



HEAVY READING

KEY FINDINGS

About 16.6 million homes will be connected to FTTH in Europe by the end of 2011, just over 8% of all homes

Wide variation between countries will continue through the next five years, with some big nations, especially Germany and the UK, lagging well behind.

Demand for bandwidth, mainly for video-related services, will increase the pressure for FTTH; buoyant growth in sales of consumer electronics will fuel the demand

Municipalities, utilities and new telcos will dominate build-out for the next few years in most countries, with incumbent build-out following several years later

Regulation will be vital in determining the speed of the build-out, and decisions at both local and European level could have a major impact

Heavy Reading – Independent quantitative research and competitive analysis of next-generation hardware and software solutions for service providers and vendors

FTTH in Europe: Forecast & Prognosis, 2006-2011

It's been almost three decades in the making, but fiber to the home (FTTH) is finally emerging into the mainstream and is set to transform the telecom environment.

As demand for bandwidth continues to climb rapidly, the transition to FTTH will ultimately be unstoppable. However, although some European countries have begun the transition to fiber or will do in 2007, Europe as a whole will lag behind the US, Japan and other major Asian nations.

No European country has yet committed to a major coordinated build-out. Nevertheless, there is strong momentum in five countries—Austria, Denmark, France, Netherlands, Sweden—and if planned build-outs in those countries go according to plan, it will put increasing pressure on neighboring countries and cities to follow suit.

The exact speed of the build-out remains dependent on a wide range of factors, some of which vary by country while others are dependent on Europe-wide decisions—especially regulatory decisions—which have not yet been made.

In light of that, this report looks at the effects of a range of leading indicators on the prospects for FTTH in Europe, and presents several scenarios built on different leading indicator scenarios. We conclude that on median assumptions, Europe as a whole will lag Japan in FTTH penetration by approximately 6 years, and the US by 1-2 years. There will continue to be very wide disparities between different countries within the EU, as well as within countries. That in turn will likely increase the pressure on regulators and politicians for further action to harmonize roll-out across the continent and prevent the growth of a new “digital divide.”

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* All charts and figures in this report are original to *Heavy Reading*.

I. Introduction & Key Findings

Fiber to the home (FTTH) has been a long time coming. First mooted as a realistic goal in the late 1970s, deployment has long been frustrated by the very high cost of deployment and the doubtful benefits on offer to end users.

Now, however, the global transition to FTTH has begun in earnest. Over the next 20 years, we expect the copper access network to be largely replaced by a fiber access network, creating massive opportunities for vendors, network builders, and service providers.

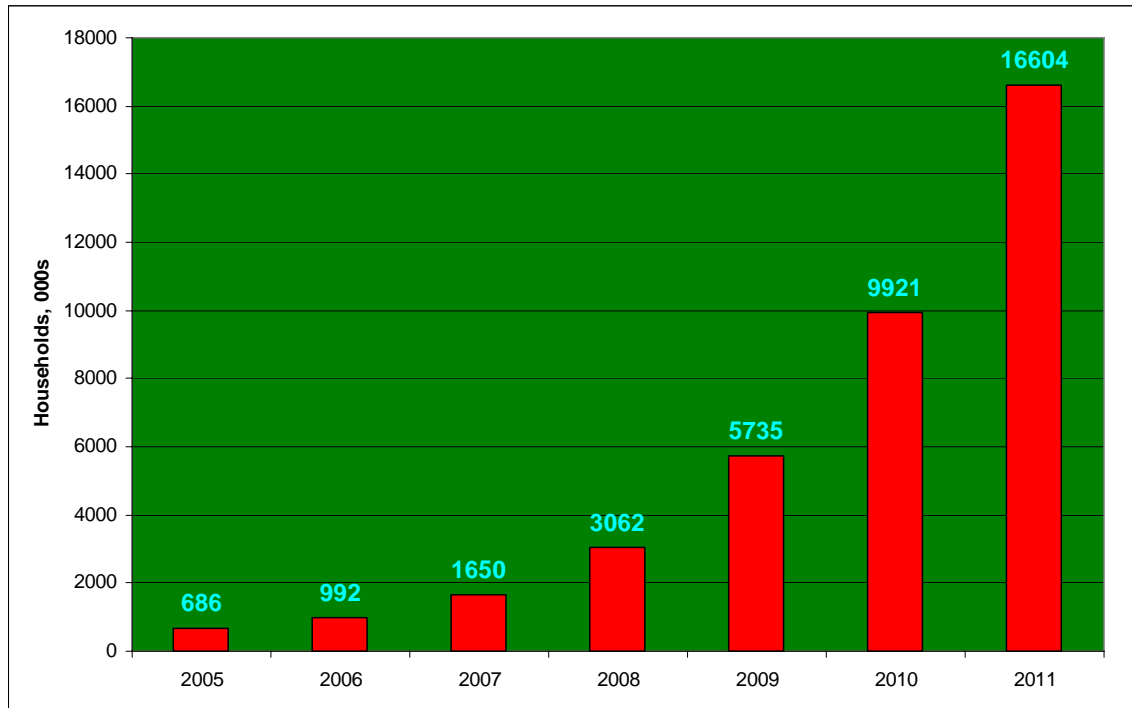
However, the transition to FTTH raises some difficult issues for Europe, which is lagging behind the US and Japan in particular. Should European telcos—especially incumbents—seek to emulate pioneering providers of FTTH in Japan and the US, where FTTH build-out has begun in earnest? Why have they not done so to date? What are the catalysts and barriers, and are they substantially different in Europe? And if incumbents do not lead the deployment, is it feasible for others—specifically, competitive telcos, utilities and municipalities—to lead mass-market deployment instead?

Through analysis of the leading indicators for FTTH, a country by country review of recent and anticipated developments, and a set of forecasts based on both optimistic and pessimistic assumptions, this report seeks answers to these questions.

The key findings of this report are as follows:

- **FTTH will reach about 16.3 million homes by the end of 2011, representing about 8.2% of all homes in the EU25 (see Figure 1.1).** The current penetration is about 0.4%.
- **There will be major disparities in penetration across European countries,** with some countries building a lead of 2-5 years over others, leading to wide and persistent disparity in the availability of FTTH. This could have significant economic and political implications for the EU over time.
- **Leading demand indicators for FTTH in Europe have seen significant improvement over the past 12 months.** In particular, there has been rapid growth in the ownership of equipment and use of services that drive demand for bandwidth. Among other things, Europe is seeing a boom in purchase of HD-ready TVs and displays, higher-specification PCs, digital cameras, MP3 players, and use of associated Internet sites such as photo and video download and blogging sites. At the same time, there has been a rapid transition to higher speed DSL services, paving the way to the next upgrade, including FTTH.
- **Supply-side indicators have been broadly neutral.** On the plus side, a whole range of new initiatives was either begun or announced in 2006. Construction of important municipal networks began in Amsterdam and Paris; Free announced ambitious plans to convert to FTTH in France; France Telecom's commercial FTTH trial began; and Danish utilities began connecting households throughout Denmark. On the other hand—except for France Telecom-- there was little public change in attitude among incumbents. Most envisage deployment of deep fiber and VDSL2, but none has set a timetable for FTTH.
- **Regulatory decisions in the period under review provided only marginal support for the transition to FTTH.** In the Netherlands, the government and the courts gave the go-ahead for construction of Amsterdam's municipal network. But the European Commission forced the German government to end regulatory relief on unbundling of Germany's VDSL network—a decision which other incumbents said would hold back incumbent deployment. The Commission is also investigating the

Figure 1.1: Growth in FTTH, 2006-2011



Note: Figures relate to EU25 countries plus Iceland, Norway and Switzerland

- **Municipal and utility networks will play an important role in early FTTH in many European countries, and in stimulating interest in the technology.** However, although municipal fiber will be very important in some countries, it is an open question whether they will come to dominate the European market as a whole. Although they will not be the most important providers in the period to 2011, incumbent telcos may ultimately be the biggest providers in most countries by virtue of their ownership of existing ducts, deployed fiber, customers, engineering know-how and financial muscle.
- **Competitive telcos have been and will continue to be important pioneers for FTTH in a few countries, albeit often from a low base initially.** CLECs have played an important role in Italy, Sweden and now, most importantly, in France. However Free—the French CLEC with ambitious plans for FTTH— may not prove typical among CLECs, and we do not expect its decision to be widely replicated by CLECs in other countries at least in the next year or two.
- **Green-field housing developments will make a slow but steady contribution to the build-out of fiber.** Compared to China and the US, Europe builds relatively few new houses per annum. All the same, green-field housing will in time be a growing factor in the spread of FTTH since it is rapidly becoming more economic to deploy fiber than copper.

What Is Fiber to the Home?

Figure 1.3 sets out the main categories of "FTTx." In this report, we refer to the first three of these, and these are the only categories included in our forecast. Furthermore, our focus is primarily on fiber to the home, not to the business.

