Achieving the Objectives of the Digital Agenda for Europe (DAE) in Italy:

Prospects and Challenges

Report of the expert advisory team appointed by President Letta:

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The opinions expressed are solely those of the authors.

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Executive Summary

Introduction

In November 2013, President Letta asked the Government Commissioner for the implementation of the Digital Agenda to set up a small team of international experts to review the broadband investment plans of the Italian telecommunications operators. The objective of this analysis was to verify whether these plans would allow Italy to achieve the targets of coverage and penetration of the ultrafast broadband network that the European Union has set for 2020 in the broader context of its Digital Agenda. The EU broadband infrastructure targets are as follows:

- By 2013, 100% of residents should be reachable by basic broadband services;
- By 2020, 100% of residents should be reachable by fast broadband services capable of delivering speeds of at least 30 Mbps; and
- By 2020, at least 50% of households should have subscribed to ultrafast broadband services capable of delivering speeds of at least 100 Mbps.

This review is part of a wider plan launched by President Letta to ensure timely implementation of all major objectives of the Digital Agenda, a project that the Government considers as one of the most important structural reforms to simplify bureaucracy, stimulate growth and promote youth employment.

The international experts who joined the Commissioner are **Gerard Pogorel**, Professore Emerito di Economia at Telecom ParisTech; and **J. Scott Marcus**, a Director at the WIK (Germany), member of the Scientific Committee of the Florence School of Regulation (Italy), and formerly a senior official at the FCC (U.S.).

The team has worked in dialogue with all major operators, who have shared the main elements of their investment plans, including the evolution of the geographical coverage of their networks. There were also frequent contacts with the institutions who are most directly involved in these issues: the National Regulatory Agency (NRA) and the Ministry of Economic Development – Communications. The team has established a constructive dialogue with them, in full respect of their respective institutional roles. In this context, it should be noted that this report addresses an industrial policy issue regarding the competitiveness of the country. It is not a review of current regulation nor an audit of any sort of operators' plans. Consequently, the analysis and subsequent deliberations on markets and prices that the NRA is currently conducting in the area of broadband networks are not the subject of our report.

The team has also benefitted from the support of the Ugo Bordoni Foundation and of two Italian experts, Vittorio Trecordi and Valerio Zingarelli, members of the Scientific Committee of the Foundation.

Companies and institutions have supported this analysis with a very open and constructive spirit by sharing confidential data in the knowledge that, without their specific consent, data, information and projections will be published only in aggregate form.

OVERVIEW

There are grounds for cautious optimism regarding the deployment and adoption of ultrafast broadband in Italy. Network operators in Italy have concrete plans to cover roughly 50% of the Italian population with fast broadband based on FTTCab/VDSL2 technology between now and roughly 2017. In contrast to the recent past, these plans are credible, and deployment is demonstrably moving forward. Given Italy's favourable characteristics (i.e. a network structure with short sub-loop lengths), these lines will be able to deliver well in excess of the 30 Mbps required by the second of the DAE broadband objectives.

There are risks that the plans will not be carried through to completion. There are serious operational and regulatory challenges. Nonetheless, we consider the plans to be credible overall.

In and of themselves, these plans will not achieve the DAE Objectives.

- There are no solid commitments to cover more than 50% of the population with fast or ultrafast broadband.
- The current plans of the network operators do not address 100 Mbps service; with expected improvements in technology, however, it is likely achievable.
- Even if most lines were able to provide 100 Mbps service (and bearing in mind that 50% penetration requires considerably more than 50% coverage), there are problems with consumer demand that would need to be addressed in order for the adoption target (DAE Objective 3) to be achieved.

In the absence of committed, energetic and sustained attention by the Italian government, DAE goals will not be fully achieved. We therefore urge the Italian government to take proportionate, appropriate steps to deal with each of the gaps within the authority available to it, with due respect for the respective competencies and independence of the European Union and of Italian regulatory and competition authorities. The following would be appropriate:

- **Comprehensive analysis, planning and monitoring** of the investment required and of investments made to achieve DAE broadband objectives, taking a balanced approach between fixed, mobile, fixed wireless, and even satellite resources, and also considering not only supply side factors but also the demand side.
- **Provision of sufficient additional funding to close coverage gaps,** drawing on European Structural Funds and other sources, based on the results of the analysis, planning and monitoring function. Attention at regional level is warranted. Compatibility with European State Aid guidelines is required.
- **Measures to drive down deployment costs,** including initiatives to enhance the radio spectrum and to enhance the efficiency of spectrum use; and promotion of infrastructure sharing, to the extent permissible under European State Aid and competition guidelines.
- **Measures to correct lagging demand for broadband services in Italy,** including digital literacy programmes. Low consumption of audiovisual services is a concern that warrants detailed analysis.

MAIN FINDINGS

1 The broadband network in Italy in comparison with other European countries is characterised by the following main aspects:

- The *coverage of basic fixed broadband networks* - typically defined as being capable of delivering bandwidth of up to 2 megabits per second (Mbps) - *is among the most extensive in Europe*: around 98% of the population (gross), even though there are still two million lines which for technical reasons can not yet deliver a minimally acceptable speed of 2 Mbps. Some of these households are now partly being served by fixed wireless solutions (according to AGCOM, there were 270,000 fixed wireless customers as of December 2013) and satellite. *This level of coverage makes Italy de facto compliant with the first EU broadband target (100% coverage of basic broadband by 2013).*
- The level of *coverage of 'next generation' fixed networks or ultrafast broadband is however among the lowest in Europe*. Moreover, the average download speed available for broadband networks in Italy compares poorly with Italy's competitors in Europe and the world. It is on investments in ultrafast broadband networks that team has focussed its work and analyses, taking as a reference the two objectives of the European Digital Agenda for 2020.
- In developing its plans, Italy can not rely on the contribution of cable television networks. Radio technology contributes - and will increasingly contribute - to extending the coverage of broadband services, but, at least in the medium term, can not be considered as an economically viable alternative to fixed broadband for large portions of the Italian population.

2 ***Some encouraging developments*** about the future development of the broadband network emerge from our review. In particular:

- The investment plans examined indicate that *over the next 2-3 years, the quality and performance of the network in fixed broadband - especially in areas with the highest population density - should improve markedly*. By 2016/2017, the coverage of networks that can deliver 30 Mbps and more should be around 50% of fixed lines in Italy (23.4 million), assuming that (1) network operators carry through on their plans, (2) technology evolves as expected, and (3) operational and regulatory challenges are promptly addressed and resolved.
- The plans contain internally consistent data between evolution of coverage, network architectures, and unit cost assumptions. The plans analysed are all based on FTTCab (Fibre To The Cabinet) technology, with the exception of Metroweb, a wholesale operator focused on the provision of FTTH (Fibre To The Home) solutions to other operators that in turn develop and retail services on Metroweb network.

With FTTCab technology, new fibre optic connections are installed between central office switches and street cabinets. The connection between street cabinets and users' homes (which is referred to as the *sub-loop*) is not upgraded from copper to fibre. It should be stressed that the configuration of the Italian network is characterised by a limited distance between cabinets and homes, with an average of 300 metres, and with about 50% of sub-loops less than 200 metres. It is reasonable to predict that *FTTCab could deliver speeds higher than 30 Mbps and closer to 80 Mbps to about 50% of homes (*under favourable conditions such as copper pairs of good quality, and proper management of interference).

- Continuous technological evolution that is expected in the coming years will allow FTTCab networks to deliver increasing performance under the same network architecture.

- Our analysis also shows a real acceleration of investment and build-out in the last part of 2013. This marks a welcome change from the recent past, where investment and development plans have been announced but have typically been implemented only to a very limited degree. It should also be recognised that the latest statistics published by international observers (e.g. DAE Scoreboard 2013, OECD broadband statistics update of 9 January 2014) do not yet reflect the most recent FTTCab developments in Italy.

3 At the same time, ***our review highlights a number of serious concerns*** that should be taken into account when defining industrial policy initiatives in this area.

- The investment programs that we have analysed – as always in the case of business plans – cover a period of three years from 2014 to 2016, but there are currently no detailed operational plans until 2020.

It is, however, clear that based on current market conditions – regulatory rules, level of demand, investment costs - the plans will not allow Italy to reach the 2020 coverage and adoption targets set by Europe.

Mobile radio networks will continue to help increase coverage in areas of lower density, but traffic analysis and the evolution of applications confirm that the increased traffic volumes can best be managed economically by fixed networks.

- all operators plan to invest in the same, high-density areas. This creates two problems:
  - Large areas of the country are not covered by the development of the network operators' plans.
  - In areas covered by multiple operators, the relative economic advantage of FTTCab in comparison with FTTH is uncertain. In aggregate - for the industry as a whole - the capital needed to deploy three cabinets is about the same as for one FTTH solution that could then potentially be shared among the operators. This is particularly true in the absence of forms of optimisation through cooperation and infrastructure sharing among operators (which would, however, require the support of the regulator).
- FTTCab build-out has blocked deployment of other technologies (Fibre to the Home). In particular, Metroweb was about to start an extensive FTTH roll-out for which it had already received a first, substantial round of funding (€ 200 million). The plan had been designed assuming that a new Fibre to the Home "passive" infrastructure would have been made available to all service providers for the delivery of ultrafast broadband services in ultra-wideband. The decision of more operators to deploy their FTTCab networks in the same areas has significantly reduced the prospect of financial return, bringing – at least for now – Metroweb FTTH plans to a halt.
- All network operators are heavily dependent on the plans of the incumbent fixed network operator. This is true to some degree in all European Member States; however, the problem is exacerbated in Italy by a lack of effective alternatives, notably cable. This means that achieving DAE Objectives depends very heavily on the fixed telecommunications network, more so than in most Member States.
- Regulatory uncertainties remain among operators when trying to share infrastructure, in particular installing equipment in the same street cabinet. AGCOM has recently approved the requirement for the incumbent to accommodate equipment of other operators. But issues remain: on the one hand it is a fact that space is limited (in general and especially in cabinets where a) the incumbent has already installed its FTTCab electronics, and b) that were not designed to house multi-operator sets); on the other hand, given the history of competitive

behaviour, we can not exclude conflicts and delays related to the resolution of this issue. Moreover, where the sharing of cabinets is not feasible, it will be necessary to build new cabinets with due regard for environmental impacts and the need for authorisations whose cost and time of release are functions of the policies of individual municipalities.

- It must be stressed that the ability to leverage the full potential of this architecture with solutions such as vectoring requires forms of structured (but as yet to be defined) coordination among operators. This is to counter the effect of interference among twisted pairs that are located in the same cable, but used by different operators with technologies of different generations. Furthermore, the possibility to reach 100 Mbps through FTTCab networks is likely to require the adoption of G.fast, a technology that is still in its infancy and that warrants further testing and development.
- Finally, it might prove premature to assume that technologies that aim at 'squeezing' more and more capabilities out of copper might be adequate substitute of fibre in the long term and capable to deliver the type of and quality of bandwidth that new services will require - not just in terms of speed but more broadly defined in terms of stability, service availability, and latency.

4 Although the review has primarily focused on supply side of the industry, the team has taken into consideration some aspects of demand as well, because the goals set by the EU depend not only on network coverage, but also on the percentage of the population connected to ultrafast networks. As is well known, Italy is among the European Member States with lowest penetration of ultrafast broadband; nonetheless, there are elements that could contribute to a more widespread and sustained demand for ultrafast connections in the years ahead.

- In many countries, demand for audiovisual services has been an important factor in the development of broadband; moreover, cable television networks have acted as effective competitive stimulus for investments by telecom operators. Due to the unique structure of its television sector, Italy has not benefitted from these developments.
- Recently, new video services over the Internet – such as catch up television – have been launched in Italy (such as Infinity, Sky River, RAI). Consumers access content through devices such as tablets and interactive SmartTV that unlike the PC do not require high levels of digital literacy. The availability of high quality content online together with the increasing popularity of devices connected to the Internet will drive new, stronger demand for high-speed connections.
- The implementation of the broader Digital Agenda should further contribute to growth, and should increase the demand for connectivity through a growing range of public services that will be made available online.

RECOMMENDATIONS

The team has identified a number of possible areas of intervention that the Government should consider to support the development of the network.

Due to the focus of the review, most of them deal with initiatives that the Government should consider to stimulate the supply side. We also highlight however the importance of initiatives in the area of demand to support the growth in adoption of ultrafast broadband.

1 Establish a structured process to monitor the implementation of operators' plans

The Government should encourage operators to publish the main elements of their investment plans indicating the areas in which over time they plan to offer high-speed connections.

At the same time, the government should establish a structured monitoring process where every six months - if not quarterly - operators communicate to AGCOM regular updates on the investments made in the period and the evolution of geographical coverage of their ultrafast broadband networks.

In addition to keeping track of fixed broadband developments, the process should also monitor:

- The deployment of LTE mobile radio and fixed wireless Broadband networks
- Technological developments that characterize the different fixed and mobile network architectures.

Such an initiative would have the following positive aspects:

- It would mark a sharp change from the past. For the first time, an industrial policy process directly driven by the Prime Minister's Office would provide a comprehensive and public visibility into the progress of broadband networks. The process would build on other similar, but less comprehensive activities that are carried out by either AGCOM (for regulatory purposes) or the Ministry of Economic Development (to allocate funds/ incentives).
- It would promptly highlight differences between what was planned and what was achieved.
- It would build an information base that could justify more direct forms of intervention if the announced plans are not being realised as expected or projected.
- such a "public" and highly visible process would also be an incentive for those involved in the development of digital services - commercial and public administration – that are essential to stimulate the adoption of ultrafast broadband connections.

2 Develop a national broadband plan for market failure areas and actively apply for European structural funds to finance it

The government has already funded in recent years the development of the broadband network in areas of market failure.

The new European structural funds for the period 2014-20 provide an opportunity to develop and launch a plan focused on the development of ultra-fast networks.

The MISE has confirmed its commitment to this approach, and the government should ensure close coordination between the regions, the Ministry of Social Cohesion, and MISE to formulate a national plan to cover areas that are not reached by the plans of the operators.

The strategic nature of the broadband infrastructure could also justify a more direct involvement of the Prime Minister's Office together with MISE and the Regions, and the creation of a dedicated unit within the structures of coordination and governance of the Digital Agenda.

Central to the plan and the process will be the development of a detailed cost model to define the funds needed to reach full coverage.

Estimates of cost vary hugely, and further detailed work is required to firm them up based on very specific design and technology assumptions.

3. Promote the sharing of investments and / or network infrastructure in order to maximize their effectiveness and to accelerate achieving geographic coverage.

Italy is subject to a great many challenges in putting capital effectively to work. Investment tends to be subject to deadlock, and duplication of investment is widespread.

This has many manifestations, and many opportunities for improvement:

- The tendency of all operators to invest in covering the same 50% of the population;
- VDSL2-specific challenges, including both street cabinet sharing, and coordination of lines where vectoring is deployed;
- Facilities sharing in the mobile network;
- Opportunities to use infrastructure from other network industries (e.g. electricity, water).

Some of these are challenges for the industry, while others are challenges for the National Regulatory Authority (NRA).

In each case, the status quo is not unambiguously bad. Much of the duplication of infrastructure tends to be positive for infrastructure-based competition, at the same time that it is negative for investment.

Italy may wish to strike a different balance (with due respect for European State Aid and competition rules) between promoting investment and promoting competition than some other Member States. At the same time, it should not be forgotten that competition is often the most important spur to investment in fast and ultrafast broadband.

No single solution is likely to magically unlock investment, but a combination of carefully crafted initiatives might help to unlock investment that to date has often been stalled. A more muscular policy on the part of the Italian government might well be called for, especially in the event that investment were to stall once again.

4. Ensure that sufficient spectrum for mobile and fixed wireless broadband is available.

In the short to medium term, radio cannot be regarded as an economically viable substitute to fixed broadband in high density areas; however, mobile and fixed wireless networks should be taken into account when developing coverage plans for low density areas.

Considering, however, that Italy has no cable television networks, radio ends being the *only available alternative infrastructure* to fixed telecommunication networks. Technology developments and growing usage will further strengthen the role of radio.

For this reason, the opportunity to allocate further spectrum to mobile and fixed wireless broadband that derives from international reallocation should be actively pursued.

Spectrum allocation policy should ensure that sufficient spectrum is available for mobile and fixed wireless broadband services. Government should take the opportunity of international and European processes that are re-purposing frequencies among various applications (including possible future use of the 700 MHz band for mobile broadband) to adopt, in consultation with stakeholders, best practice and to ensure that Italy can fully exploit wireless technology advances in the evolution of its digital infrastructures.

5 Promote the demand for high-bandwidth digital

Even though, as stated above, the focus of our work had been on investment plans and supply side of broadband development, it is in our view extremely important the Government continues to pursue initiatives aimed at promoting adoption of broadband by citizens.

In light of (1) the somewhat lower-than-average tendency for Italians who possess a computer to also have an Internet connection at home, together with (2) the fact that Italy has more elderly citizens than most Member States (who are less likely to subscribe to Internet services), combined again with (3) a low propensity to consumer online audiovisual services, measures to promote digital literacy could have particularly great impact in Italy.

These should include

- The continued implementation of the broader Digital Agenda to broaden the quantity, quality and ease of use of Public Services online.
- digital literacy initiatives such as the one RAI is planning as part of its public service broadcaster
- - assessment of the root causes and potential remedies for Italy's low consumption of audiovisual content over broadband

1. Introduction

President Letta has identified the implementation of the Digital Agenda as one of the key elements of his Government's program. Growth and new jobs, particularly for the youngsters, are a key government's priority and the Digital Agenda is regarded as an essential initiative to deliver this objective, accelerate and strengthen economic recovery and enhance Italy's competitiveness.

In this context, in June 2013, President Letta appointed a Government Commissioner to expedite the implementation of Digital Agenda Projects through the identification of key priorities, the adoption of clearer governance processes, the definition of a stronger role for the Italian Digital Agency and a closer monitoring of how the Italian Digital Agenda was progressing against the EU targets.

In the first phase of work, the activity of the Commissioner has been primarily focused on main e-government projects; it has led to the definition of three key priorities, to the review of the Italian Digital Agency's Charter and to the establishment of a tighter project management process. Encouraging progress has been made on all fronts and of the three priority projects two have entered an execution phase (E-Invoice and ANPR) whilst for the third (Digital Identity) a public consultation has been completed and an implementation decree should be signed by Q1 2014.

More recently, also following the EU Council of last October where the heads of EU Governments reviewed progress of the European Digital Agenda, President Letta has broaden the focus of the work to include a review of the broadband infrastructure.

Italy as all other EU Member States considers broadband networks as a critical infrastructure for economic growth, competitiveness of businesses and social inclusion of citizens – and a prerequisite to deliver e-government services to its citizens. As such no Digital Agenda implementation can be assured without a parallel monitoring of how broadband infrastructure will evolve.

Against this background, President Letta asked the Commissioner to select two international telecommunications policy experts and to perform a review of broadband with a particular focus on Italy's position versus the quality and coverage targets that the EU has set as part of the Digital Agenda for 2020. The international experts who joined the Commissioner are **Gerard Pogorel**, Professore Emerito di Economia at Telecom ParisTech; and **J. Scott Marcus**, a Director at the WIK (Germany), member of the Scientific Committee of the Florence School of Regulation (Italy), and formerly a senior official at the FCC (U.S.).

This document summarises the findings of the work.

1.1. The nature of the mandate

In setting the vision for the Digital Agenda, the European Union has indicated specific targets for broadband infrastructures. In each of the Member States,

- By 2013, 100% of residents should be reachable by basic broadband services;
- By 2020, 100% of residents should be reachable by fast broadband services capable of delivering download speeds of at least 30 Mbps; and
- By 2020, at least 50% of households should have subscribed to ultrafast broadband services capable of delivering download speeds of at least 100 Mbps.

It is against these targets that President Letta asked the team of experts to perform a review of the broadband infrastructure with a specific focus on three questions:

- What are the investment and network development plans of the main operators?
- Given the current status of the Italian broadband infrastructure, what coverage and quality are these plans likely to deliver in the coming years?
- Is the basic, fast and ultrafast broadband coverage evolution that will be delivered by current plans consistent with the 2020 EU targets?

The questions define the nature of our mandate: not a regulatory review, nor a check on commitments that operators have in the context of their license, but an important "module" of the Digital Agenda's activity aimed at assessing the trajectory of the broadband infrastructure evolution against the targets that the EU has set for its Member States.

1.2. Organisation, methodology and description of the process

The status and evolution of broadband infrastructure is currently monitored (albeit with various degrees of detail and with varying objectives) by a number of public bodies and institutions including:

- **Ministry of Economic Development - Communications** that on a yearly basis reviews operators' network development plans to identify geographic areas that are unlikely to get covered without some form of public funding.
- **AGCOM** that collects and monitors (among other info) data on service quality and coverage.
- **Fondazione Ugo Bordoni** (part of the Ministry) that performs quality measures on fixed and mobile networks.
- **Organo di Vigilanza** that monitors the quality of service delivered by the incumbent operator to its wholesale customers.

We have received valuable support from the Ministry, AGCOM and their experts and we would like to thank them for their cooperation. The Fondazione Ugo Bordoni, under the mandate of the Ministry of Economic Development – Communications, contributed the technical expertise of their staff and of two members of their Scientific Committee: **Vittorio Trecordi** and **Valerio Zingarelli**. Many other organisations have supported our efforts, including the European Investment Bank (EIB). We were also able to access (within the limits of confidentiality to which each of these institutions must conform) relevant information and data for our analysis.

Given the forward-looking nature of the questions that we had to address, we have integrated the information available from institutional sources with direct access to main operators who, through a series of sessions, have shared data on a voluntary (but confidential) basis on their investment and network plans. Companies and institutions have collaborated in this analysis with a very open and constructive spirit.

A comprehensive list of meetings and interviews appears in Annex 1 at the end of this report. Briefly, we have worked with the following operators (in alphabetical order):

- Fastweb
- Metroweb
- Telecom Italia
- 3
- Vodafone
- Wind

1.3. Structure of this document

Key Findings appear at the beginning of each chapter. They are collected for convenience in Section 8.1 in the concluding chapter of this report. Similarly, recommendations appear throughout the text at the point at which they are relevant and substantiated, but they are collected and grouped for convenience in Section 8.2 in the concluding chapter of this report.

This report is comprised of an Executive Summary and Introduction. Next comes a discussion of the current situation (Chapter 2), followed by an explanation of alternatives to the fixed telecommunications network in Italy (Chapter 3). We then discuss promising developments and opportunities (Chapter 4), followed by worrisome developments and challenges (Chapter 5). We then present our assessment of prospects for broadband deployment and adoption, together with a very rough estimate of likely costs of achieving DAE Objectives going forward (Chapter 6). We then offer views on the measures the Italian government should take to ensure that DAE Objectives are met (including a discussion Key Performance Indicators (KPIs) and how they should be monitored in the future) (Chapter 7), and a summary of key findings and recommendations (Chapter 8). Finally, an Annex lists the firms that we met with or interviewed.

We also include three annexes. The first lists our interviewees. The second provides background on variants of fibre-based network access technologies. The third annex provides a detailed review of our cost estimation.

2. Where does Italy stand today in achieving DAE goals?

Key Findings

- Fixed network basic broadband coverage in Italy is broadly in line with European targets for 2013, both in absolute terms and also in comparison with other EU Member States.
- By contrast, coverage of fast broadband (30 Mbps or more) in Italy is the worst among the Member States of the EU. The total absence of cable is a major contributor to this deficit.
- Broadband penetration is also a concern. Even though coverage is high, adoption is low. Indeed, among its peer group of Western European Member States, Italy ranks last.
- The nominal speed of the access link is only one measure of the speed of the network. The speed of the core network and aggregation network also impact total throughput. In terms of total throughput, Italy ranks badly in comparison with European and global competitors.

As previously noted, the Digital Agenda for Europe calls upon the Member States to achieve ambitious goals in terms of both deployment and adoption of basic broadband and fast broadband (Next Generation Access (NGA)):

- By 2013, 100% of residents should be reachable by basic broadband services;
- By 2020, 100% of residents should be reachable by fast broadband services capable of delivering (download) speeds of at least 30 Mbps; and
- By 2020, at least 50% of households should have subscribed to ultrafast broadband services capable of delivering download speed of at least 100 Mbps.

Many have noted that there is substantial ambiguity in these goals. Do they refer to nominal speeds, or actual speed delivered? Are they required in both directions, or only in the more common (download) direction? Must they be achieved in each Member State, or only in Europe as a whole? These differences may seem subtle, but they have large implications for deployment costs. Unless otherwise noted, we assume in this report that DAE speed requirements refer to the nominal or advertised speed in the downstream direction, and we assume that Italy must achieve them.

In understanding fixed network usage characteristics, it is important to distinguish between *coverage* (the number of households that could be served) and *penetration* (the fraction of households that actually take up the service. The first and second DAE Objectives refer only to coverage. The third refers explicitly only to penetration; however, it is clear that sufficient penetration cannot be reached unless there is sufficient deployment and corresponding coverage.

In the sections that follow, we consider Italy's basic broadband coverage, fast broadband coverage, broadband penetration, and the effective speed actually delivered. In terms of basic broadband coverage, Italy is doing reasonably well. In terms of every other measure, there are grounds for concern.

2.1. Basic broadband coverage

Fixed network basic broadband coverage in Italy is quite good, both in absolute terms and also in comparison with other Member States of the EU. As shown in Figure 1, substantially all of Italy has basic broadband coverage of 95% or more. Only 12.4% of the population is considered to be rural. Fixed basic broadband coverage is estimated to be 98.4%.[1]

Figure 1. Basic broadband coverage in Italy (end of 2012).

