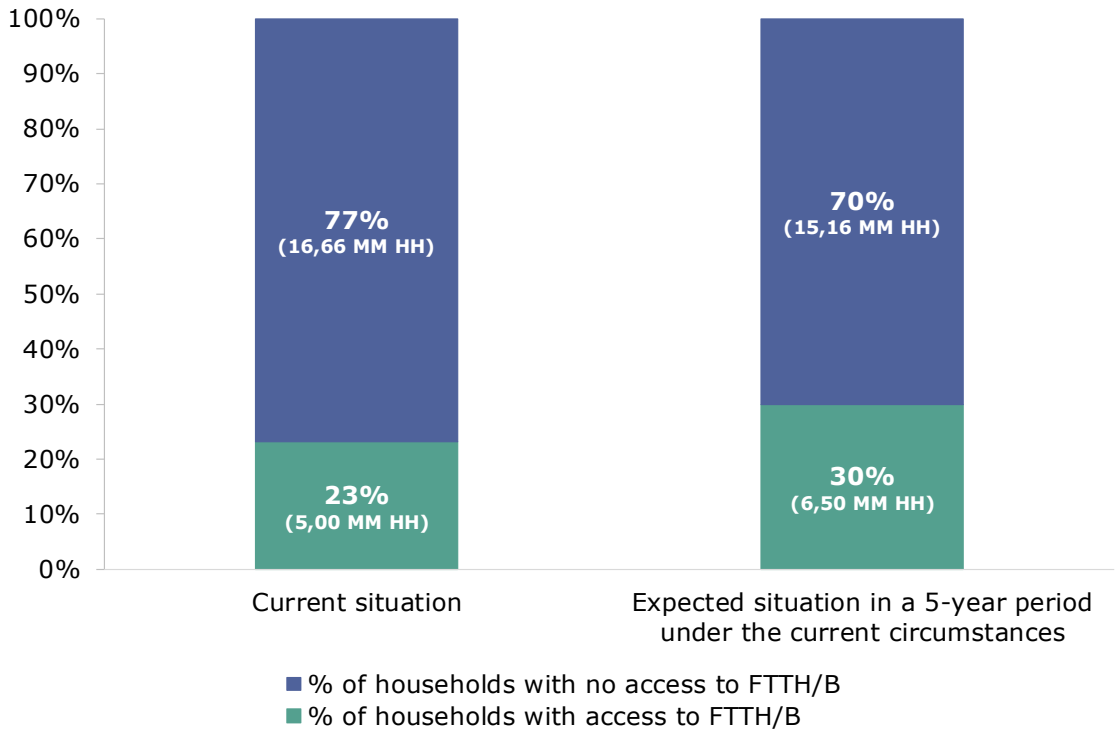

Exhibit 4.1: Proportion of total households with access to FTTH/B under current circumstances [Source: Axon Consulting]

This gap in FTTH/B coverage does not necessarily have to materialize. As our study has shown, the potential for the expansion of FTTH/B in Turkey can go significantly above the indicated number of 6,50 million households. This number could potentially increase to 11,26 million households in Turkey by market-driven mechanisms under the right regulatory and market conditions.

A first conclusion from our study is therefore that keeping the current course in terms of broadband policy would imply a very high cost for Turkey. The cost would come in the form of foregone investments, reduction of ultrafast coverage, choice and quality of service for consumers and, most importantly, slower transition of the country towards a digital economy.

Conclusion 2: Promoting a friendly environment for commercially-driven network roll-out would open up the investment opportunity and could lead to an additional 535 million USD in private investment and 4,76 million additional households with FTTH/B coverage

Our business case analysis presented in the previous sections indicates that a large part of the cost for the OAN would comprise the cost of deploying new civil infrastructure. The investments required to build a FTTH/B network in Turkey would be reduced by between 31% to 45% in case that civil infrastructure could be reused.