Figure 1.3: Types of Fiber Deployment

FIBER TO THE...	DEFINITION
Home (FTTH)	Includes fiber to both individual houses and to apartment blocks
Building (FTTB)	To an MDU or apartment block, but not to each floor, desk, or apartment
Apartment (FTTA)	Includes fiber from the basement switch to the apartment itself
Premises (FTTP)	In other words, to any kind of building
Dormitory (FTTD)	Usually on college and university halls of residence
Node (FTTN)	Up to about 1,500 meters from the premises
Curb (FTTC)	Up to about 150 meters from the premises, but not in the final drop
"X" (FTTX)	Up to any point in the network further than the central office

Where single-dwelling units (SDUs) – including detached housing, terraced housing, and so on – are being connected, there is only one basic type of connection, which we call FTTH. Where multi-dwelling units (MDUs) are being connected, there are two markets: one in which fiber ends at the basement switch or router and the final connection is over copper, called FTTB; and one in which it continues right into the apartment, here called FTTA.

When we refer generically to "FTTH," we are talking about all three types of connection, but they are different, and the discussion throughout includes some consideration of this difference.

FTTC bears some similarities to FTTB, in that the final connection is over copper, sometimes using the same technology – VDSL. However, since a line has to be drawn somewhere, this report and in particular its forecast is based only on situations where fiber actually enters the residential building, be it to the basement, the house, or the apartment.

II. Leading Indicators For FTTH: Supply and Demand

2.1 Introduction

In this section, we look at the main factors that are both encouraging and, in some cases, discouraging development of FTTH.

Figure 2.1: Leading Indicators For FTTH

LEADING INDICATOR	DEVELOPMENTS OVER THE PAST 12 MONTHS	POTENTIAL DEVELOPMENTS OVER THE NEXT 12 MONTHS
Demand-oriented Indicators		
Marketing and take-up of 2 nd generation broadband products (4Mbit/s+)	Positive: though very variable across Europe; in all countries, the last 12 months has seen a strong trend to marketing of higher-speed services	Positive: intensifying competition and a continuing emphasis on new services enabled by ADSL2+ and VDSL will drive upgrade to higher speeds in many countries
Broad ICE trends and take-up—HDTV, next-generation games machines, H-DVD, video/photo blogging etc	Neutral: in general, Europe has lagged behind other countries in take-up of new technology, but penetration is beginning to grow strongly for a wide range of FTTH friendly technologies	Positive: strong sales of next-gen games machines, HDTVs, higher-spec computers and cameras are all expected in late 2006 and 2007, driving demand for bandwidth
Supply-Oriented Indicators		
Stated attitudes and plans of incumbent telcos	Negative: little change in the past 12 months	Neutral: major changes in attitude are unlikely in 2007
Competitive and entrepreneurial telco plans and their impact	Neutral: widespread coverage of Free, but no change in Fastweb or B2's shift from FTTH to ULL copper, and no other major developments	Neutral: although major new FTTH entrants are possible in 2007, probability is not high, in our view
Municipal and utility plans and their impact	Positive: plans moving forward in two key cities, Amsterdam and Vienna, and more broadly in Denmark, Norway and Sweden	Neutral: further major developments are possible but on balance we do not expect big changes in 2007
Greenfield housing and construction	Neutral: No change in housing builds, but the economic case is moving quickly towards FTTH for greenfield	Positive: the case for FTTH in Greenfield will continue to strengthen in 2007, and will lead to more deployment
Other Indicators		
Equipment and construction cost trends	Positive: cost still falling steadily on both equipment and construction side, driven in part by deployment outside Europe	Positive: continuing rise in global penetration and competition for market share will drive prices down again in 2007
Regulatory and political changes at European and national level	Neutral: some positive local developments, but no real change at European level	Neutral: Current uncertainties should be clarified as a result of major decisions in Brussels, but it remains to be seen if this drives FTTH deployment
Events outside region and their political & commercial impact	Positive: widespread coverage of developments in both the US and Japan putting pressure on telcos and regulators	Positive: awareness of continuing strong deployment trend in the US and Japan will grow

The most important indicators for fiber take-up are shown in figure 2.1, together with a summary of the current situation in Europe as we see it. The rest of this section takes a brief look at recent developments in each of these areas in more detail.

2.1 Take-Up of High-Speed Broadband Products

In Japan and South Korea, simple demand for more bandwidth—that is, higher-speed Internet connections—has been the most important driver for deployment and take-up higher-speed broadband services, and has been more important in justifying the move to fiber than new video services. A survey by NTT, the biggest provider of FTTH, found that 89 percent of users looking to move to fiber cited "higher bandwidth" as the main reason for the shift.

This finding, if repeated in Europe, could see demand for 50Mbit/s or more picking up sharply in a year or two, based on the underlying demand drivers described here in section 2.2. Europe has already seen a rapid shift in broadband marketing in most countries through 2005-2006 from services offering 1Mbit/s download speeds or less to services offering 4-20Mbit/s. Marketing strategy for these new services varies: in many countries (eg Germany and the Netherlands) they are marketed as premium products and priced accordingly, meaning that take-up is limited to early adopters; in others, including France and the UK, the new speeds are the standard product in most cases, and most broadband users are shifting to these higher-speed products.

The overall take-up of 2nd generation DSL (and cable) services is difficult to gauge since most service providers do not publish any information on the number of subscribers taking specific packages. Our estimate, however, is that the number of European broadband subscribers taking a service with downstream speeds of 2Mbit/s or more has grown from around 5% at the end of 2004 to around 20% at the end of 2006, and will reach 30% by the end of 2007. This shift effectively primes the market for the next big leap, to 50Mbit/s, starting in 2007.

The rapid take-up of higher-speed 2nd generation broadband products in 2006 is broadly positive for FTTH, since it pushes copper lines more quickly towards their limit and may in the end encourage providers—especially incumbents—to bring forward planned fiber strategies.

2.2 Take-Up of Advanced ICE Services

The last year has seen a continuing rapid take-up in equipment and services that predispose consumers to seek higher-speed Internet offerings.

On the equipment side, there has been a whole range of highly positive developments for higher-speed broadband. According to one estimate [by GfK], Western European spending on consumer electronics grew by 18% between H1 2005 and H1 2006, and much of this new equipment is used directly or indirectly on the Internet. Among the key categories

- **More powerful PCs:** over the last 12 months the price of PCs has fallen rapidly in Europe; average-specification desktop and laptop computers are now typically cheaper than flat-screen TVs—a remarkable turnaround in only a few years. These new computers are more media-friendly in every way. They can store more media, play media more easily, and typically have large widescreen format displays. And the European market for PCs has been buoyant, growing by about 10% in 2006. Approximately 25 million household computers were sold in 2006.
- **More digital cameras:** at the start of 2006, approximately 50% of households in Europe owned a digital camera, and this figure will likely grow to around 60% in 2006. Storage capacity and photo size are also both growing quickly, creating frustration with upload services; about 20% of all European households are thought to have used online services to upload photos.

- **More large flat-screen TV displays, especially “HD-ready” TV displays:** 2006 was the breakthrough year for HD sets, with more than 50% of purchased TVs carrying the HD-ready symbol, against only 5% in 2005. This transformation is being driven partly by a rapid decline in prices; the cost of an LCD HD-ready TV nearly halved in 2005 and continued to fall quickly in 2006.
- **More portable MP3 music players:** one estimate suggests that over 35 million MP3 players will be sold in Europe in 2006, an increase of nearly 30% on the previous year. Like digital cameras, the storage capacity of MP3 players is rising, encouraging more downloading (and uploading) of music to and from online music and file sharing sites. Many can also store photographs and video clips or programs.
- **Next-generation games machine launches:** the first of these, the Xbox 360, was launched by Microsoft in November 2005 and a total of 500,000 machines were sold in Europe in 2005, with an expectation that at least 3 million would be sold in 2006. Xbox 360 includes a live free Internet gaming service; there is also a premium version of this. Sony plans to launch its PlayStation 3 in March 2007, and downloading of HD content is a key part of its proposition for the PS3. The third device, the Nintendo Wii, was launched in Europe in December 2006. All three have much higher specification, hence the games consume more capacity and bandwidth.
- **High-definition DVD launches** in two competing formats, Blu-ray and HD-DVD. Both launched in 2006, enabling up to 200 Gbytes of data to be stored on a single disc—many times more than a conventional DVD. The first Blu-ray machines appeared in Europe in October 2006, while HD-DVD launched in November.

There have also been parallel developments on the services side:

- **More use of online video and photography storage sites,** and associated rise in personal blogging: although no figures on European use are available, monthly visitors to the most popular new video site, YouTube, grew from 2.8 million in August 2005 to 72 million in August 2006; we estimate that approximately 20% of these users are in Europe. The new Internet TV service, Joost, may have a similar impact in 2007.
- **Beginning of HDTV services and consumer take-up of these services:** use of HDTV services is increasing more slowly than the purchase of HDTV sets—there were no more than 1-2 million subscription users in Europe at mid-2006—but as HDTV sets become the norm over the next year, so use of HDTV is likely to grow quickly in Europe. There are over 25 HD feeds in Europe in 2006, and the number is growing rapidly.