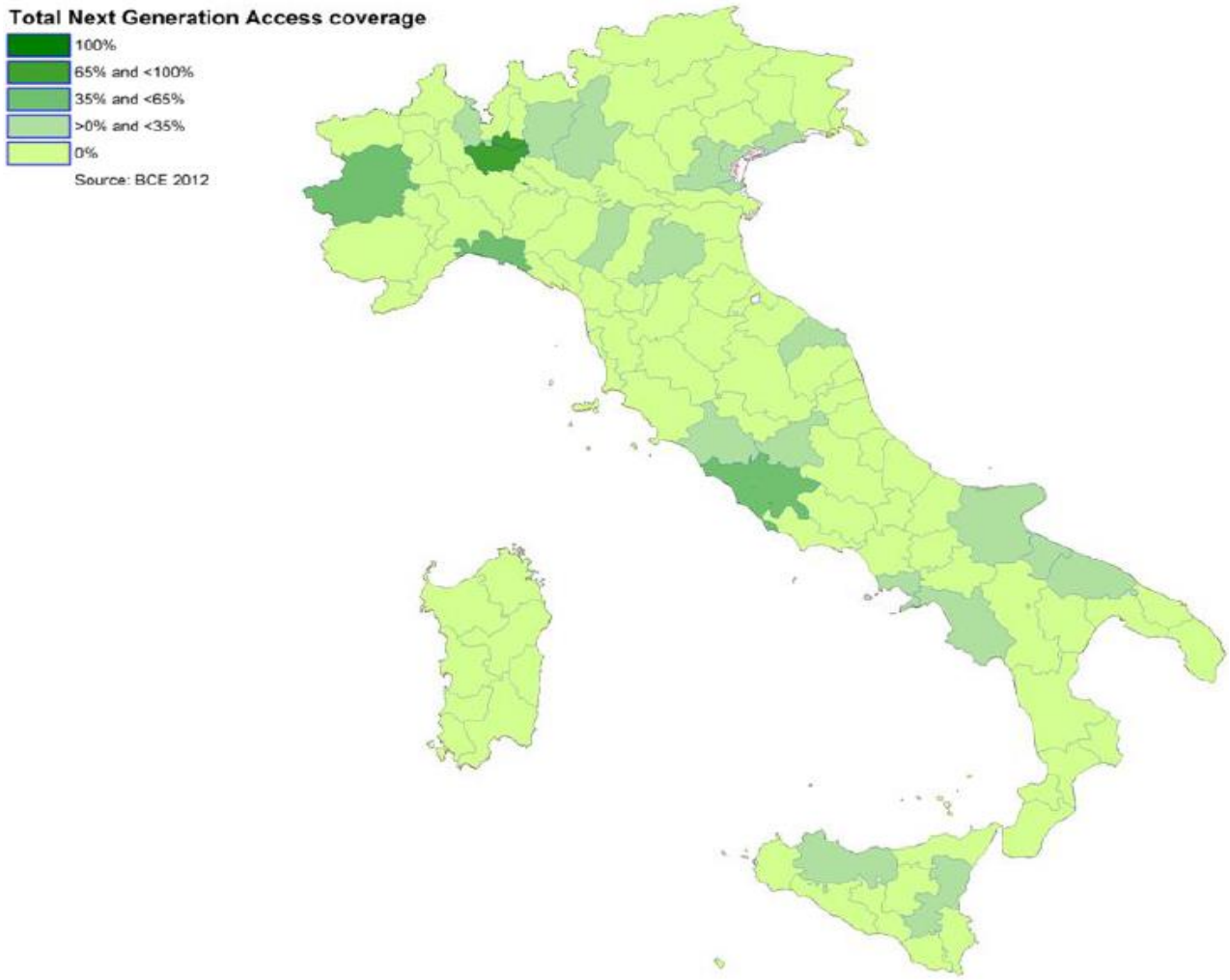
Source: Point Topic (2013), Broadband Coverage in Europe in 2012.

[1] Point Topic (2013), Broadband Coverage in Europe in 2012.

2.2. Fast and ultra-fast broadband coverage

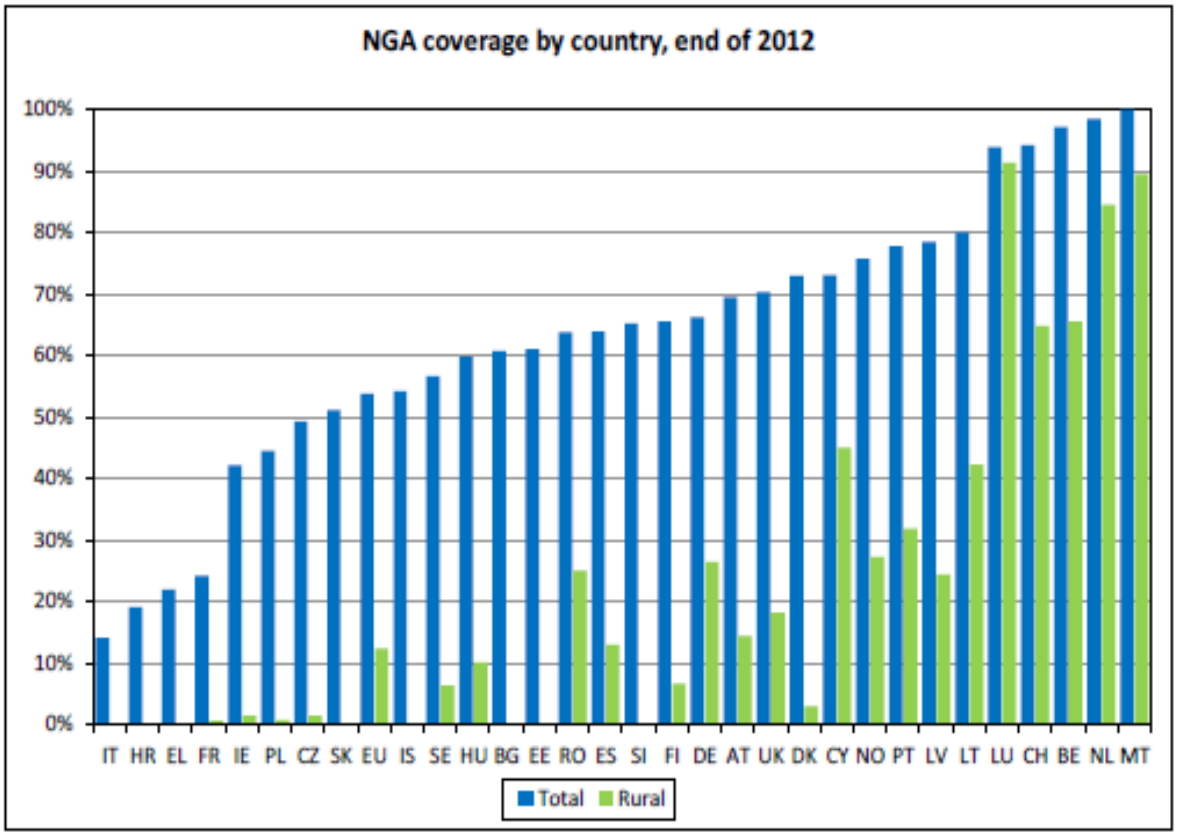
By contrast, coverage of fast broadband (30 Mbps or more) in Italy is the worst among the Member States of the EU, as is depicted in Figure 2 and Figure 3. The total absence of cable is a major contributor to this deficit.

Figure 2. Fast broadband (more than 30 Mbps) coverage in Italy (end of 2012).



Source: Point Topic (2013), Broadband Coverage in Europe in 2012.

Figure 3. Fast broadband coverage by Member State (end of 2012).



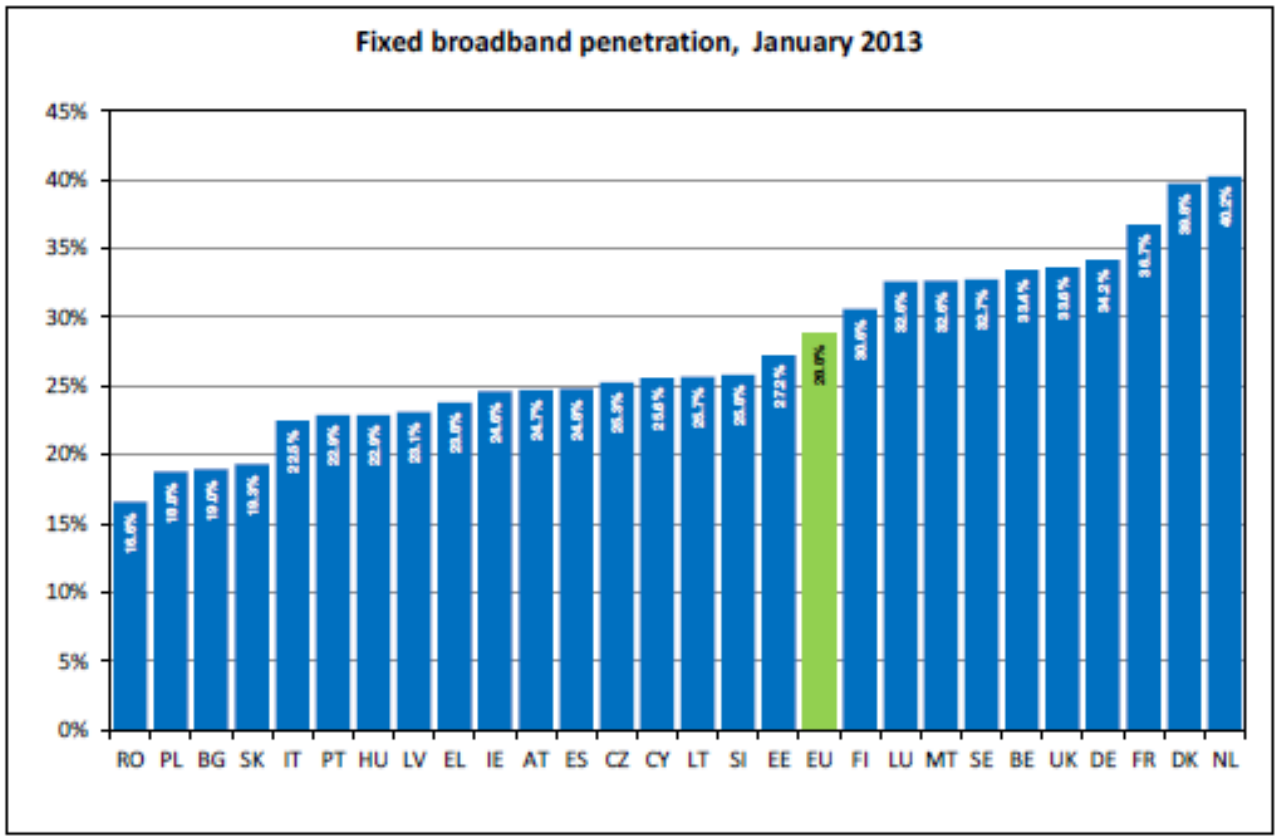
Source: Point Topic (2013), Broadband Coverage in Europe in 2012.[2]

[2] See European Commission (2013), Digital Agenda Scoreboard 2013, Chapter 2, 12 June, SWD(2013) 217 final.

2.3. Penetration

Broadband penetration provides cause for further concern. Even though coverage is high, adoption is low. Indeed, Italy ranks fifth worst among EU Member States; however, among its peer group of Western European Member States, it ranks last. Only Romania, Poland, Bulgaria and Slovakia score worse.

Figure 4. Fixed broadband penetration (January 2013).



Source: Communications Committee[3]

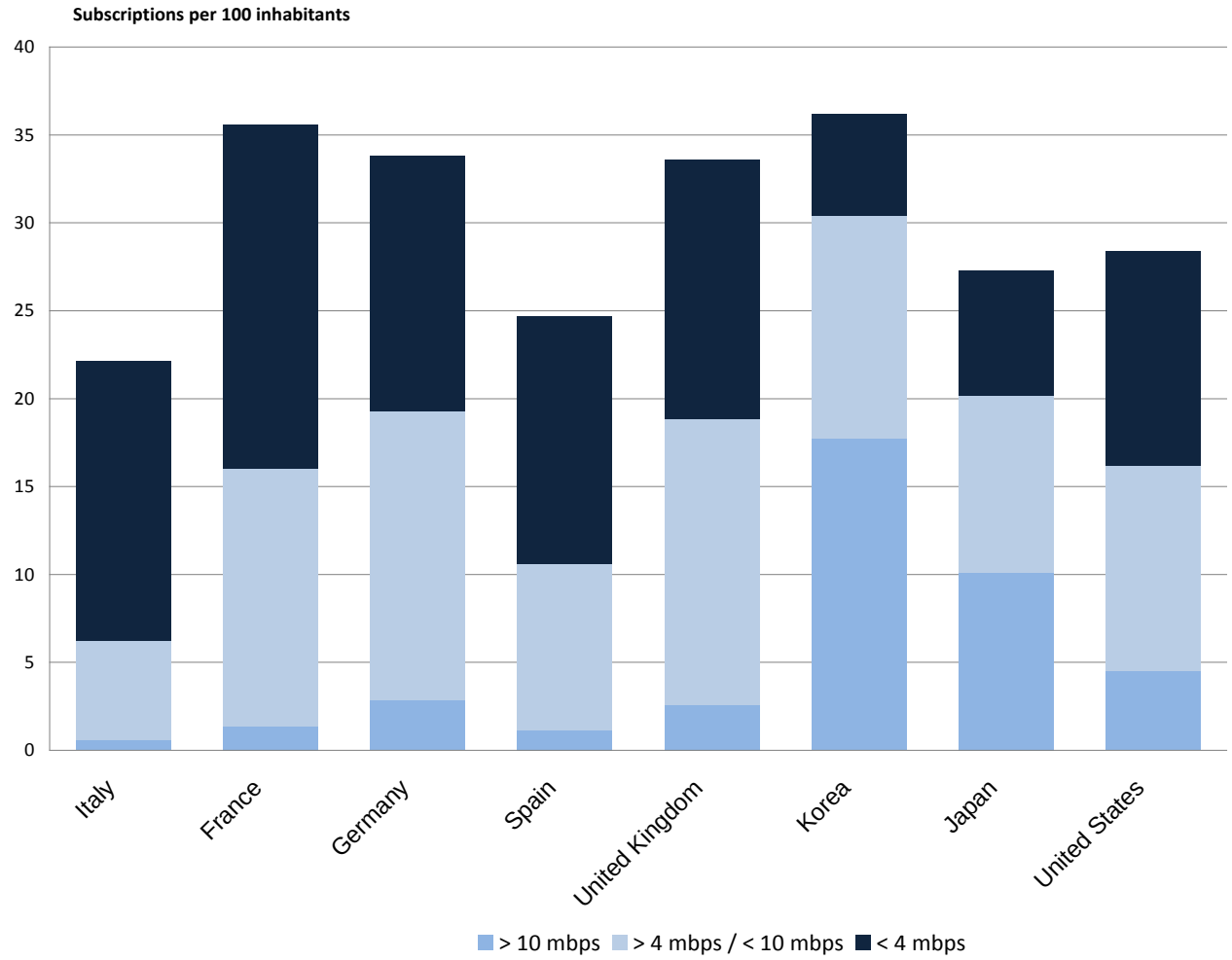
[3] See European Commission (2013), Digital Agenda Scoreboard 2013, Chapter 2, 12 June, SWD(2013) 217 final.

2.4. Broadband speed delivered and quality of service

As noted earlier in this chapter, the nominal speed of the access link is only one measure of the speed of the network. The speed of the core network and aggregation network also impact total throughput. By this measure, Italy ranks rather badly in comparison with European and global competitors.

Figure 5 denotes the percentage of inhabitants served by broadband with an effective, measured speed (as computed by the firm Akamai) of less than 4 Mbps, 4 to 10 Mbps, or greater than 10 Mbps. Broadband in Italy is, to a disproportionate extent, in the slowest category. Very little of the deployed broadband actually achieves even as much as 10 Mbps.

Figure 5. Percentage of inhabitants served by broadband of a given effective speed (2012).



Source: OECD Communications Outlook[4]

In recent years, the gap between Italy and other countries in terms of available download speed has widened.[5] The situation appears to be getting worse, not better.

[4] OECD (2013), *OECD Communications Outlook 2013*, OECD Publishing. doi: 10.1787/comms_outlook-2013-en. Based on OECD subscription data (June 2012) merged with Akamai's actual speed data (2nd quarter, 2012).

[5] Maurizio Dècina (2013), La qualità dell'accesso ad Internet in Italia: realtà e prospettive, available at: https://www.misurainternet.it/documenti/presentazioni/Decina.pdf.

3. Alternatives to the fixed telecommunications network

Key Findings

- *Cable television service is non-existent in Italy.*
- *Mobile services based on forms of LTE are unlikely to be adequate,* in our judgment, to serve as a full substitute in the period 2014-2020 for 100 Mbps fixed broadband service, nor to serve as a full substitute for fixed broadband services at 30 Mbps in areas of moderate to high population density. Mobile service can and will serve as a substitute for 30 Mbps broadband in areas of low density.
- Fixed wireless service is small today in terms of number of subscribers, but covers a substantial fraction of the Italian territory. Policymakers should not ignore it.
- Satellite should be considered as a substitute service only for a very small percentage of users who cannot practically be reached in any other way. The latency characteristics that are inherent in geosynchronous satellites are unavoidable, and (together with limitations in bandwidth capacity) render the service unattractive where alternatives are available.

Achievement of DAE Objectives in Italy necessarily will depend heavily on the fixed telecommunications network. Other technologies, notably mobile broadband and Fixed Wireless Broadband, generally serve as economic *complements* or *partial substitutes*, but are unlikely to fully substitute for the fixed telecommunications network over the period 2014-2020.

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- Fixed wireless service is small today in terms of number of subscribers, but covers a substantial fraction of the Italian territory. Policymakers should not ignore it.
- Satellite should be considered as a substitute service only for a very small percentage of users who cannot practically be reached in any other way. The latency characteristics that are inherent in geosynchronous satellites are unavoidable, and (together with limitations in bandwidth capacity) render the service unattractive where alternatives are available.

3.1. Cable

Italy is nearly unique among European Member States in having no cable television coverage whatsoever.[6] This has numerous implications for the prospects for fast and ultrafast broadband, none of them positive.

- In the rest of Europe, cable generally provides the vast majority of fast and ultrafast broadband service today. In Italy, it will be necessary to meet DAE objectives solely on the strength of the telecommunications network.[7]

[6] Only Greece is comparably devoid of cable television.

- The competitive spur that cable provides to the telecommunications incumbent is conspicuous by its absence in Italy.
- The absence of cable further complicates an already challenging media environment in Italy. Audiovisual content, which represents a key demand driver in most EU Member States, is largely unavailable in the Italian language to alternative distributors (e.g. Over-the-Top (OTT) players) in Italy.

We make no specific recommendations in regard to cable. That ship has sailed.

3.2. Mobile services

The capabilities of mobile networks (and also of fixed wireless, as we explain in Section 3.3) have grown substantially in recent years. Usage of mobile networks has grown correspondingly.

Mobile wireless broadband technology is continuously improving its capacity thanks to greater spectral efficiency, denser cell packaging (using smaller cells), evolved MIMO antenna technology, increased backhauling capacity, dynamic frequency usage, and carrier aggregation.

Italian Telecom mobile operators benefit from these improvements. They are currently rolling out 4G LTE mobile cellular networks and services that offer greater downstream and upstream data rates than those that were possible with previous HSPA technologies. The peak data rate available in an LTE cell is on the order of 10-100 Mbps downstream, depending on the condition of the radio link (i.e. signal to noise ratio) and on the sharing of available radio capacity among active users. The highest theoretical peak data rate on the transport channel is 75 Mbps on the uplink, while on the downlink the rate can theoretically reach a peak of 300 Mbps (thanks to spatial multiplexing). It is rare, however, for the planning of an LTE radio system to target delivery of 30 Mbps downstream per cellular user (and even more rare to target 100 Mbps) because it would be difficult to achieve a return on investments.

LTE-Advanced, currently under development by market players and standard organizations, is expected to increase access speeds in various ways. LTE-Advanced aims at achieving an increased peak data rate (3 Gbps downlink and 1.5 Gbps uplink), higher spectral efficiency (from a maximum of 16 bits/s/Hz in R8 to 30 bits/s/Hz in R10), an increased number of simultaneously active subscribers, improved performance at cell edges (e.g. for 2x2 MIMO downlink at least 2.40 bits/s/Hz/cell, carrier aggregation, and intra-site and inter-site Coordinated Multi-Point (CoMP) transmission/reception .

The amount of data carried over mobile networks has dramatically increased in the last few years, with multimedia content being an important component of the growth. This increased use of multimedia content, such as real time broadcast content, high definition audio/video streaming, podcasts, file casts, on-line gaming, social networking and downloading of applications, coupled with a trend towards immediate and on-the-move use of personalised video-based content, imply a need for network capacity that is only likely to increase in future years.

Radio spectrum is key to the capacity of both mobile and fixed wireless networks, but lack of radio spectrum is frequently a bottleneck to network capacity. For that reason, it is crucial that spectrum policy support the necessary growth of mobile networks (and also of fixed wireless networks).

[7] No other infrastructure seems to be up to the task.

Mobile in Italy, including mobile broadband, is widely used. Substantial deployment of LTE and LTE Advanced technologies can reasonably be expected; nonetheless, the impact of these technologies relative to meeting the DAE Objectives is less than one might think, for several reasons:

- The speeds that are often quoted in the press usually reflect the greatest speed that the technology could ever achieve, assuming only a single user close to the transmission mast and with no contention within the cell. Effective throughput tends to be much less, except in areas where population density is low.
- In the period 2014-2020, mobile services will be effective and important in achieving 30 Mbps broadband service in low density areas in Italy (i.e. rural areas as defined in this report), but are not expected to be effective in achieving 100 Mbps service.
- In urban and suburban areas, mobile service is more likely to be an *economic complement* used in addition to fixed broadband rather than an *economic substitute* for fixed.
- Recent work shows that most data from nominally mobile devices is in practice already sent over private Wi-Fi from home or work.[8] This implies once again that the mobile network primarily serves as a complement to fixed broadband, rather than a substitute.

All of this notwithstanding, mobile provides a crucial substitute for the fixed network in low density areas, and a valuable complement in high density areas. It provides a modest competitive spur to fixed network deployment. In recent work, we have recommended that an additional DAE Objective specifically geared to mobility be added.

The Government should develop Italy's international strategy (in consultation with stakeholders) on the use of radio spectrum in order to make its voice heard at European level and global level. Spectrum allocation is internationally coordinated to a significant degree in order to avoid cross-border interference. A number of frequency bands have been identified that could potentially be progressively released for wireless broadband, either for exclusive use of for some form of shared use. There has been considerable interest in re-purposing[9] the 700 MHz band (which is now used for television broadcasting services) so as to enable its use for mobile broadband services. This would add another band with excellent coverage and building penetration properties to the 800 MHz band that will be available from 2013 for mobile services. The change in use of the 700 MHz band was already anticipated in the 2012 World Radiocommunication Conference (WRC) decision to reallocate the 700 MHz band to include mobile services (which include mobile broadband services) immediately following the 2015 WRC; this means, however, that the decision is in effect not yet finalised. For that matter, there has been growing interest over the past year or two in sharing this band between broadband and broadcast use, or perhaps between these uses and public safety. For this band and for others, Italy should prepare to develop its position so as to provide input to the European Commission, especially in the context of the multi-annual *Radio Spectrum Policy Programme (RSPP)*,[10] and in response to the questions posed in the context of preparations for the next World Radiocommunication Conference (WRC -15).

The 700 MHz band has been of particular interest, but there are any number of bands that could potentially be used to expand the amount of radio spectrum available for mobile, fixed, and Wi-Fi broadband services.

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[8] Marcus, J.S., Burns, J. (2013), Impact of traffic off-loading and related technological trends on the demand for wireless broadband spectrum; study for the European Commission.

[9] The term of art is "re-farming".

[10] European Union (2012), Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme.

Table 1. Spectrum bands that might be of interest for wireless services.

Timeline	Frequency band	Remarks
Current priorities	1452-1492 MHz (UHF-L Band)	The band is harmonised for Supplemental Downlink (network-user communications). Currently, the band is not used in Italy.
Medium term (2015-2020)	700 MHz	Subject to preliminary provisions set by the European Radio Spectrum Policy Programme (RSPP). Heavily used in Italy for digital terrestrial broadcasting.
	2.3-2.4 GHz	The European framework for the harmonised use of this band is under completion. Currently, the band is marginally used for incumbent services in Italy.
	3.6 – 3.8 GHz	This band is already harmonised for Electronic Communications Services in Europe.
Possible release in the long run (post 2020)	3.8 – 4.2 GHz	Potentially attractive for a very large amount of bandwidth, suitable for dense high-capacity networks. Severe constraints, due to coexistence issues with incumbent users, are still to be solved.
	1350 -1518 MHz (1.5 GHz Band)	Currently employed mainly for military and scientific uses. Possible release of sub-portions.
	5350-5925 MHz (5 GHz Band)	Likely to become increasingly important for Wi-Fi evolutions. Severe constraints, due to coexistence issues with incumbent users, are still to be solved.

Source: Fondazione Ugo Bordoni

For all of these reasons, it is important to ensure that no unnecessary impediments stand in the way of the use of mobile services to provide consumer broadband. We have not examined spectrum management practices in Italy as part of this study, but would nonetheless venture the following recommendations as representing European best practice.

Recommendation 1. Include mobile broadband as a major element of the planning process.

Mobile broadband should play a role nearly equivalent to that of fixed in the planning process for meeting DAE Objectives. Mobile is a substitute for fixed in low density areas; a mobile complement to fixed in areas of greater density; and serves as a competitive spur to fixed network deployment.

Recommendation 2. Ensure that sufficient spectrum for mobile and fixed wireless broadband is available.

Spectrum allocation policy should ensure that sufficient spectrum is available for mobile and fixed wireless broadband services. Government should take the opportunity of international and European processes that are re-purposing frequencies among various applications (including possible future use of the 700 MHz band for mobile broadband) to adopt, in consultation with stakeholders, best practice and to ensure that Italy can fully exploit wireless technology advances in the evolution of its digital infrastructures.

Recommendation 3. Follow best practice in regard to spectrum sharing and secondary markets.

Continuing attention is called for to ensure that spectrum secondary markets (e.g. spectrum trading) are effective, and that opportunities for sharing and collective use are fully exploited.

Recommendation 4. The migration to small cells and Wi-Fi off-load pose opportunities for greater network capacity.

The evolution of the network toward smaller cells with more limited coverage potentially offers greater spectrum re-use, and thus substantially greater effective capacity. This trend of evolution within the macro-cellular is linked to the tendency toward spectrum off-load both to small cells and to Wi-Fi.

Recommendation 5. Policymakers should pay attention both to the fixed and the mobile networks.

For small cells and large, fixed back-haul capacity is crucial. Clearing away impediments to fixed network deployment is thus crucial to the mobile network as well. The evolution of fixed and mobile networks are intertwined, implying that a comprehensive approach is warranted in order to pay due attention to both.

3.3. Fixed Wireless Broadband (FWB)

The Point Topic study of broadband coverage on behalf of the European Commission[11] shows Italy as benefitting from 45% coverage by Fixed Wireless Broadband (FWB). This is substantial. In the European discussion, FWB services do not always receive the attention that they deserve.

In Italy, three main players offer Fixed Wireless Broadband (FWB) services. Two of them transmit on 3.4-3.6 GHz licensed frequencies, while the third uses unlicensed spectrum in the bands 3.5, 3.7 and 5.4 GHz. Each major player serves about 100.000 customers, while a number of small players are focused on offering focused on offering local to specific territories.

