Study on the Development of the Submarine Cable Market

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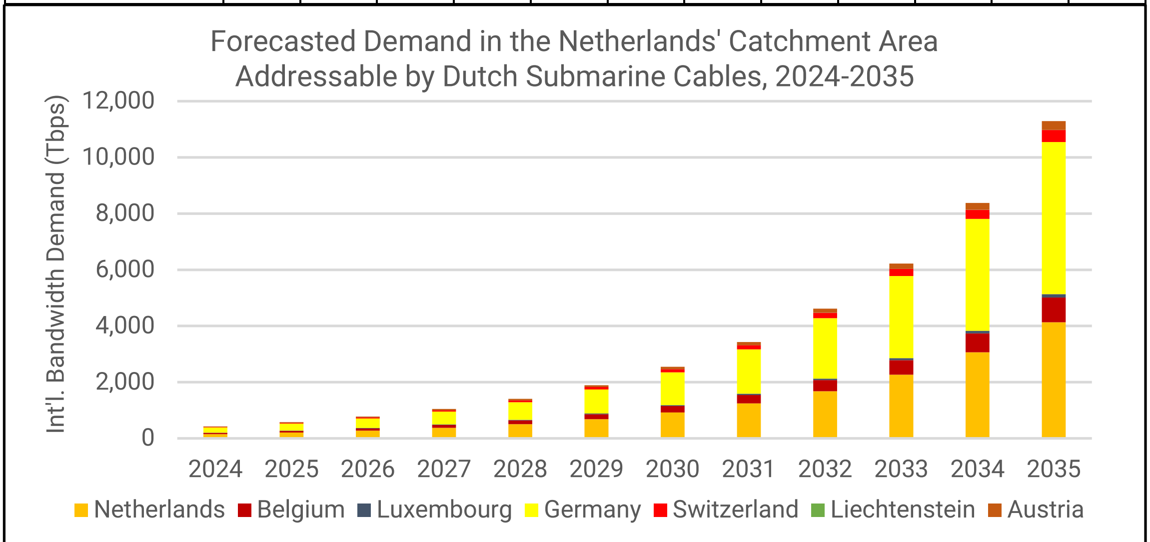
I. Executive Summary

This study presents an analysis of the submarine cable market in the Netherlands and surrounding countries, focusing on overall submarine bandwidth supply, demand, and pricing, as well as submarine cable system costs. The study concluded that if the Netherlands continues to attract and support next-generation submarine cable infrastructure and leverage its robust digital ecosystem of data centers, internet exchange points (IXPs), and IP transit, the country will be positioned as a preferred international submarine cable gateway for more than 132 million residents and 10 million businesses.

The study's model of international bandwidth demand conservatively indicates that the addressable bandwidth opportunity for Dutch submarine cables, comprising both demand from the Netherlands as well as a share of the demand in adjacent markets, will grow at a CAGR of 35 percent over the next 11 years, from 430 terabits per second (Tbps) in 2024 to 11.3 petabits per second (Pbps) in 2035. This compares to historical growth of 33 percent between 2010 and 2023.

Figure 1: Forecasted Demand in the Netherlands' Catchment Area Addressable by Dutch Submarine Cables (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Netherlands	152	206	278	375	506	683	922	1,244	1,680	2,268	3,062	4,133
Belgium	45	59	78	102	133	175	229	300	392	514	673	882
Luxembourg	7.6	10	13	16	21	27	34	44	56	72	93	119
Germany	184	250	340	463	629	856	1,164	1,582	2,152	2,927	3,981	5,413
Switzerland	23	30	39	51	66	86	113	147	192	251	327	427
Liechtenstein	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.6	2.0	2.6	3.3	4.2
Austria	17	23	30	38	50	65	84	110	143	185	241	313
Total – Netherlands Catchment Area	430	578	777	1,045	1,406	1,892	2,546	3,429	4,617	6,220	8,380	11,293



Bandwidth demand in the Netherlands and across Europe has been extremely robust post-pandemic, driven by increased next-generation mobile data consumption, widespread adoption of fiber optic connections to homes and businesses, and the continued trend of remote work and videoconferencing. In addition, demand for cloud services and bandwidth-intensive AI applications has led to more intensive data center bandwidth demand and connectivity requirements, particularly to and from data center hubs such as the FLAP-D (Frankfurt, London, Amsterdam, Paris, Dublin) markets.

Demand for bandwidth to global destinations has shown and will continue to show strong growth; benchmarking of historical demand on transoceanic routes and in peer markets revealed a historical CAGR range of between 32 and 47 percent since 2010, and forecasted growth of 31 and 45 percent during the forecast period leading up to 2035. In particular, the African intercontinental, Europe-to-Asia, and East Asian regional submarine cable markets are each forecasted to grow at rates exceeding 40 percent. Despite this, the majority (93 to 94 percent) of the Netherlands region's submarine cable bandwidth demand will be for content in North America and Europe, translating into significant forecasted investment in transatlantic (Netherlands-US) and cross-Channel (Netherlands-UK) submarine cable projects.

By year-end 2024, the supply of submarine cable bandwidth in the Netherlands will be provided by nine active submarine cables, including eight regional European systems (one of which is currently under construction) and one transatlantic system, for a total of 444 fiber pairs serving European destinations (mostly the United Kingdom) and eight fiber pairs across the Atlantic to the United States. However, these systems are not considered to be collectively sufficient for the Netherlands' future international capacity requirements. The Netherlands' only transatlantic system, Atlantic Crossing-1, entered service in 1999 and has already exceeded its planned technical lifespan. Four of the country's regional European systems are also at least 25 years old, which could present potential technical limitations on the use of new transmission technologies going forward. This effectively leaves the Netherlands with only four next-generation submarine cables controlled by only a handful of operators, as three are single-owner systems connecting to the UK and the fourth is a two-investor system linking to Denmark.