More importantly, our study shows that the introduction of agile and efficient civil infrastructure reutilization measures would result in an *increase* (not a decrease) of investments by private agents in FTTH/B networks. Our model suggests that investments by private operators in FTTH/B networks would further increase by up to 535 million USD with the presence of civil infrastructure reuse, leading to an additional up to 4,76 million increase in the number of households covered.

Metric	Without reutilisation of civil infrastructure (status quo)	With reutilisation of civil infrastructure	Impact of civil infrastructure reutilisation
Total households covered (in million)	6,50	11,26	**+4,76**
Additional households covered with respect to current coverage (in million)	1,50	6,26	**+4,76**
Additional private investments (in USD million)	413	948	**+535**
Private investments per additional household (USD/HH)	275	151	**-124**

Exhibit 4.2: Impact of civil infrastructure reuse in terms of covered households and private investment (under the take-up sensitivity case 2) [Source: Axon Consulting]

The findings of our study are fully aligned with the international experience. Government and regulatory bodies around the world have been aware for some time already of the importance of enforcing adequate mechanisms to facilitate an efficient use of existing civil infrastructure for new FTTH/B networks.

Measures typically adopted by governments and regulatory agencies around the world to facilitate such reuse include the following:

- Imposition of obligations to operators to provide access to existing ducts, poles and other civil infrastructure, either on the basis of market dominance (such as in United Kingdom, France, Spain and many other EU Member States), or as a general obligation applicable to all service providers (such as in Portugal).
- Reuse of civil infrastructure from other industries and/or public utilities, such as electricity, water or transportation.
- Facilitation of permits, and reuse of civil infrastructure from public authorities.
- Obligations on any new constructions (including water, energy, transport, sewage networks, new buildings) to leave suitable space for fibre deployment.
- Support the development of a common platform that would enable through time an instantaneous and online referencing of available ducts and other channels in a certain area.

In this regard, it is worth highlighting that even though there currently exists in Turkey a regulatory initiative to promote the sharing of the ducts of the incumbent

fixed-line operator, the reduced take-up of the service suggests that such mechanism is not working well in practice. As for reuse of other civil infrastructure, the extent to which such measures are present in Turkey is at best very limited, or inexistent. In fact, according to the statistics from the local regulators and Vodafone Turkey, as of 2015 there were less than 1.000 km of shared ducts in Turkey, as opposed to 28.760 km in France, 10.000 km in Spain and 7.523 km in Portugal.

We understand that although the history of duct sharing regulation dates back to 2012, the process since then has been a rather slow one, allowing alternative service providers to file duct-sharing applications only since April 2015.

Conclusion 3: Moderate financial and regulatory support from the government to an Open Access Network could help boost expansion and provision of FTTH/B networks to all Turkish households living in cities of over 100.000 inhabitants

Our study suggests that the right conditions apply in Turkey for the government to consider some sort of intervention to help expand the current footprint of FTTH/B networks. We have seen that all six principles that, according to international best practice should guide any government intervention in broadband markets, apply largely in Turkey.

As per our analysis, the intervention scheme that best fits the particular circumstances in Turkey would be those of an 'Open Access Network', built, owned and (mostly) financed by the private sector, which would operate under certain obligations, including the provision of cost-oriented, affordable and non-discriminatory wholesale access to all retail operators.

Such a scheme would diminish the financial commitments required from the government and would eliminate any risk for the government associated with the operations of such network (or networks) – other than general supervision of its operations and determination of the appropriate conditions of access. The presence in Turkey of several competing telecommunication operators with strong financial and operational capacities, which have signalled a determination to operate in this market, would also facilitate the implementation of such a scheme.

Based on our analysis of the economics currently associated to the deployment of FTTH/B networks in Turkey, we believe that an ambitious yet achievable target for such a scheme would be to provide coverage, over a 5-year period, to all households in Turkey located in population centres with 100.000 thousand or more inhabitants.

Such target would amount to 76% of all households in Turkey having FTTH/B coverage. If achieved, this would put the country as a clear leader in the region in

terms of FTTH/B coverage and at par with some of the most advanced countries in the world.