According to the latest 3Q2013 data available from AGCOM, there are 270,000 FWB customers. This is small relative to the total number of households in Italy, but not much different from the actual number of fibre customers in the same period (290,000). The number of customers is expected to increase, because FWB is playing a central role in the latest and ongoing MiSe tenders for basic broadband digital divide.

FWB technology has advantages of its own, and is improving over time, just as mobile broadband is improving. Italian FWB providers offer top speeds of up to 25 Mbps today, and plan to evolve to 50 Mbps and more by 2015.

- FWB radio planning can be more effective and more predictable than with mobile wireless technology. The performance provided to active customers can be better than with mobile because the radio link is not dependent on the mobility of terminal equipment.
- Advances in radio technology have steadily increased the modulation efficiency of usage of spectrum (from about 1 bit/s/Hz for HyperLAN, to around 2 bit/s/Hz for 802.16/Wimax, and to 4 to 8 bit/s/Hz in emerging radio technologies exploiting efficient modulation and evolved MIMO techniques).

FWB is definitely relevant to DAE Objective 1 (basic broadband coverage), and probably also DAE Objective 2 (30 Mbps coverage) over the 2014-2020 time frame. Whether it is suitable to DAE Objective 3 (50% adoption of 100 Mbps service) during the period 2014-2020 remains to be seen.

[11] Point Topic (2013), Broadband Coverage in Europe in 2012.

We have not made any detailed recommendations about FWB, but it is clear that it should be included in the monitoring programme that we call for in Chapter 7.

Recommendation 6. Include Fixed Wireless Broadband (FWB) in the planning process.

Fixed Wireless Broadband (FWB) should be included within the scope of planning for the achievement of DAE Objectives.

3.4. Satellite

Satellite appears likely to play only a minimal role in meeting DAE Objectives, but for the most remote areas (islands, mountainous terrain) it is likely to be the only practical option.

The orbital altitude for a geosynchronous satellite is fixed, and inherently leads to delay of some 270 milliseconds (about a quarter of a second). The speed of light is a law of nature that is not amenable to technological improvement. This inherent delay limits the desirability and suitability of satellite services. The capacity of satellite communications, which must be shared among all users, is substantial but nonetheless would likely pose constraints if widespread use were attempted.

Recommendation 7. Include satellite in the planning process as a "gap filler".

Satellite should be included as a "gap filler" within the scope of planning for the achievement of DAE Objectives. For certain remote areas, use of satellite is indispensable.

4. Promising developments and opportunities

Key Findings

- Key network operators, notably including Telecom Italia and Fastweb, have credible and realistic deployment plans, and are deploying to these plans. Vodafone has made credible commitments to invest. Italy is fortunate to have fixed network competitors that are willing and able to invest in fast broadband infrastructure.
- Italy represents an ideal case for a relatively inexpensive form of fast broadband, namely FTTCab/VDSL2 due to the relatively short length of copper sub-loops.
- Technological advances to VDSL are likely to further enhance FTTCab capabilities.
- It is likely that it will eventually be necessary to eventually build out solutions that are even more capable than FTTCab/VDSL2; however, that does not necessarily mean that it is unwise to deploy FTTCab/VDSL2 today. If the investment to upgrade is deferred substantially, then the ability to apply the capital to other productive uses in the interim has substantial value to Italy; moreover, deployment costs are likely to be lower in the future than they are at present. It is likely that more than one technology will be present in Italy in any case.
- RAI, Mediaset, and SKY have all announced and released new IP-based platforms for catch-up television on the Internet. Increased availability of high quality audiovisual content could help drive demand for fast broadband going forward.

There are a number of possible grounds for cautious optimism in Italy. Key among these, in our view, are:

- Key network operators, notably including Telecom Italia and Fastweb, have credible and realistic deployment plans.[12] These are often coupled (in contrast with past experience) with actual deployments. Vodafone also recently committed to invest in a major three-year program for fixed ultrafast broadband infrastructure roll-out starting in 2014.
- Italy represents an ideal case for a relatively inexpensive form of fast broadband, namely FTTCab/VDSL2.

4.1. Deployment plans of the network operators

The plans of the network operators are, as far as they go, reasonably plausible and credible; however, as we explain in Chapter 5, numerous gaps, interdependencies, and uncertainties in planning have emerged. The plans of all network operators tend to focus on areas of greatest population density while neglecting area of low density, thus neglecting large portions of the national territory. There are thus large gaps that will presumably need to be addressed through public funding. Nonetheless, Italy is fortunate to have fixed network competitors that are willing and able to invest in fast broadband infrastructure. Not every EU Member State has this.

[12] Much of this deployment has taken place within the past six months, and consequently is not yet fully captured in the statistics provided by the European Union, the OECD and the ITU.

This section provides a brief summary of their plans, based on our interviews. In the interest of protecting commercially sensitive information of the network operators, this report refrains from presenting more detailed findings.

- **Telecom Italia** presented a three year basic plan (2013-15) based on FTTCab roll-out based on their own business drivers. The plan has been extended to 2016, taking into account also the funding and coverage targets required by MiSe tenders. These plans should provide coverage to some 50% of Italian households by 2016 or so, and potentially to more than 80% of the Italian population by the end of the decade (including MiSE tenders funding contribution). Telecom Italia plans to spend € 1.7 billion in the period 2014-2016 for its ultrabroadband plan on the fixed network (€ 1.8 billion including investments for OSS).

  AGCOM confirms that Telecom Italia has achieved its planned roll-out programs presented in the last two years. Moreover, quality indicators of the TI copper network have progressively improved due to preventive measures to counter infrastructure saturation (one of the main causes of KO to OLOs on LLU).

- **Fastweb** is executing its two year investment plan (2013-14) based on FTTC architecture as announced at the end of 2012. The final coverage target is 3.5 million lines by 2014 in addition to the two million FTTH lines already covered mainly across seven large Italian cities (Milano, Genova Torino, Roma, Bologna, Napoli, Bari). The roll-out is based fully on a private investment of € 400 million, and benefits from a coordination agreement with Telecom Italia for joint operational planning and deployment to ensure that infrastructure investment can be shared efficiently where possible. The final coverage will be around 20% of the total households by 2014. Fastweb is on track with its implementation plan, half way through its target coverage and started offering services based on FTTC in 12 cities with speeds up to 100 Mbps. Fastweb has not announced its investment plans beyond 2014, which are highly dependent on the regulatory conditions around sub-loop unbundling; however, it indicated that to reach 50% total households coverage by 2018, it would require an additional € 1.6 billion for a deployment, which would take around four years.

- **Metroweb** is a neutral passive infrastructure operator. Its mission is to deploy fibre optics access networks (ducts and cables) in the major metro areas. Fastweb is Metroweb's main customer, but Metroweb also serves Telecom Italia, Wind, Vodafone and other service providers. In Milano, thanks to the Metroweb fibre network, Fastweb serves about 200,000 customers through FTTH technology since the early 2000s. Further deployments are in progress.

  In March 2012, Metroweb proposed a € 4.5 billion investment plan to provide 5.6 million FTTH lines in 30 major cities. At present, this plan has been put on hold by Metroweb's shareholders (F2i and FSI/Cassa Depositi e Prestiti) as a consequence of the launch of alternative overlapped plans (e.g. by TI, Fastweb and Vodafone), mainly based on FTTCab. According to Metroweb, this could cause a delay in the adoption of a unique full fiber access solution.

  While Metroweb strongly believes that FTTH is the more adequate solution to serve emerging ultrabroadband needs in the more dense urban areas (20% of the population), they agree that FTTCab can satisfy the needs in mid-density areas (30% of the population). The remaining 50% of the population, on top of the present ADSL solutions, could be adequately covered by LTE and other wireless technologies.

- **Vodafone** currently offers NGN services based on VULA and bitstream services provided by Telecom Italia Wholesale. Vodafone also has a contract with Metroweb to offer services based on FTTH GPON architecture (currently under deployment) in Milan. Vodafone credibly claims to be ready to launch an incremental investment plan on FTTCab. The decision of AGCOM to mandate regulated sharing to existing and forthcoming Telecom

Italia cabinets has opened up infrastructure competition, removing the bottleneck. Vodafone is now rolling out a three year FTTCab plan aiming at coverage of about 26% of households by 1Q2017. Added to the target 600,000 households covered by the FTTH GPON plan by 2016, Vodafone plans sum up to near 29% covered households.

- **Wind** is currently focused on developing the mobile broadband network; however, Wind has also started to provide ultrafast broadband in Milano, based on the agreement with Metroweb for the roll out of a FTTH based on GPON solution. The ultrafast broadband customer base is expected to grow to some 150,000 in 2017. On a general basis, the Wind approach is to extend the ultrafast service based on the infrastructure made available in each specific area and foresee the development of a common wide infrastructure for which is open to entertain discussions on possible means of participation..
- **3** is focused on mobile and LTE.
- **Infratel** has developed its own forecast of investments needed for extensive deployment of FTTcab. Infratel estimates an investment of around one billion euro to cover the main 151 cities (Comuni), corresponding to 31% population coverage. They estimate € 1.6 billion to cover 450 cities, corresponding to 50% population coverage, and € 4.2 billion to cover around 8,000 cities, corresponding to 95% of the population.

4.2. Feasibility of cost-effective FTTCab/VDSL2

As recently as two years ago, most experts assumed that broadband speeds of 100 Mbps would necessarily imply deployment of Fibre-to-the-Premises (FTTP) or Fibre-to-the-Home (FTTH). These are relatively expensive solutions, inasmuch as the need to run fibre all the way from the central office (with its Main Distribution Frame (MDF)) to the customer premises implies a considerable investment in civil works, primarily digging.

Very-high-bit-rate digital subscriber line 2 (VDSL2) is an alternative technology that enables the use of existing copper to the home.[13] Typically, the copper from the MDF to the street cabinet is replaced with fibre optics. Such *Fibre-to-the-Cabinet VDSL2 (FTTCab/VDSL2)* solutions tend to be a significantly less expensive per home passed than FTTP or FTTH solutions because the high cost of civil works to individual buildings is avoided. A street cabinet can serve 100-200 homes or more.

In general, the deeper that fibre is driven into a telecommunications network, and the less the copper that remains, the great the throughput that can be supported; however, driving fibre deep into the network also entails very substantial cost, not so much for the fibre itself, but rather the cost of digging to deploy it (often referred to as the cost of "civil works").

A number of technological innovations (sometimes referred to as "the second life of copper") have substantially increased the bandwidth available using advanced forms or successors of VDSL2.

- *Vectoring* is a transmission method that employs noise cancellation across the line signals on different copper pairs in the same bundle to reduce crosstalk between them and thus to improve performance.[14]
- *Bonding* uses two (or more) copper pairs to enhance throughput.[15]

[13] VDSL2 is standardised in ITU-T G.993.2 (2005).
[14] See ITU-T G.993.5: "Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers" (2010).
[15] Bonding is addressed in ITU-T G.998.x. Typically, bonding is useful only where a second pair is available.

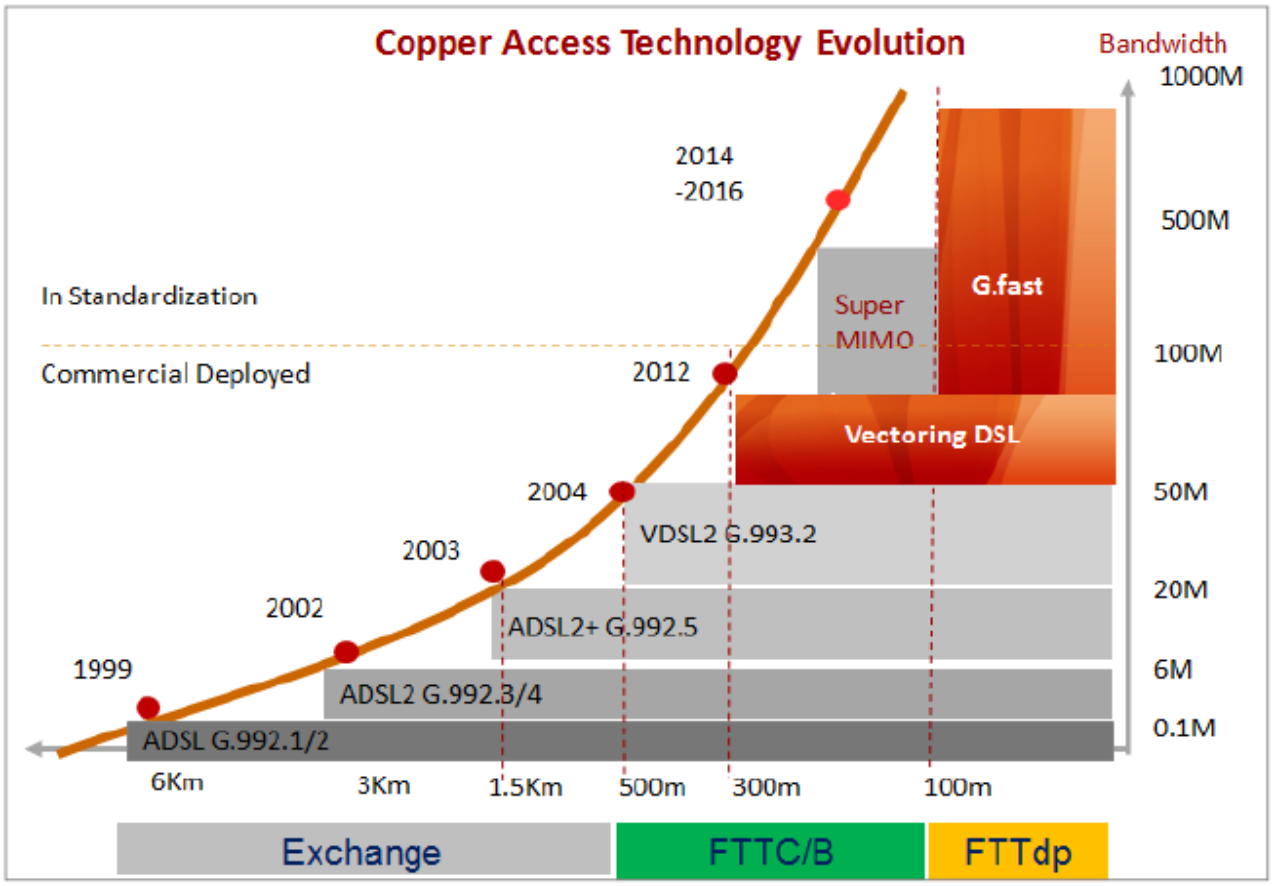
- *G.Fast* is an emerging technology that achieves extremely high speed where copper loop lengths are very short, generally less than 300 metres.

The trade-offs among these various technologies are complex. A somewhat detailed review of VDSL2, vectoring and G.Fast appears in Annex 2 to this report. At the risk of over-simplifying, a few generalisations are in order:

- Copper sub-loop lengths in Italy are among the shortest in Europe. This is an ideal configuration for the less expensive technologies in the FTTCab/VDSL2 family.
- VDSL2 itself is well-suited to speeds of 30 Mbps, and can achieve substantially higher speeds for many lines in Italy (but not necessarily for all).
- VDSL2 with vectoring can achieve speeds of 70-80 Mbps over many of the lines available in Italy, and is expected to be realistically deployable within the next year or two.
- G.Fast can achieve speeds that are even considerably higher over short enough loops.

Figure 6 summarises the interrelationships among realistically available speed, copper sub-loop length, and the evolution of technology over time.

Figure 6. The evolution of technologies that provide broadband over copper.

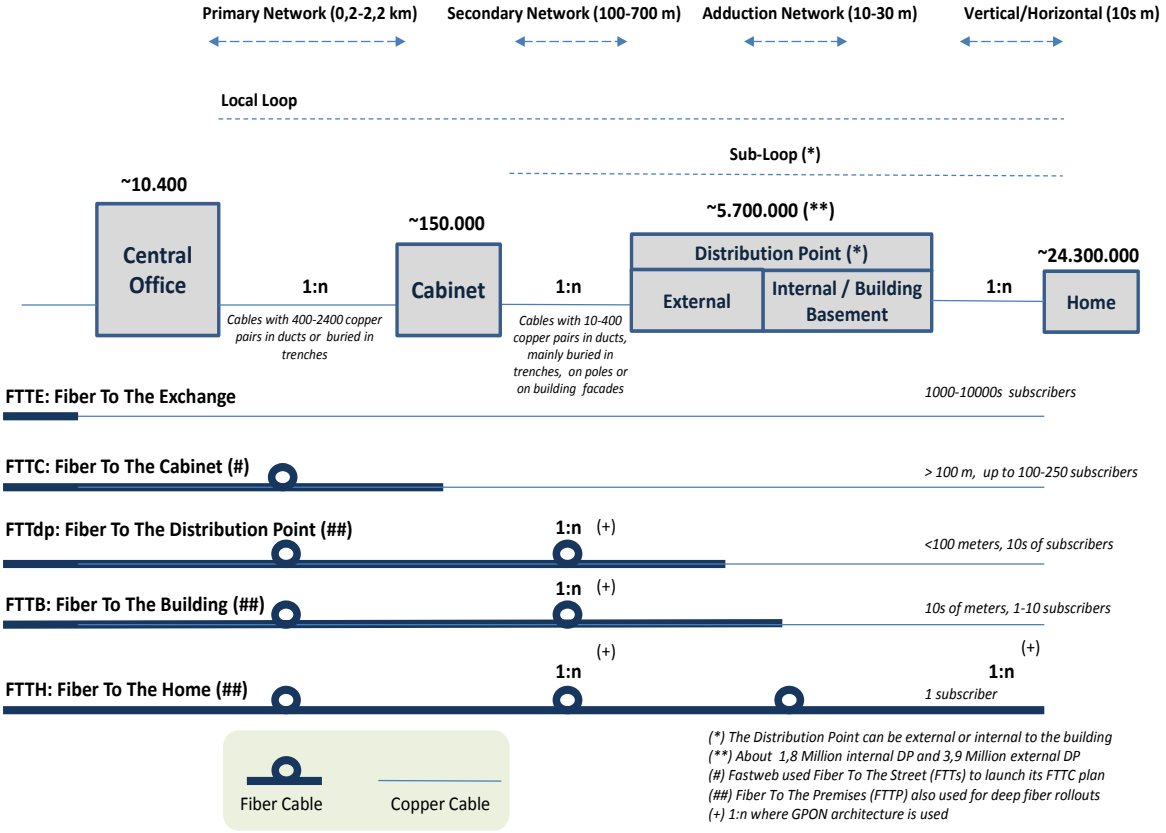


Source: Huawei

How is this evolution likely to play out in the Italian context? Figure 7 and Figure 8 provide a view that has been reviewed with the network operators. Fibre will be driven progressively deeper into the network over time. Each step will provide greater speed, and in most cases greater reliability and lower OPEX (operating expense) as well. Each step will also be associated with greater cost;

however, it is not necessary to take the higher (and thus more expensive) steps until there is consumer demand for those services.

Figure 7. Italian access network and FTTx options.



Source: Fondazione Ugo Bordoni

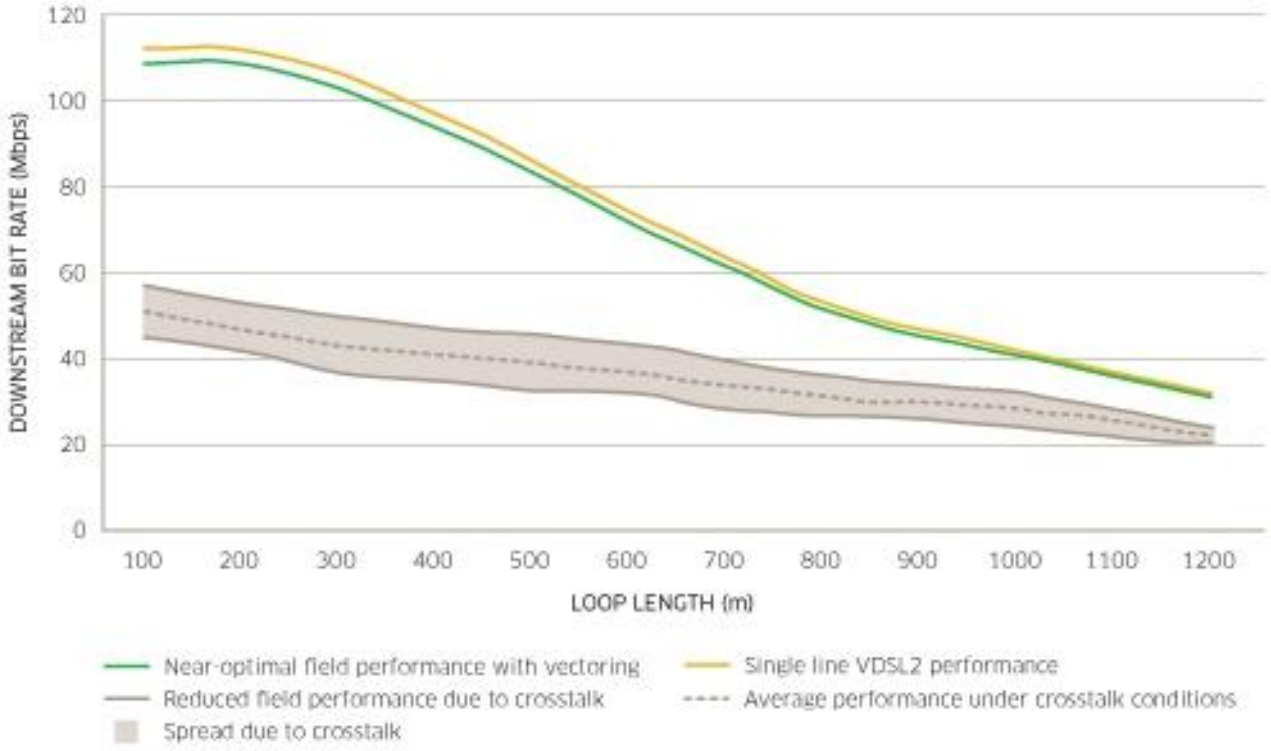
Figure 8. The journey of the Italian network from today to tomorrow.

	Current View	*Future View*
FTTE: Fiber To The Exchange	*ADSL2+ up to 20 Mbps and 1 Mbps upstream*	*VDSL2 evolution up to 50 Mbps DS and 10 Mbps US depending on copper length, copper quality and concurrent usage of pairs in a cable, vectoring to secure top speed on pairs bundled in a loop cable*
FTTC: Fiber To The Cabinet	*VDSL2 up to 30 to 100 Mbps DS and 3 to 30 Mbps US based on sub-loop length (up to 100Mbps for sub-loops < 300 m), vectoring being tuned to secure top speed on pairs bundled in a sub-loop cable*	*VDSL2 evolution to improve performance/distance tradeoff, depending on copper quality and concurrent usage, vectoring to secure top speed on pairs bundled in a sub-loop cable – G.Fast (sub-loops<100m)*
FTTdp: Fiber To The Distribution Point		*VDSL2 evolution and G.Fast, vectoring up to 500-1000 Mbps aggregate (DS+US)*
FTTB: Fiber To The Building		*VDSL2 and G.Fast, vectoring up to 1000 Mbps aggregate (DS+US)*
FTTH: Fiber To The Home	*scalable to >= 1 Gbps* *Existing footprint Metro-Ring and P2P up to 100 Mbps DS and US* *GPON: shared bandwidth up to 2.5/1 Gbps*	*scalable to >= 1 Gbps* *Metro-Ring and P2P scalable to >=1 Gbps* *GPON: shared bandwidth up to 10/2.5 Gbps* *NGPON2: shared bandwidth up to 80/80 Gbps*

Source: Fondazione Ugo Bordoni

It had been hoped at one point that vectoring alone would deliver speeds of up to 100 Mbps. More recent estimates suggest that this is only possible under the most ideal circumstances. Speeds in the range of 60-80 Mbps seem to be more realistic, based on today's vectoring implementations, as shown in Figure 9.

Figure 9. The relationship of sub-loop length to speed under vectoring.



Source: Alcatel-Lucent[16]

In practice, these trade-offs are complex. Neither Vectoring nor G.Fast could meet the 100 Mbps DAE Objective 3 requirement for all lines in Italy today; however, that is not the real requirement. What the DAE Objectives require is that they be able to offer 100 Mbps service (however defined) by 2020, and that they do so for enough lines to enable 50% of households to subscribe. Given the rate at which the technology is improving, it is distinctly possible that that might be achievable without extending fibre beyond the street cabinet for a substantial fraction of Italian households.

Based on what is known today, one could reasonably expect half of Italian households to be suitable for G.Fast in 2018-2020 without the need to extend the fibre connection. The average sub-loop length in Italy is just 300 metres. The median sub-loop length is about 200 metres, i.e. half of all sub-loops are shorter than 200 metres.

It is quite possible that this will not be quite sufficient to meet DAE Objective 3. Should that be the case, it would still be feasible to extend fibre from the street cabinet to a distribution point (at or close to the building) in order to shorten the distance over which copper must carry the signal.

In a 2011 study of the costs of broadband deployment, the European Investment Bank (EIB) made the following estimates of the costs per household of ADSL2, FTTCab/VDSL2, FTTH, and FTTB

[16] Alcatel-Lucent (2012), VDSL2 Vectoring in a Multi-operator Environment – Separating Fact from Fiction, at: http://www2.alcatel-lucent.com/techzine/vdsl2-vectoring-in-a-multi-operator-environment-separating-fact-from-fiction/#sthash.lL2V61Nv.dpuf, viewed 24 January 2014.

deployment.[17] The EIB did not consider vectoring or G.Fast; however, *we make the assumption here that, in cases where no additional fibre deployment is required, the equipment cost per port for equipment capable of vectoring and/or G.Fast in 2018-2020 will be no greater than that of VDSL2 equipment in 2011 or today*. Based on progressive improvements in semi-conductor price/performance (Moore's Law), this assumption seems reasonable.

The figures in Table 2 distinguish among urban (greater than 500 inhabitants per Km^2), suburban (between 100 and 500 inhabitants per Km^2), and rural (less than 100 inhabitants per Km^2) areas. (Note that we made adjustments to some of these cost estimates in developing our own estimates of the cost of meeting DAE Objectives in Italy today, as explained in Annex 3.)

Table 2. Cost per household to deploy various broadband technologies (euro).

	Urban	Suburban	Rural
ADSL2	40	80	200
FTTC/VDSL2	250	500	1800
FTTB	350	1000	2700
FTTH	460	1150	2800
LTE	50	110	380

Source: EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets"[18]

In general, FTTCab solutions cost roughly one fourth to one third as much as FTTP/FTTH solutions (see also Table 7 in Annex 3). They can also be two to three times as quick to deploy as FTTP/FTTH solutions. Business trade-offs for network operators are, however, complex and are linked to the regulatory environment.