Terabit Consulting's model of global submarine cable demand forecasts that between 2025 and 2032, 12 new transatlantic cables, eight new Europe-to-Asia cables, five new South American intercontinental cables, and one new African intercontinental cable will be required to accommodate market demand for bandwidth. A conservative forecast of the outgoing bandwidth demand in the Netherlands' catchment area, coupled with a forecast of that demand's addressability by Dutch submarine cables, reveals that approximately 22.7 percent of transatlantic demand would be efficiently served by Dutch submarine cable landing points, equating to the forecasted construction of at least two new transatlantic submarine cables serving the Netherlands by 2032. Although demand could theoretically be accommodated by new regional systems interconnecting through existing hubs (e.g. Netherlands-UK cables offering onward transatlantic capacity via UK-US cables), deployment of direct transatlantic cables connecting the Netherlands to North

America bring several inherent commercial and technical advantages over the use of two or more interconnecting paths, including decreased risk and lower latency.

Additionally, for purposes of network redundancy and efficiency there will be an attractive business case for investment in submarine infrastructure connecting the Netherlands to other markets, particularly on the Europe-to-Asia route; continued construction of submarine cables to European destinations such as the United Kingdom will also be imperative to ensure the Netherlands' continued leadership as a digital hub. Moreover, to maximize the resiliency of the country's submarine cable infrastructure, deployment of submarine cables on other routes (for example, from the Netherlands to Germany, Scandinavia, France, Spain, or Portugal) would bring further value.

The price of submarine cable bandwidth (which is traditionally sold in the form of both short-term leases and long-term indefeasible rights-of-use or IRUs) has dropped significantly over the last 35 years of the transoceanic fiber optic cable era. This price erosion has been driven by two primary factors: first and foremost, advancements in optical transmission technology that have massively reduced the per-bit unit costs of constructing submarine systems; and second, competition among submarine cable operators, particularly in the wholesale market. The current monthly lease price of a 100 Gbps transatlantic wavelength is between $5,500 and $7,500; by comparison, a 10 Gbps transatlantic wavelength cost the same price in 2014, so bandwidth prices have effectively decreased by 90 percent over the last ten years. Intra-European 100 Gbps wavelengths, meanwhile, are currently priced at approximately $1,000 per month.[1]

Historically, there were significant differences in the pricing of capacity to different Western European endpoints, primarily as a function of distance and the level of competition in each marketplace. However, as of 2024 sources confirmed that the pricing of bandwidth had converged for most major markets; for example, transatlantic wavelengths from the United States to London, Paris, Amsterdam, or Frankfurt are all priced equally for identical service levels.

Submarine cable construction costs have typically ranged from $10 million for the simplest point-to-point cable with no submerged electronics, to as much as $1 billion for the most complex, repeatered, multipoint intercontinental systems. A detailed cost analysis indicates that the cost of new submarine deployment along several regional routes serving the Netherlands would range from $30 million for an unrepeatered UK-Netherlands cable to $106 million for a repeatered Ireland-Netherlands system.

There are no material country-by-country differences in the costs of developing submarine cable infrastructure in Europe other than the obvious costs incurred by geographical and bathymetrical considerations. That is, any differences in project costs between European countries are primarily a function of a cable project's length and the universal challenges related to its marine installation, such as burial requirements. For example, a transatlantic cable path from New York to the Netherlands is approximately

[1] USD has served as the historical currency for quotations of submarine cable construction costs and submarine cable bandwidth leases/purchases.

13 to 14 percent longer than a path from New York to the United Kingdom, incurring higher costs for both cable and submerged electronics. Additionally, while cables across the open sea are mostly surface-laid in deep water, a cable continuing on to continental Europe will incur higher burial costs to ensure the adequate protection of the cable in shallow and heavily-fished waters, such as in the North Sea, and cable burials in the region often involve complex crossings of pipelines and other cables. Ultimately, the study's cost analysis performed by technical experts Axiom indicated that a US-Netherlands cable will cost 15 percent more than a US-UK cable, due to the costs of supplying a longer cable with additional repeaters and equalizers, as well as more complex burial requirements and potentially higher-dimensioned power feed equipment (PFE). Beyond these technical considerations, the Netherlands is not considered to be at any competitive advantage or disadvantage compared to other European markets with respect to the costs of installing like-for-like submarine cables; for example, regulatory and permitting processes and timelines, as well as seabed occupancy fees, do not vary significantly between European markets.

In conclusion, as one of the most robust digital ecosystems in the world, the Netherlands' internet, IXP, data center, and transit network infrastructure will continue to drive strong growth in demand for international submarine cable bandwidth. At the same time, the sustained health of that digital ecosystem, and its ability to flourish, will be dependent on the development of next-generation, diverse, high-capacity submarine bandwidth connecting the Netherlands to Europe, North America, and beyond. The country's existing submarine infrastructure, while offering nominal bandwidth capacity of more than 450 fiber pairs, is nonetheless insufficient for future demand because of deficiencies in its modernity (more than half of the country's submarine cables are over 25 years old), diversity (ownership of newer systems is concentrated among just five owners), and geographic reach (most cables connect only to the United Kingdom, and the Netherlands' sole transatlantic cable is expected to be retired in the near-future). Investment in new regional and long-haul submarine cables is clearly justified by the current and forecasted bandwidth demand of the Netherlands and its adjacent markets, and an analysis of bandwidth pricing and cable construction costs did not identify any obstacles to the Netherlands' competitiveness in attracting investment. To that end, strategic collaboration between the public and private sectors, including initiatives like the Dutch Subsea Cable Coalition and the coordinated efforts of regional and EU partners, will be crucial for advancing the country's submarine cable development and enhancing the value of the Netherlands' digital hub.