Expressed in alternative terms, the suggested intervention would bring FTTH/B coverage to between extra 5,20 million to 11,46 million Turkish households which would otherwise not have coverage.

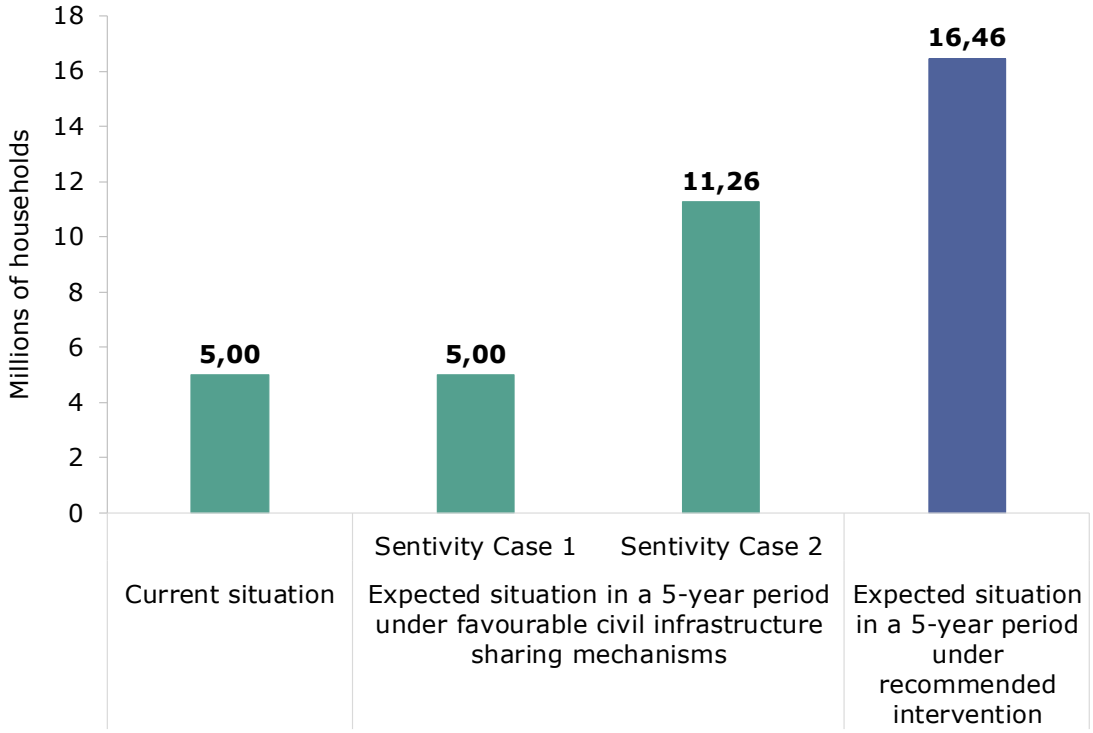

Exhibit 4.3: Impact of the recommended intervention in terms of households covered with FTTH/B [Source: Axon Consulting]

According to our estimations, the suggested scheme would have public funding requirements in the range of 81 million USD (in the most optimistic scenario of high take-up by users) to 489 million USD. While these are sizable amounts, they are not misaligned with previous broadband policy interventions by the government to bring broadband coverage to rural areas. These estimations assume that the measures for reuse of civil work described in our second recommendation are in place and are available for the builder of the Open Access Network. This public funding would in turn mobilize estimated additional private investments of 792 million USD, which would contribute to increased employment and economic activity.

Metric	Expected situation in a 5-year period under favourable civil infrastructure mechanisms	Expected situation in a 5-year period under potential incentives	Impact
Total households covered (in million)	11,26	16,46	**+5,20**
Additional households covered with respect to current coverage (in million)	6,26	11,46	**+5,20**
Public funding requirements (in USD million)	-	81 to 489	**+81 to 489**
Additional mobilization of private investment (in USD million)	948	1.740	**+792**

Exhibit 4.4: Impact of the recommended scheme on public funding and private investments [Source: Axon Consulting]

Annex A: Open access broadband networks and government support in the international experience

As a consequence of the strategic importance placed on next-generation broadband by international governments, there is a significant body of literature available that examines the open access networks' ownership models that can be and have been used to deliver significant investment in next-generation networks and services in other countries.