FTTCab/VDSL2 solutions seem to be more than adequate to meet realistic demand through 2020 and somewhat beyond. Unless there is a strong argument to be made that Italy needs to go substantially beyond DAE Objectives, and assuming no radical increase over time in broadband usage per household, there is a strong argument for proceeding with FTTCab/VDSL2 solutions for DAE Objectives 2 and 3.

It is likely that it will eventually be necessary to eventually build out solutions that are even more capable than FTTCab/VDSL2; however, if that investment is deferred ten years or more, then the ability to apply the capital to other productive uses in the interim has substantial value to Italy. Moreover, deployment costs are likely to be lower in the future than they are at present.

We hasten to add that it is not the goal of public policy to choose technological winners or losers; nonetheless, where government is called upon to make industrial policy decisions, it is necessary (and indeed unavoidable) to make realistic estimates of costs and benefits under reasonable assumptions, as we are doing here.

With that said, we refer the reader to the rough estimates of deployment costs that appear in Annex 3 to this report.

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[17] EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets". this report is not publicly available; however, the key findings appear in Hätönen, J. (2011), The economic impact of fixed and mobile high-speed networks, *EIB Papers,* Volume 16, No 2, pp. 30-59; available at: http://www.eib.org/infocentre/publications/all/eibpapers-2011-v16-n02.htm.

[18] Again, this report is not publicly available; however, the key findings appear in Hätönen, J. (2011), The economic impact of fixed and mobile high-speed networks, *EIB Papers*, Volume 16, No 2, pp. 30-59; available at: http://www.eib.org/infocentre/publications/all/eibpapers-2011-v16-n02.htm.

4.3. Increased availability of catch-up video

RAI, Mediaset, and SKY have all announced and released new IP-based platforms for catch-up television on the Internet. This represents a welcome departure from recent history.

Our interviews suggest that Italian network operators and Over-the-Top (OTT) players have had somewhat limited access to audiovisual content in the Italian language, which has likely inhibited consumer interest in fast broadband (see Section 5.5.5). The increased availability of catch-up video implies that one key aspect of this challenge appears to be on the mend.

Rapidly growing penetration of new devices capable of delivering high quality audiovisual content on demand over the internet, increasingly entailing both download and upload, has already driven very significant growth in traffic, and is likely to accelerate over time. Smart TV, connected game consoles, and tablets will all be offering services and catering to a growing market of bandwidth hungry customers.

While most of these devices are used in wireless mode, the vast majority of consumption happens in Wi-Fi mode, which requires (and drives demand for) high quality high bandwidth fixed connections.

The imminent commercial availability of 4K ultra HDTV sets is likely to further strengthen these trends.

Importantly, these applications require a much lower level of digital literacy than personal computers. In the coming years, they might significantly contribute to reducing the digital divide and driving demand for connectivity and broadband in large segments of the market that have been far less interested in these developments in the past.

5. Worrisome developments and challenges

Key Findings

- In achieving DAE broadband Objectives, Italy faces numerous challenges.
  - Uncertainty as to whether the deployment plans will continue to be pursued.
  - Challenges in covering the 50% of households that are not addressed by current plans of network operators.
  - Two million copper lines of low quality require special attention.
  - Heavy reliance on Telecom Italia to meet the DAE broadband Objectives.
  - Numerous challenges in putting capital effectively to work. This has many manifestations: (1) locked-up investment in the case of Metroweb; (2) the tendency of all operators to invest in covering the same 50% of the population; (3) VDSL-specific challenges, including both street cabinet sharing, and coordination of lines where vectoring is deployed; (4) sharing in the mobile network; and (5) opportunities to use infrastructure from other network industries (e.g. electricity, water). Some of these are challenges for the industry, while others are challenges for the National Regulatory Authority (NRA). Italy may wish to strike a different balance (with due respect for European State Aid and competition rules) between promoting investment and promoting competition than some other European Member States. At the same time, it should not be forgotten that competition is often the most important spur to investment in fast and ultrafast broadband.
  - Challenges regarding demand. Concerns include a declining number of fixed lines, penetration of fixed broadband that is stalled at current levels, limited consumption of audiovisual content, an aging population, and too few personal computers.

→ All of this leads to an unsettling but seemingly inescapable conclusion: ***DAE goal #3 will not be fully achieved without substantial additional public policy intervention.***

In Chapter 4, we presented the good news; in this chapter, we present the bad.

Key concerns and challenges are heavily intertwined, and include:

- Uncertainty as to whether the deployment plans will continue to be pursued. Many previous plans have languished.
- It is unclear how to cover all of the 50% of households that are not addressed by current plans of network operators. Two million copper lines of low quality require special attention.[19]
- Heavy reliance on Telecom Italia to meet the DAE broadband objectives.
- Where cabinets and copper bundles are to be shared, the likely technology (VDSL2 with vectoring) requires coordination among network operators.
- In the absence of public policy initiatives, there is a substantial potential for inefficient and duplicative deployment of capital.
- At many different levels, there is insufficient demand in Italy at present. This takes on many forms: declining fixed lines, penetration of fixed broadband stalled at current levels, limited access to audiovisual content in the Italian language, an aging population, and too few personal computers.

[19] This is a concern inasmuch as the plans of all fixed network operators (with the exception of Metroweb) rely heavily on the exploitation of existing copper.

All of this leads to an unsettling but seemingly inescapable conclusion: ***DAE goal #3 will not be fully achieved without substantial additional public policy intervention.***

5.1. Will deployment plans continue to be pursued?

The plans of the network operators were in some sense more advanced and more credible than some of us had expected at the outset; nonetheless, they raise a number of serious issues and concerns.

- Plans to 2016 seem to have some substance. *Plans for the period 2017-2020 are exceedingly tentative.* This is perhaps not surprising or inappropriate, but it poses challenges for the government's planning efforts.
- Italy has extensive experience with seemingly plausible broadband plans that were not carried through.[20]
- A change of control at Telecom Italia potentially injects additional uncertainty into its plans.
- Although the network operators have plans, *they would ideally all choose to cover roughly the same households* (in areas of high density and high disposable income, as explained in Section 5.2).
- Largely because of this, their business plans are highly intertwined with one another, reflecting potential first-mover and second-mover effects and the concern that the business case will not support many profitable competitors accessing the same homes (the "take rate" will be too low).
- Most network operators are heavily dependent on the plans of Telecom Italia as the only realistically feasible first mover (see Section 5.3).
- The business plans of competitors are also intertwined with several open aspects of regulatory policy, including network separation and access to street cabinets (see Section 0).
- Collectively, there is the *risk of deadlock* – the operators might not move pending resolution of regulatory actions and the plans of competitors.

There is no single "silver bullet" that will solve these problems. We believe that an active programme, with support from the highest levels of government, is needed to monitor progress toward achieving DAE Objectives and to take corrective action if progress flags. This is the focus of Chapter 7 of this report, where we provide detailed recommendations that seek to address the concern.

5.2. Covering the remaining households

The plans of the network operators do not necessarily lead to the required coverage.

- Coverage of 50% of the population at speeds well in excess of 30 Mbps seems to be achievable without subsidy; however, getting beyond roughly 70% coverage, even in 2020, probably depends on significant subsidy. Some of this subsidy is already in place (e.g. MiSe), but not all.
- Although the operators have plans, the numbers are not additive. *They would ideally all choose to cover roughly the same households* (in areas of high density and high disposable income).

[20] Francesco Caio (2009), available at http://www.camera.it/temiap/file%203352.pdf.

- Only Metroweb has concrete plans for 100 Mbps coverage (and those plans are on hold for now). The plans of other network operators have the clear potential for upgrade to 100 Mbps service (e.g. by means of upgrade of DSLAMs to support vectoring and G.Fast), but no concrete funding for cabinet improvements or for driving fibre deeper into the network.
- Two million copper lines of low quality require special attention.
- *The declining number of fixed lines poses a real concern.* Telecom Italia historically assumed 24 million lines. Many of our current planning assumptions are based on 22 million lines. At the same time, many interviewees expect the number of fixed lines to decline to less than 20 million in 2020. How are these "cord cutters" to be served with 30 Mbps or 100 Mbps broadband?

In Chapter 7 of this report, we call for a comprehensive national programme, with support from the highest levels of government, to forecast the likely level of subsidy required in order to achieve DAE Objectives and to monitor progress in achieving the objectives.

Those detailed forecasts need to consider in detail the problem areas that we could only lightly touch on in this report (see Annex 3), and to revise the forecast over time as technology opens (or closes) new doors:

- For upgrades from 30 to 100 Mbps, what is the actual trend in equipment cost per port?
- How much *coverage* at 100 Mbps is needed to achieve 50% household *penetration* (see Section 5.5, which deals with the linkage to demand side factors)?
- How much aggregate subsidy is needed to serve areas of low population density and/or disposable income (see Annex 3)?
- What is the most efficient way to serve the two million households that have copper of quality too low to support VDSL2?

5.3. Limited alternatives to Telecom Italia's fixed network

All network operators are heavily dependent on the plans of the incumbent fixed network operator. This is true to some degree in all European Member States; however, the problem is exacerbated in Italy by a lack of effective alternatives, notably cable (see Section 3.1).

This means that achieving DAE Objectives depends very heavily on the fixed telecommunications network, more so than in most Member States.

There are facilities-based fixed network alternatives to the incumbent's fixed network, for instance in Milan, but they cover in aggregate only a small fraction of the population. Other technologies, notably mobile broadband and Fixed Wireless Broadband, generally serve as economic *complements* or *partial substitutes*, but are unlikely to fully substitute for the fixed telecommunications network over the period 2014-2020 (see Chapter 3). To reiterate:

- *Cable television service is non-existent in Italy.*
- *Mobile services based on forms of LTE are unlikely to be adequate*, in our judgment, to serve as a full economic substitute in the period 2014-2020 for 100 Mbps fixed broadband service, nor to serve as a full substitute for fixed broadband services at 30 Mbps in areas of moderate to high population density. Mobile service can and will serve as a substitute for 30 Mbps broadband in areas of low density.

- Fixed wireless service is small today in terms of number of subscribers, but covers a substantial fraction of the Italian territory. Policymakers should not ignore it.
- Satellite should be considered as a substitute service only for a very small percentage of users who cannot practically be reached in any other way. The latency characteristics that are inherent in geosynchronous satellites are unavoidable, and (together with limitations in bandwidth capacity) render the service unattractive where alternatives are available.

In addition, the practical reality is that achieving DAE Objectives in Italy is heavily dependent on the historic incumbent. Only Telecom Italia has the infrastructure and the resources to enable a comprehensive nationwide achievement of DAE Objectives for broadband. If Telecom Italia fails to act, other market players have only limited ability to jump in to fill the gap. Deadlock among the market players would be likely, which has largely been the case until very recently. A possible return to deadlock and delay among the market players would be likely if Telecom Italia does not continue its current, more promising fast broadband deployment trajectory (see Section 4.1).

5.4. Challenges in putting capital effectively to work

Italy is subject to a great many challenges in putting capital effectively to work. Investment tends to be subject to deadlock, and duplication of investment is widespread.

This has many manifestations, and many opportunities for improvement:

- Locked-up investment in the case of Metroweb;
- The tendency of all operators to invest in covering the same 50% of the population;
- VDSL-specific challenges, including both street cabinet sharing, and coordination of lines where vectoring is deployed;
- Facilities sharing in the mobile network;
- Opportunities to use infrastructure from other network industries (e.g. electricity, water).

Some of these are challenges for the industry, while others are challenges for the National Regulatory Authority (NRA).

In each case, the status quo is not unambiguously bad. Metroweb's determination not to invest, for example, is a legitimate business decision, but with the consequence that capital is sitting idle. Much of the duplication of infrastructure tends to be positive for infrastructure-based competition, at the same time that it is negative for investment.

Italy may wish to strike a different balance (with due respect for European State Aid and competition rules) between promoting investment and promoting competition than some other Member States. At the same time, it should not be forgotten that competition is often the most important spur to investment in fast and ultrafast broadband.

No single solution is likely to magically unlock investment, but a combination of carefully crafted initiatives might help to unlock investment that to date has often been stalled. A more muscular policy on the part of the Italian government might well be called for, especially in the event that investment were to stall once again.

5.4.1. Capital that is locked up

FTTCab plans started by Telecom Italia and Fastweb in 2012-2013 resulted in the freezing of Metroweb plans aiming at massive rollouts of FTTP, based on firm funding of € 200 million. Metroweb plans assumed a roll-out of passive fibre infrastructure to the home (including fibre vertical cabling), making it available to serve the plans of telecoms operators willing to roll out ultrafast broadband services. Deployment by all three operators would have been unprofitable. Consequently, Metroweb froze their plans.

From the viewpoint of economics, the change of plans is not per se a market defect. It is normal for businesses to change plans as circumstances change, and in the Hayekian view it is appropriate that investment flows to the apparently more cost-effective technology. What is unfortunate is that the investment capital appears to be bottled up, rather than being re-applied.

5.4.2. The tendency to invest in covering the same areas

In competition law and economics, one tends to have great concern about any geographic partitioning of the territory. In terms of the build-out of fast and ultrafast broadband, European State Aid rules already recognise that parts of national territory are unlikely to sustain more than one network in any case.

With that in mind, coordination (as is done by for instance Telecom Italia and Fastweb) would appear to be positive and welfare-enhancing overall.

The network separation discussion that Italy has experienced over the past year is in some ways a manifestation of the same considerations. Experience in countries such as Sweden suggests that a carrier-neutral municipal network, available to all service providers, can provide a practical means of avoiding duplicate investment and assuring non-discriminatory access to network services at wholesale level.

There is, however, no "silver bullet", no panacea. Recent experience in New Zealand and Singapore demonstrates that structural separation can lead to its own problems.

5.4.3. Striking the right balance in order to avoid duplicative or inefficient use of capital

To what extent should infrastructure be duplicated?

The network plays a strategic role in the development of the country. Faced with a gap between the plans and announced investments of network operators in comparison with that which is needed, and thus with delay that impacts Italy's competitiveness in comparison with other countries, the government should consider actively encouraging investment.

Public / Private Partnerships (PPPs) should be considered, as well as means of promoting infrastructure sharing. Both look to lower effective unit costs for private investors, and thus to accelerate upgrades to speed and to geographic coverage.

Some forms of voluntary infrastructure sharing can harm competition, especially since infrastructure sharing inherently entails some degree of sharing of plans among commercial parties that ideally would be aggressively competing with one another. General public policy considerations thus argue somewhat against infrastructure sharing; however, duplication of infrastructure is wasteful. Thus, there is often a trade-off to be made.

Given the importance of investment at this juncture, a somewhat more permissive attitude toward infrastructure sharing would appear to be in order, as long as there is no clear risk of significant competitive harm.
Infrastructure sharing can also come about, in effect, as a result of a regulatory mandate (e.g. a procompetitive SMP remedy to make infrastructure available at cost-based prices and/or on a non-discriminatory basis). Here, the trade-offs entail static versus dynamic efficiency over time.

These trade-offs manifest in multiple ways in regard to the deployment of fast broadband in Italy.

- Should competing network operators be permitted to share the same cabinet, or must a second operator build its own (unsightly) cabinet adjacent to that of the incumbent (see Section 5.4.4.1)?
- To what extent should public policy encourage multiple network operators to share the same DSLAM (e.g. via bitstream access) (see Section 5.4.4.2)?
- To what extent might sharing of mobile masts or spectrum be cost-effective (see Section 5.4.5)?
- To what extent should network operators be able to capitalise on infrastructure deployed for unrelated purposes (power, water, sewage) (see Section 5.4.6)?

Inability to share can lead to (needless) duplication of investment. Simple arithmetic makes clear that three operators, each deploying its own DSLAM to a street cabinet, will in many cases collectively invest more than it would have cost a single operator to deploy a more efficient and more capable *Fibre to the Premises (FTTP)* solution.

The actual wisdom of sharing infrastructure, however, is highly subject to specific circumstances. Some forms of sharing entail high *transaction costs* among the sharing parties.

Recommendation 8. Avoid imposing needless roadblocks on infrastructure sharing.

Where commercial parties wish to share infrastructure, policymakers should be careful not to impose needless roadblocks; however, competitive aspects will usually need to be carefully examined.

5.4.4. Sharing concerns that are specific to VDSL2

Two noteworthy challenges have emerged in regard to the deployment of FTTCab/VDSL technology. One relates to the sharing of the street cabinet itself, the other to the possible sharing of lines with a single binder (which poses challenges in regard to noise cancellation with vectoring.

5.4.4.1. Sharing the street cabinet

The implementation of multi-operator FTTCab infrastructure roll-outs, particularly the possibility to share cabinets hosting the VDSL2 equipment of more than one player, continues to be a bone of contention among the network operators. AGCOM recently imposed an obligation on the incumbent to host equipment of other operators. AGCOM is working to finalize the rules and conditions to implement multi-operator cabinet sharing; however, the physical space for the deployment of cabinets is inherently limited (especially for roll-outs not designed with multi-operator sharing in mind), and delays and barriers due to anti-competitive behaviours cannot be

excluded based on previous experience. Moreover, where the sharing of existing Cabinets would not be applicable, the deployment of new cabinets will necessarily be needed, with potential problems due to environmental impact and variable local authorities permit policies.

We make no recommendation at this time, since we anticipate that AGCOM is on the verge of publishing its decision.

5.4.4.2. Sharing lines within the VDSL2 binder

As we explain in greater detail in Annex 2, the ability of VDSL2 to deliver the 100 Mbps speeds called for in DAE Objective 3 is heavily dependent on cross-talk among copper pairs in a binder. Vectoring technology has been developed to reduce cross-talk.

For cross-talk cancellation to be effective, all lines in the binder must be monitored and controlled. Any uncontrolled VDSL2 line (i.e. an *alien line*) results in crosstalk that cannot be suppressed, reducing vectoring gain. The more alien lines there are in a cable, the lower the gain. Thus, in a multi-operator scenario where the lines in the same binder could belong to different operators and could be terminated on different nodes, the gains of vectoring can only be preserved through effective coordination and orchestration of the usage of pairs among the network operators that share the use of the copper wires in a binder.

This implies the need for some solution, typically a regulatory solution. Different solutions have been attempted in different Member States. Sometimes, the approach has been to rely on virtual solutions (such as *bitstream* or *Virtual Unbundled Local Access (VULA)* solutions) where all copper pairs within a bundle are managed by a single network operator.

AGCOM is in the midst of finalising a decision that apparently addresses this very issue. It is not the government's role to tell AGCOM how to regulate; however, we note here that a solution is needed. As noted in Section 4.2 and in Annex 2, coordination and orchestration among the operators who share the use of the copper wires in a binder is required if the benefits of vectoring are to be preserved. The issues of concurrent delivery of different generations of copper broadband access technologies in pairs bundled in the same binder should be carefully considered.

We make no recommendation at this time, since we anticipate that AGCOM is on the verge of publishing its decision.

5.4.5. The mobile network

The mobile network also provides opportunities for constructive sharing, notably of spectrum and of masts.

The recent auction of spectrum (including the 800 MHz band) for LTE appears to contain positive elements. The coverage obligations for municipalities of 3,000 persons or less were divided among five winners, so that each was obliged to care for 900 of the municipalities (with permission to make trades among themselves). This avoids needless and wasteful duplication.

Masts also provide a good opportunity for sharing. In the United States, for instance, masts are typically provided by neutral third parties to all network operators.

5.4.6. Use of infrastructure from other network industries

The European Commission proposed a new set of measures in the form of a Regulation[21] in 2013 that would empower network operators to ask providers of other network infrastructures (including electric power, water, and more) to make a reasonable commercial offer for the use of their facilities. An appeal can be taken to the National Regulatory Authority (NRA) if the network operator receives no response, or is unhappy with the response. These seemingly quite sensible proposals are under consideration by the European Parliament; moreover, a number of Member States have implemented similar measures at national level. Our feeling is that Italy could benefit from aggressive support of the Regulation (which in any case does not depend on transposition into national law).

Recommendation 9. Pay close attention to the proposed EU Regulation to facilitate cross-sector infrastructure sharing.

Italy should pay close attention to the proposed Regulation to reduce the cost of deploying high-speed electronic communications networks. If the Regulation is not promptly enacted, Italy could consider enacting similar measures at national level.

5.5. Challenges regarding demand

Italy is subject to a number of demographic factors that limit take-up of fast broadband. This is important for multiple reasons:

- Limits to expected adoption also limit the incentives of network operators to deploy.
- Societal benefits flow from adoption and use of the networks. Deployment alone is of little value.
- DAE broadband objective #3 calls for adoption of 100 Mbps broadband by 50% of all Europeans. *If there is insufficient demand, the target will not be met, even if network deployment proceeds as is hoped.* Policy interventions are likely needed.

5.5.1. An aging population, with limited access to a personal computer

Only 68% of Italian households have a computer. This is rather low for a Western European country, and means that a key antecedent for broadband Internet access is weak. Consistent with other European countries, households with three or more people are far more likely to have a computer than those with only one or two, and those in large towns are more likely to have a computer than those in rural areas (72% versus 53%).[22]

Italy has a relatively old population, with small families. Italy is one of only two European Member States where more than 20% of the population is more than 65 years of age.[23] Large, young families are much more likely to take up Internet service (including broadband) than older smaller families.

[21] European Commission (2013), Regulation of the European Parliament and of the Council on measures to reduce the cost of deploying high-speed electronic communications networks.

[22] TNS Opinion & Social (2013), E-Communications Household Survey (November 2013), special Eurobarometer 396. survey conducted for the European Commission, field work February-March 2013.

[23] Konstantinos GIANNAKOURIS (2008), "Ageing characterises the demographic perspectives of the European societies", eurostat 72/2008.

Table 3. Internet adoption as a function of age (November 2012).

	The ageing society		
	55-64	65-74	75+
EU27	59%	38%	17%
EU15	64%	43%	18%
NMS12	39%	19%	11%

Source: TNS Opinion & Social, E-Communications Household Survey (November 2013), special Eurobarometer 396.[24]

There are various reasons why Italians do not already have Internet access at home. According to recent survey data, 66% of those say that it is because no one in the household is interested in the Internet. Less than 7% consider the cost of Internet access, even together with the cost of a personal computer or with the cost of initial installation, to be the main reason, and only 2% attribute their lack of connection to being in an area not served by broadband. Interestingly, 4% say that they do not subscribe because they are not sure what the Internet is. Collectively, these data suggest that neither price nor availability of broadband is a substantial impediment – the largest impediment is that no family member recognises sufficient value in having Internet access at home.

There are actions available to the Italian government to help educate Italian consumers, including the elderly and the disadvantaged, as to the benefits of the digital economy. The digital literacy programme that RAI is developing pursuant to its licence obligations is expected to provide a good example. A number of other candidate actions are likely to have more to do with the education system than with traditional telecommunications regulation; consequently, there would appear to be a need for "joining up" different policy strands across education, media policy, and telecommunications policy. This is an area where further study would appear to be warranted.

Recommendation 10. Measures are required to promote digital literacy.

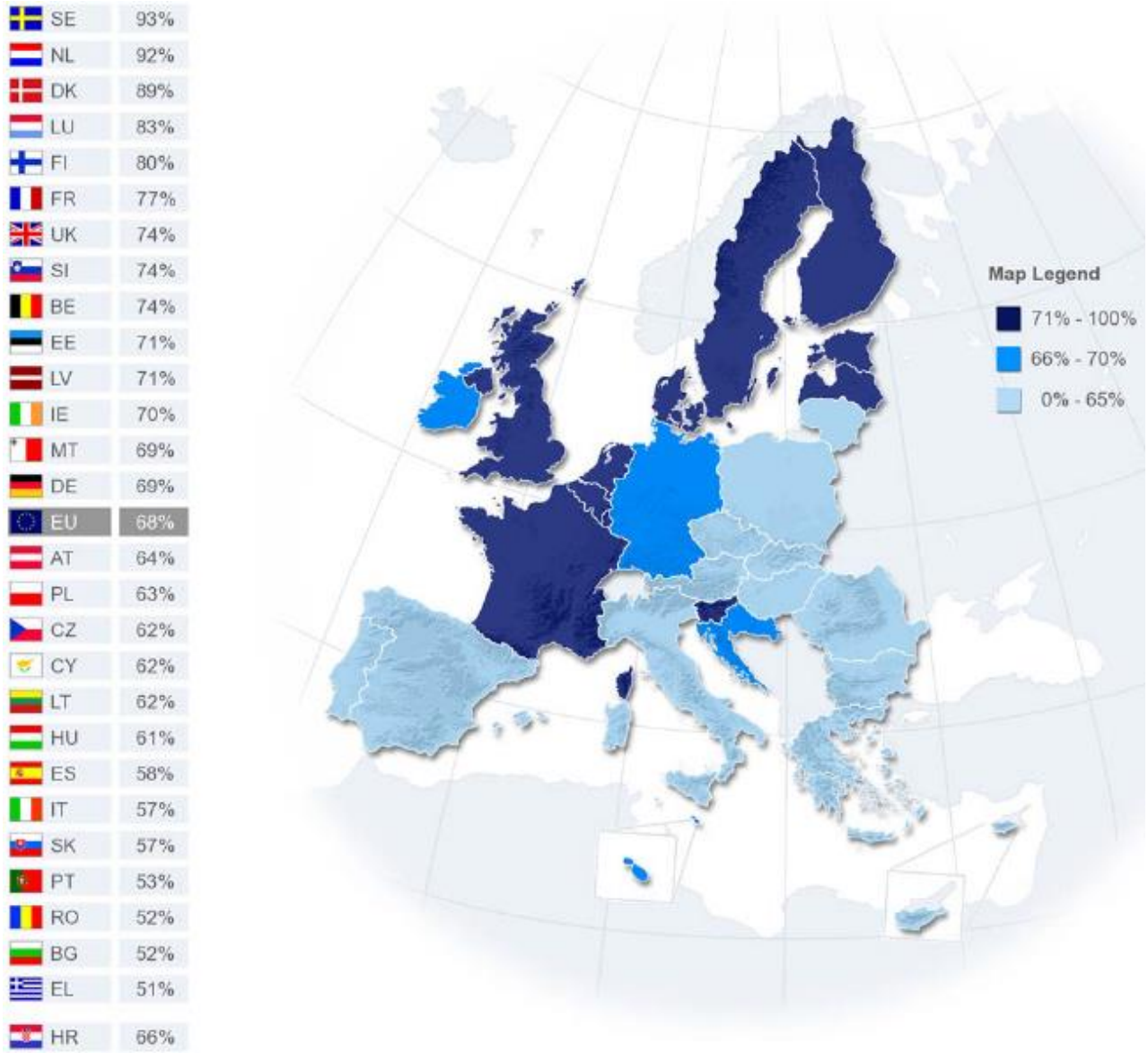
In light of (1) the somewhat lower-than-average tendency for Italians who possess a computer to also have an Internet connection at home, together with (2) the fact that Italy has more elderly citizens than most Member States (who are less likely to subscribe to Internet services), combined again with (3) a low propensity to consumer online audiovisual services, measures to promote digital literacy could have particularly great impact in Italy.