II. Introduction

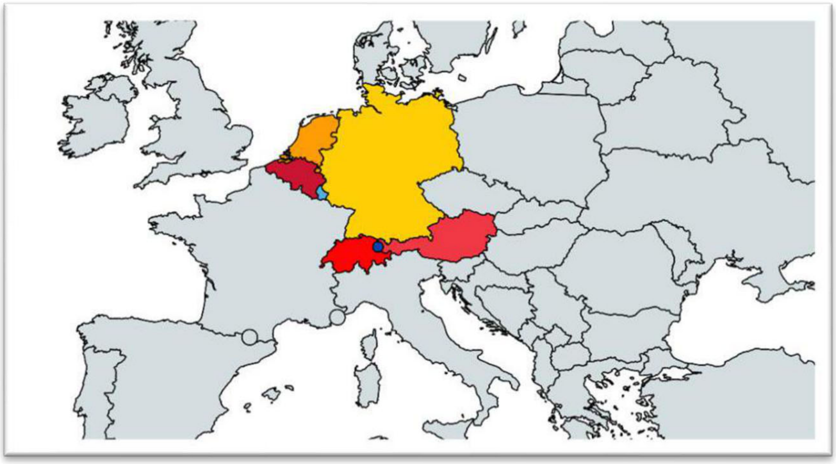
Between May and August 2024, Terabit Consulting and Axiom performed a detailed analysis of the current and future developments in the local submarine cable market in the Netherlands region as well as globally, in order to provide an empirical underpinning for the prioritization of particularly relevant and interesting subsea cable systems.

The results of the analysis are presented in this study, which comprises the following elements, as enumerated in its terms of reference:

Theme	Research Questions	Chapter(s)
Development of data and bandwidth demand	- Quantitative estimate of expected development of bandwidth demand for period 2024-2035 i. In the Netherlands and its hinterland ii. In a set of relevant other regions in Europe iii. In global growth regions - Reflection on existing level of subsea cable connectivity between global growth regions and the EU.	III, IV
Existing and planned cable systems	- A table of existing submarine cable systems in Northern and Western Europe, containing as a minimum above mentioned relevant information per cable - A table of projected submarine cable systems in Northern and Western Europe, containing as a minimum above mentioned relevant information per cable - A map presenting the submarine cable systems included in the above requested tables - A critical reflection comparing the existing and planned cable systems to the forecast of the expected development of bandwidth demand - Recommendations for relevant possible new cable routes, based on above-mentioned characteristics	V, VI
Capacity and fiber pair pricing	- Current capacity pricing in Netherlands and in a relevant set of neighboring countries, in euros - Reflection on the relevant factors influencing the current capacity pricing - Current fiber pair pricing and in a relevant set of neighboring countries, in euros - Reflection on the relevant factors influencing the current fiber pair pricing	VII
Cable construction costs	- Estimate of the level of current cable construction costs i. in the Netherlands' western and northern coastal area ii. in a set of relevant surrounding countries - Estimate of the future level of cable construction costs. Estimate should provide insight in expected evolution of cable construction costs in the coming 10 years. i. in the Netherlands' western and northern coastal area ii. in a set of relevant surrounding countries	VIII

The analysis determined that the Netherlands is a logical and efficient submarine gateway for at least seven European countries, comprising the Netherlands itself and a "catchment area" of adjacent and nearby markets served in part by terrestrial transit linkages to the Netherlands' submarine cable infrastructure, namely:

1. Netherlands
2. Belgium
3. Luxembourg
4. Germany
5. Switzerland
6. Liechtenstein
7. Austria



The European market is primarily served by two types of submarine cables: short, regional, repeaterless systems of a few hundred kilometers or less (e.g. cross-Channel, UK-Netherlands cables) and longer repeatered systems connecting Europe to other regions (e.g. transatlantic cables from Europe to North America). The Netherlands' geographic position and strong digital ecosystem of data centers, internet exchange points, and network infrastructure makes it an ideal landing country for both categories of cables, leveraging onward transit connectivity provided by Europe's abundant terrestrial fiber networks. The "catchment area" defined by the study is estimated to represent more than 90 percent of addressable demand, but Dutch submarine cables are also positioned to capture transit demand from adjoining regions. This includes traffic passing to and from Central and Eastern European markets (notably, bandwidth demand coming *from* the United Kingdom was not determined to be a significant addressable market, since much of the UK's international bandwidth demand is directed toward the United States, and 80 percent of traffic between the UK and mainland Europe is transited via the Channel Tunnel).

The analysis concluded that if the Netherlands remains competitive in attracting and facilitating next-generation submarine cable infrastructure, it will be able to leverage its strong ecosystem of data centers, internet exchange points, and IP transit to be a preferred international gateway for a total addressable market of more than 132 million inhabitants, 10 million businesses, and hundreds of universities across the catchment area.

Methodology

The *Study on the Development of the Submarine Cable Market* draws on Terabit Consulting's and Axiom's internal data collection and project experience as well as the most up-to-date statistical data from a variety of sources, including the International Telecommunications Union (ITU), national regulatory agencies, internet exchange points

(IXPs), and interconnection databases. The bulk of Terabit's and Axiom's data on bandwidth, pricing, competition, and costs, was based on intelligence sourced directly from industry stakeholders during collaboration on projects, industry meetings, conferences, etc.

Terabit Consulting has collected, curated, and analyzed data and intelligence about international bandwidth markets and infrastructure since the company's inception in 2000. Terabit Consulting and Axiom have had direct involvement in dozens of major telecommunications infrastructure projects worldwide, including multiple submarine and terrestrial projects serving Europe and collaboration on several high-profile studies covering the European market including IOEMA and submarine system suppliers' analysis.

Terabit's Model of International Bandwidth Demand, which has evolved through several iterations with the input of key industry stakeholders since its creation almost a quarter-century ago, analyzes and forecasts residential and business peak-hour demand flows as well as data center, cloud, and hyperscaler traffic, taking into account a wide range of data including demographical and economic statistics, telecommunications network usage, data center configurations and energy consumption, and forecasted investment.

All data was subject to cross-checking against different sources, including data parsed from border gateway protocol (BGP) routing tables and IXP looking-glass statistics. Given Terabit's constant examination of historical data over the last 20 years, Terabit is particularly sensitive to issues of over-reporting, historical revisions, varying definitions of bandwidth types, and adjustments in reporting methodologies; these inconsistencies were addressed in its modeling. Depending on the source, some datasets were also subject to curve-fitting and regression analyses.