The typical ownership models observed internationally are briefly summarized below.

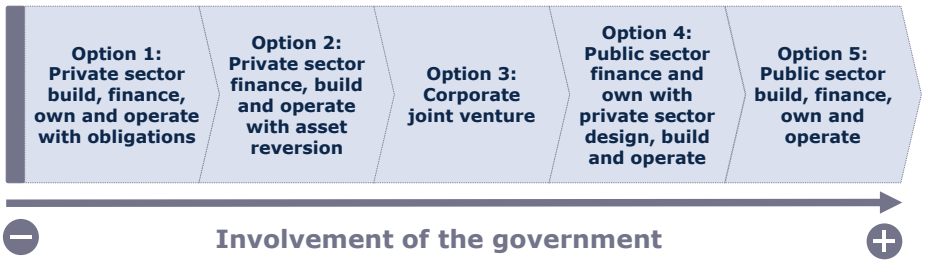

Exhibit A.1: Summary of typical ownership models observed internationally [Source: Axon Consulting based on international practice]

- **Option 1: Private sector build, finance, own and operate with obligations**. Government contracts with a private market player (or several market players) who will finance, design, build, own and operate the fixed broadband infrastructure. Capital subsidy will be paid to the private market players through grants, which are paid during deployment and through the operational life of the contract. The private market players retain ownership of the network at the end of the expiry contract.

- **Option 2: Private sector finance, build and operate with asset reversion.** Government contracts with a private market player (or several market players) who will finance, design, build and operate the broadband infrastructure. The private market players will derive economic benefit from the infrastructure for the duration of the contract at which point ownership will revert to the public sector. On a similar basis to the previous option, capital subsidy will be paid to the private market players during deployment and through the operational life of the contract.

- **Option 3: Corporate joint venture**. The government and a private market player (or several market players) form a joint venture that will design, build

and operate the wholesale network. Both parties own equity in the entity and split the risk and rewards of ownership. Equity is invested by the government and the private market players over the deployment period in proportion to their shareholdings.

- **Option 4: Public sector finance and own with private sector design, build and operate**. Government funds and owns the wholesale network and contracts with a private market player (or several market players) for the network's design, build and operation. The partner derives the economic benefit from the network and bears the commercial risk of wholesale operations until contract expiry.

- **Option 5: Public sector build, finance, own and operate**. Government designs, builds, operates and owns the wholesale network. It will derive all benefits associated with development and operation of the wholesale network and assume all risk. There is no private sector involvement in the project beyond the contracting of network design and build.

A wide number of countries have implemented the aforementioned ownership models in their intervention strategy. The exhibit below summarizes some examples.

Ownership models	International examples
Option 1: Private sector build, finance, own and operate with obligations	Ireland, United Kingdom
Option 2: Private sector finance, build and operate with asset reversion	-
Option 3: Corporate joint venture	New Zealand, Singapore
Option 4: Public sector finance and own with private sector design, build and operate	France
Option 5: Public sector build, finance, own and operate	Australia

Exhibit A.2: International examples of ownership models [Source: Axon Consulting]

Australia, due to lack of private sector participation in the process, is the only country that has opted for Option 5 by taking a government-owned open access approach by establishing the National Broadband Network Company (NBNCo) in 2009, that is responsible for the design and the build of the infrastructure. Australia's NBNCo model places all of the risk on the public sector and has run into public funding issues several years after its launch.

In contrast, New Zealand and Singapore have instead opted for creating network companies through Option 3, which is forming a joint venture that is co-owned among several private entities and the government. As mentioned before, this method has the added benefit of distributing the risk among all of the co-investors in the open access network while allowing government support in the initial deployment phases where there are high cost barriers. For example, in New Zealand the government is responsible for the roll-out down the street while the private sector is responsible for funding the fibre to the premises upon customer request. Therefore, the government bears the initial risks of the immature market. As end-user fibre take-up increases, the private sector will gradually repay the government's investment, which can in turn be invested again towards infrastructure roll-out. Through this model, fibre roll-out in New Zealand has been progressing very well with the initial targets increases from the conclusions of revision conducted in September 2014.