[24] Op. cit.

5.5.2. Internet penetration

Eurostat survey data clearly show that Internet penetration in Italy is among the lowest in the EU. This is consistent with subscription data maintained by the European Commission's DG Connect. Overall Internet subscription (including dial-up, mobile broadband) is an important driver for fast broadband.

Figure 10. Percentage of households with an Internet connection (as of March 2013).



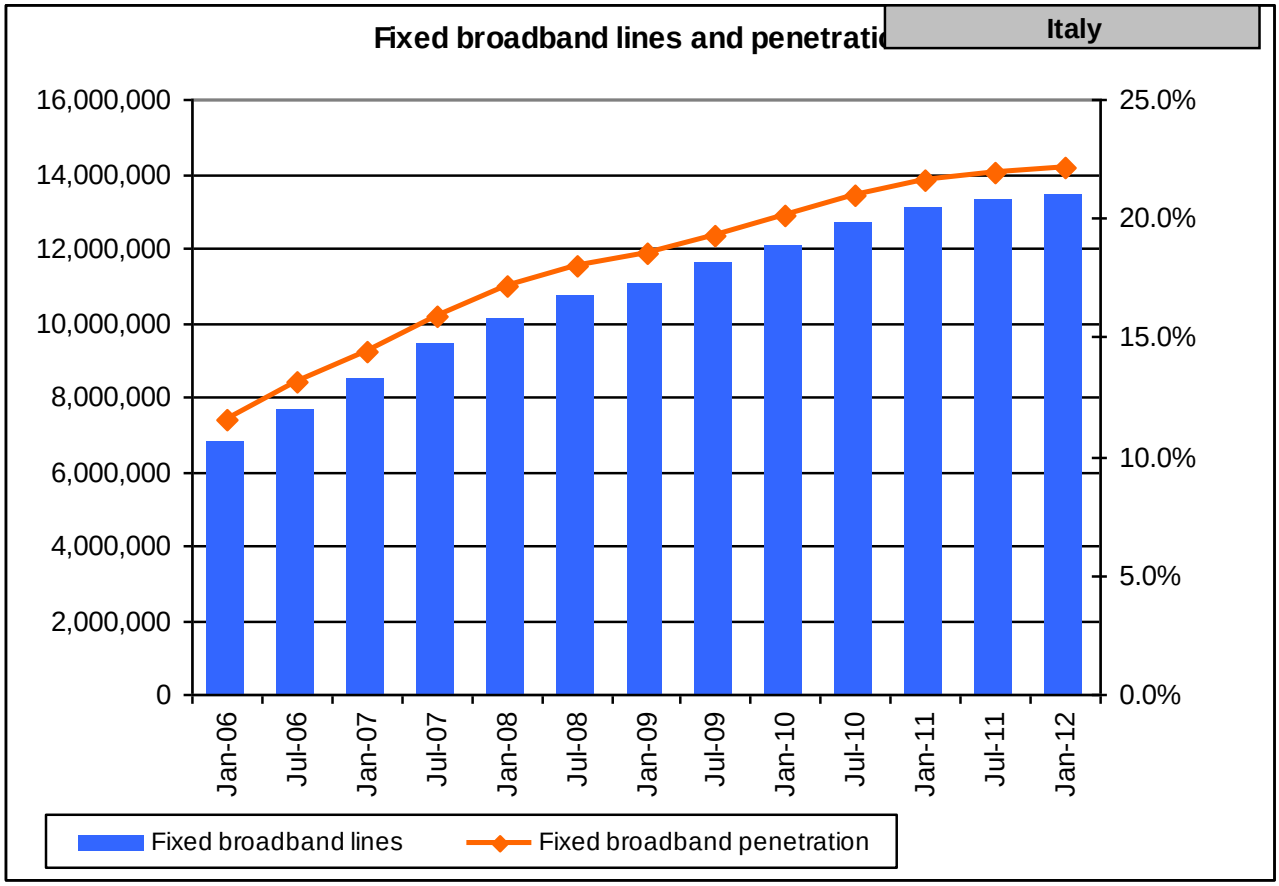
Source: TNS Opinion & Social, E-Communications Household Survey (November 2013), special Eurobarometer 396.[25]

[25] Op. cit.

5.5.3. Fixed broadband penetration

Fixed broadband penetration is some 14,000,000 lines; however, the growth of penetration is visibly flattening out over time (which is not unexpected in principle, but the degree to which it is happening is striking).

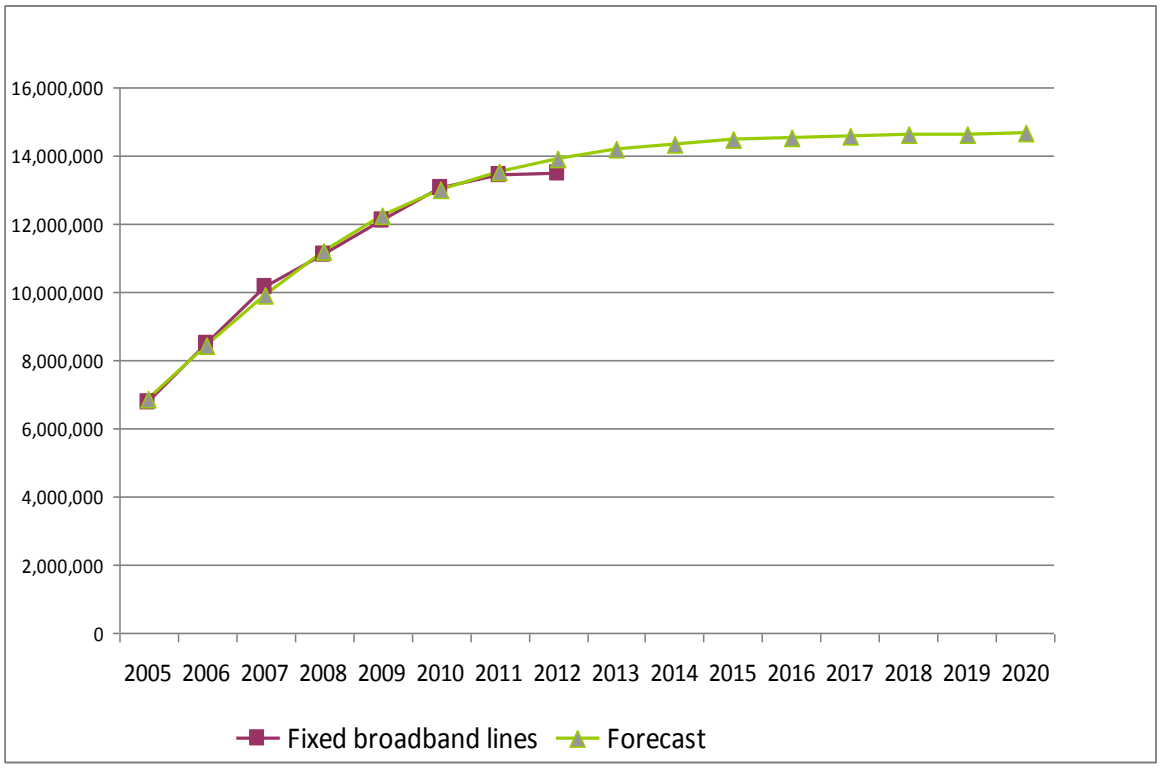
Figure 11. Fixed broadband lines and penetration in Italy.



Source: European Commission, DAE Scoreboard Online Country Charts (viewed December 2013).

Most technological adoption is felt to follow an "s-shaped" pattern referred to as a logistics curve. A simple extrapolation of the above data using a logistics curve yields a troubling tendency for adoption to level off at some 14.6 million households, well short of the 24.6 million Italian households.

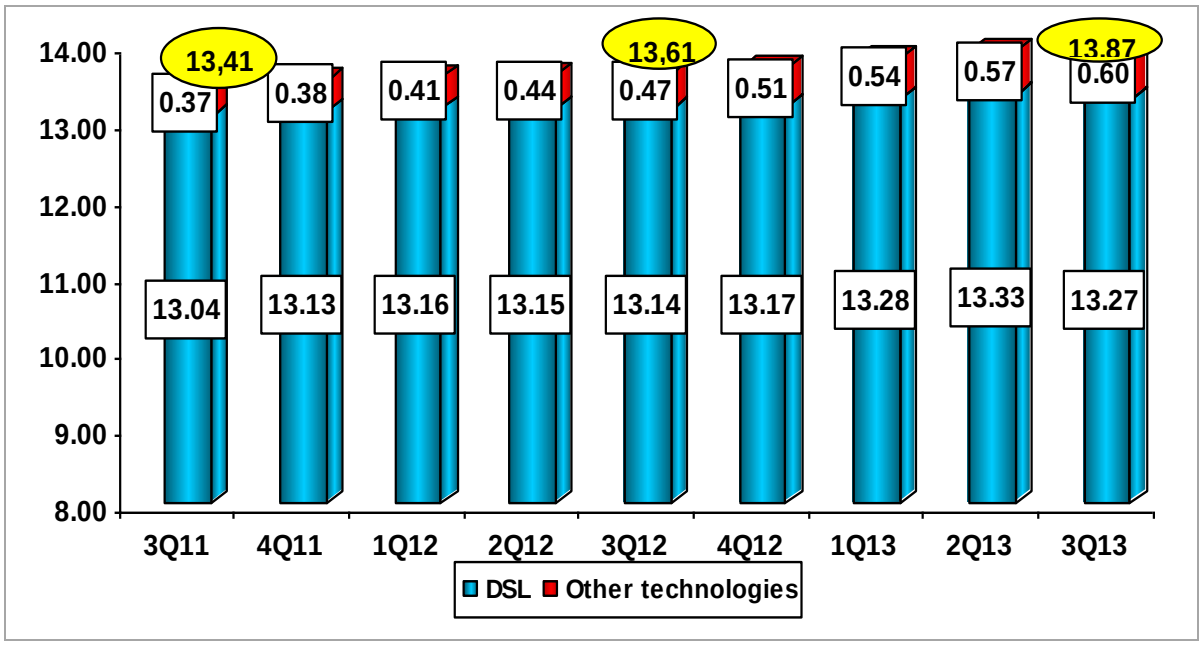
Figure 12. Projected fixed broadband adoption in Italy to 2020.



Sources: DAE Scoreboard for figures to 2012, WIK forecast

AGCOM, the Italian NRA, recently released a new *Osservatorio Trimestrale*, which includes fixed network and fixed broadband penetration data. The new data shows a worrisome levelling off of broadband penetration, as well as a distinct decline in levels of fixed penetration. If anything, the AGCOM actual data through 2013 are even less encouraging than the logistics curve projection based on the Commission's data through 2012. The *Compound Annual Growth Rate (CAGR)* of broadband subscriptions from 3Q2011 to 3Q2013 is a tepid 1.7%.

Figure 13. Broadband subscriptions in Italy (3Q2011-3Q2013).

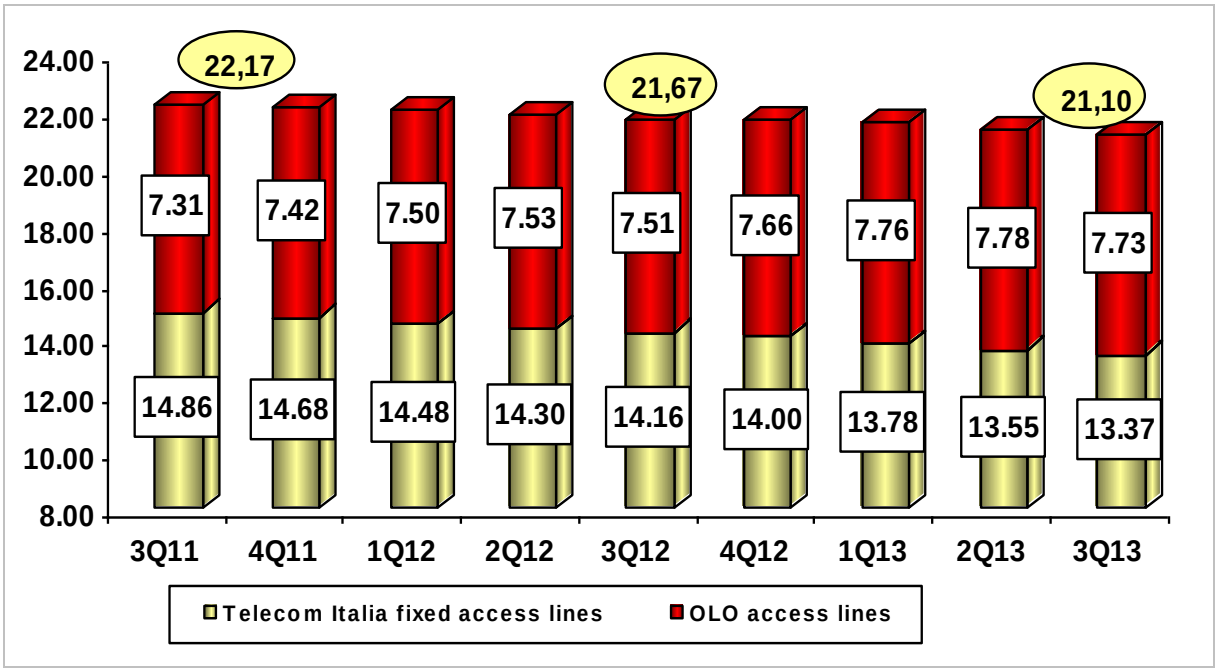


Source: AGCOM

5.5.4. Overall fixed lines

Meanwhile, the same AGCOM data show a decline in the number of fixed lines. Historically, nearly all Italian homes were connected to the fixed network. Today, of 24.6 million Italian households, only 21.1 million have fixed network connections, and the number is continuing to decline (see Figure 14). A simple extrapolation of the present trend implies that more and more Italians will "cut the cord", leading to a total of just under 18 million fixed lines in service by 2020.

Figure 14. Fixed access lines in Italy (3Q2011 - 3Q2013).



Source: AGCOM

Of course, the decline in fixed lines is a common phenomenon among European Member States, and the flattening of demand for broadband subscriptions is not surprising. Neither is a law of nature; rather, they reflect weakness in consumer demand, and an apparent perception that ultrafast broadband has only limited practical utility. If a greater percentage of Italian consumers were to perceive greater utility in ultrafast broadband connections (that are difficult to realise without a fixed network connection) than the percentage that does today, then it would be likely that more consumers would retain a fixed network connection, and more would subscribe to ultrafast fixed broadband.

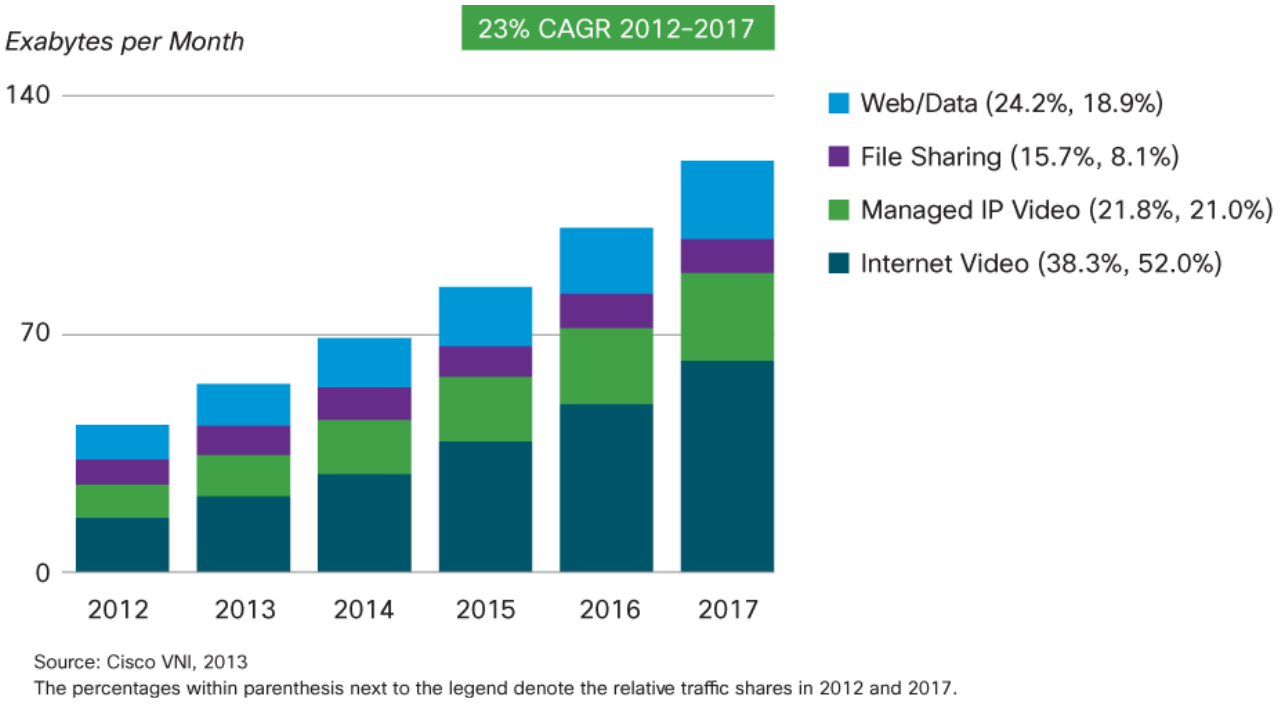
5.5.5. Media

Italy has, to say the least, a unique media environment as a result of its historical evolution over the past twenty years. More recently, however, there are positive signs emerging in regard to catch-up video (see Section 4.3), suggesting that one aspect of this concern may be on the mend.

The absence of cable, over-emphasis compared to other Member States on over-the-air content, and deficits in terms of media pluralism have all served to undermine the evolution of high quality audiovisual services over the Internet.

This poses significant challenges in regard to broadband adoption. Throughout the world, audiovisual media are the largest driver of broadband traffic, and thus of demand for fast broadband services, as shown in Figure 15.

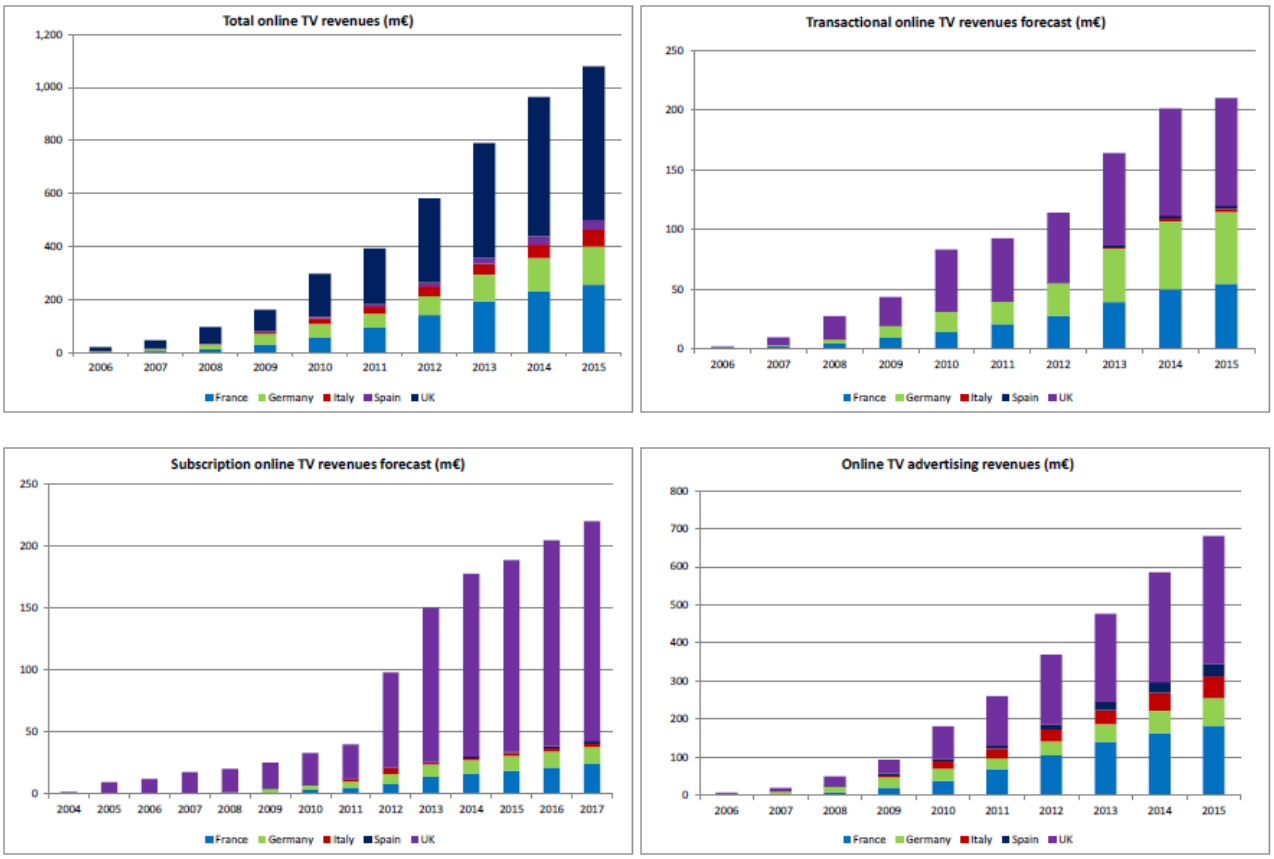
Figure 15. Predicted Internet traffic (2012-2017).



Source: Cisco VNI (2013).

Some interviews suggest that the availability of content in the Italian language to Over-the-Top providers (OTTs) is limited, thus posing an impediment to consumer demand. For many aspects of online video, revenues in Italy are negligible, while other Member States steam ahead.

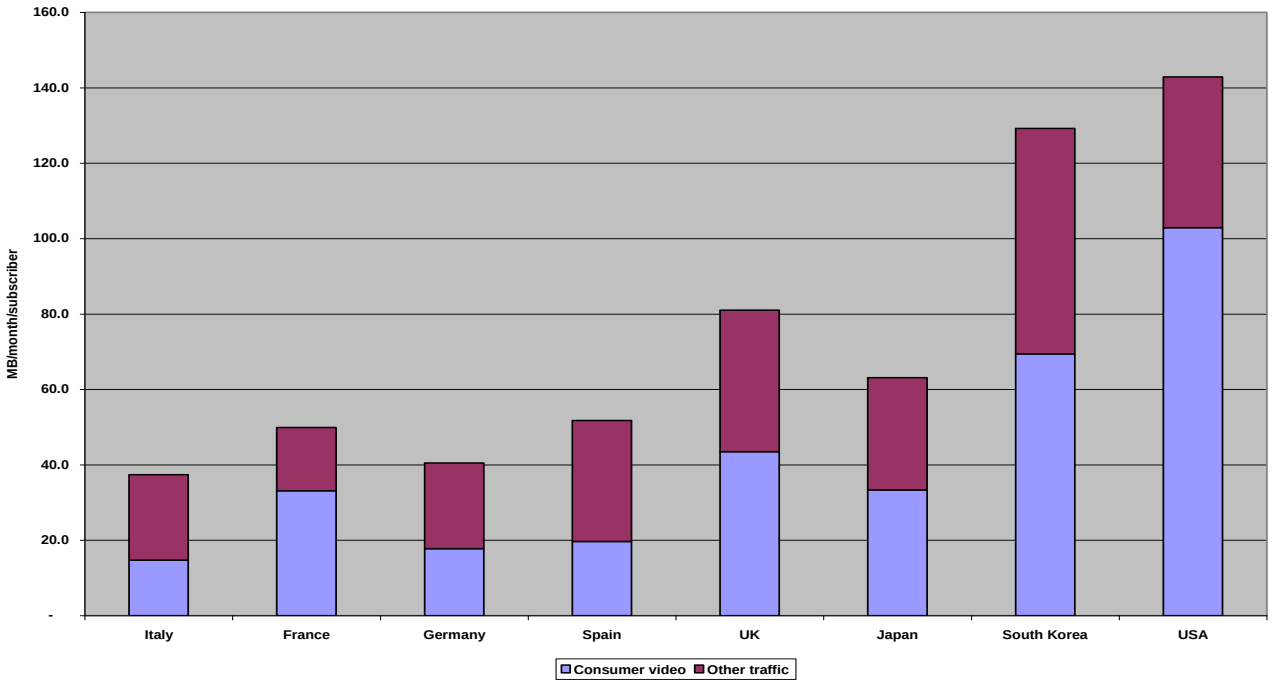
Figure 16. Online video revenues.



Source: HIS Screen Digest (reported in European Commission (2013), DAE Scoreboard 2013).

Based on Cisco VNI traffic estimates and projections, it is clear that bandwidth consumption in Italy is lower in Italy than in other "big five" EU Member States, and also lower than many global competitors including Japan, South Korea, and the United States. Consumer video bandwidth consumption (the light blue portion of each column in Figure 17) clearly makes a large contribution to this deficit.

Figure 17. Bandwidth consumption per household, Italy and selected countries (2012).



Source: Cisco VNI online data (2013), WIK calculations

Actual speed delivered through the network (which can differ from the raw access speed) is also conspicuously lower in Italy than in other "big five" EU Member States, and much lower than global comparator countries (see Figure 5).

Is this a cause of the low video consumption, or an effect (network operators do not build capacity due to lack of demand), or both? Delivered speed does not correlate perfectly with delivered bandwidth. Some countries (notably Japan) provide high bandwidth, and yet bandwidth consumption (including video consumption) does not appear to be high; however, it is fair to say that where bandwidth availability is low, bandwidth consumption cannot be high. The causality may flow in both directions in Italy: low video consumption undermines the incentives of network operators to deploy greater bandwidth, at the same time that limited bandwidth availability limits the ability of consumers to avail themselves of audiovisual content over the Internet.

Our Terms of Reference for this short study focus primarily on the *supply* of broadband, not on the *demand* for it; nonetheless, we would be remiss were we not to point out that DAE Objectives are not likely to be achieved in Italy, nor to bring the desired benefits even if they were achieved, unless complementary initiatives to increase Italian consumption of online linear, on-demand and interactive media are also implemented and effective.

Recommendation 11. Assess the causes of low consumption of audiovisual content over the Internet in Italy.