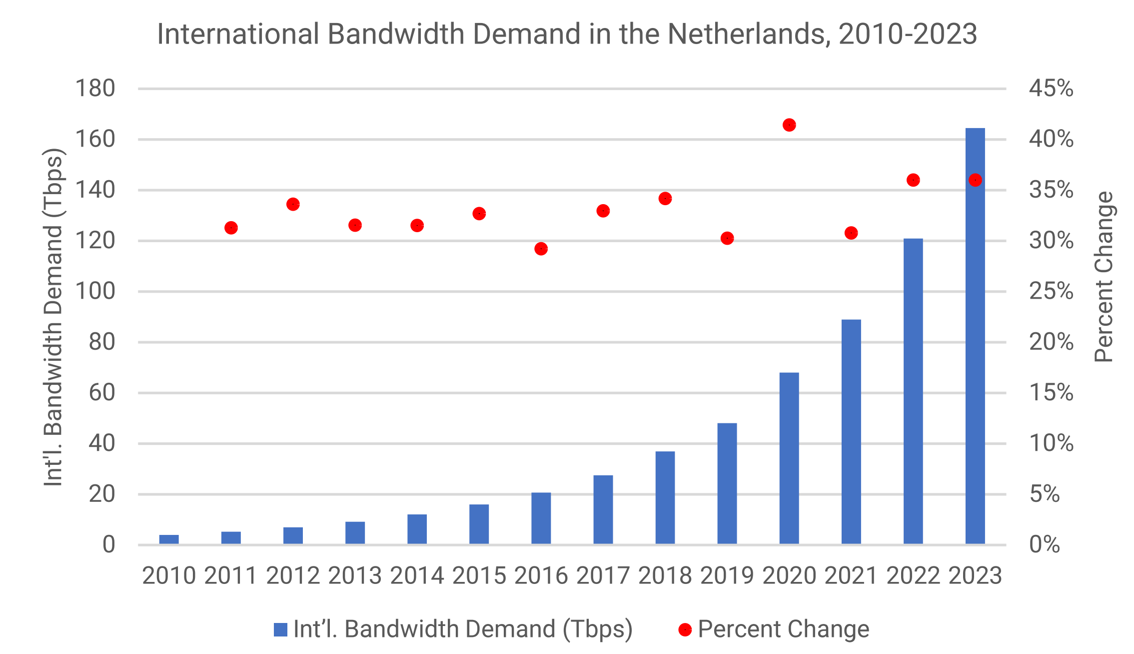
III. Bandwidth Demand in the Netherlands and Its Catchment Area

a. Netherlands Bandwidth Demand

Terabit's analysis revealed strong demand for submarine connectivity to and from the Netherlands, driven by growing consumer demand for data-intensive applications on both mobile and fixed platforms, as well as unprecedented growth in data-center-to-data-center traffic to fuel content consumption and demand for cloud services.

Figure 2: Historical International Bandwidth Demand in the Netherlands (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	4.0	5.2	7.0	9.2	12	16	21	28	37	48	68	89	121	164
Percent Change		31%	34%	32%	32%	33%	29%	33%	34%	30%	41%	31%	36%	36%
CAGR (2020-2023)	34%													
CAGR (2018-2023)	35%													
CAGR (2010-2023)	33%													



Bandwidth demand growth in the Netherlands has been robust, particularly post-pandemic. The Dutch government has shown a commitment to advancing the development of high-speed broadband technologies, with strong digitalization and connectivity policies in place.

The Netherlands is a major IXP hub, with over 25 active multi-network IXPs serving approximately 3,000 networks. Dutch IXPs offer a total of 165 Tbps of connected capacity, including more than 50 Tbps at AMS-IX.

The Netherlands benefits from its status as an established "FLAP-D" (Frankfurt, London, Amsterdam, Paris, Dublin) market for data center and related infrastructure. Estimates of data center inventory in Amsterdam region range from 500 MW (source: Cushman & Wakefield) to 1,000 MW (source: CBRE); the Dutch Data Center Association placed the nationwide figure at 863 MW across 187 facilities as of 2024. Future data center investment is expected to focus on specific opportunities such as edge data centers and latency-sensitive applications, as well as sustainable, energy-efficient technologies and facility designs. Of the world's ten largest hyperscalers, four (Google, Microsoft, Huawei, and Oracle) have implemented data centers in the Netherlands, with five facilities between them and a sixth under construction. Amazon, Meta, Apple, and IBM also have significant presences in the region through collocated facilities.

Challenges facing the continued growth of the Netherlands' digital ecosystem include concerns over energy sustainability and land use which have resulted in limitations on new data center construction, particularly at the hyperscale level (>10 hectares and >70 MW connected load).

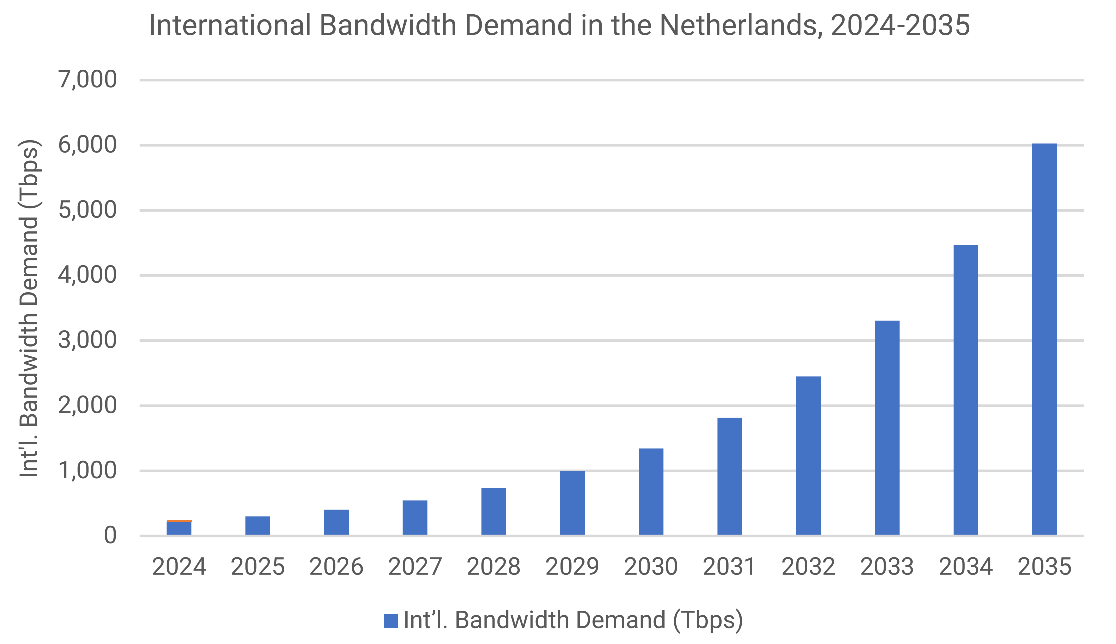
Figure 3: Netherlands Bandwidth Demand Growth Factors: Key Metrics