There is, of course, no straight-line correlation between take-up of these kinds of equipment services and FTTH. For example, there has been particularly strong take-up of new HD televisions in Germany and the UK, two countries with little FTTH to date. **Through time, however, developments in consumer electronic devices and services in Europe in 2006 will have a highly positive impact on demand for high-bandwidth Internet services, and we expect more of the same in 2007.**

2.3 Stated Attitudes and Plans of Incumbent Telcos

In Japan, and increasingly in the US, FTTH penetration is being driven by the incumbent telco. So far this has not been the case in Europe, and over the past 12 months there has been only modest change in the publicly-stated attitudes of incumbents.

The first (and to date only) European incumbent to make a major public commitment to FTTH is France Telecom, which says that it will not deploy FTTN or FTTC as an interim step. It began deploying FTTH for a commercial trial in 2006, and large-scale deployment will begin in the second half of 2007; FT expects to pass 1 million homes by the end of 2008. Its plans are discussed in 3.3. Telecom Italia has also said it will deploy some FTTH alongside VDSL in dense urban ar-

eas. And nearly all incumbents are likely to make greater use of FTTH for green-field housing developments (see 2.6).

Some vendors say there is more activity under the radar, but we have not taken that into account in our forecast here. More important, perhaps, several big telcos have acknowledged that the rapid growth in demand, as well as competition have effectively forced them to bring forward their expectations for 3rd generation broadband running at speeds of 50-100Mbit/s.

Despite a few positive indicators, however, most European incumbents believe that FTTN and VDSL2 or ADSL2+ will provide all the bandwidth they need through to 2010 or later.

Ultimately, we believe European incumbents may be forced by competition and political pressures to move further and faster than they currently anticipate. However, that is unlikely to translate into widespread public commitment to FTTH among incumbents until at least 2008, which means no ILEC build-out of FTTH on the scale of Verizon or NTT in most countries before 2009-2010 or later.

Figure 2.2: Public Attitudes to FTTH, Selected Incumbents

Incumbent	Public Attitude
BT	Mostly FTTN + VDSL. No commitment on date of deployment for this. No business case seen for FTTH, except for some green-field
Belgacom	Has rolled out VDSL; thought to be considering FTTH, but no public commitment to date
Deutsche Telekom	Strong commitment to FTTN + VDSL2, but recently abandoned VDSL2 roll-out; no current plans for FTTH
France Telecom	Strong commitment to FTTH. Large-scale deployment likely to begin toward the end of 2007 and ramp up quickly in 2008
KPN	No published plans for FTTH, but extending fiber to street cabinets and planning VDSL2 launch from May 2007
TDC	Planning big VDSL2 roll-out; no FTTH deployment currently foreseen
Telecom Italia	Says it will use FTTN +VDSL2, but will also deploy FTTH in some situations. No timetable, but likely to begin deployment in late 2007 or early 2008
Telefonica	Rolling out VDSL2, no significant roll-out of FTTH currently envisaged

2.4 Competitive and Entrepreneurial Telco Plans and Their Impact

The single most significant development in European FTTH in 2006 was the announcement by French broadband service provider Free that it intended to begin a large-scale transition to FTTH in 2007. The company says it will offer connections to up to 4 million, and also intends to make its fiber available to other service providers.

Elsewhere, however, there is little sign—to date—that any similarly placed competitive telco is ready to make a similarly bold commitment. Unlike most competitive telcos elsewhere, Free is relatively free of debt, and makes a profit. Typically, however, European CLECs are in no position to commit large funds to capital projects, and are mostly committed initially to investment in ULL from incumbents to reach customers. Moreover, competitive pressures to move forward may not be as strong.

Free is in this sense one of a kind—its business model may not be followed by many, at least in the short term. Indeed, the two European FTTH pioneers that most resemble Free, Italy's Fastweb and Sweden's B2, have largely shifted from FTTH to ULL+DSL, and show no sign of reversing that strategy.

At the same time, however, there is small-scale entrepreneurial development in many countries, often associated with new housing. These are typically in newer or refurbished apartment blocks, and this is one area where there has been steady development in the former nations of the Soviet bloc, albeit largely on a scale typically measured in hundreds rather than thousands of units.

Free's decision has given a big boost to European FTTH in 2006, but is unlikely to be followed in the short-terms by its peers elsewhere.

2.5 Municipal and Utility Plans and Their Impact

Municipalities and utilities have taken center stage in European FTTH in the past 12 months, especially since announcements by the cities of Amsterdam and Vienna in 2006, each described in more detail in the relevant country sections.

Figure 2.3 lists the most important municipal initiatives, and shows that many got underway during 2006. In the country sections in part 3 of this report, there is further discussion of individual projects.

Figure 2.3: Key Municipal & Utility FTTH Construction Projects

City	Total Homes To Be Passed	Start Date	End Date
Amsterdam	450,000	October 2006	2013
Cologne	250,000	July 2006	2009
Dong Energi (Denmark)	900,000 [all homes in utility area]	2006	N/A
Lyse Telecom (Norway)	250,000*	2005	N/A
Reykjavik	200,000	2006	2011
Sweden			
Vasteras (Sweden)	60,000	2004	2007
Vienna	900,000	2006	2011

*planned connected customers in all areas

There is now significant municipal or utility fiber, actual or planned, in five countries—Austria, Denmark, Netherlands, Norway and Sweden—and there is smaller-scale activity in several other countries including France and Spain. In total, the number of houses that these projects are committed to pass in published plans is in the region of 5 million homes, and we expect in 2007 that there will be further announcements.

The motivations for these initiatives vary, as does the relationship between utilities and municipalities. Business models are variable too. On the municipal side, most are driven by a frustration with the incumbent telco and/or cable MSO, and a sense that the city is in danger of being “left behind;” and that sense has clearly grown over the past 12 months. On the utility side, FTTH is seen as an opportunity to broaden existing service portfolios.

Do the positive developments in Amsterdam and Vienna suggest that much wider build-out by municipalities may be imminent? It would be rash to generalize. In some countries, like the UK, utilities are wholly privatized and unlikely, in our view, to join muni-style build-outs. In others, local municipalities lack the funds or the power or both to undertake such builds. Social housing is a big factor in several municipal build-outs (e.g. in Amsterdam, Vasteras and Vienna) but in many cities housing is mostly privately owned or ownership is highly fragmented among many landlords, making it much more difficult to implement a municipal network. .

All the same, the builds in key cities will at the least encourage cities elsewhere to investigate the possibility of constructing networks, and some of those will translate into further build-outs. In this sense, developments over the past 12 months are clearly positive for FTTH in Europe.

2.6 Green-field Housing Build-Out

The case for fiber is much stronger where a green-field network is being constructed to connect new housing developments, and the economic case is moving rapidly toward all-fiber networks for large new green-field housing projects. Not only are costs coming down, but the cost of copper pairs is rising relative to fiber because of the high cost of copper on the world market—though prices have fallen recently, copper is twice as expensive as it was in 2004, making fiber more attractive.

This means that the amount of new housing construction is a significant factor in estimating FTTH deployment.

Reliable and comparable data on housing construction is patchy, but the evidence shows that in the most developed parts of Europe, new housing development is slower than in other regions of the world. In particular, stricter planning laws tend to work against the kind of large-scale new developments seen in the US and China. Typically, new housing in European countries represents around 1-1.5% of all housing per annum. Not all this housing is suitable for fiber deployment: much new housing is so-called “in-fill”—small-scale developments where it’s still simpler and cheaper for the incumbent to connect to an existing exchange or street cabinet using copper pairs.

The estimates for new-build, below, are based on historic information, but the margin of error in some cases may be significant. Housing construction moves in cycles, so data on new housing construction must be treated with care. In Germany, for example, new housing builds halved between 1997 and 2002. Nor does housing track country size. Countries with very high rates of new housing construction in recent years include Greece, Ireland, Portugal and Spain. Those with low rates of build include Italy and Sweden. In some countries, new housing construction is driven by vacation and holiday homes, so there is no necessary relationship between high rates of build and high rates of FTTH.

Costs clearly moved in favor of the use of fiber for larger green-field developments during 2006. However, green-field FTTH will be extremely patchy given the low levels of housing development in European countries, and will not be a big factor in the transition to mass-market fiber.