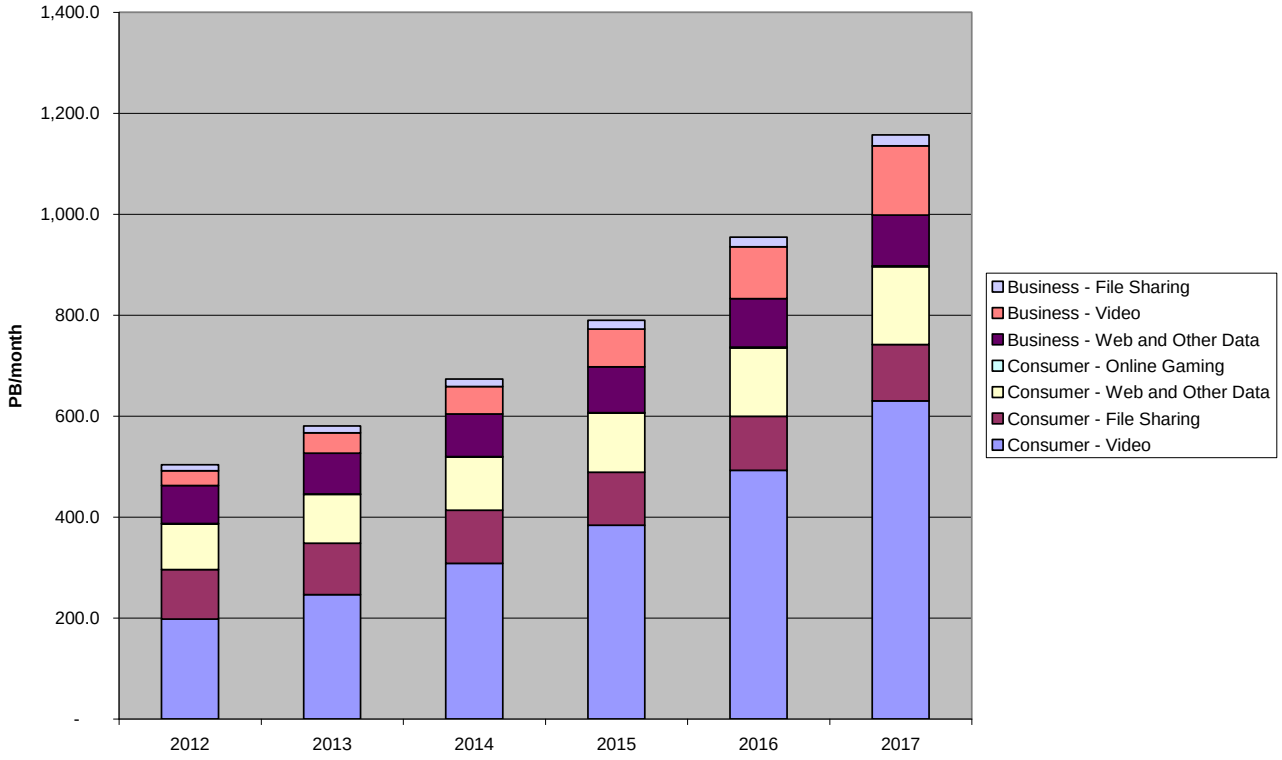
Low consumption of audiovisual services is a concern that warrants detailed analysis. Ongoing study of the Italian media environment is called for. Public policy initiatives to promote the ability of market players to offer both linear and interactive online media may be required.

5.5.6. Internet traffic

The Cisco VNI provides a good overall source of traffic estimates and forecasts. Their projections of Italian consumer and business fixed Internet traffic going forward are generally plausible.

Note that the great majority of traffic today is fixed network traffic. The majority of that traffic is video; however, as noted in Section 5.5.5, consumption of audiovisual media in Italy significantly lags that of many other European Member States. In that section, we present a 2012 comparison of Italy to other EU Member States and to global competitors. In Figure 18, we provide Cisco's Italy-specific forecast of the evolution of bandwidth demand over time.

Figure 18. Predicted evolution of bandwidth demand in Italy over time.



Source: Cisco VNI online database, WIK calculations

5.5.7. Overall assessment of demand factors

These trends have troubling implications as regards meeting the third of the DAE Objectives (adoption of 100 Mbps broadband service by at least 50% of households by 2020). To meet DAE Objective 3, there must be some 12.3 million 100 Mbps subscriptions to distinct permanent households in 2020 (i.e. half of the 24.6 million households).

It is unlikely that wireless services will be delivering 100 Mbps services in 2020; consequently, the 12.3 million subscriptions would represent more than two thirds of the 18 million fixed subscriptions that would then exist.

Moreover, if only 14.6 million fixed broadband subscriptions are active, as we project, this means that *84% of all fixed broadband subscriptions must be capable of supporting 100 Mbps*. This seems highly unlikely.

All of this implies that, no matter what happens with deployment of fixed broadband infrastructure, *achievement of the third DAE objective in Italy is unlikely unless consumer demand changes in its level and its character*. This might happen spontaneously over time if either a "killer application" were to emerge, or simply because consumers develop a better understanding over time of the benefits that derive from subscription to ultrafast broadband; alternatively, it might be possible for policymakers to promote an appreciation of the benefits of ultrafast broadband by means of a conscious programme to educate consumers and to inculcate digital literacy. In any event, the clear implication is that *the demand side cannot be ignored*.

Recommendation 12. Monitor the decline in fixed network connections and consider whether anything can be done to reverse it.

The marked tendency of Italians to "cut the cord" to the fixed network requires steadfast attention going forward. It is difficult to see how any programme to meet the DAE Objectives could succeed unless this tendency is reversed.

6. Prospects for achieving the DAE broadband objectives

Key Findings

- **DAE Objective 1**: Italy had 98.4% fixed basic broadband coverage as of the end of 2012. This is above average among EU Member States. It is reasonable to assume that the remainder can be covered by Fixed Wireless Broadband (FWB), mobile services, and satellite, and to claim that DAE Objective 1 has for the most part been met.
- **DAE Objective 2**: There are numerous challenges. Coverage of substantially the full Italian population at 30 Mbps will require forms of public funding.
  - Network operators have presented credible plans that could result in 50% or more of households being able to access 30 Mbps or more download speeds by 2016-17.
  - Coverage to additional households depends, however, on forms of public subsidy and/or Public-Private Partnerships (PPPs).
  - Estimates of the expenditure required to reach 100% coverage vary greatly. A detailed cost modelling effort is needed.
  - The expenditure required (even in the higher estimates) could be within the range of EU structural funds that Italy could allocate to the development of this essential digital infrastructure.
- **DAE Objective 3**: Italy's prospects are uncertain at best.
  - There is very little visibility into network operator plans that would provide 100 Mbps.
  - Given that Italy benefits from a short average copper sub-loop length of just 300 meters, it is likely that many FTTCab lines could deliver speed substantially in excess of those achieved in other countries. Whether they will fully reach 100 Mbps is uncertain.
  - Prospects for achieving DAE Objective 3 are dismal unless a number of key demand trends can be reversed.
  - Our preliminary feeling is that FTTCab deployments, with an upgrade to G.Fast in the last three years of this decade, represents a pragmatic solution for much of Italy. It is likely that more than one technology will exist in Italy in any case.
  - There are large cost uncertainties in achieving adoption by 50% of households.
- **Infrastructure sharing**: The degree to which infrastructure sharing can be achieved plays a key role in all scenarios, and may influence which scenario is chosen.
- **Cost modelling**: A serious cost modelling effort is in order, and it needs to be joined up with the planning and monitoring activities that we have proposed.

In this section, we provide an overall assessment of the likelihood that the DAE broadband objectives will in fact be achieved. (For a discussion of associated costs, see Annex 3). We begin by noting key risks and opportunities in achieving coverage penetration, and then discuss the three DAE broadband objectives in turn.

6.1. Achievement of DAE Objective 1: full coverage with basic broadband in 2013

Italy had 98.4% fixed basic broadband coverage as of the end of 2012.[26] This is above average among EU Member States.

It is reasonable to assume that the remainder can be covered by Fixed Wireless Broadband (FWB), mobile services, and satellite, and to claim that this DAE Objective has for the most part been met.

Having said this, it is important to bear in mind that *Digital Agenda Objective 1 does not clearly specify a minimum speed that must be achieved.* For most purposes, including the DAE Scoreboard and the Point Topic broadband coverage reports, the Commission has interpreted basic broadband as representing any broadband at speeds in excess of 144 Kbps (i.e. faster than ISDN).[27]

As previously noted, there are some two million lines in Italy that have serious problems.

- Some are simply too long.
- Some have one or another outdoor equipment problem.
- Some are limited to 640 Kbps, which fails to meet most expectations today even if it nominally comply with DAE Objective 1.

According to AGCOM statistics, there are currently only 270,000 subscribers to FWB services; however, 45% of the Italian population has FWB coverage. The coverage is what is relevant here, not the number of subscriptions. Thus, FWB likely plays a large role in providing the option of coverage to consumers who could not readily be served over the copper-based fixed network.

A 2011 study by the European Investment Bank estimated a coverage gap of some 1.5 million households for DAE Objective 1.[28] We estimate a cost of some € 264 million to cover them, using ADSL2 in urban and suburban areas, and LTE or FWB in rural areas (see Annex 3); however, we have not interpreted this to mean that additional funding is required. First, some of these households may have been covered since 2011, when the EIB analysis was conducted; second, the cost of coverage is probably already addressed through existing programmes, notably MiSe.

6.2. Achievement of DAE Objective 2: full coverage with 30 Mbps broadband by 2020

Over the next two to three years, Italians residents and businesses in the larger cities should benefit from an increase in available bandwidth as operators deploy FTTCab networks, assuming that network operators carry through with their plans. The roll out plans that we have analysed are consistent with the investments that operators have in their plans and should result in 50% or more of households (or lines) being able to access 30 Mbps or more download speeds by 2016-17. Furthermore, given the specific layout of the Italian access network (with an average sub-loop length of some 300 meters), it is likely that many lines could deliver substantially better performance.

[26] Point Topic (2013).
[27] European Parliament (2013), Entertainment x.0 to Boost Broadband Deployment.
[28] EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets".

Coverage of an additional 40% or so of the population should be possible with the application of structural funds.

The imbalance between the operators' plans for high-density areas and their lack of plans for low-density areas is a matter of significant concern.

Roughly two million lines (call it 8%) have quality problems that make them unsuitable for FTTCab. Some of these locations can be served using wireless / mobile services; others, however, may need other measures. Assessing what to do with these "problem children" lines is challenging.

Declining subscription to the fixed network also raises challenges, as previously noted.

Wireless LTE coverage is likely to contribute to meeting this objective, and not only for lines with quality problems.

DAE Objective #2 should be achievable at reasonable cost, assuming proper monitoring and follow-through on the part of the responsible public institutions. The spread among estimates by knowledgeable experts is, however, enormous (see Table 4).

The previously noted EIB (2011) study provided a range of estimates, depending for instance on whether DAE Objectives were interpreted as being advertised speeds versus guaranteed speeds, and whether guaranteed in both directions or only downstream. They found a cost of € 10.2 billion to achieve advertised speeds of 30 Mbps for all Italian households, versus a cost of € 14.0 billion to achieve 30 Mbps guaranteed in the downstream direction only. Note, however, that these estimates did not take the use of vectoring technology into account.

Following the logic of the EIB (2011) study, we come up with a very rough cost estimate of € 9.2 billion to achieve DAE Objective 2 for 100% of households in Italy (see Annex 3). By contrast, Infratel has estimated the need for € 4.2 billion to achieve FTTCab coverage of 95% of population, which might prove to be adequate (given that many of the 5% remaining could be covered using LTE or Fixed Wireless Broadband). Meanwhile, Point Topic estimates € 12.2 billion to achieve DAE Objective 2 in Italy: € 2.4 billion urban, € 3.1 billion suburban, and € 6.7 rural.[29]

The estimates provided by Italian operators committed to FTTCab (see Section 4.1) and that of Infratel may appear at first blush to be rather low in comparison with the EIB and Point Topic estimates; a rigorous comparison, however, would be difficult. The estimates are not necessarily measuring the same thing.

- The committed plans of the network operators reflect CAPEX costs for coverage the 50% of the Italian population where costs are lowest.
- There is greater uncertainty in the CAPEX cost estimates of the network operators (and Infratel) for the second, more expensive 50% of the population.
- Some estimates are per household passed, others are per connected household. For FTTCab, there is a difference.
- The international estimates are based in part on overall European characteristics that are not fully adjusted to reflect Italian circumstances.

[29] Point Topic (2013), *Europe's broadband investment needs: Quantifying the investment needed to deliver superfast broadband to Europe*.

Table 4. CAPEX required to achieve 30 Mbps coverage.

Source of estimate	Coverage	CAPEX needed (€ billion)
Infratel	95% of population	€ 4.2
WIK (2014)	100% of households	€ 9.2
Point Topic (2013)	100% of households	€ 12.2
EIB (2011)	100% of households	€ 10.2 to € 14.0

Source: WIK

The expenditure required (even in the higher estimates) could be within the range of EU structural funds that Italy could allocate to the development of this essential digital infrastructure.

Interestingly, Point Topic identifies Italy as a country with an enormous opportunity to profitably deploy fast broadband in urban areas. Far less fast broadband has been deployed in Italy's cities than in most Member States, even though the deployment should in principle be profitable. At the same time, the cost of doing so is appreciable.

Table 5. EU cities with the greatest broadband investment needs (€ million)

City	Urban investment needed (€m)
Athens, GR	**210**
Rome, IT	**189**
Naples, IT	**157**
Barcelona, ES	**131**
Turin, IT	**98**
Milan, IT	**97**
Madrid, ES	**60**
Lille, FR	**58**
Bari, IT	**58**
Salonika, GR	**58**

Source: Point Topic (2013), *Europe's broadband investment needs*.

6.3. Achievement of DAE Objective 3: adoption of 100 Mbps broadband by 2020

As of today, there is little or no visibility of what happens after 2017. No firm plans are in place to extend FTTCab much beyond the coverage of the top cities, nor for upgrades above the capabilities of FTTCab/VDSL with vectoring (apparently not more than 80-90 Mbps under even the best of circumstances).

As things stand, FTTCab will be the only deployment that will contribute to the upgrade of available (fixed) bandwidth in Italy for the foreseeable future. FTTCab offers less bandwidth than FTTP or FTTH; however, if FTTCab is upgraded to incorporate vectoring in the near term and G.Fast technology to the cabinet or distribution point (beginning circa 2017), FTTCab solutions might well be adequate to achieve the 100 Mbps DAE objective.

Italy's short sub-loop lengths are a very favourable case for FTTCab solutions; however, a careful analysis will be needed, because the speed of vectoring and of G.Fast is heavily dependent on the quality and length of the sub-loop.

The degree to which infrastructure is shared could have a strong influence both on the choice of technology between FTTCab/VDSL2 versus FTTP/FTTH, and on deployment details within each technology.

It is not the government's job to tell network operators what to deploy, but our analysis requires us to make assumptions for planning purposes. Our inclination at this point is that FTTCab is likely to be a pragmatic choice for Italy in the coming years, and more economically viable in the intermediate term planning horizon of individual operators. This approach would be in line with what has happened in the UK, Germany, and a number of other European Member States, although it will take place three to five years later in Italy. In order to achieve 50% adoption, it is presumably necessary to achieve at least 75% coverage. Driving fibre to that many homes would be an expensive proposition; consequently, in the absence of arrangements to lower costs below present levels (such as infrastructure sharing), FTTCab is likely to remain the more economically viable option in most areas.

To the extent that G.Fast involves only the DSLAMs, and no civil works, the cost should be manageable. There may be the need, however, to drive fibre closer to some homes (i.e. to the distribution point) in order to fully achieve 100 Mbps or more to 80-90% of homes.

The planning assumption we would suggest is that FTTCab deployments, with an upgrade to G.Fast in the last three years of this decade, represents the most suitable and cost-effective solution for Italy. There will be cost, to be sure, but the cost does not seem to be unmanageable.

In Annex 3 to this report, we have included an extremely rough estimate of the cost of achieving DAE Objective 3. There are large uncertainties in that estimate.

6.4. Comprehensive cost modelling is called for

A serious cost modelling effort is in order, and it needs to be joined up with the planning and monitoring activities that are presented in Chapter 7. In particular, the cost modelling results should be a key input to the National Broadband Plan put forward in Section 7.1 and to the periodic monitoring put forward in Section 7.3; at the same time, the model should benefit from data gathered during the periodic monitoring.

Demand factors, to the extent known (e.g. through the monitoring process), need to be taken into consideration. This cost modelling effort does not necessarily need to be conducted at the level of regulatory cost modelling, however, since the objectives here are different.

Recommendation 13. Make a comprehensive determination of the cost of achieving DAE Objectives 1, 2, and 3.

The Italian government should initiate a comprehensive cost modelling effort to determine likely costs of fully achieving DAE Objectives 1, 2, and 3 under suitable assumptions. The cost modelling results should become a key input to a National Broadband Plan. They should be a key input to the periodic monitoring process that we have advocated, and should also benefit from the data collected by the monitoring process. The results should be reviewed periodically, and updated as appropriate.

Recommendation 14. Provide sufficient funds to achieve DAE Objectives 1, 2, and 3.

Once the costs are properly analysed, the Italian government should ensure that sufficient funds are available to enable achievement of DAE Objectives 1, 2, and 3. This could include the use of European structural funds and other suitable instruments. Due care must be taken to conform to European State Aid rules.

7. Ensuring progress toward meeting DAE Objectives

Key Findings

- *The digital economy can play a crucial role in promoting GDP growth, employment, consumer empowerment, and government transparency. The deficits in terms of deployment and adoption of fast and ultrafast broadband that we have identified in this study are therefore appropriately a matter of national concern.*
- *Leadership and concerted attention on the part of the Italian government are called for in order to ensure that Italy achieves its full potential.*
- A proper institutional setting is called for in order to ensure that monitoring of *Key Performance Indicators (KPIs)* takes place on an ongoing basis.
- The Italian Government, informed by technological and regulatory considerations, should take the lead in formulating the KPIs.
  - KPIs are needed not only for *supply*, but also for *demand*.
  - KPIs should include not only the factors that would enable Italy to meet DAE Objectives, but also the supporting factors needed to enable fast and ultrafast broadband to deliver real benefits to Italian consumers and businesses.
  - KPIs must constitute *SMART indicators* that address all key attributes, while recognising their interdependencies.
- The periodic monitoring of KPIs, however, should be at arm's length from the Italian government. For monitoring to be appropriately objective and transparent, it should be conducted by an agency that is somewhat insulated from any political consequences. Candidate organisations include the Italian NRA AGCOM, the Organo di Vigilanza (OdV), and the Fondazione Ugo Bordoni (FUB). We suggest AGCOM overall. A complementary assessment of relevant fixed and mobile network technology trends could either be assigned to the Fondazione Ugo Bordoni, or else contracted through a public procurement.
- Whatever agency conducts the monitoring, it should have suitable resources in terms of funds and staffing, and should be obliged to report its findings on a predictable calendar (probably annual).
- There is a clear need for transparency, and for enabling informed public discussion and debate; however, much of the data developed by the monitoring process will in its nature be commercially sensitive, and therefore cannot be made public by the government. The government should not force public disclosure, but can invite and encourage commercial parties to voluntarily expose enough to enable meaningful public discussion.
- Putting a monitoring process in place is essential in all scenarios; however, monitoring alone does not assure that DAE Objectives will be met.
- We believe that the most appropriate mechanisms to ensure that network operators carry actual deployments forward can most appropriately be driven by the same public funding that will be needed in any case to achieve DAE Objectives. Public funding will inevitably be associated with commitments; thus, the network operator that accepts the funds is subject to commercially enforceable obligations, rather than to legal or regulatory obligatory obligations, if it fails to carry through on its commitments.

Having completed this evaluation, we are strongly of the view that a proper institutional setting is called for in order to ensure that monitoring takes place on an ongoing basis.

Leadership is called for. Given the number of different initiatives that need to be initiated and coordinated among Italian public institutions, leadership from the highest levels of the Italian government is required (see Section 7.1).

It is not our intent to overly specify how monitoring should be implemented – that is a matter for ongoing consideration by the Italian government. We have, however, chosen to provide a number of hopefully helpful remarks as to what should be monitored (Section 7.1), and how it should be monitored going forward (Section 7.3), and what instruments might be used if progress proves to be insufficient.

7.1. Leadership on the part of the Italian government

If there is one central observation that clearly emerges from our work, it is that *Italy is behind in terms of deployment and adoption of fast and ultrafast broadband, and that leadership and concerted attention on the part of the Italian government is called for*.

No one seriously questions the importance of the digital economy today. It can play a crucial role in promoting GDP growth,[30] employment, consumer empowerment, and government transparency. The deficits that we have identified in this study make clear that Italy is at risk of not achieving its full potential. This is appropriately a matter of national concern.

Many different Italian public institutions have a role to play. Our perception is that each is doing more or less what it has been asked to do, but that the policies overall are not joined up as they need to be. AGCOM has a role to play, but this is by no means solely a regulatory matter. The Ministry has a role to play, but Italian deficits cannot be addressed solely by supply side measures. This is a complex matter of industrial policy, entailing both supply side and demand side aspects. Attention is needed from the highest levels of Italian government in order to ensure that the different strands of policy come together.

Recommendation 15. Create a comprehensive *National Broadband Plan* for Italy.

A National Broadband Plan that considers the full range of programmatic instruments and issues, addressing both the supply side and the demand side, is warranted. It needs to include an allocation of responsibilities among the responsible public institutions. It should not seek to direct regulatory and competition authorities that by their nature must function independently, but it can inform them of government priorities in terms of meeting DAE Objectives, and can invite them to take the action that they deem suitable. Given that different policy strands will probably need to be implemented by different public institutions, a central Italian planning and coordination unit reporting to the Prime Minister will be required.

Recommendation 16. Engage not only Italian industry, but also the Italian people.

Consumers and many segments of Italian business need to be engaged, not just the network operators. The Italian people need to understand that they are, and need to be, a key part of the digital economy. They need to understand that they, too, have a role to play. Modern technologies need to be understood and used. The government has a role in communicating this. National conferences and other means of popularising the full range of Digital Agenda initiatives should be considered.

[30] See Analysys Mason (2013), *The Socio-Economic Benefits of Bandwidth*, study for the European Commission.

7.2. Key Performance Indicators (KPIs)

Based on the foregoing, a number of characteristics of the indicators that should be measured have become clear.

First, an ongoing monitoring programme for *Key Performance Indicators (KPIs)* is called for. The one-off informal process initiated in this study is hopefully helpful, but equivalent work needs to be embedded in a proper institutional setting, and supported with proper staffing and funding.

Second, it is clear that KPIs are needed not only for *supply*, but also for *demand*. If users continue to disconnect from the fixed network, and if they do not find interesting and compelling services online, then DAE Objectives will probably not be met, and are unlikely to deliver the hoped-for benefits even if they were somehow to be met.

Third, the KPIs should include not only the factors that would enable Italy to meet DAE Objectives, but also the supporting factors needed to enable fast and ultrafast broadband to deliver real benefits to Italian consumers and businesses.

Fourth, the KPIs need to include measures of all key attributes, and needs to clearly distinguish among them (while recognising their interdependencies). The reporting should focus on measurable performance to date, rather than aspirational projections; however, a certain amount of predictive work is unavoidable, since it is for instance necessary to track network investments against needs going forward. Candidate KPIs must address:

- **Coverage** of fixed, mobile, fixed wireless, and cable networks at various speeds and capabilities.
- **Penetration** of each of these services needs to be monitored.
- **Overlaps** in both coverage and penetration need to be understood.
- **Usage of network services by consumers** provides key context for the other data.
- **Remaining investment** needed to achieve DAE Objectives.
- **Investment to date** in broadband deployment.

Fifth, the KPIs will likely have to cross-compare information derived from multiple sources. Penetration data provided by network operators are invaluable, but many aspects of consumer usage can only be determined by survey data (such as the annual e-Communications household surveys conducted on behalf of the European Commission). Overlaps in coverage are crucial to a full understanding of coverage, but are not fully visible in statistics provided by network operators.

Sixth, all KPIs should be *SMART Indicators*. The identification of clear and appropriate metrics is helpful in translating from aspirational goals to practical policy implementation, and in monitoring progress toward achievement of goals. In European policymaking, a generally accepted practice (which some might argue is honoured more often in the breach than in the observance) is to identify SMART indicators for any policy intervention. SMART is an acronym:

- **Specific:** The indicator must be sufficiently concrete that one understands whether it has been achieved.
- **Measurable:** If you cannot measure something, you cannot manage it, and cannot hope to achieve it.

- **Attainable:** Goals may be aspirational, but there is no point in establishing goals that have little practical chance of being reached.
- **Relevant:** The objective must be relevant to the underlying objective that one seeks to achieve.
- **Time-bounded:** In the absence of a time frame in which a goal should be achieved, you never know whether it might be reached "some day".

7.3. The procedure

The *definition* of KPIs is by its nature a process driven by policy. Thus, the choice of metrics properly reflects political considerations, informed by technological and regulatory policy considerations.

This suggests that the Italian Government should take the lead in formulating the KPIs, subject to the broad guidelines elaborated in Section 7.1. In the interest of transparency and objectivity, a public consultation process over the proposed KPIs would be in order.

The *periodic monitoring* of KPIs, however, should be at arm's length from the Italian government. For monitoring to be appropriately objective and transparent, it should be conducted by an agency that does not live or die based on the findings, but rather by an organisation that is somewhat insulated from any political consequences. Candidate organisations include the Italian NRA AGCOM, the Organo di Vigilanza (OdV), and the Fondazione Ugo Bordoni (FUB).

The agency conducting the monitoring must be able to ensure the confidentiality and security of commercially sensitive data provided by market players, and to publish it only in redacted form where necessary. It must be able to support its data requests with compulsory legal process.

Our suggestion would be that AGCOM is probably the organisation best positioned to conduct the overall assessment. As a *National Regulatory Authority (NRA)*, they have the necessary independence from the Government. They have the necessary legal powers, and already deal with commercially sensitive data.

An assessment of technology trends for both fixed and mobile networks as they impact achievement of the DAE broadband Objectives needs to be part of this process. For this part of the process, the Fondazione Ugo Bordoni (FUB) may possibly be better positioned than AGCOM. Alternatively, this analysis could be contracted to an independent firm through a public procurement. If the technology assessment is not done by AGCOM, there would need to be coordination with AGCOM's overall monitoring of KPIs in order to ensure that the assessment focuses on those aspects of technological evolution that are actually relevant.

Whatever agency conducts the monitoring, it should have suitable resources in terms of funds and staffing, and should be obliged to report its findings on a predictable calendar (probably annual).