	Netherlands, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	Dutch Digitalisation Strategy (2021), Digital Connectivity Action Plan (2021), Digital Economy Strategy (2022)	+0.5%
IXP Connected Capacity (Tbps)	165	+1.5%
Data Center Market (MW)	863	+1.5%
Hyperscaler Data Centers	Google - Eemshaven, Middenmeer, Winschoten (under development) Microsoft – Amsterdam Huawei – Amsterdam Oracle – Amsterdam	+1.5%

Using benchmarked quantitative impacts of each major factor from its Model of International Bandwidth Demand, Terabit concludes that bandwidth growth in the Netherlands will exceed the regional baseline European CAGR of 30 percent by 5 percentage points, translating into forecasted growth of 35 percent annually.

Figure 4: Forecasted International Bandwidth Demand in the Netherlands (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	222	300	405	546	738	996	1,344	1,815	2,450	3,307	4,465	6,027
CAGR (2023-2035)	35%											

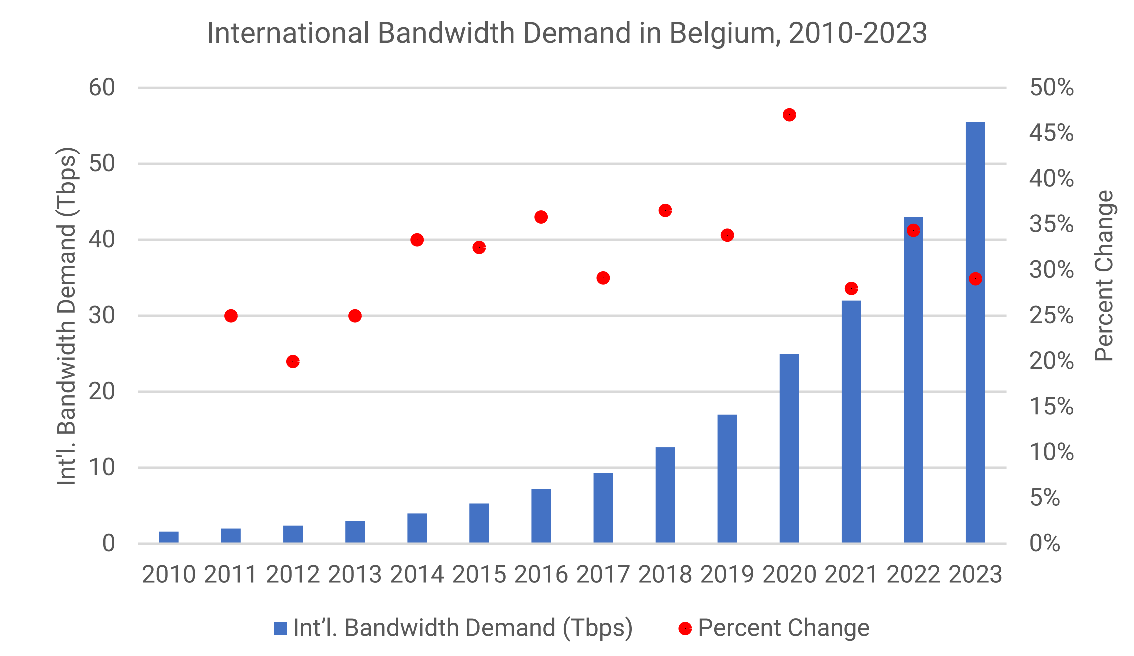


b. Belgium Bandwidth Demand

Belgian demand is a key addressable market for Dutch submarine cable transit bandwidth. The country is served by only four submarine cables, including an outdated Europe-to-Asia cable (Sea-Me-We-3, which entered service in 1999), and three cables to England which entered service in 1999, 2000, and 2023. Consequently, Belgium relies on the Netherlands, France, and the United Kingdom for access to much of its intercontinental submarine cable capacity, including transatlantic bandwidth.

Figure 5: Historical International Bandwidth Demand in Belgium (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	1.6	2.0	2.4	3.0	4.0	5.3	7.2	9.3	13	17	25	32	43	56
Percent Change		25%	20%	25%	33%	33%	36%	29%	37%	34%	47%	28%	34%	29%
CAGR (2020-2023)	30%													
CAGR (2018-2023)	34%													
CAGR (2010-2023)	31%													



Belgian bandwidth demand has grown roughly in line with European averages, but fixed broadband adoption rates, including fiber-to-the premises and ultra-fast broadband, have trailed most of Western Europe. In 2021 Belgium's Federal Council of Ministers launched a national plan for fixed and mobile broadband to encourage uptake throughout the country during the period between 2022 and 2024, including the expansion service availability to 138,000 households outside of existing coverage areas.

There are only two internet exchange points in Belgium, a scarcity that is largely attributable to its proximity to other better-connected hubs such as Amsterdam with its 25 IXPs. Connected capacity of all ports at the two exchanges is approximately 4 Tbps.

The Belgian data center market is relatively small compared to the FLAP-D hubs, with the Belgian Digital Infrastructure Association estimating the colocation data center market at 85 MW and the hyperscaler data center market at 90 MW. Among the ten largest hyperscale data center operators, only Google operates facilities in Belgium (in St. Ghislain), although Microsoft is in the process of developing three data center installations in facilities that are both proprietary and collocated.