As for Singapore, NetCo is the entity formed for the fibre network which has an open access structure. It is a consortium of several private companies with a 36 percent funding from the government, while the rest (more than 1.4 USD billion) is expected to come from the private sector. As a high-income island state, Singapore might not be a template for national service provisioning, however it raises an interesting point. Even in an affluent city-state where operational circumstances (high proportion of multi-dwelling blocks) are favourable, significant government funding is needed. This suggests that government funding may be needed in most countries.

Sweden, which has the highest penetration of FTTH/B in Europe among the OECD countries, has taken a diversified approach and created open access networks on municipal levels.

For the case of France, France Telecom was selected through a competitive tender process to undertake the design, build and operation of the network as part of a 10-year contract in order to provide access networks on municipal levels (e.g. Auvergne region).

In addition to this, recently the French regulator has mandated network sharing for in-building wiring on national level. Under this model, one operator signs a contract with the building owner and becomes the main operator within the building. This operator is in charge of constructing and maintaining the networks and offering passive access to alternative operators, either through a dedicated or shared fibre line.

For the cases of Ireland and the United Kingdom, Option 1 has been chosen as the appropriate approach in creating an open access network, where the government

has contracted private sector companies to finance, design, build, own and operate the fixed broadband infrastructure.

It is important to note that the analysis of the international experience demonstrates that the government intervention has had positive outcomes in the fixed broadband market across a wide number of countries. However, a variety of ownership models are used across the world, illustrating that the choice of ownership model employed needs to be tailored to the situation and that there is no 'one-size-fits-all' solution. A decision on the appropriate ownership model therefore needs to consider all of ownership options on their respective merits.

Annex B: Principles of the business case model for Turkey

In order to perform a numerical assessment of relevant economic and performance metrics for the configuration of an open access network in Turkey, a business case model has been developed.

An overview of the high-level structure of this business case model is presented in the exhibit below.