Recommendation 17. The Italian government should take the lead in defining suitable KPIs for monitoring progress relative to DAE Objectives.

The Italian government should define suitable KPIs. In doing so, the government should be informed by technological and regulatory considerations. KPIs should reflect both supply side and demand side consideration, and should consider not only what is needed to achieve DAE Objectives, but also the factors that contribute to enabling the DAE to deliver the desired benefits to Italian consumers and industry. Multiple sources will likely be required. All KPIs should be SMART indicators. A public consultation should be conducted regarding the KPIs.

Recommendation 18. The Italian government should assign monitoring responsibilities to a suitably independent agency, and should provide the necessary resources to enable proper monitoring.

The Italian government should arrange for regular monitoring of KPIs by a suitably independent agency, probably AGCOM. A periodic assessment of relevant fixed and mobile network technology trends is also required, which would not necessarily be conducted by AGCOM itself (assuming that the responsibility is assigned to AGCOM), but would need to be coordinated with AGCOM. Suitable financial and staff resources need to be assigned to the responsible agency, and it needs to be obliged to report on a predictable periodic calendar.

Our experience in this study is that network operators have done negligible planning for more than three years in the future. This is perhaps not unexpected in a rapidly changing field, and we readily acknowledge that there is no point in generating planning documents that might prove to be the purest speculation; nonetheless, we think that the network operators would benefit from thinking about what they might want to do in a longer planning horizon, and communicating that through the monitoring process that we have put forward here.

Recommendation 19. Invite network operators to provide at least preliminary plans that extend to 2020.

Network operators should be encouraged to expand their planning horizon so as to have at least a preliminary view of how they will approach network deployments in, say, the period 2018-2020.

As previously noted, moving Italy forward should be of interest to all Italians. There is a clear need for transparency, and for enabling informed public discussion and debate; however, much of the data developed by the monitoring process will in its nature be commercially sensitive, and therefore cannot be made public by the government.

Making plans public implies complex trade-offs. The ability of firms to keep their business plans secret is an important element of competition that should not be undermined. At the same time, some sharing of plans would be required in any case in order to identify opportunities for the sharing of infrastructure (see Section 5.4.5).

The network operators and other commercial parties that provide information to the monitoring process are best positioned to determine what information can be publicly disclosed. The government should not force public disclosure, but can invite and encourage commercial parties to voluntarily expose enough to enable meaningful public discussion.

For voluntary disclosure of plans to work, policymakers and the public need to be mature in their approach. *Plans are plans, not commitments.* Circumstances change rapidly in the world of networking and information technology. Plans can change for legitimate reasons.

Recommendation 20. Encourage network operators to voluntarily make their deployment plans public.

Network operators should be invited and encouraged to publicly disclose those aspects of their broadband deployment plans that do not reveal commercially sensitive data. This will facilitate informed public discussion and debate.

7.4. Acting on the results of the monitoring process

Putting a monitoring process in place is essential in all scenarios; however, monitoring alone does not assure that DAE Objectives will be met.

What happens if monitoring targets are not achieved? What actions are available to Italian policymakers?

Achieving DAE Objectives intersects with universal service objectives, but at its core, it is not a regulatory exercise. The DAE is an instrument of industrial policy, not of regulation, and consequently falls appropriately within the purview of the Italian government rather than the National Regulatory Authority (AGCOM).

It is however precisely for this reason that a new solution is called for. One of the most likely failure modes would entail insufficient investment on the part of one or more Italian network operators. If an Italian network operator does not make planned for (or hoped for) investments in broadband networks, as has often been the case in the past, it is generally not subject to regulatory or legal sanctions. Business plans can change over time, for legitimate reasons or otherwise – but it is not the government's role to determine whether businesses have made wise business decisions.

With that said, the options available to the Italian government appear to involve either:

- Influencing the commercial incentives of the network operators by, for example, offering subsidies to support broadband deployment to the less attractive parts of the national territory; or
- Using commercial means to somehow steer the behaviour of the network operators, either through contractual means or by taking an ownership interest and board seat or seats of one or more network operators.

The latter is, in our judgment, unwise. It is likely to mire the government in conflicts of interest, and uncertainties as to the appropriateness of State Aid. For these reasons, we concentrate on the former approach.

The development of Digital infrastructure is one of the areas the EU has identified as suitable for public funds; however, as discussed, Italy has not been particularly effective in taking advantage of the EU structural funds in the period 2006-13 and a change in approach is needed to achieve better results in the coming cycle.

Subsidies should therefore be based on the need to draw a National Plan for a fast and ultrafast broadband network rather than a series of regional plans, with a strong coordination from the Centre and with a detailed description of the areas that should benefit from such an investment. It could also be a platform for a strong 'contract' between State and Regions whereby various Institutions underwrite their commitment to the implementation of the broadband vision each for its own part/role: from funding to issuing permits, and so on.

This would be an effective complement to monitoring activities: whilst the government keeps a close eye on private investments in the network, it also works actively with the EU and the Regions to expedite the roll out in areas that are not covered by private investments.

The Minister for Economic Development (Department of Communications) ought to be the institution accountable for coordinating such a plan, working closely with Ministry for Coesione Sociale, in charge of submitting request for structural funds to the EU.

The Department of Communications already plays a coordinating role regarding public funds, but it might be necessary, if a more national and structured approach is pursued, to strengthen its capabilities in this area.

Public funding will inevitably be associated with commitments; thus, the network operator that accepts the funds is subject to commercially enforceable obligations, rather than to legal or regulatory obligatory obligations, if it fails to carry through on its commitments.

As with monitoring programmes, a strong statement by/a close involvement of the Prime Minister in this area might lead to a step change in the planning and management of EU structural funds. Probably, should this be pursued further, the creation of an ad hoc monitoring unit in Palazzo Chigi should be considered. Central government would have (probably for the first time) a unified and coordinated view of how fast /where /using which technology *both* private and public funds are invested and with what impacts on ultra fast broadband coverage.

Recommendation 21. The Italian government should use its funding for meeting the DAE Objectives to help ensure that they are met.

The Italian government, together with other national and European resources, should provide enough funding to ensure that all supply side aspects of DAE Objectives 1, 2, and 3 can be substantially met. In doing so, the Italian government should seek to obtain enough leverage over network operators that accept funding to enable the Italian government to monitor deployment shortfalls and, to some extent, to remedy them.

8. Findings and recommendations

There are grounds for cautious optimism regarding the deployment and adoption of ultrafast broadband in Italy. Network operators in Italy have concrete plans to cover roughly 50% of the Italian population with fast broadband based on FTTCab/VDSL2 technology between now and roughly 2017. In contrast to the recent past, these plans are credible, and deployment is demonstrably moving forward. Given Italy's favourable characteristics (i.e. a network structure with short sub-loop lengths), these lines will be able to deliver well in excess of the 30 Mbps required by the second of the DAE broadband objectives.

There are risks that the plans will not be carried through to completion. There are serious operational and regulatory challenges. Nonetheless, we consider the plans to be credible overall.

In and of themselves, these plans will not achieve the DAE Objectives.

- There are no solid commitments to cover more than 50% of the population with fast or ultrafast broadband.
- The current plans of the network operators do not address 100 Mbps service; with expected improvements in technology, however, it is likely achievable.
- Even if most lines were able to provide 100 Mbps service (and bearing in mind that 50% penetration requires considerably more than 50% coverage), there are problems with consumer demand that would need to be addressed in order for the adoption target (DAE Objective 3) to be achieved.

In the absence of committed, energetic and sustained attention by the Italian government, DAE goals will not be fully achieved. We therefore urge the Italian government to take proportionate, appropriate steps to deal with each of the gaps within the authority available to it, with due respect for the respective competencies and independence of the European Union and of Italian regulatory and competition authorities. The following would be appropriate:

- **Comprehensive analysis, planning and monitoring** of the investment required and of investments made to achieve DAE broadband objectives, taking a balanced approach between fixed, mobile, fixed wireless, and even satellite resources, and also considering not only supply side factors but also the demand side.
- **Provision of sufficient additional funding to close coverage gaps,** drawing on European Structural Funds and other sources, based on the results of the analysis, planning and monitoring function. Attention at regional level is warranted. Compatibility with European State Aid guidelines is required.
- **Measures to drive down deployment costs,** including initiatives to enhance the radio spectrum and to enhance the efficiency of spectrum use; and promotion of infrastructure sharing, to the extent permissible under European State Aid and competition guidelines.
- **Measures to correct lagging demand for broadband services in Italy,** including digital literacy programmes. Low consumption of audiovisual services is a concern that warrants detailed analysis.

The remainder of this chapter provides a recapitulation of our key findings (as they appear at the beginning of each chapter) and our recommendations. The key findings appear in Section 8.1. Section 8.2 provides an overview of our recommendations, together with pointers to the recommendations that appear throughout this report.

8.1. Findings

Following the sequence of presentation of the report as a whole, our key findings are as follows.

8.1.1. Where does Italy stand today in achieving DAE goals?

- Fixed network basic broadband coverage in Italy is quite good, both in absolute terms and also in comparison with other Member States of the EU.
- By contrast, coverage of fast broadband (30 Mbps or more) in Italy is the worst among the Member States of the EU. The total absence of cable is a major contributor to this deficit.
- Broadband penetration is also a concern. Even though coverage is high, adoption is low. Indeed, among its peer group of Western European Member States, Italy ranks last.
- The nominal speed of the access link is only one measure of the speed of the network. The speed of the core network and aggregation network also impact total throughput. In terms of total throughput, Italy ranks badly in comparison with European and global competitors.

8.1.2. Alternatives to the fixed telecommunications network

- *Cable television service is non-existent in Italy.*
- *Mobile services based on forms of LTE are unlikely to be adequate*, in our judgment, to serve as a full substitute in the period 2014-2020 for 100 Mbps fixed broadband service, nor to serve as a full substitute for fixed broadband services at 30 Mbps in areas of moderate to high population density. Mobile service can and will serve as a substitute for 30 Mbps broadband in areas of low density.
- Fixed wireless service is small today in terms of number of subscribers, but covers a substantial fraction of the Italian territory. Policymakers should not ignore it.
- Satellite should be considered as a substitute service only for a very small percentage of users who cannot practically be reached in any other way. The latency characteristics that are inherent in geosynchronous satellites are unavoidable, and (together with limitations in bandwidth capacity) render the service unattractive where alternatives are available.

8.1.3. Promising developments and opportunities

- Key network operators, notably including Telecom Italia and Fastweb, have credible and realistic deployment plans, and are deploying to these plans. Vodafone has made credible commitments to invest. Italy is fortunate to have fixed network competitors that are willing and able to invest in fast broadband infrastructure.
- Italy represents an ideal case for a relatively inexpensive form of fast broadband, namely FTTCab/VDSL2 due to the relatively short length of copper sub-loops.
- Technological advances to VDSL are likely to further enhance FTTCab capabilities.
- It is likely that it will eventually be necessary to eventually build out solutions that are even more capable than FTTCab/VDSL2; however, that does not necessarily mean that it is unwise to deploy FTTCab/VDSL2 today. If the investment to upgrade is deferred substantially, then the ability to apply the capital to other productive uses in the interim has substantial value to Italy; moreover, deployment costs are likely to be lower in the future than they are at present. It is likely that more than one technology will be present in Italy in any case.

- RAI, Mediaset, and SKY have all announced and released new IP-based platforms for catch-up television on the Internet. Increased availability of high quality audiovisual content could help drive demand for fast broadband going forward.

8.1.4. Worrisome developments and challenges

- In achieving DAE broadband Objectives, Italy faces numerous challenges.
  - Uncertainty as to whether the deployment plans will continue to be pursued.
  - Challenges in covering the 50% of households that are not addressed by current plans of network operators.
  - Two million copper lines of low quality require special attention.
  - Heavy reliance on Telecom Italia to meet the DAE broadband Objectives.
  - Numerous challenges in putting capital effectively to work. This has many manifestations: (1) locked-up investment in the case of Metroweb; (2) the tendency of all operators to invest in covering the same 50% of the population; (3) VDSL-specific challenges, including both street cabinet sharing, and coordination of lines where vectoring is deployed; (4) sharing in the mobile network; and (5) opportunities to use infrastructure from other network industries (e.g. electricity, water). Some of these are challenges for the industry, while others are challenges for the National Regulatory Authority (NRA) AGCOM. Italy may wish to strike a different balance (with due respect for European State Aid and competition rules) between promoting investment and promoting competition than some other Member States. At the same time, it should not be forgotten that competition is often the most important spur to investment in fast and ultrafast broadband.
  - Challenges regarding demand. Concerns include a declining number of fixed lines, penetration of fixed broadband that is stalled at current levels, limited consumption of audiovisual content, an aging population, and too few personal computers.

⇒ All of this leads to an unsettling but seemingly inescapable conclusion: ***DAE goal #3 will not be fully achieved without substantial additional public policy intervention.***

8.1.5. Prospects for achieving the DAE broadband objectives

- **DAE Objective 1:** Italy had 98.4% fixed basic broadband coverage as of the end of 2012.
  - This is above average among EU Member States.
  - It is reasonable to assume that the remainder can be covered by Fixed Wireless Broadband (FWB), mobile services, and satellite, and to claim that DAE Objective 1 has for the most part been met.
- **DAE Objective 2:** There are numerous challenges. Coverage of substantially the full Italian population at 30 Mbps will require forms of public funding.
  - Network operators have presented credible plans that could result in 50% or more of households being able to access 30 Mbps or more download speeds by 2016-17.
  - Coverage to additional households depends, however, on forms of public subsidy and/or Public-Private Partnerships (PPPs).
  - Estimates of the expenditure required to reach 100% coverage vary greatly. A detailed cost modelling effort is needed.

- The expenditure required (even in the higher estimates) could be within the range of EU structural funds that Italy could allocate to the development of this essential digital infrastructure.

- **DAE Objective 3:** Italy's prospects are uncertain at best.
  - There is very little visibility into network operator plans that would provide 100 Mbps.
  - Given that Italy benefits from a short average copper sub-loop length of just 300 meters, it is likely that many FTTCab lines could deliver speed substantially in excess of those achieved in other countries. Whether they will fully reach 100 Mbps is uncertain.
  - Prospects for achieving DAE Objective 3 are dismal unless a number of key demand trends can be reversed.
  - Our preliminary feeling is that FTTCab deployments, with an upgrade to G.Fast in the last three years of this decade, represents a pragmatic solution for much of Italy. It is likely that more than one technology will exist in Italy in any case.
  - There are large cost uncertainties in achieving adoption by 50% of households.
- **Infrastructure sharing:** The degree to which infrastructure sharing can be achieved plays a key role in all scenarios, and may influence which scenario is chosen.
- **Cost modelling:** A serious cost modelling effort is in order, and it needs to be joined up with the planning and monitoring activities that we have proposed.

8.1.6. Ensuring progress toward meeting DAE Objectives

- The digital economy can play a crucial role in promoting GDP growth, employment, consumer empowerment, and government transparency. The deficits in terms of deployment and adoption of fast and ultrafast broadband that we have identified in this study are therefore appropriately a matter of national concern.
- Leadership and concerted attention on the part of the Italian government are called for in order to ensure that Italy achieves its full potential.
- A proper institutional setting is called for in order to ensure that monitoring of *Key Performance Indicators (KPIs)* takes place on an ongoing basis.
- The Italian Government, informed by technological and regulatory considerations, should take the lead in formulating the KPIs.
  - KPIs are needed not only for *supply*, but also for *demand.*
  - KPIs should include not only the factors that would enable Italy to meet DAE Objectives, but also the supporting factors needed to enable fast and ultrafast broadband to deliver real benefits to Italian consumers and businesses.
  - KPIs must constitute *SMART indicators* that address all key attributes, while recognising their interdependencies.
- The periodic monitoring of KPIs, however, should be at arm's length from the Italian government. For monitoring to be appropriately objective and transparent, it should be conducted by an agency that is somewhat insulated from any political consequences. Candidate organisations include the Italian NRA AGCOM, the Organo di Vigilanza , and the Fondazione Ugo Bordoni (FUB). We suggest AGCOM overall. A complementary assessment of relevant fixed and mobile network technology trends could either be assigned to the Fondazione Ugo Bordoni, or else contracted through a public procurement.

- Whatever agency conducts the monitoring, it should have suitable resources in terms of funds and staffing, and should be obliged to report its findings on a predictable calendar (probably annual).
- There is a clear need for transparency, and for enabling informed public discussion and debate; however, much of the data developed by the monitoring process will in its nature be commercially sensitive, and therefore cannot be made public by the government. The government should not force public disclosure, but can invite and encourage commercial parties to voluntarily expose enough to enable meaningful public discussion.
- Putting a monitoring process in place is essential in all scenarios; however, monitoring alone does not assure that DAE Objectives will be met.
- We believe that the most appropriate mechanisms to ensure that network operators carry actual deployments forward can most appropriately be driven by the same public funding that will be needed in any case to achieve DAE Objectives. Public funding will inevitably be associated with commitments; thus, the network operator that accepts the funds is subject to commercially enforceable obligations, rather than to legal or regulatory obligatory obligations, if it fails to carry through on its commitments.

8.2. Recommendations

The Italian Government should commit itself to achieving DAE goals as a means of promoting societal welfare, innovation, and employment.

Four initiatives to support supply (corresponding to clusters of the recommendations presented throughout this report) emerge from this work:

- The Italian Government should institutionalise periodic monitoring of progress toward achieving DAE objectives. As a related matter, government should encourage operators to make their overall coverage plans public.
- A National Broadband Plan to should be developed and funded through EU structural funds in close cooperation with Regions but under the leadership of a central Italian planning and coordination unit.
- Consideration must be given to permitting infrastructure sharing, but with due respect for competition and EU rules.
- Domestic and international initiatives to harmonise and reallocate radio spectrum should be used to ensure an effective deployment of wireless broadband networks as a complement and a competitive stimulus to fixed broadband.

Government should also continue to promote demand. Demand is not a topic that was at the centre of our remit for this analysis, but demand will play a crucial role in ensuring that Italy reaches the EU 2020 targets, and it is the focus of several of our recommendations.

In the concluding sections of this report, we consider each of these areas in turn. We close with a list of all of the recommendations, together with the page number where they first appear in the body of the text.

8.2.1. Periodic monitoring of progress

In order to move the process forward, it is necessary to systematically identify Key Performance Indicators, to monitor their evolution over time, and to be prepared to take correction action in the event that expected progress is not achieved. A proper institutional design is required, with an appropriate division of responsibilities among the corresponding public bodies.

- The Italian government should define suitable Key Performance Indictors (KPIs). In doing so, the government should be informed by technological and regulatory considerations. KPIs should reflect both supply side and demand side consideration, and should consider not only what is needed to achieve DAE Objectives, but also the factors that contribute to enabling the DAE to deliver the desired benefits to Italian consumers and industry. Multiple sources will likely be required. All KPIs should be SMART indicators. A public consultation should be conducted regarding the KPIs.
- The Italian government should arrange for regular monitoring of KPIs by a suitably independent agency, probably AGCOM. A periodic assessment of relevant fixed and mobile network technology trends is also required, which would not necessarily be conducted by AGCOM itself (assuming that the responsibility is assigned to AGCOM), but would need to be coordinated with AGCOM. Suitable financial and staff resources need to be assigned to the responsible agency, and it needs to be obliged to report on a predictable periodic calendar.
- Network operators should be encouraged to expand their planning horizon so as to have at least a preliminary view of how they will approach network deployments in, say, the period 2018-2020.
- The Italian government, together with other national and European resources, should provide enough funding to ensure that all supply side aspects of DAE Objectives 1, 2, and 3 can be substantially met. In doing so, the Italian government should seek to obtain enough leverage over network operators that accept funding to enable the Italian government to monitor deployment shortfalls and, to some extent, to remedy them.

As a related matter, there is a clear need for transparency, and for enabling informed public discussion and debate; however, much of the data developed by the monitoring process will in its nature be commercially sensitive, and therefore cannot be made public by the government. The network operators and other commercial parties that provide information to the monitoring process are best positioned to determine what information can be publicly disclosed. The government should not force public disclosure, but can invite and encourage commercial parties to voluntarily expose enough to enable meaningful public discussion.

- Network operators should be invited and encouraged to publicly disclose those aspects of their broadband deployment plans that do not reveal commercially sensitive data. This will facilitate informed public discussion and debate.

8.2.2. Create and fund a National Broadband Plan

Leadership and concerted attention on the part of the Italian government are called for in order to ensure that Italy achieves its full potential. A proper institutional framework is called for, and it needs to be linked to a National Broadband Plan and to the periodic monitoring process that we have called for (see Section 8.2.1). A comprehensive cost modelling effort is in order, and the Italian government must then ensure that resources for the plan are found, with a large proportion likely coming from European structural funds.

Many different Italian public institutions have a role to play. This is a complex matter of industrial policy, entailing both supply side and demand side aspects. Attention is needed from the highest levels of Italian government in order to ensure that the different strands of policy come together.

- A National Broadband Plan that considers the full range of programmatic instruments and issues, addressing both the supply side and the demand side, is warranted. It needs to include an allocation of responsibilities among the responsible public institutions. It should not seek to direct regulatory and competition authorities that by their nature must function independently, but it can inform them of government priorities in terms of meeting DAE Objectives, and can invite them to take the action that they deem suitable. Given that different policy strands will probably need to be implemented by different public institutions, a central Italian planning and coordination unit reporting to the Prime Minister will be required.
- Consumers and many segments of Italian business need to be engaged, not just the network operators. The Italian people need to understand that they are, and need to be, a key part of the digital economy. They need to understand that they, too, have a role to play. Modern technologies need to be understood and used. The government has a role in communicating this. National conferences and other means of popularising the full range of Digital Agenda initiatives should be considered.
- The Italian government should initiate a comprehensive cost modelling effort to determine the likely costs of fully achieving DAE Objectives 1, 2, and 3 under suitable assumptions. The cost modelling results should become a key input to a National Broadband Plan. They should be a key input to the periodic monitoring process that we have advocated, and should also benefit from the data collected by the monitoring process. The results should be reviewed periodically, and updated as appropriate.
- Once the costs are properly analysed, the Italian government should ensure that sufficient funds are available to enable achievement of DAE Objectives 1, 2, and 3. This could include the use of European structural funds and other suitable instruments. Due care must be taken to conform to European State Aid rules.

8.2.3. Promote infrastructure sharing where appropriate

Deployment of fast and ultrafast broadband is inherently an expensive proposition. Infrastructure sharing could reduce those costs; however, sharing entails some risk that competition might be negatively impacted, since it is usually not practical for all network operators to share equally.

Striking the right balance is largely a matter for AGCOM and for the Italian competition authority, not for the government; however, the government has a legitimate interest in promoting a proper balance among these competing interests.

A new and promising initiative at European level seeks to enable infrastructure sharing with other sectors, including electricity, gas and water.

- Where commercial parties wish to share infrastructure, policymakers should be careful not to impose needless roadblocks; however, competitive aspects will usually need to be carefully examined.
- Italy should pay close attention to the proposed European Regulation to reduce the cost of deploying high-speed electronic communications networks. If the Regulation is not promptly enacted, Italy could consider enacting similar measures at national level.

8.2.4. Initiatives to harmonise and reallocate spectrum

In the European discussion of fast and ultrafast broadband, there is a tendency to focus excessively on the fixed fibre-based telecommunications network. Wireless solutions also have a crucial role to play:

- As a full substitute for the fixed network in areas that are remote, or where density of consumers is low.
- As a competitive spur to the fixed network.
- As a complementary alternative to the fixed network in areas of moderate to high density.
- As a distinct service offering distinct capabilities, notably mobility.

At the same time, the fixed and wireless networks are intertwined today. Most of the traffic from devices that we think of as mobile in fact traverses the fixed network after being off-loaded (most often by means of Wi-Fi at home or at work). A balanced, comprehensive approach is called for.

We have not conducted a detailed review of spectrum management practices in Italy. Much of what follows is simply a restatement of generally accepted best practice in Europe.

- Mobile broadband should play a role nearly equivalent to that of fixed in the planning process for meeting DAE Objectives. Mobile is a substitute for fixed in low density areas; a mobile complement to fixed in areas of greater density; and serves as a competitive spur to fixed network deployment.
- Spectrum allocation policy should ensure that sufficient spectrum is available for mobile and fixed wireless broadband services. Government should take the opportunity of international and European processes that are re-purposing frequencies among various applications (including possible future use of the 700 MHz band for mobile broadband) to adopt, in consultation with stakeholders, best practice and to ensure that Italy can fully exploit wireless technology advances in the evolution of its digital infrastructures.
- Continuing attention is called for to ensure that spectrum secondary markets (e.g. spectrum trading) are effective, and that opportunities for sharing and collective use are fully exploited.
- The evolution of the network toward smaller cells with more limited coverage potentially offers greater spectrum re-use, and thus substantially greater effective capacity. This trend of evolution within the macro-cellular is linked to the tendency toward spectrum off-load both to small cells and to Wi-Fi.
- For small cells and large, fixed back-haul capacity is crucial. Clearing away impediments to fixed network deployment is thus crucial to the mobile network as well. The evolution of fixed and mobile networks are intertwined, implying that a comprehensive approach is warranted in order to pay due attention to both.
- Fixed Wireless Broadband (FWB) should be included within the scope of planning for the achievement of DAE Objectives.
- Satellite should be included as a "gap filler" within the scope of planning for the achievement of DAE Objectives. For certain remote areas, use of satellite is indispensable.

8.2.5. Promote demand for broadband services

We were asked primarily to study the *supply* of broadband access services, not the *demand* for them; however, it is apparent that the largest challenges to achieving DAE Objective 3 are on the

demand side. Adoption of 100 Mbps service by 50% of Italians cannot possibly be achieved unless more Italians come to see benefits in fast and ultrafast broadband service, and develop the willingness to pay for it.

- In light of (1) the somewhat lower-than-average tendency for Italians who possess a computer to also have an Internet connection at home, together with (2) the fact that Italy has more elderly citizens than most Member States (who are less likely to subscribe to Internet services), combined again with (3) a low propensity to consumer online audiovisual services, measures to promote digital literacy could have particularly great impact in Italy.
- Ongoing study of the Italian media environment is called for. Public policy initiatives to promote the ability of market players to offer both linear and interactive online media may be required.
- The marked tendency of Italians to "cut the cord" to the fixed network requires steadfast attention going forward. It is difficult to see how any programme to meet the DAE Objectives could succeed unless this tendency is reversed.

8.2.6. Index of specific recommendations

Each of our recommendations first appears in the body of the text, together with substantiation. A list of recommendations follows, noting the page on which the recommendation appears.