Figure 2.4: Estimated New Houses/Apartments per Year, Selected European Countries

Country	New Houses Per Annum (Thousands)
Austria	34
Denmark	18
France	334
Germany	260
Italy	135
Netherlands	67
Poland	93
Spain	404
Sweden	20
UK	183
EU 25	2100

Source: UNECE, most recent year available (usually 2002)

2.7 Construction and Equipment Cost Trends

Construction Costs

Of all the factors that have hindered deployment of FTTH, the cost of construction is undoubtedly the biggest, and on the whole, construction costs appear to be higher in Europe than in other territories. The main reason for this is that in much of the US and in Japan, it's possible to use aerial fiber. In many cities in Europe, cost of digging in fiber, including the final drop, is very high, and regulation in some cases may be onerous, increasing this cost further. However, as the table shows, the environment for construction has shown mildly positive improvement over the past 12 months, and may continue to improve. In particular, applications of new techniques such as micro-trenching and flexible drilling are said by some vendors to be resulting in an 80% reduction in civil costs where they are being used.

Figure 2.5: Key Factors Influencing Construction Costs Detailed

FACTOR	SITUATION IN EUROPE OVER PAST 12 MONTHS
Local labor costs	NEUTRAL: Variable, but generally stable
Local regulations on digging	NEUTRAL: No evidence of major changes here
Availability of ducts and dark fiber	NEUTRAL: No evidence of major changes here
Aerial vs. underground cabling	NEUTRAL: No evidence of major changes here
Changes in construction technology	POSITIVE: new technologies may construction costs

Equipment Costs

Equipment forms only a relatively small part of the overall cost wherever there is significant construction to do, and pricing, as in other electronics sectors, is global. However, the cost of equipment is still a factor in decision-making, especially where deployment and digging costs are relatively modest. Equipment costs are also a major factor in green-field deployments, where the service provider may be directly comparing to the cost of a new copper or part-copper build-out.

Costs of most equipment components are falling steadily. For PON equipment, price per subscriber for the optical line terminal (OLT) is falling below \$100 per subscriber, while the optical network terminal (ONT) is falling below \$250.

As well as falls in the cost of basic componentry, system vendors are making their own contributions to lowering costs. For example, several vendors have launched modular hybrid MSAPs that can house both DSL and fiber line cards; while this does not lower the cost of equipment, it lowers the cost of transition in existing networks there is a mix of DSL and fiber customers.

Equipment costs will continue to fall as deployment spreads, in line with general trends in the cost of optoelectronic components, and those costs are now widely seen to be similar to or lower in some cases than a new copper build.

Bottom line: although the overall cost per subscriber continued to fall in 2006, it is falling only slowly because cost is usually dominated by the cost of construction rather than electronics. Equally, the cost varies very widely from place to place, with estimates for the total cost ranging from below \$1,000 to more than \$5,000 per connected customer. This will continue to make the business case a challenge, and remains the biggest impediment to FTTH roll-out in Europe.

2.8 Regulatory and Political Changes

Two key European regulatory decisions on FTTH occurred in 2006, though the ultimate effect of these decisions is unclear.

First, the Commission ordered the German government to reverse a decision to give Deutsche Telekom exclusive use of its new FTTN-VDSL2 network, which it began deploying in 2006. The Commission strongly opposed the plan—leading DT to say that it would slow its build-out if the original decision was revoked. As a result, the German government proceeded with its plan, granting DT a “regulatory holiday” during which it will enjoy exclusive right to provide services on its network. As a result, the Commission has said it will take legal action against the German government during 2007. In a final twist, DT said in January 2007 that it was abandoning the VDSL2 build in favor of deployment of ADSL2+

The pressure on the Commission to change its policy is growing. At the BBWF in October, all four major incumbents publicly called for relief on both FTTH and FTTN/C build-outs, and France Telecom, the only incumbent committed to FTTH, implied that it too might slow down its plans if it does not get the right decision.

On the face of it, the EU’s apparent intransigence looks like a negative factor for fiber build-out, but it may not ultimately make as much difference as the incumbents insist. Although Verizon made much of the decision by the FCC to give it relief on unbundling, we believe Verizon would have built its network anyway. Our overall view is that the lack of regulatory relief is a mildly negative factor, in the short term, but will not make much difference over the longer term.

The second major decision occurred on the municipal front; a legal and political wrangle in the Netherlands over the construction of a city network in Amsterdam ended in a positive outcome for FTTH, and construction of this network began in October 2006.

Meanwhile the Commission’s important review of European telecommunications regulation, due for completion in 2006, may result in further changes, some of which could be very important for FTTH. In speeches in 2006 Commissioner Viviane Reding said she was considering all potential options, including measures that might make it easier to justify fiber deployment, particularly “open access” or municipal fiber. One important option floated in the EC’s Communication on the Review, published in June 2006, was structural separation of incumbent wholesale and retail operations—though it is unclear, at present, how this would affect FTTH builds.

Overall, regulatory decisions in 2006 were neutral for FTTH, but many key decisions remain to be taken at the European level.

2.10 Events Outside Europe And Their Impact

FTTH is a global phenomenon, and there is no doubt that developments outside Europe—especially in Asia—are beginning to have an impact on regulators and politicians, both at European and local level.

Several developments were important in this regard in 2006:

- **In Japan**, the total number of FTTH-connected households reached 5 million in early 2006, 10% of all households. On current trends, over 20% of households will be connected by the end of 2007, and the number of DSL subscribers is now declining. Penetration in Japan is over ten times that in the EU and Japan is now approximately five years ahead of Europe in the move to FTTH; by 2010-2011, Japanese providers believe they will have connected over half of all Japanese households to FTTH.

- **In the US**, the total number of FTTH-connected subscribers reached 1 million in September 2006, FTTH penetration is now more than twice the penetration rate in the EU, and the gap between the two is growing, largely as a result of Verizon's build-out. The evident success of the latter, which is on target to pass 6 million households by the end of 2006, as originally planned, is attracting increasing attention in Europe.
- **In China** there was also strong evidence in 2006 that FTTH is ready to take off, with RFI's out from major incumbent telcos and new telcos throughout the country. Hence, for example, China Telecom has connected 10,000 households to date and is likely to move forward with commercial deployment in the second half of 2007, while CNC, the other major incumbent, has also connected around 10,000 households and has similar deployment plans. Separately, rapid build-out of FTTH was confirmed in Taiwan, where Chungwha Telecom, the incumbent, said it would grow to 500,000 connected FTTH subscribers this year, and 2.4 million by 2010.

There has also been a good deal of small-scale development in countries including Australia, Mexico, Pakistan and Thailand, and in Middle Eastern oil states. Awareness of these regional trends is growing, and creating a groundswell particularly among regional and local politicians. So far, however, this has had little or no public effect on European incumbent plans.

Overall, extra-European developments in FTTH in 2006 have been mildly positive for FTTH in Europe since they have increased the pressure on European regulators and politicians to be seen to be ensuring that Europe is not left behind.

2.10 The Alternatives: FTTN, FTTC, VDSL2

VDSL2, now beginning to be deployed widely in Europe, presents a strong alternative to FTTH. VDSL2 is a more complex but also a more flexible standard than ADSL2+, and can be used in a variety of configurations to optimize performance on short and long loops and to provide both symmetric and asymmetric bandwidth schemes. VDSL2 offers ILECs an interim step to FTTH that may increase bandwidth (especially upstream) tenfold without such high investment. This is undoubtedly the reason that it is emerging as the technology of choice for most European ILEC networks, in either an FTTN or FTTC architecture.

In theory, VDSL2 can offer 100 Mbit/s of capacity in both upstream and downstream directions simultaneously. However, this assumes that extremely short loops are used – for example in in-building FTTB deployments – that little or no noise or crosstalk is present in the cables, and that the full 30MHz transmission bandwidth is used. More realistically, the capacity of VDSL2 will depend on the quality of the access cables and also the cabling topology used in a given operator's network – for example, whether there are bridged taps in the network. Most services offer no more than 50Mbit/s downstream speeds, though further developments in copper networks remain possible. In October 2006, an industry consortium led by ECI was launched to champion Dynamic Spectrum Management (DSM), said by its supporters to increase speeds on copper lines even further by reducing cross-talk.

Whatever the theory, many incumbent telcos are adopting VDSL2 in practice, and in the absence of unexpected developments in demand and competition, this will dampen FTTH buildout. Among those who have publicly committed to this approach are Belgacom, Deutsche Telekom, Telecom Italia, Swisscom, TDC and Telefonica.

Overall, VDSL2 developments in 2006 were mildly negative for FTTH. Actual deployment has begun to drive up confidence in VDSL2, and there is little sign of a major change of heart among the big incumbent telcos.

III. European Deployment of FTTH

This section looks at activity in ten countries of Europe in 2006: the “Big Five” European nations of France, Germany, Italy, Spain and the UK, which together account for 65% of all European households, and five pioneering countries where there has either been significant construction of FTTH already or there are firm plans to build in the next 12-24 months. Together, these ten countries account for the overwhelming majority (well over 90%) of all build-out of FTTH in the EU25 today, and will continue to do for at least the next 2-3 years.

3.1 Austria

In January 2006, the city of Vienna announced firm plans to build an FTTH network to connect all households in the city. The city described fiber-based broadband as a “service of general interest” that should be treated as a public resource in the same way as water or energy supply. The city government itself plans to use it for a range of services including e-government, healthcare and social services, and services for the elderly. The project is being run by the municipal utility Stadtwerke Wien, which is wholly owned by the city.