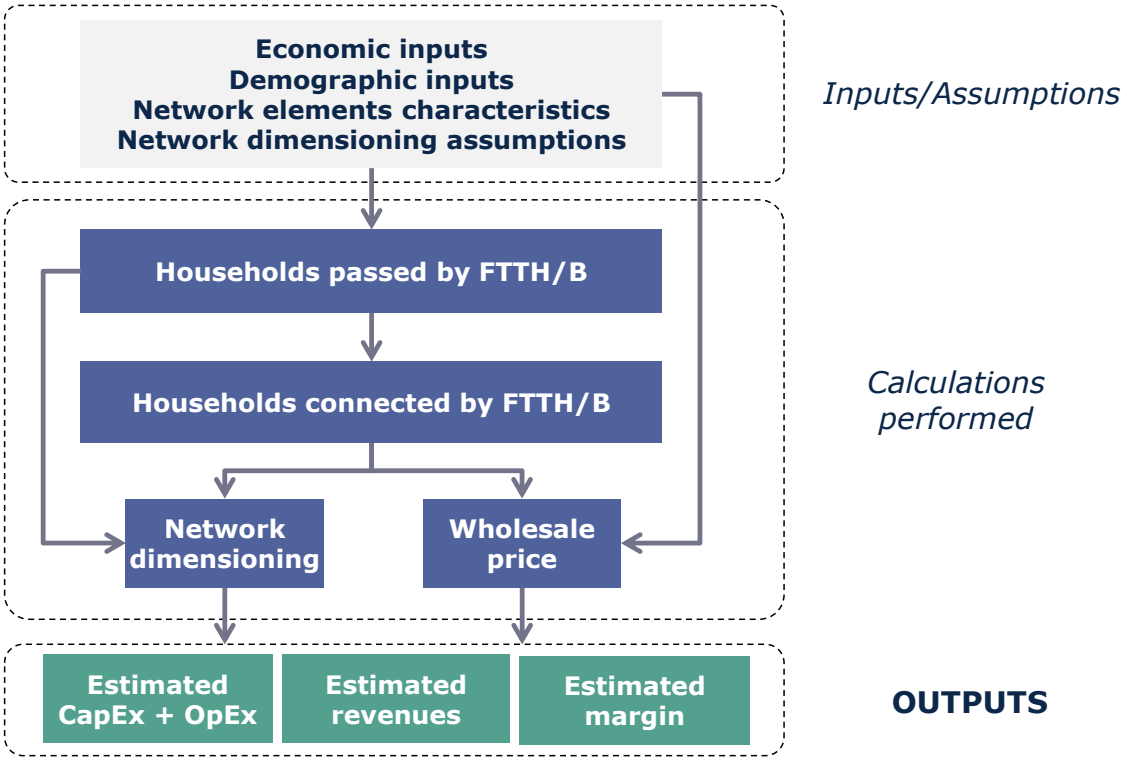

Exhibit B.1: Overview of the structure of the business case model [Source: Axon Consulting]

In the following paragraphs, a description of the inputs and assumptions considered in the business case model is provided.

Economic inputs

The exhibit below summarizes the economic inputs considered in the business case model, together with the source of reference.

Input	Value	Source of reference
Weighted Average Cost of Capital (WACC)	12%	Axon Consulting based on international references
Wholesale price	76,80 USD/year	Vodafone

Exhibit B.2: Summary of economic inputs used in the business case model [Source: Axon Consulting]

Demographical inputs

A characterization of the Turkish territory has been performed in order to typify the households according to the following classification: urban, suburban and rural. The exhibit below illustrates an overview of the methodological approach followed for classifying the existing households in the country.

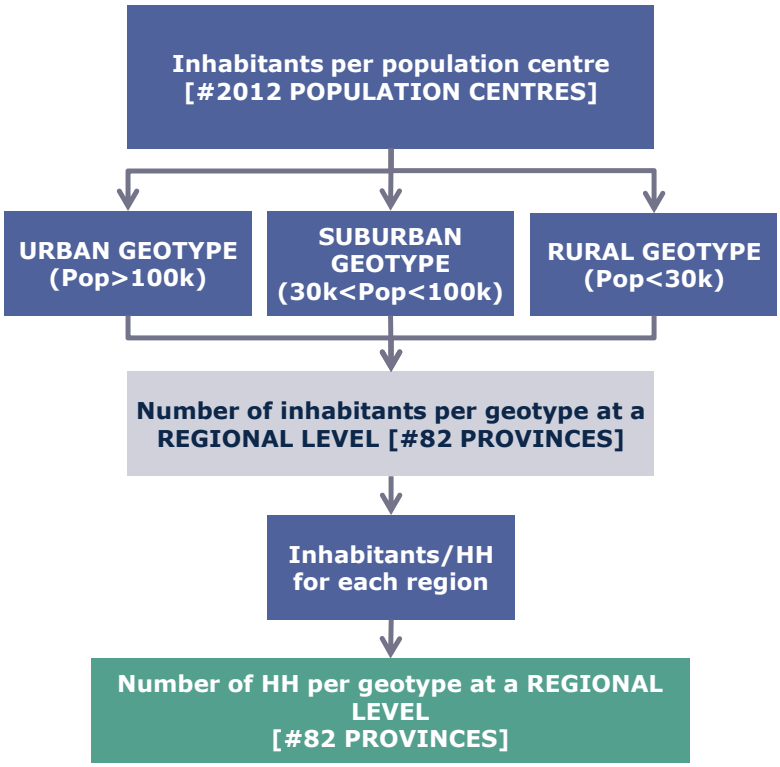

Exhibit B.3: Overview of the approach followed for classifying the Turkish territory [Source: Axon Consulting]

As illustrated above, the first step within the methodological approach gathers the inhabitants of Turkey into a total of 2012 population centres. The source of reference for this information is GeoNames, a geographical database available and accessible through various web services under a Creative Commons attribution license, which integrates geographical data such as location, elevation and population.