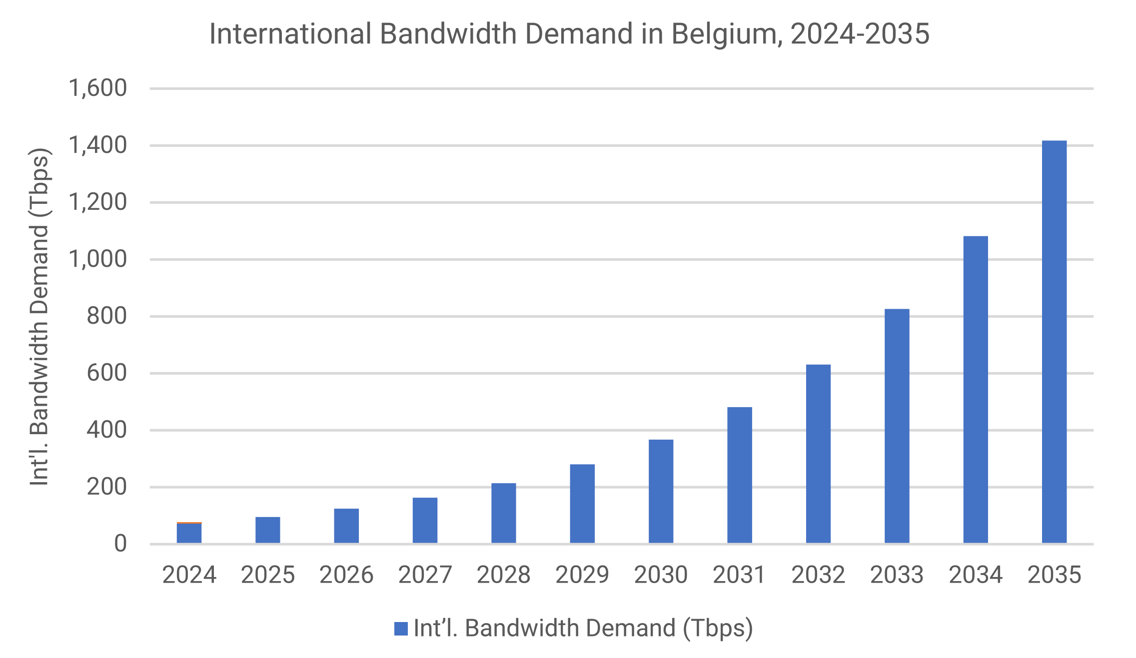
Figure 6: Belgium Bandwidth Demand Growth Factors: Key Metrics

	Belgium, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	National Plan for Fixed and Mobile Broadband (2021)	+0.5%
IXP Connected Capacity (Tbps)	4	neutral
Data Center Market (MW)	175	neutral
Hyperscaler Data Centers	Google – St. Ghislain Microsoft – Brussels (under development)	+0.5%

Terabit forecasts that bandwidth growth in Belgium will exceed the regional baseline European CAGR of 30 percent by 1 percentage point, i.e. CAGR of 31% over the 2024-2035 forecast period.

Figure 7: Forecasted International Bandwidth Demand in Belgium (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	222	300	405	546	738	996	1,344	1,815	2,450	3,307	4,465	6,027
CAGR (2023-2035)	31%											

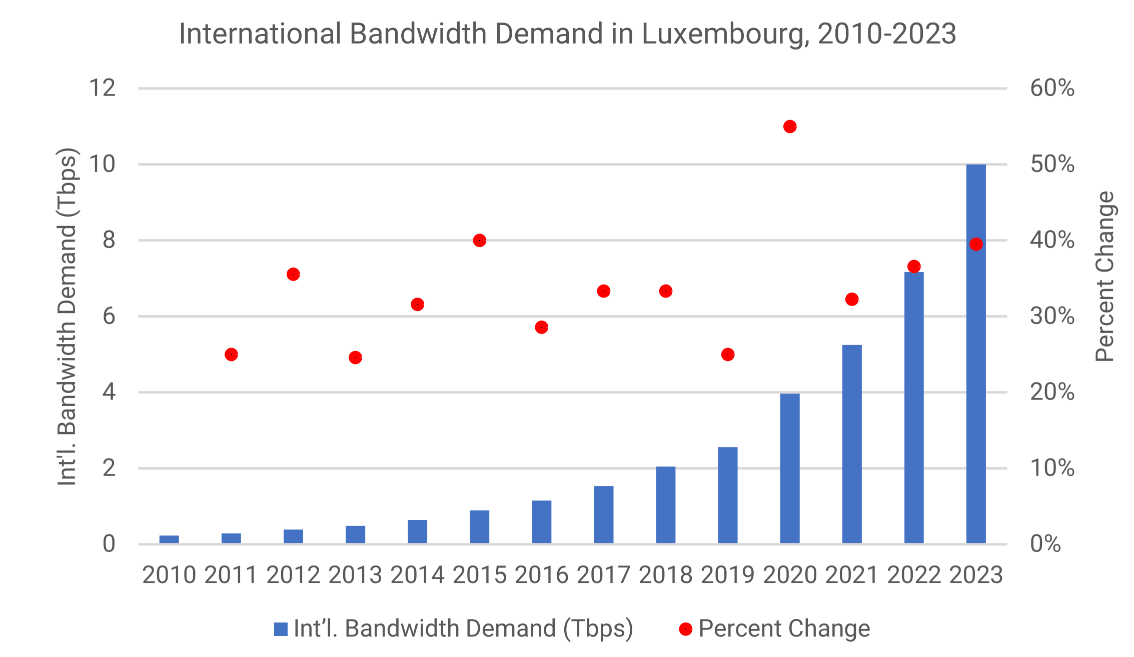


c. Luxembourg Bandwidth Demand

The Grand Duchy of Luxembourg, with its population of 672,050, is consistently ranked as having the world's highest per-capita GDP per capita (excluding microstates) and has become a hub for multinational corporate investment. As a landlocked country, Luxembourg is dependent on neighboring markets for transit capacity and access to submarine cables.