This is the single most ambitious FTTH project in Europe today, with a plan to pass 960,000 homes and 70,000 business premises when the project is completed in 20xx. This represents 30 percent of all households in Austria, making it the largest single city project of its kind in Europe. Build-out will be gradual, with 50,000 homes to be passed in the first phase, which began in mid-2006. The second stage will be larger, involving 250,000 households, and will start in 2008. The service will be engineered for 100Mbit/s delivery initially, with 1Gbit/s possible.

Like many municipal initiatives, the Vienna network will benefit from a wide range of existing ducts and cables (an estimate 2,200km of ducting alone). In particular WienStrom (the power company) and WienKanal (the sewer system) both have existing assets and experience. A key aspect of the Vienna plan is the use of the sewer system wherever possible – an approach that is expected to reduce fiber-laying costs by at least half.

For its part, Telekom Austria is showing a greater enthusiasm than most European incumbents for FTTH; it built a commercial FTTH network in an old mining town in Austria, and hinted recently that it is ready to move to an FTTB + VDSL2 strategy to compete with both the new initiatives and the powerfully positioned cable MSO. The company also said in 2006 that it was evaluating FTTH as a possible next-generation access technology to be used alongside VDSL2.

At the same time, the decision in Vienna is likely in our view to have an impact on nearby cities, not only in Austria, but also (for example) in cities in southern Germany. Some vendors report an increasing interest in the whole middle European region as a result of the Viennese decision.

3.2 Denmark

Though a small country, Denmark has emerged as an important pioneer for FTTH, with electricity utilities leading the way.

According to the Denmark's Competition Authority, utilities plan to pass almost 1 million homes with fiber under the current plan – more than 35 percent of all Danish housing. Total planned investment is €1.3 billion – about €1,300 per house passed. This ambitious plan coincides with a financial liberalization measure that came into effect in 2005 and allows the utilities to invest capital for any purpose. A widespread replacement of the existing electricity supply infrastructure is providing an opportunity to bury fiber along with new electricity cables.

Figure 3.1 provides further details. As it shows, 2006 was a major year for FTTH in Denmark, since most of the utilities began deployment in earnest this year, and ISPs are now connecting customers over these networks, which are mostly open access wholesale networks.

Figure 3.1: FTTH Deployment in the Danish Utility Market

Company	Potential Customers	Plans
DONG Energi	900,000	Plans to serve all areas by 2010; commercial deployment began in 2006
Energi Denmark ESS	73,000; up to 200,000 following completion of merger with Sydvest Energi	Deployment underway DETAILS?
Energimidt	160,000	2,000 connected end 2005
HEF	80,000	ADD
SEAS-NVE	300,000	ADD
SEF	35,000	5,000 connected by end 2006
Tre-For	50,000	6,000 by end of 2006 planned

The Danish incumbent, TDK, has no plans for mass deployment of FTTH. Its current plans entail a move to FTTN and VDSL2.

3.3 France

France saw many positive developments for FTTH in 2006. Although the situation in France is somewhat confusing, with various political and commercial interests jockeying for position, it is likely to become the most highly penetrated of the big five EU nations through the next five years.

The most important development occurred in September 2006 when Free, France's 2nd largest broadband service providers, announced that it planned to deploy an FTTH network to "10 million customers and 4 million connection points," in the words of the company's statement. Total investment will be E1billion by 2012, suggesting that the actual number of connected households will be no more than a few million by then. The company says the service will initially run at 50Mbit/s symmetric and construction will start in Paris, the nearby Hauts-de-Seine region and several other cities some time in 2007.

In October 2006, Free acquired CiteFibre, an entrepreneurial outfit that is already offering services in some parts of Paris. CitéFibre has been using existing fibers and ducts belonging to the Métro subway system, and had originally intended to pass 100,000 houses by 2007. As of October 2006 it said that it had 130 buildings cabled representing 4,000 households, of which 500 were connected, with authorization for a further 4,000 households to be connected.

A second company, Erenis, is also constructing an FTTB network in the eastern part of Paris and intends to pass 85,000 homes before the end of 2006, and 1 million by 2010. It has signed two joint-marketing deals with two large housing associations in the area, and is using the sewage system for some of the fiber. At mid-2006, the company said it had 7,500 subscribers.

In January 2006, the Mayor of Paris announced plans for an FTTH network throughout Paris, but it now seems likely that this will be constructed through the private initiatives just outlined. The city is offering assistance by making sewers and other conduits available at a lower price than hitherto, and is also lowering the price of the final drop into buildings. The city anticipates that 650,000 households will be connected to fiber by 2009.

France has seen a good many small-scale local municipal initiatives. Until recently, these were mostly small-scale and rural, for example in Pau and Gonfreville, and often supported by EU structural funds.

Meanwhile France Telecom is the first European incumbent to make a clear commitment to FTTH. It began a large-scale commercial pilot of the service in Paris and nearby Hauts-de-Seine in May 2006, and it says it has no plans for an interim fiber technology (e.g. FTTN and VDSL). While the company has not committed to a specific timetable, it says it will evaluate its experiences at the end of 2006 and probably extend the "experimental commercial" phase in 2007 to other regions. It cites a wide range of potential applications driving the move to FTTH, including HDTV, instant downloads, high-quality videoconferencing, and secure data storage, among others.

3.4 Germany

Germany is Europe's largest country, accounting for almost 20% of all households, but it has also been among the most conservative on broadband until recently, partly because there has been little facilities-based competition in broadband.

However, several positive developments in 2006 could change this situation over the next year or two. In particular, several municipalities have announced plans to build fiber networks, the most important of which is in Cologne and the surrounding area. NetCologne, indirectly owned by the city of Cologne, is working with local utility RheinEnergie to build a city-wide network, with a planned investment of €250 million over a three-year period connecting "115,000 multifamily dwellings and business premises out of Cologne's total 203,000 buildings," according to its press statement. NetCologne began construction work on this network in July 2006.

Another significant project is in Eastern Bavaria, where alternative operator R-KOM is planning to roll out an active Ethernet FTTH network in 19 locations this year. There are also some smaller initiatives, for example in Schwerte, which is planning to use sewage pipes to cut the price of the final drop. The project is being run by Stadtwerke Schwerte, majority owned by municipalities but also part-owned by RWE.

Also in 2006, Deutsche Telekom began connecting households to its FTTN/VDSL2 network, but still has no plans to move directly to FTTH. Indeed, its aim seems to have been to close off the argument and forestall any significant move to FTTH or FTTB in the next three to four years. The VDSL2 plan was rolled out in ten major cities in 2006, covering about 3 million households, with 50 cities in total to be covered in the current plan.

As noted earlier in the regulatory section (2.7), Germany also bore witness to a major dispute between DT, the German government and the European Commission. The Commission reversed a decision by the government to relieve DT from the obligation to unbundled its new VDSL network. The argument continues, however, and a compromise may yet be reached that gives DT relief for a limited period.

3.5 Italy

Italy is home to Europe's largest FTTH pioneer, Fastweb, which has connected approximately 200,000 households to its fiber networks, mostly in Milan. However, Fastweb's strategy has evolved over the past two years: it now aims to become Italy's second telco, and to that end it will, at least initially, base its network expansion almost entirely on unbundled Telecom Italia loops, not its own fiber networks. There is no indication that it plans to return to the fiber strategy.

Fastweb's all-fiber network is largely confined to Milan and a few other cities, and growth is now confined to connecting new customers in areas already equipped for fiber connections.

Fastweb is not the only fiber-based network in Italy, though it is by far the largest. There are several small municipal networks, as well as some larger regional initiatives that may lead to more

widespread government involvement in fiber builds. However, there was little sign of movement here in 2006.

There were, however, more positive signs from the incumbent, Telecom Italia. The company had previously said it saw a need for 50Mbit/s connections in the near future; this year it added that it would use a mixture of FTTC, FTTB and FTTH to build its next-generation access network, with "FTTC first" except in densely populated metropolitan areas, where it anticipates using FTTB. The company said that laboratory modeling had suggested that 20-25% of homes might be connected via FTTB in dense urban areas.

3.6 The Netherlands

While relatively few households have been connected to fiber yet, there is little doubt that the Netherlands is the hottest European FTTH market today, primarily because many municipalities are either deploying or looking to deploy fiber. Towns and cities that have announced plans are shown in figure 32.

The plans have been controversial. As well as KPN, the incumbent telco, the Netherlands has a nearly ubiquitous cable MSO network, with most operators offering triple-play packages. These companies have launched a series of legal challenges to try to prevent construction of networks in Amsterdam and in some other cities. The most important of these challenges was in Amsterdam; the dispute ultimately ended up in the Dutch parliament, where in June 2006 the parliament declared the new networks legal.