Each population centre is identified with the correspondent province and classified according to the following thresholds:

- Urban: Population centres of more than 100.000 inhabitants.
- Suburban: Population centres of more than 30.000 inhabitants and less than 100.000 inhabitants.
- Rural: Population centres of less than 30.000 inhabitants.

The result of the previous step is the number of inhabitants for each region and classified into urban, suburban and rural areas. According to this classification, the next step comprises the application of the average inhabitants per household for each of the 82 regions. This information is extracted from the Turkish Statistical Institute for the year 2015.

The outcome of this calculation is the number of households for each of the 82 regions and clustered into urban, suburban and rural areas. According to this approach, the characterization of the Turkish territory would be as follows:

Geotype	% of households
Urban	76%
Suburban	14%
Rural	10%
TOTAL	**100%**

Exhibit B.4: Characterization of the territory [Source: Axon Consulting]

The resulting disaggregation is aligned with the urban population rate published by the World Bank for the year 2015 (74%).

Network elements characteristics

When estimating the expenditures (CapEx[23] and OpEx[24]) in the business case model, a number of network elements of reference have been considered, as illustrated in the exhibit below.

[23] Capital expenditures.
[24] Operational expenditures.

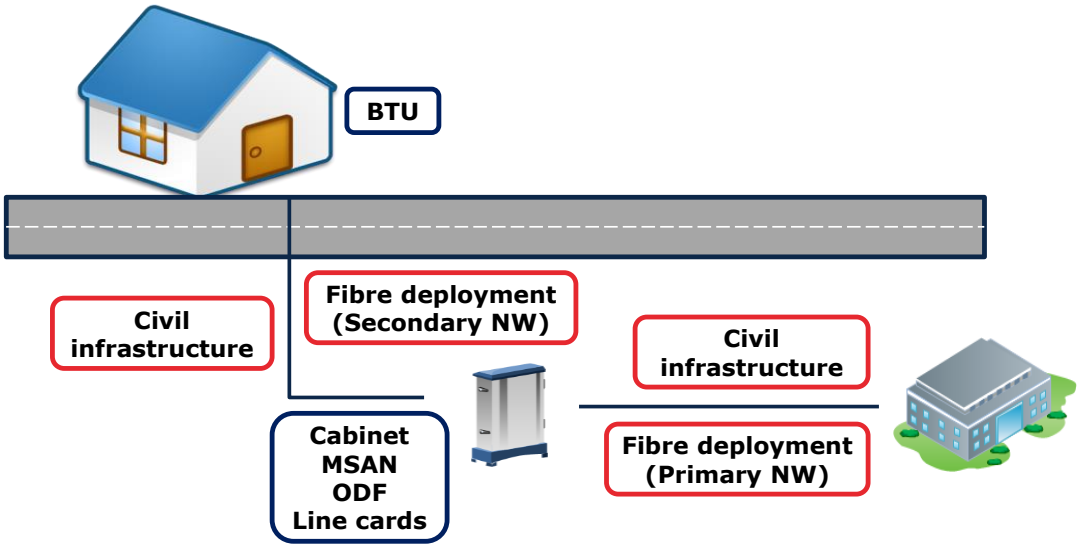

Exhibit B.5: Overview of the network elements considered in the business case model [Source: Axon Consulting]

The exhibit below summarizes the characteristics of these network elements in terms of unitary CapEx, unitary OpEx and useful life.