Figure 8: Historical International Bandwidth Demand in Luxembourg (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	0.2	0.3	0.4	0.5	0.6	0.9	1.2	1.5	2.0	2.6	4.0	5.2	7.2	10
Percent Change		25%	36%	25%	32%	40%	29%	33%	33%	25%	55%	32%	37%	40%
CAGR (2020-2023)	36%													
CAGR (2018-2023)	37%													
CAGR (2010-2023)	34%													



Although its consumer market is comparatively small, Luxembourg boasts broadband coverage of nearly 100 percent, and the country also generates substantial multinational corporate bandwidth demand. The Luxembourgish government, via the Department of Media, Connectivity, and Digital Policy and the Digital Luxembourg initiative, has implemented an Ultra High-Speed Broadband Strategy 2021-2025, which seeks to expand availability and accelerate ultra high-speed adoption among consumers and businesses.

The Luxembourg Internet Exchange (LU-CIX) is the country's only IXP; its total connected capacity is 2.6 Tbps. Luxembourg's data center market is estimated to be approximately 25 MW, but none of the ten major international hyperscalers have data center facilities in the country.

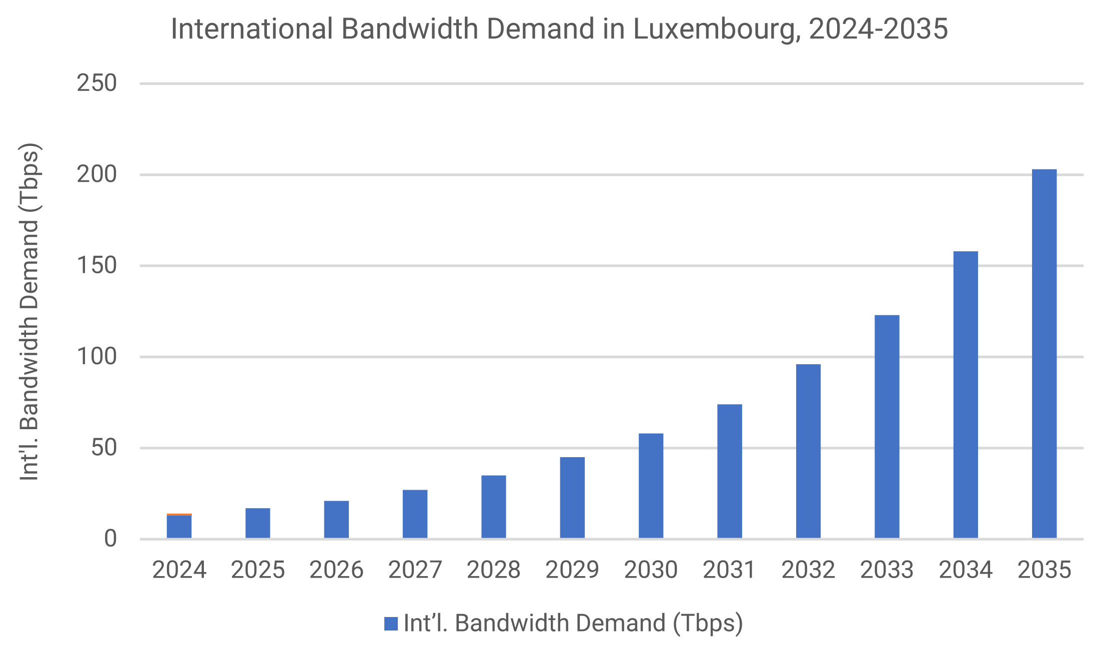
Figure 9: Luxembourg Bandwidth Demand Growth Factors: Key Metrics

	Luxembourg, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	Ultra High-Speed Broadband Strategy 2021-2025 (2021)	+1.5%
IXP Connected Capacity (Tbps)	2.6	-1%
Data Center Market (MW)	25	-1%
Hyperscaler Data Centers	None	-1%

Terabit forecasts that Luxembourgish international bandwidth demand growth will trail the regional baseline European compound annual growth rate of 30 percent by 1.5 percentage points, i.e. a CAGR of 28.5% over the 2024-2035 forecast period.

Figure 10: Forecasted International Bandwidth Demand in Luxembourg (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	13	17	21	27	35	45	58	74	96	123	158	203
CAGR (2023-2035)	29%											

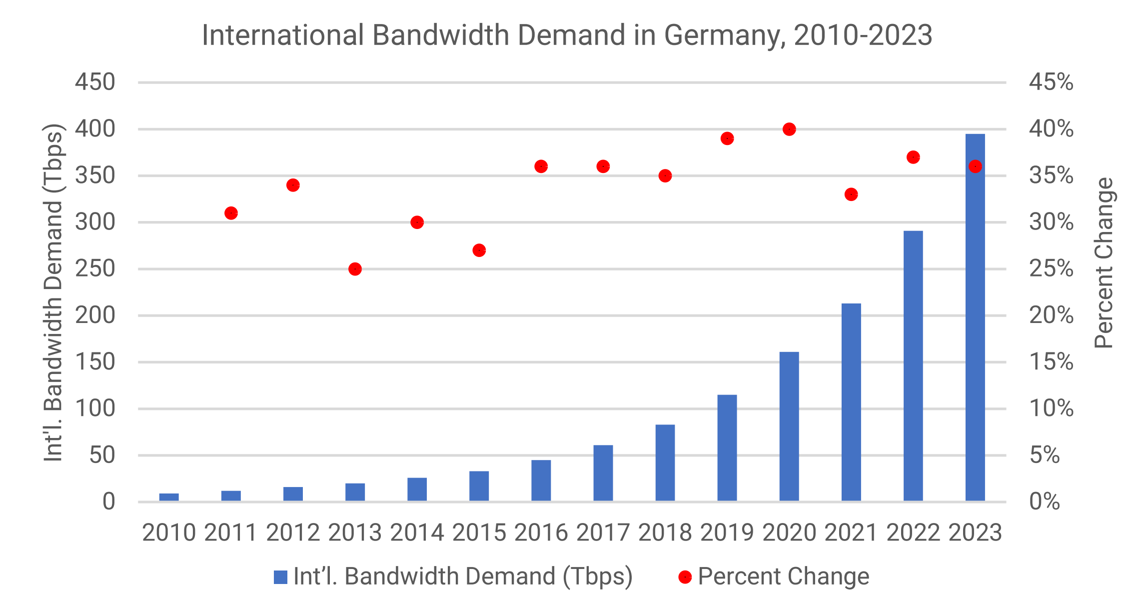


d. Germany Bandwidth Demand

Although Germany is served by its own submarine cables, its submarine connectivity is not robust, primarily because the terrestrial pan-European fiber network infrastructure that has been built out since the late-1990s provides more efficient digital connectivity to Germany's European partners, as well as to onward intercontinental connectivity via European landing points in the Atlantic and Mediterranean regions. Consequently, Germany is expected to rely on Dutch submarine and transit bandwidth in the coming years to serve its burgeoning demand, particularly in states in close proximity to the Netherlands, including the country's economic powerhouse North Rhine-Westphalia and its connectivity hub Frankfurt. Stakeholders such as the German Council on Foreign Relations have stressed the need for Germany to work with partners to strengthen Europe's submarine cable infrastructure.