As a result, Amsterdam began construction of its landmark network in October 2006. In the first stage, between 2006-2007, 40,000 homes will be passed, with completion of the entire network slated for 2013. As elsewhere in the Netherlands, Amsterdam has adopted a three-layer model consisting of a passive infrastructure (Glazvezelnet Amsterdam) in which the city owns one third, ING Investment Management owns one third, and five housing associations own the other third in a public-private partnership (the housing associations collectively account for over half of all housing in Amsterdam); an active layer which was awarded to BBned; and a service provider layer where 75 service providers are said to be ready to offer services. The plan is to use "smart digging" with other utilities to keep the cost down. The plan is based on an expectation that it will achieve 50 percent penetration of homes passed.

Figure 4.3: Municipal Networks in the Netherlands

NETWORK	ACTUAL HOMES CONNECTED	PLANNED HOMES PASSED
Almere	2,000	80,000 by 2010
Amsterdam (Planned)	N/A	450,000*; 40,000 in the first stage
CasaNet	2,000	
Nuenen (part of the Kenniswijk Project)	7,500 connected, 90% of all homes passed	Being extended into Eindhoven, a much larger city
Portaal Housing Assn. (Planned)	N/A	55,000 in five cities
Rotterdam (Planned)	1,500	40,000 initially
The Hague (Planned)	N/A	Committed to build, but no firm plans

**includes businesses.*

In **Rotterdam**, the network, called the Fiber Maas is mostly driven by the need to connect offices, businesses, schools and so forth, but there is also a plan eventually to connect houses via ar-

rangements with local housing cooperatives. At mid-2006 there were 4,000 connections, including businesses and schools.

In **Eindhoven**, a small network connects 8,000 homes, but the city intends to connect the whole city (population 700,000) over time.

In **The Hague**, city authorities have talked of a city-wide network ultimately passing 240,000 houses, but without any actual commitment to date.

In addition to these major initiatives, there are many smaller networks, of which the new town of **Almere** is among the early examples. This is another public-private partnership with ambitious plans ultimately to connect about 80,000 households; it began roll-out proper in the second half of 2006.

There is also some limited CLEC activity—for example in Hillegom, where Lybrandt is constructing an FTTH network, and says it may also construct a network in the larger city of Harlem.

Meanwhile KPN said in 2006 that it intends to build out more FTTX in future. The company says that it will collocate fiber and/or ducts with CityNet in Amsterdam, and intends to offer its own fiber rather than using CityNet. KPN says it already is laying FTTH for green-field deployments.

3.7 Norway

The most important FTTH provider in Norway is Lyse Tele – a subsidiary of Lyse Energi, a multi-utility services company. Lyse Tele said at October 2006 it had contracted for service with 45,000 customers, mostly FTTH, and had a further 10,000 on a waiting list; this makes it one of Europe's larger projects. Lyse said during 2006 that is planned to connect another 200,000 customers over the next five years in Lyse and the surrounding area, and Lyse Tele, which is franchising its solution both in Norway and elsewhere, says that the total potential including these franchise operations is one million households. Lyse Tele's penetration of homes passed is encouraging for other builders: it reported between 60-80% penetration, driven by intensive pre-selling before an area is built out.

In Oslo, meanwhile, the entrepreneurial outfit Viken Fibernet has begun building an FTTH network and is now connecting customers.

3.8 Spain

Spain saw little change in 2006. The most significant fiber project in the country is in the Principality of Asturias, where the government initiated an €19 million project to connect former mining communities to an FTTH network. Work began on the network in 2005; it will ultimately reach 20,000 homes, covering all communities in the region, with a projected 80 percent subscribing.

A much larger fiber project is also in the planning stages in the region of Catalonia, though the focus of this is currently metropolitan and long-distance fiber, and it is unclear if it will involve much FTTH.

At the same time, Telefónica has made several public statements on the need for regulatory relief in order to enable it to move toward a fiber-based network. In presentations, the company has noted that bandwidth beyond 50 Mbit/s will be needed in the medium term, but it has made no clear commitments in terms of actual deployment timetables or the type of FTTx it intends to use. It seems highly likely that, like other European operators, it will move initially to VDSL2.

3.9 Sweden

Sweden has the highest penetration of FTTH today, driven both by the early deployment of FTTH by two major competitive telcos – Bredbandsbolaget (a.k.a. B2) and Bostream, which subsequently merged and were then acquired by Norwegian incumbent Telenor – and by strong municipal and utility involvement right across Sweden.

FTTH development has been assisted by the structure of the Swedish housing market, with much housing owned communally by housing associations, making it easier for FTTH entrants to create across-the-board agreements for fiber deployment. The strong build-out has also been facilitated by the Swedish Urban Network Association (SSNF), which reports that 200 out of 290 municipalities have a self-owned fiber network of some kind in place (not necessarily FTTH at this stage, though many are building or considering building). These include an ambitious fiber project in the northern province of Vasterbotten, which intends to make fiber available to most households over time.

Many of these networks modeled on Stokab, Stockholm's pioneering open municipal infrastructure, which aimed to reduce digging by creating a single infrastructure that is open to all-comers. Stokab has about 450 customers, including 60 network service providers and operators, and is a profitable concern. In 2005, the city council said that it intended to offer connections to the city's 100,000 council-owned apartments.

One of the most advanced of these is in Vasteras, a Swedish town 100 km west of Stockholm. The FTTH network in Vasteras is being built by a utility owned by the municipality, Malarenergi – which operates it through its subsidiary Malarenergi Stadsnat ("City Network"). To date, 23,000 apartments and 7,000 houses have been connected in Vasteras. This represents about half of all households in the city, making this the most successful all-fiber municipal network of any significance in Europe. The total includes all of the 13,000 apartments owned by the main local housing authority, Mimer, of which about 60 percent are actually using services. Completion of the network is expected by 2007.

To date, incumbent TeliaSonera has made no significant pronouncement about FTTx, suggesting that the gradual buildout of fiber by municipalities will continue to dominate, although TeliaSonera is itself bidding to build and manage some of these networks. As for B2, it has been focused for several years on building market share via unbundled local loops, and has no published plans to return to an FTTH strategy.

Though there were no major developments in 2006, Sweden will likely maintain its early lead for some time.

3.10 UK

Of all the major European nations, the UK shows the least inclination to move toward fiber, and although BT has been experimenting with FTTH for almost two decades, it does not currently see a case to deploy it. In a presentation in October, the company said it was modeling the case for FTTC and VDSL, and said that this "may be a near-term solution," but said it was "difficult to contemplate how it makes sense to go to FTTP/FTTH" except in some green-field builds. There are also very few local initiatives in the U.K., since municipal government is weak and dependent on central funding.

The UK regulator Ofcom has given little encouragement to FTTH; it warned recently that it would lead to "costly distortions in the market if we are not as neutral as possible in respect to technologies." Ofcom argued that the case for fiber was especially difficult in the UK market.

However, some vendors say that there are a number of initiatives under the radar that may change the balance in the next 12 months. There is also one major municipal project called Digi-

tal Region South Yorkshire that involves bringing high-speed broadband to 500,000 houses, though it's not clear at this stage how many (if any) will be connected using FTTH; a strong emphasis on price in UK public projects suggests the network may in the end comprise largely of FTTN. The timetable for the project suggests a decision will be made at the end of 2006.

FTTH Forecast

4.1 Assumptions & Main Forecast

This forecast consists of a high-level generic forecast and regional and country forecasts for major countries. It also segments the market by type of provider, type of property.

The main cumulative forecast is shown in the introductory section, figure 1.1.

As figure 4.2 shows, this overall picture conceals major differences in penetration which we expect to persist through the next five years. Figure 4.2 shows our expectations for the ten countries we presented in detail in section 3.