Element		Unit	Unitary CapEx (USD)	Unitary OpEx (USD)	Useful life (Years)	Source of reference
MSAN		per equipment	31.116	768	5	International benchmark
ODF		per equipment	29.968	877	5	International benchmark
Cabinet		per equipment	2.342	-	5	International benchmark
Fibre cable		per km	123	13	24	International benchmark
BTU		per equipment	31	-	5	International benchmark
Line card		per equipment	629		7	International benchmark
Ducts	**Scenario A[25] (rental)**	per km	-	279	1	Regulation on right of way regarding fixed and mobile communications infrastructure
	Scenario B[25] (deployment)	per km	22.638	63	30	Vodafone

Exhibit B.6: Summary of the network characteristics inputs used in the business case model [Source: Axon Consulting]

[25] The descriptions of Scenario A and B are detailed in the section 'Crafting a Broadband Plan for Turkey'.

We note that the deployment cost of ducts (22.638 USD/km) presented above represents the cost of construction only. Any fees that may be charged by various state entities (such as the municipalities) in the form of rights of way or other descriptions are not included.

For the quantification of the net present value of the network expenditures, the above CapEx and OpEx have been annualized along the useful life of the element. The annualized figures for a 5-year period (i.e. 5 times the annualized figure) have been calculated as a net present value utilizing the WACC value presented in Exhibit B.2. The unitary net present value figures for each of the network elements are presented in the exhibit below.

Element		Unitary NPV expenditure (USD)
MSAN		33.885
ODF		33.128
Cabinet		2.342
Fibre cable		104
BTU		31
Line card		497
Ducts	**Scenario A (rental)**	1.004
	Scenario B (deployment)	10.359

Exhibit B.7: Summary of the net present value of the expenditures for each of the network elements [Source: Axon Consulting]

Network dimensioning assumptions

When estimating the number of network elements needed for the FTTH/B expansion, a number of assumptions have been considered in the business case model. These assumptions are summarized in the exhibits below.

Network	Geotype	Average distance of the fibre/civil infrastructure (Kms.)
Primary network	Urban	0,3
	Suburban	0,9
	Rural	1,8

Network	Geotype	Average distance of the fibre/civil infrastructure (Kms.)
Secondary network	Urban	0,6
	Suburban	1,5
	Rural	5,0

Exhibit B.8: Summary of the assumptions for the deployment of fibre cables and civil infrastructure [Source: Axon Consulting]

Element	Value
Maximum number of customers per cabinet	2.000
Maximum number of cabinets per node	5
Max number of lines per FTTx line card	256

Exhibit B.9: Summary of the net present value of the expenditures for each of the network elements [Source: Axon Consulting]

Annex C: Sources of reference for the figures of coverage, take-up and prices

Sources of reference for the figures of COVERAGE

Country	Year of reference	Source of reference
Bulgaria	2015	FTTH Council of Europe
Denmark	2015	European Commission
Finland	2015	European Commission
Japan	2014	Japan Telecoms Market Report 2015
Norway	2015	European Commission
Portugal	2015	European Commission
Romania	2015	European Commission
Russia	2015	FTTH Council of Europe
South Korea	2014	South Korea Telecoms Market Report 2015
Spain	2015	European Commission
Sweden	2015	European Commission

Exhibit C.1: Sources of reference for the figures of coverage

Sources of reference for the figures of TAKE-UP

Country	Year of reference	Source of reference
Bulgaria	2015	FTTH Council of Europe
Denmark	2015	OECD
Finland	2015	FTTH Council of Europe
Japan	2014	Statistical Handbook of Japan 2015
Norway	2015	FTTH Council of Europe
Portugal	2015	OECD
Romania	2015	FTTH Council of Europe
Russia	2015	FTTH Council of Europe
South Korea	2015	South Korea Telecoms Market Report 2015
Spain	2015	OECD
Sweden	2015	FTTH Council of Europe

Exhibit C.2: Sources of reference for the figures of take-up

Sources of reference for the figures of PRICES

Country	Year of reference	Source of reference
Bulgaria	2016	Operator's website
Denmark	2015	OECD
Finland	2015	OECD
Japan	2015	OECD
Norway	2015	OECD
Portugal	2015	OECD
Romania	2016	Operator's website
Russia	2016	Operator's website
South Korea	2016	Operator's website
Spain	2015	OECD
Sweden	2015	OECD

Exhibit C.3: Sources of reference for the figures of prices