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Recommendation 2. Ensure that sufficient spectrum for mobile and fixed wireless broadband is available. 26
Recommendation 3. Follow best practice in regard to spectrum sharing and secondary markets. ...26
Recommendation 4. The migration to small cells and Wi-Fi off-load pose opportunities for greater network capacity. 27
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Recommendation 15. Create a comprehensive *National Broadband Plan* for Italy. 62
Recommendation 16. Engage not only Italian industry, but also the Italian people. 62
Recommendation 17. The Italian government should take the lead in defining suitable KPIs for monitoring progress relative to DAE Objectives. 65
Recommendation 18. The Italian government should assign monitoring responsibilities to a suitably independent agency, and should provide the necessary resources to enable proper monitoring. 65
Recommendation 19. Invite network operators to provide at least preliminary plans that extend to 2020. 65

Recommendation 20. Encourage network operators to voluntarily make their deployment plans public. 66
Recommendation 21. The Italian government should use its funding for meeting the DAE Objectives to help ensure that they are met. 67

Annex 1: Interviews conducted

Network operators

Telecom Italia (Roberto Opilio, Head of Technology; Francesco Nonno, Head of Regulatory Affairs; and Giancarlo D'Orazio, Head of Network Planning)

Fastweb (Alberto Calcagno, Chief Executive Officer; Mario Mella, Chief Technical Offer; Federico Ciccone, Chief Strategy Officer; Giovanni Moglia, Head of Legal and Regulatory Affairs; Lisa Di Feliciantonio)

Metroweb (Alberto Trondoli, Chief Executive Officer; Guido Garrone, Chief Operating Officer)

Vodafone (Enrico Resmini, Residential Business Unit Director at Vodafone IT; Gianluca Pasquali, Strategy Director at Vodafone IT; Sando Falleni, Head of @H@O Execution Unit at Vodafone IT; and Marilisa Cesaro, Legal and Regulatory Affairs)

Wind (Claudio Ongaro, Chief Strategy Officer; Ermanno Berruto, Head of Architectures)

3 (Vincenzo Novari, Chief Executive Officer).

Equipment manufacturers

Huawei (Dr. Juan Rendon)

Alcatel Lucent (Florian Damas, Director of Public Affairs; Franco Micoli, Head of Regulatory and Public Affairs, Italy)

Qualcomm (Isabella De Michelis, Vice President, Public Policy and Government Affairs; Wassim Chourbaji, Senior Director, Government Affairs)

Public institutions

Ministero dello Sviluppo Economico (Antonio Catricalà - Vice Minister, Roberto Sambuco – Head of Communications Department)

AGCOM (Angelo Cardani, President; Annalisa D'Orazio, Capo di Gabinetto; Francesco Sclafani, Secretary General; Antonio Perrucci, Direttore della Direzione Analisi dei mercati concorrenza ed assetti; Paolo Lupi, Direzione Analisi di Mercato e concorrenza; Davide Gallino, Head of Unit, Equivalence of access; Loredana Vajano, Head of Unit Servizi Regolamentati e Contabilità regolatoria)

Organo di Vigilanza (Prof. Antonio Sassano, President)

Infratel (Salvatore Lombardo, Chief Executive Officer)

Fondazione Ugo Bordoni (Alessandro Luciano, President and Chief Operating Officer; Mario Frullone, Deputy Chief Operating Officer)

European Investment Bank (EIB) (Harald Gruber, Head of Division, Digital Economy and Education; and Jussi Hätönen)

Experts

WIK (Dr. Karl-Heinz Neumann, Dr. Thomas Plückebaum)

Annex 2: VDSL2, vectoring, and G.Fast technology

VDSL2 (Very-high speed Digital Subscriber Line), defined by the ITU-T G.993.2, is a technology used to achieve high-speed data rates in access networks based on copper. It represents an enhancement of VDSL and has been developed to be well-matched with ADSL2+, obtaining bit rate up to 100 Mbps. VDSL2 works on 17MHz (17a) and30 MHz (30a) band, which can be further divided up into multiple upstream and downstream sub-channels, providing even higher bandwidth over short distances.

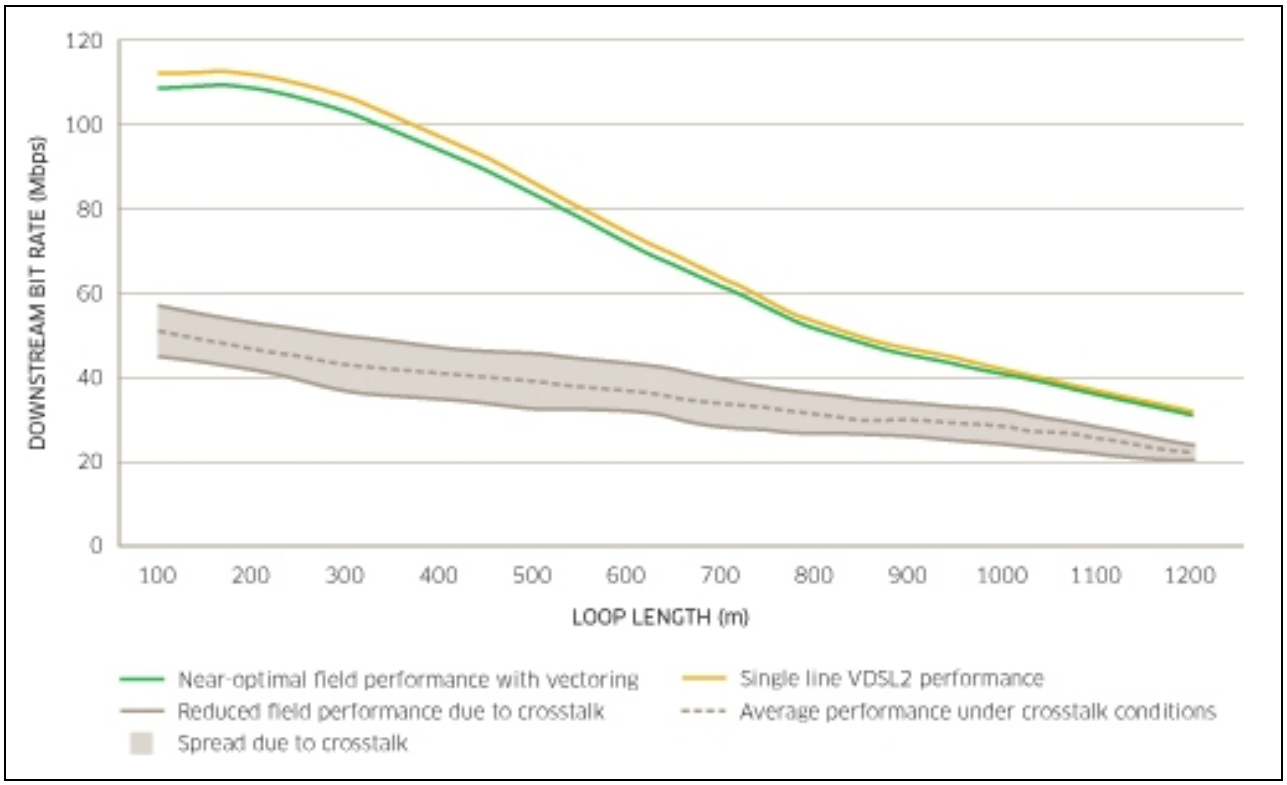
The main drawback of VDLS2 is strong performance degradation for increasing reaches between the Central Office/Cabinet and users, due to interferences (crosstalk) on twisted pairs in the same binder. Downstream and upstream signals may cause two types of crosstalk: FEXT (Far End Crosstalk) and NEXT (Near End Crosstalk). FEXT is the interference caused by signals propagating in the same direction on close lines, while NEXT is caused by counter propagating signals. In xDSL systems, FEXT effect grows for increasing line lengths, while, due to the particular channel access method based on FDMA (Frequency Division Multiple Access), NEXT has a minor impact than FEXT.

Therefore, although VDSL2 could provide rates up to 100 Mbps, crosstalk limits its performance. Vectoring has been developed and proposed in order to address crosstalk limitations.

VDSL2 Vectoring (ITU-T G.993.5) allows higher bit-rates by cancellation of crosstalk on VDSL2 lines in the same cable. This technology continuously elaborates signals on the fly evaluating the interference among all lines in the same binder; this information is exploited to remove crosstalk on each line, allowing to push performance up to the upper bound available.

The main advantage of Vectoring consists in providing higher data rates than VDSL2 for longer loop lengths.In VDSL2 Vectoring, it is possible to reach the maximum rate that a noiseless, single VDSL2 copper pair can reach. Moreover, thanks to continuous monitoring of interference for properly management of signal transmissions, Vectoring guarantees stable and predictable network performance, like in the case of a single line.

Figure 19. The relationship of sub-loop length to speed under vectoring.



Source: Alcatel Lucent

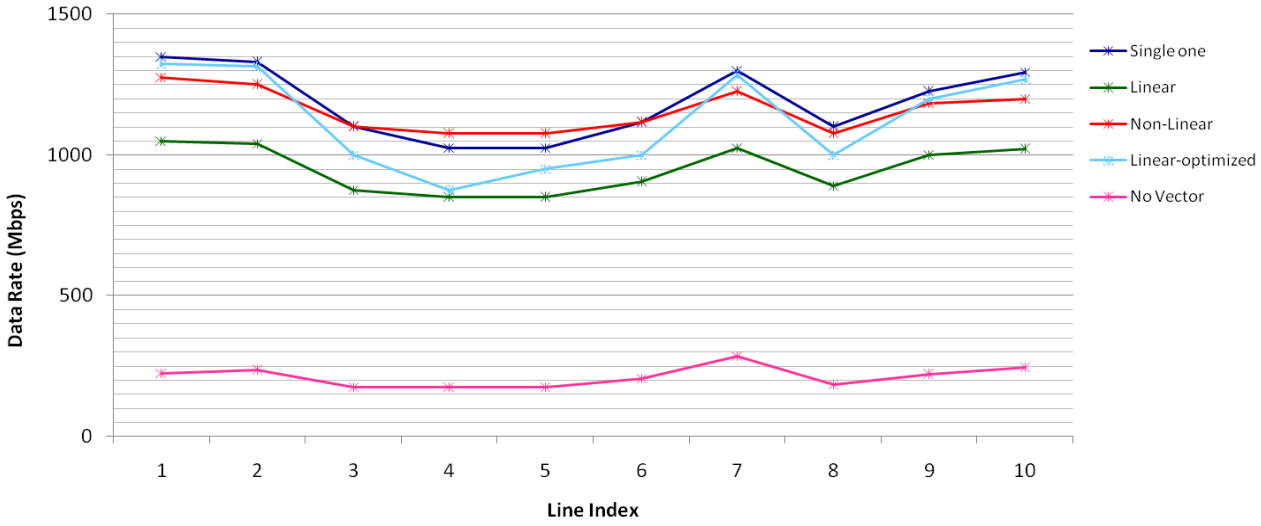
With the aim to obtain the best results, all lines in the cable must be monitored and controlled to cancel crosstalk. Any uncontrolled VDSL2 line (alien line) results in unsuppressed crosstalk, reducing vectoring gain. The more alien lines there are in a cable, the lower the gain. Thus, in a multi-operator scenario, where the lines in the same binder could belong to different operators and could be terminated on different nodes, it is practically impossible to preserve Vectoring advantages.

G.Fast is a technique that allows transmissions up to 1 Gbps on copper networks, but there exist severe constraints to fully exploit this technology, as the loop length must be lower than 100 m. Although not yet clearly defined, frequency spectrum should be around 106 MHz in the initial stage and 212 MHz in future developments. G.Fast works with the same DMT (Discrete Multi-Tone) modulation as xDSL systems, but it uses TDD (Time Division Duplex) instead of FDD (Frequency Division Duplex), resulting in a more flexible ratio definition. The wider frequency band allows G.Fast to achieve ultra-high data rates for short reaches between nodes and users (i.e., over 500 Mbps for distances of 100-200 metres, up to 1 Gbps for reaches shorter than 100 metres). Moreover, since in TDD tones could be directional, G.Fast results more efficient for the data transfer of asymmetric applications.

As VDSL2 systems, G.Fast could be affected by crosstalk interference among lines in the same cable and the actual performance could be severely degraded if noise cancellation techniques are not implemented. Two vectoring options are available for G.Fast: the improved linear precoding algorithm and the non-linear precoding algorithm. Although the non-linear algorithm obtains higher rates, its complexity results in a difficult and expensive implementation. Thus, in the first release of G.Fast, the linear algorithm is implemented to cancel crosstalk among lines.

G.Fast is in pending approval by ITU-T (April 2014). The first G.Fast equipment is expected to be available in 2015.

Figure 20. G.Fast performance over lines of 100 metres



Source: Huawei

Feasibility of different broadband solutions in the Italian scenario

In Italy, the average loop length is about 300 metre. In this scenario, VDSL2 Vectoring is theoretically able to provide speeds up to 100 Mbps and it is suitable for network architectures, mainly FTTCab, that network operators are currently deploying. Similarly, G.FAST is in principle capable to provide ultra-high speeds up to 1 Gbps for shorter distances, resulting to be suitable for FTTB and FTTdp network architectures, where fibre is deployed closer to the user. Table 2 shows the attainable bit rate for Italian regions, according to actual loop length, by means of Vectoring technology. It is important to highlight the loop length is different in some regions, and Vectoring could not be considered the only solution to meet DAE objective in those regions.

From the practical viewpoint, several constraints may prevent to achieve the full potential of these technologies.

As already mentioned, in a multi-operator scenario mutual interference among copper lines cannot be controlled, resulting in a dramatic decrease of performance, thus failing to meet DAE Objective 3.

This reflects in the need to roll out new fibres. Fibre To the Home deployment is the long-term network architecture that will enable operators to deliver ultra-high unlimited bandwidth. Different technologies are available, both in *point-to-point (P2P)* and shared infrastructures *(Passive Optical Network (PON))* solutions; however, the main drawback is the high implementation cost due to scattered population, home fibre wiring, and slow roll-outs.

Annex 3: The cost of achieving DAE objectives

A comprehensive, detailed assessment of the cost of achieving DAE Objectives 1, 2, and 3 in Italy is well beyond that which can reasonably be accomplished in a brief study such as this one. First, neither time nor budget was available for a serious cost modelling effort. Second, there are quite substantial uncertainties that would need to be addressed.

Nonetheless, it is possible and useful to provide a rough sizing of the magnitude of the problem.

There are a number of key aspects that need to be considered, some of which are well known, others of which are somewhat speculative. Among them:

- The number of households to be covered, and their distribution over the national territory.
- The current and expected status of network deployment in Italy – who is covered, and how?
- The likely evolution of technology, and its implication for the cost of coverage.
- The cost of coverage, under suitable assumptions, for each candidate technology.

Following the general approach of a number of publicly available studies, we take the approach of

- dividing Italy into zones of increasing population density (since this is the strongest single determinant of network cost),
- estimating the number of households in each zone,
- (greater than 500 inhabitants per Km^2),
- estimating the zone-specific incremental cost per household of each upgrade,
- for each DAE Objective, summing up the aggregate cost of upgrades in each zone.

Urban, suburban and rural zones

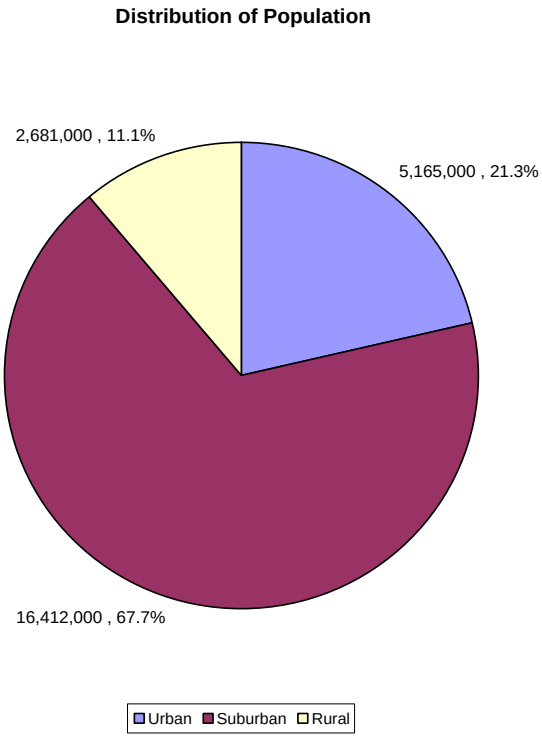
We benefit from a number of previous studies by the European Investment Bank (EIB),[31] the consulting firm Point Topic,[32] and the consulting firm WIK.[33]

The WIK studies entail a breakdown into multiple *geo-types* of progressively lower population density (i.e. progressively more rural), each containing roughly equal numbers of households.

The Point Topic and EIB studies use a simpler breakdown into urban, suburban and rural areas. This is sufficient for our purposes in this study. The EIB worked from a 2006 population of 24.3 million households, distributed over urban (greater than 500 inhabitants per Km^2), suburban (100 to 500 inhabitants per Km^2), and rural areas (less than 100 inhabitants per Km^2) as shown in Figure 21.[34] This accords reasonably well with ISTAT census data for 2011, which show 24,141,324 *permanent* households (i.e. "households occupied by residents"). If non-permanent residences (e.g. vacation houses) were included, the figure would instead be 28,863,604; however, we are of the view that the DAE should not be interpreted as requiring coverage of vacation houses.

[31] EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets".
[32] Point Topic (2013), *Europe's broadband investment needs: Quantifying the investment needed to deliver superfast broadband to Europe*.
[33] Karl-Heinz Neumann et al. (2014), „VDSL Vectoring reduziert Investitionsvolumen für Breitbandausbau deutlich", in info (forthcoming).
[34] Point Topic (2013) also used a three-way breakdown, but their urban zone had a density of 600 or more inhabitants per Km^2.

Figure 21. Population distribution of Italy (households, 2010).



Source: EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets".

Estimating the need for improved coverage

The EIB (2011) study[35] includes an estimate of the number of urban, suburban, and rural households not covered by each candidate technology. Given that the growth in broadband subscriptions has been on the order of 1% per year since the EIB study was conducted, the data should be close enough to current levels for our purposes.

Table 6. Coverage gap for each technology type in Italy (2011).

Coverage Gap	Households	ADSL2	VDSL2	FTTB	FTTH	LTE
Urban	5,165,000	52,000	5,165,000	3,181,000	5,061,000	52,000
Suburban	16,412,000	985,000	16,412,000	16,412,000	16,412,000	1,149,000
Rural	2,681,000	483,000	2,681,000	2,681,000	2,681,000	2,681,000
	24,258,000	1,520,000	24,258,000	22,274,000	24,154,000	3,882,000

Source: EIB (2011).[36]

Estimating the cost per household of each upgrade

As we have seen, the EIB computed cost per household for quite a range of different technologies (see Table 2). For most purposes, we are using their estimates.

[35] EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets".
[36] Ibid.

The cost per household of deploying FTTCab / VDSL2 (optionally with vectoring and G.Fast) is a crucial parameter for this analysis. The EIB estimates[37] were made for Europe overall, not for Italy (which benefits from favourable characteristics, as explained in Annex 2 and in Section 4.2). Moreover, at the time of the EIB (2011) study, vectoring was less mature. Neither vectoring nor G.Fast were considered in the study. For multiple reasons, the EIB values for this key parameter are not appropriate for our use here.

Point Topic used a similar approach to that of EIB, but instead of €250/500/1800 per household for VDSL2, Point Topic used €150/900/2000. This figure, like that of the EIB study, is a European estimate rather than being specific to Italian circumstances.

In a WIK 2008 study of the costs of fast and ultrafast broadband on behalf of ECTA (the trade association of European competitors), WIK found a cost per Italian urban home connected of €190 under suitable assumptions. This is not the same as the cost per home passed.

A soon-to-be-released WIK study [38]shows a somewhat higher cost, but based on German specificities. It also demonstrates dramatic savings in comparison with FTTH point to point (P2P) solutions.

Table 7. Costs per home connected of FTTCab/VDSL with vectoring (at 70% penetration).

Cluster	FTTH/P2P	FTTCab Vectoring	Delta in %
1	1,440 €	320 €	78%
2	1,650 €	350 €	79%
3	1,740 €	370 €	79%
4	1,780 €	370 €	79%
5	1,840 €	370 €	80%
6	1,940 €	380 €	80%
7	2,010 €	410 €	80%
8	2,180 €	420 €	81%
9	2,230 €	440 €	80%
10	2,410 €	480 €	80%
11	2,440 €	500 €	80%
12	2,480 €	520 €	79%
13	2,560 €	560 €	78%
14	2,640 €	600 €	77%
15	2,650 €	590 €	78%
16	2,710 €	640 €	76%
17	2,670 €	680 €	75%
18	3,030 €	830 €	73%
19	3,410 €	1,020 €	70%
20	4,310 €	1,390 €	68%
Total	2,410 €	560 €	77%

Source: WIK (2014)

[37] EIB (2011), "Assessing the cost of fulfilling the EU2020 DAE targets".
[38] Karl-Heinz Neumann et al. (2014), „VDSL Vectoring reduziert Investitionsvolumen für Breitbandausbau deutlich", in *info* (forthcoming).

Based on their field experience and current investment roll-out, Fastweb indicates an average cost per home passed of around €100.

Estimating the cost of G.Fast-capable equipment is speculative, since the technology does not yet exist; however, we consider it reasonable to assume that the cost per DSLAM port in 2018-2020 for VDSL2 DSLAMs capable of supporting vectoring and G.Fast will be no greater, in light of Moore's Law improvements, than the cost of VDSL2-capable DSLAMs today.

All things considered, and assuming that the network operators are probably best positioned to judge Italian specificities today (at least for the households that they have decided to deploy), we have assumed costs of €125/400/1800 per household for urban, suburban and rural areas respectively.

Estimating the overall cost of achieving each of the three DAE Objectives

DAE Objective 1 (full coverage of basic broadband) is largely met; however, the EIB data show some gaps in suburban and rural areas. We have assumed that those in suburban areas would be served with ADSL2, while those in rural areas would instead be served using LTE or equivalently Fixed Wireless Broadband (FWB).

Table 8. Upgrades needed to achieve DAE Objective 1.

OBJECTIVE #1 HH	ADSL2	LTE	
Urban	52,000		52,000
Suburban	985,000		985,000
Rural		483,000	483,000
	1,037,000	483,000	1,520,000

Source: WIK

The costs can then be estimated by multiplying the number of households by the cost per household of that technology in that zone. We use LTE costs as a proxy for FWB costs. This yields a modest cost of €264 million CAPEX.

Table 9. Cost to achieve DAE Objective 1.

OBJECTIVE #1 Cost	ADSL2	LTE	
Urban	€ 2,080,000	€ -	€ 2,080,000
Suburban	€ 78,800,000	€ -	€ 78,800,000
Rural	€ -	€ 183,540,000	€ 183,540,000
	€ 80,880,000	€ 183,540,000	€ 264,420,000

Source: WIK

DAE Objective 2 calls for full coverage at 30 Mbps. Here, we assume that all of the urban and suburban households that do not yet have FTTH or FTTB need to be upgraded to VDSL2, ideally with vectoring and optionally G.Fast when available.

We assume that roughly 7% of the population (exclusively in rural areas) cannot cost-effectively be served with VDSL2. We assume instead that it is necessary to roll out LTE (or FWB) service to

these users. Since some of them would already have been served with LTE or FWB to meet DAE Objective 1, we subtract those users out so as to avoid double-counting them.

There are some two million lines where the copper-based service is of poor quality, due to long lines, outdoor equipment issues, or simply slow equipment. For the rural areas of Italy, we assume that these are covered within the 1.2 million lines that would be served under our estimate by LTE or FWB. For the rest, we assume for purposes of this report that the cost of necessary upgrades are already included in the large number of VDSL upgrades required. A full assessment would require time and resources that are not available for this short exploratory study.

Table 10. Upgrades needed to achieve DAE Objective 2.

OBJECTIVE #2 HH	VDSL2	LTE	
Urban	3,077,000		3,077,000
Suburban	16,412,000		16,412,000
Rural	982,940	1,215,060	2,198,000
	20,471,940	1,215,060	21,687,000

Source: WIK

Multiplying by the cost per household of each upgrade, we get the following rather substantial costs of some €9.2 billion.

Table 11. Cost to achieve DAE Objective 2.

OBJECTIVE #2 Cost	VDSL2	LTE	
Urban	€ 384,625,000	€ -	€ 384,625,000
Suburban	€ 6,564,800,000	€ -	€ 6,564,800,000
Rural	€ 1,769,292,000	€ 461,722,800	€ 2,231,014,800
	€ 8,718,717,000	€ 461,722,800	€ 9,180,439,800

Source: WIK

Costs to meet DAE Objective 3 are far more speculative, since they depend on demand for services. Conspicuously, since the median sub-loop length is 200 metres, *half of the Italian population could be covered with G.Fast service with a speed well in excess of 100 Mbps with no extension at all of fibre, and thus with no additional civil works cost art all, if one could be sure that every covered household would order the service.*

Obviously, this cannot be assumed. We instead assume that 75% of the population needs to be covered with 100 Mbps service if 50% adoption is to be achieved. In practice, all of these households will be suburban, since (1) all urban households would have been upgraded to meet DAE Objective 2 and will tend to have short enough sub-loop lengths to meet DAE Objective 3, and (2) none will be in rural areas since DAE Objective 3 can be met without incurring the high costs that rural upgrades would entail.

Table 12. Upgrades needed to achieve DAE Objective 3.

OBJECTIVE #3 HH	VDSL2
Urban	-
Suburban	6,064,500
Rural	-
	6,064,500

Source: WIK

The cost of these fibre extensions is difficult to estimate. In order to set a generous upper bound, we assume that the cost cannot be higher than the difference between the cost of FTTP coverage versus that of VDSL2 coverage.

Table 13. Cost to achieve DAE Objective 3.

OBJECTIVE #3 Cost	VDSL2
Urban	€ -
Suburban	€ 3,638,700,000
Rural	€ -
	€ 3,638,700,000

Source: WIK

For all three DAE Objectives, then, we come up with the following combined costs.

Table 14. Cost to achieve all three DAE Objectives.

Cost to meet Objectives	Objective 1	Objective 2	Objective 3	Total
Urban	€ 2,080,000	€ 384,625,000	€ -	€ 386,705,000
Suburban	€ 78,800,000	€ 6,564,800,000	€ 3,638,700,000	€ 10,282,300,000
Rural	€ 183,540,000	€ 2,231,014,800	€ -	€ 2,414,554,800
Total	€ 264,420,000	€ 9,180,439,800	€ 3,638,700,000	€ 13,083,559,800

Source: WIK