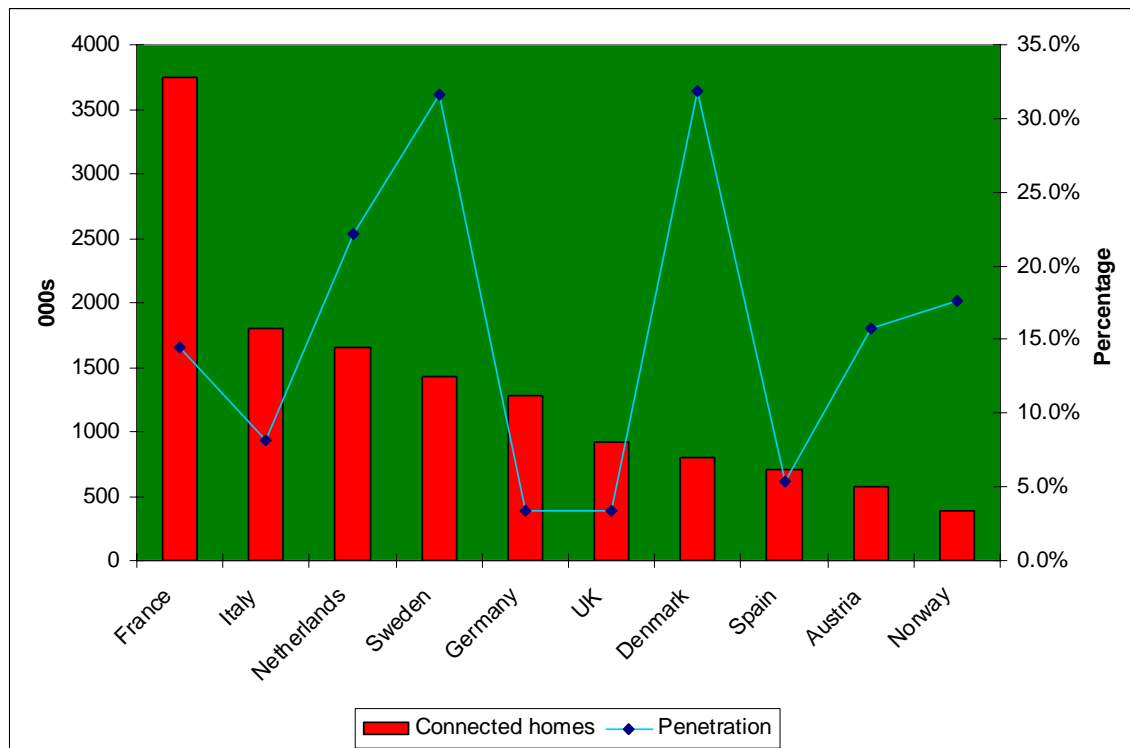
Briefly, the main factors that underlie these differences, in approximate order of importance, are:

- Attitudes and plans of the three main types of builders
- Regulation and government policy
- Local construction cost issues, especially availability of ducts and local cost factors
- Density of housing, proportion of MDUs and greenfield construction
- Local appetite for high-bandwidth services

Note that this listing, and the order of the listing, do not indicate that these are **overall** the most important issues. Some issues—such as cost of equipment and underlying demand—evidence little difference between countries, even though they are very important overall.

These differences are important, and account for the wide differences we expect in penetration through the next five years. However, as with all other new technologies, the sharp differences we see will diminish over time as all countries move in the same basic direction.

Figure 4.2: FTTH Households & Penetration in the Main Ten Countries (2011)



4.2 Optimistic and Pessimistic Scenarios

In this section, we build on the forecast in 4.1 by providing to alternative scenarios based on optimistic and pessimistic views of outcomes for our leading indicators for FTTH deployment (see section 2 for further details on these indicators).

Figure 4.3 explains how we created these alternative forecasts. The basic ideas here are as follows:

- Leading indicators that can potentially have a strong effect if they occur can delay or accelerate broadband penetration by up to two years; those with a medium effect by 6 months; those with a weak effect, three months. Hence if (for example) the first three pessimistic assumptions shown in the chart occur, the total effect is a delay of 18 months.
- Where we believe that either of the proposed outcomes is more likely, we have taken this into account in measuring the impact—hence for example in the case of the first indicator—marketing and take-up of 2nd generation product—since we do not expect the pessimistic assumption to occur, we have increased its potential impact if it **does** occur. In effect, this takes into account our confidence in the likely outcome we expect
- In the accompanying forecast, we do not assume that all factors, optimistic or pessimistic come into play in each scenario, since this is highly unlikely. Instead we have assumed that three or four factors occur—a much more likely outcome.

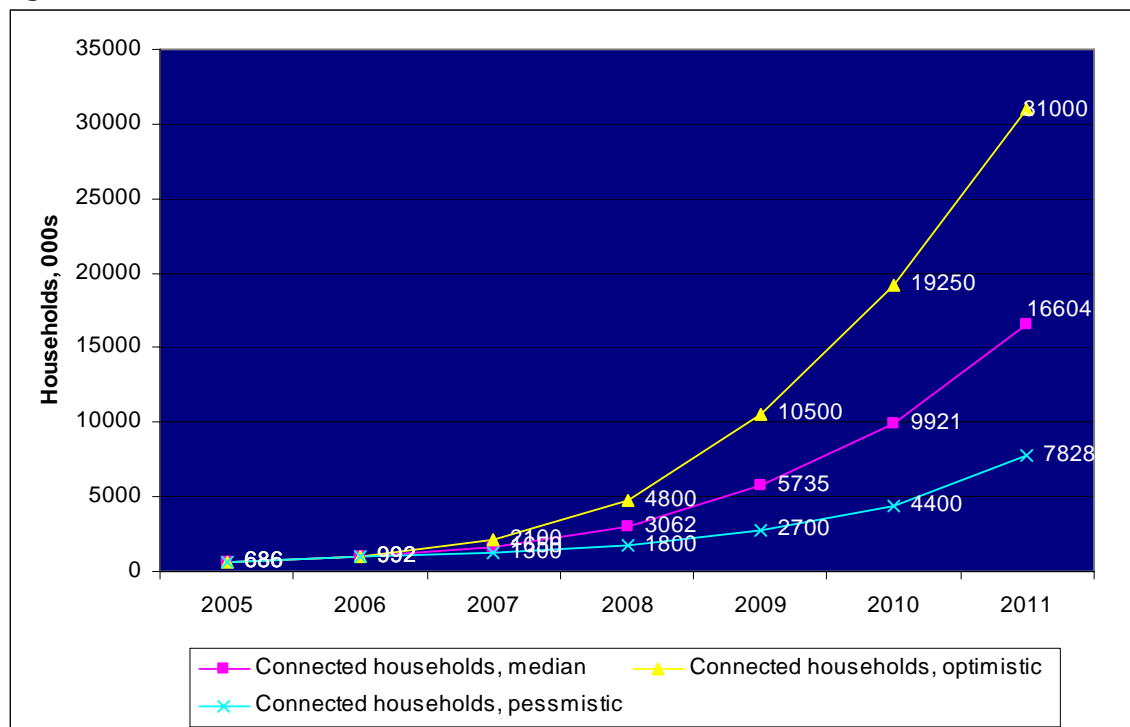
Figure 4.3: Leading Indicators—Optimistic and Pessimistic Assumptions

Leading Indicator	Pessimistic assumptions	Optimistic assumptions
Marketing and take-up of 2 nd generation broadband products (8mbit/s+)	Most users choose lowest-price broadband options; pricing tends to tiered premium product model, discouraging shift to higher speed services; ULL runs into difficulties, muting competition	Competition leads most broadband providers to encourage shift to higher-speed packages at same price point; continuing success of ULL encourages intense competition around price per megabit
Service & CE trends—HDTV, next-generation games machines, video/photo blogging etc	Economic downturn affects equipment purchasing; consumers ignore HDTV service offerings; interest wanes in Internet video and photo sites	Boom in CE equipment purchasing continues; big upsurge in interest and use of HDTV; massive boom in use of video and photography sites on Internet
Stated attitudes and plans of ILECs	Strong commitment to ADSL2+ and VDSL is maintained through most of the forecast period by most incumbents	Pressure of end-user demand, competition and regulation lead to much faster deployment than currently envisaged
Entrepreneurial broadband activity (CLECs)	Financial and competitive pressure forces CLECs to trim capex; Free plan fails to achieve objectives	Free build-out begins successfully, leading to imitation in some other countries
Municipal and utility plans and impact	Activity largely confined to existing planned builds; builders run into difficulties keeping to timetables; investors (including utilities) lose interest	Planned builds have a big impact elsewhere as political movement builds across Europe; early deployments achieve or exceed goals in homes passed and penetrated, increasing confidence among investors
Equipment and construction cost trends	New construction techniques fail to have a real impact; copper price stabilizes or falls; only modest falls in electronic equipment pricing	New construction techniques encourage build-outs; copper price continues to rise; competition drives big drop in electronic equipment pricing

Regulatory and political changes at European and national level	Muni build-outs successfully challenged; incumbents delay builds to pressure regulators for relief	Active and widespread encouragement to muni builds at local political level; EU reaches rapid decisions on next-gen regulation; incumbents proceed with plans regardless of relief issue
Events outside region and their political & commercial impact	Verizon runs into difficulties with penetration/financing; muni builds challenged in US; Japan build-out slows; China build-out delayed	AT&T announces major FTTH build; US muni movement gathers pace; US CLECs continue big build-out; Japan achieves planned growth; China begins aggressive build-out in 2007
Assumed effect	Deployment at end 2011 delayed by 1.5 years	Deployment at end 2011 accelerated by 1.5 years
Potential impact		
HIGH	Factor delays penetration by 9 months	Factor accelerates penetration by 9 months
MEDIUM	Factor delays penetration by 6 months	Factor accelerates penetration by 6 months
LOW	Factor delays penetration by 3 months	Factor accelerates penetration by 3 months
Bold Face	Most likely outcome; items where no text is bold are evenly balanced	

The impact on uptake is shown in figure 4.4. The overall difference in uptake between the optimistic and pessimistic scenario is about three years; because FTTH is in a period of very high growth from one year to the next, this results in big difference in outcome for the end of the forecast period. In terms of penetration, the optimistic scenario results in a penetration rate in 2011 of 15.6%; the pessimistic scenario results in a penetration rate of 3.8%.

Figure 4.4: Forecasts With Different Assumed Scenarios

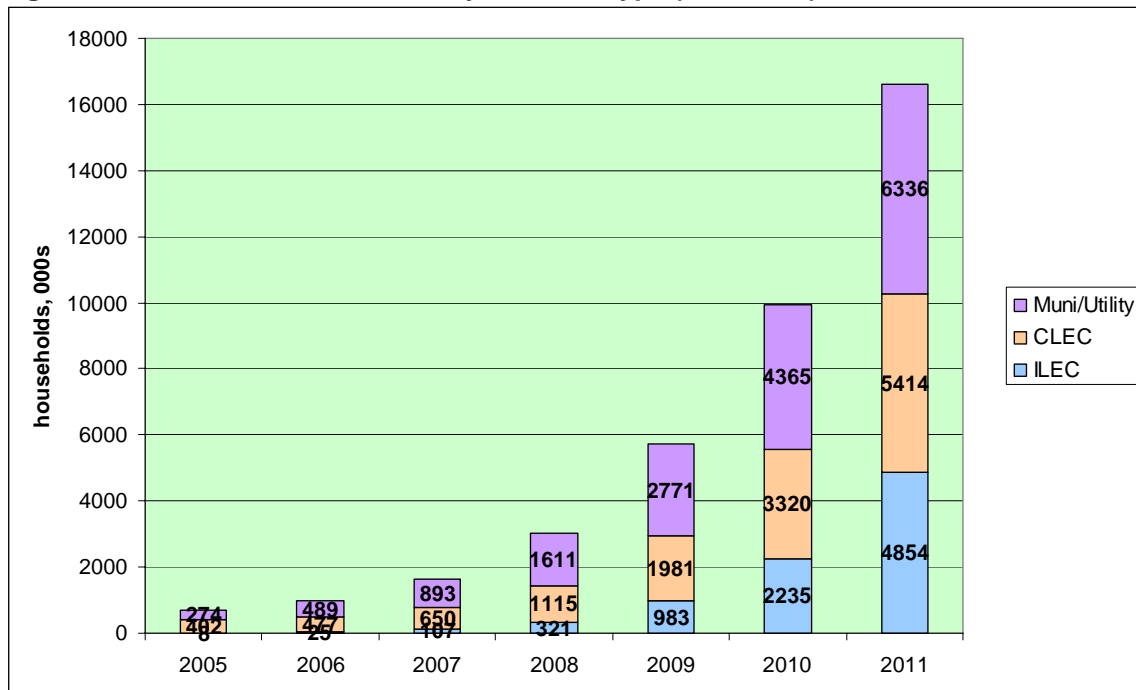


4.3 Deployment by Provider Type

The broadband market in general is marked by major differences in the type of dominant operator, and the degree to which the incumbent telco controls the market, and this will continue in the fiber world. Regionally and nationally, there will be big differences.

In creating this forecast, we assumed three basic types of provider: ILECs, CLECs, and municipality/utility developers. While elsewhere in the world ILECs are tending to dominate roll-out, this has not been the case in Europe, and the situation will change only slowly. The most important providers for the foreseeable future will be municipalities and utilities, with ILECs beginning to make an impact from 2009. CLECs will also play a role, especially in France, which accounts for almost half the CLEC figure for 2011 in figure 4.5

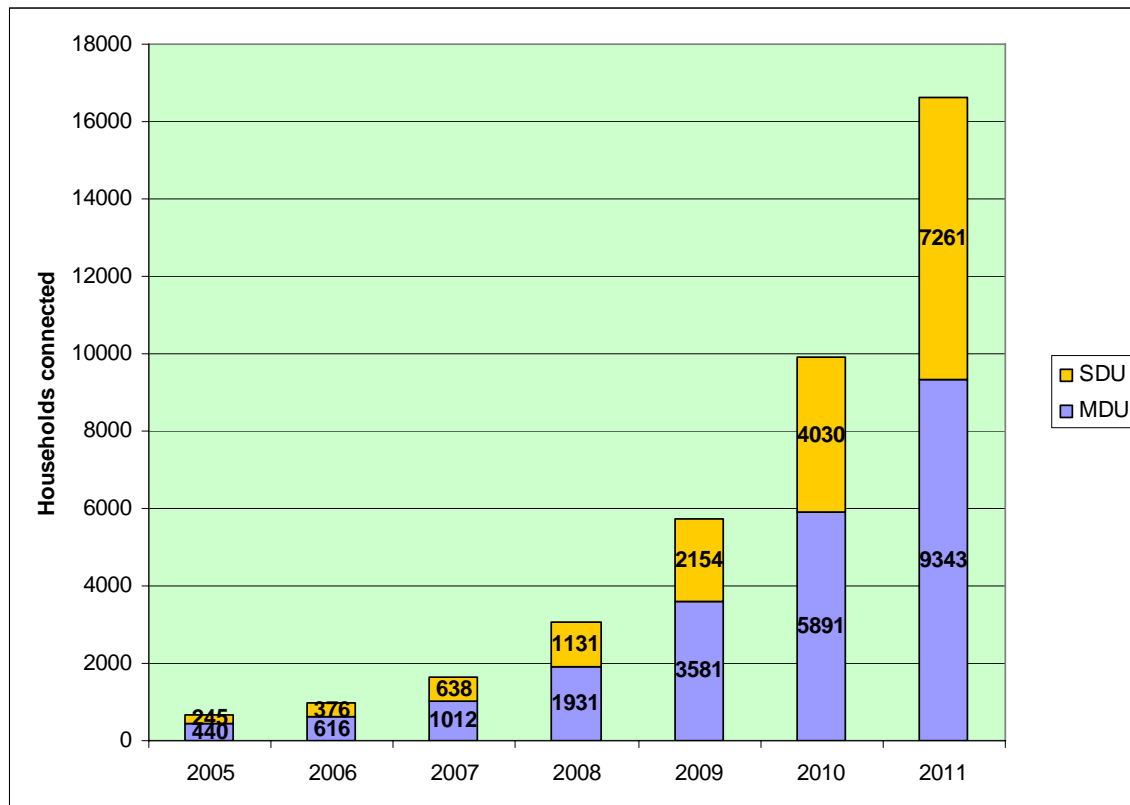
Figure 4.5: Connected Households by Provider Type (2005-2011)



7.5 Deployment by Household Type

Figure 4.6 shows deployment by type of household. Initial fiber developments have been strongly skewed towards MDUs in many countries, reflecting the early build-out in some densely populated cities such as Milan. That is likely to continue, but as penetration grows the balance will swing slowly back toward SDUs, ultimately reflecting the overall balance of housing stock in Europe.

Figure 4.6: Connected Households by Household Type (2005-2011)



7.6 Conclusion: The Future of FTTH in Europe

Though FTTH penetration grew in Europe during 2006, it was a frustrating year for those who see it as the future of broadband. In the US, connections more than doubled to over 1.5 million households, while in Japan almost 4 million new connections were added. In Europe—a much larger market than either the US and Japan—new connections grew by only about 400,000 households.

In 2007, we expect some modest further improvement, but the market will not really take off, in our view, until 2008. The main reason for this slow relatively slow ramp-up is the relative lack of interest in FTTH among incumbent telcos in Europe. Uncertainty about regulation in the light of the EU's current regulatory review is also acting as a drag on developments.

Yet the pressure will continue to build, and that may yet result in a faster take-up than we are currently predicting in our median forecast. Specifically, things could happen more quickly if:

- Economic revival drives explosive growth in very high speed copper-based broadband, or in key consumer electronics sectors, or both
- Decisions at the EU strongly encourage infrastructure investment either by incumbents or by competitive telcos

For FTTH watchers, these are the important areas to watch in 2007. For now, caution remains the watchword in Europe, but real take-off in European FTTH could occur anywhere between the second half of 2007 and the first half of 2009. Tracking the indicators set out in Figure 2.1 will provide an early warning of just when the acceleration will begin.

Appendix A: About the Author

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Finnie has been researching telecommunications for almost 20 years, formerly as a journalist and latterly as an analyst and consultant. He joined *Heavy Reading* in 2004 from a ten-year tenure at the Yankee Group. Among other things, Finnie has been responsible for a series of reports on next-generation broadband, including *Next-Generation Broadband in Europe: The Need for Speed*, March 2005, *Residential DSL Gateways: Beyond the Router*, February 2006, and *FTTH Worldwide Market & Technology Forecast*, June 2006.

At the Yankee Group, Finnie researched a wide range of topics, latterly establishing a European broadband and media practice. As a journalist, he was editor-in-chief of the award-winning industry paper *Communications Week International* and has edited several other leading trade publications.

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