Figure 11: Historical International Bandwidth Demand in Germany (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	9.1	12	16	20	26	33	45	61	83	115	161	213	291	395
Percent Change		31%	34%	25%	30%	27%	36%	36%	35%	39%	40%	33%	37%	36%
CAGR (2020-2023)	35%													
CAGR (2018-2023)	37%													
CAGR (2010-2023)	34%													



The German Federal Government's Digital and Gigabit Strategies, both launched in 2022, prioritize the development of fiber-to-the-home and 5G technologies. Although the country faces challenges in broadband deployment due to a relatively large rural population (approximately 22 percent of the total), the strategies foresee continued government facilitation of FTTH and 5G (as well as subsequent technologies) through 2030.

There are approximately 50 internet exchange points nationwide, connecting to more than 3,300 networks, making Germany the largest national IXP market; however, unlike other European countries, IXPs are relatively evenly dispersed throughout the country and the largest single metropolitan IXP market, Frankfurt, is home to approximately one dozen by itself. Total connected capacity of the IXPs is 130 Tbps, including 75 Tbps at DE-CIX Frankfurt.

Germany's total data center market, including colocation and hyperscale, is estimated to be on par with the Netherlands', at approximately 1,000 MW, led primarily by Frankfurt but with growing investment in Munich, Berlin, Dusseldorf, Nuremburg, and Stuttgart.

Among continental European markets, Frankfurt has the highest concentration of hyperscaler data centers, with seven out of the ten leading tech companies present, i.e. Google, Amazon, Microsoft, Alibaba, Tencent, OVHCloud, and Oracle, combining for more than a dozen data center facilities either in operation or under development.

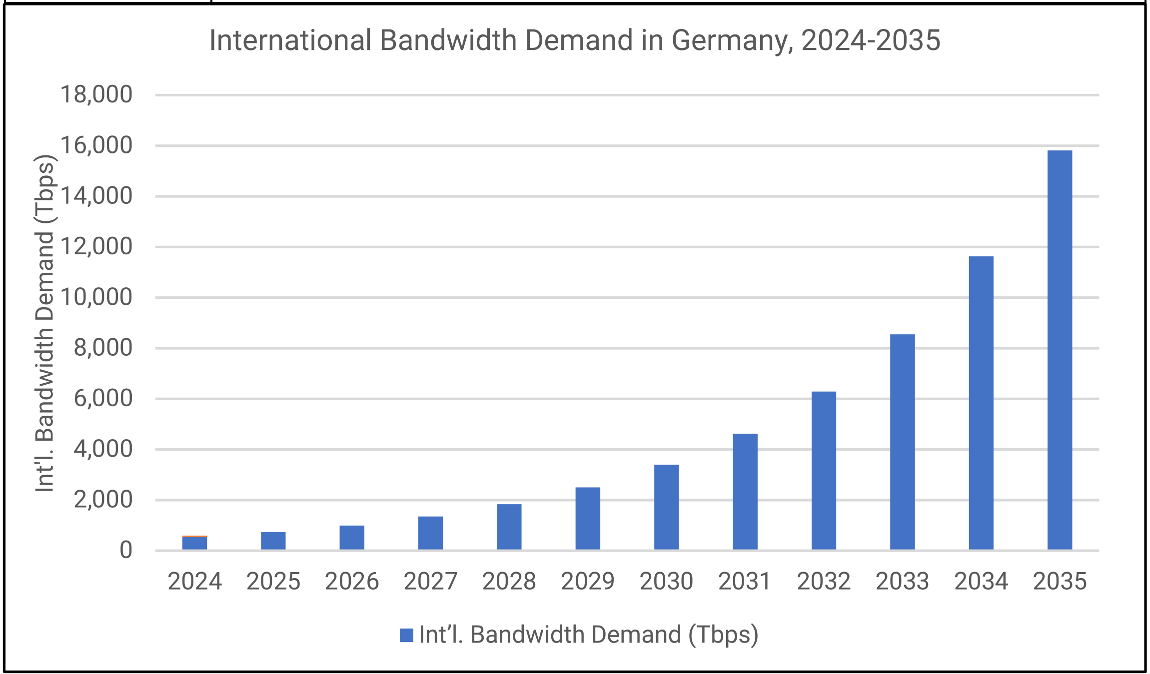
Figure 12: Germany Bandwidth Demand Growth Factors: Key Metrics

	Germany, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	Digital Strategy for Germany (2022), Gigabit Strategy (2022)	+0.5%
IXP Connected Capacity (Tbps)	130	+1.5%
Data Center Market (MW)	1,000	+1.5%
Hyperscaler Data Centers	Google – Hanau Amazon – Frankfurt, Frankfurt expansion (under development) Microsoft – Frankfurt (2), Berlin, Magdeburg, North Rhine-Westphalia (planned) Alibaba – Frankfurt Tencent – Frankfurt OVHCloud – Frankfurt (2) Oracle - Frankfurt	+2.5%

The combined quantitative impact of Germany's bandwidth demand growth factors is a forecasted 6 percent premium over the baseline 30 percent forecasted growth rate for European bandwidth demand, translating to forecasted bandwidth growth of 36 percent compounded annually for the period 2024 to 2035.

Figure 13: Forecasted International Bandwidth Demand in Germany (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	537	731	994	1,351	1,838	2,499	3,399	4,623	6,287	8,550	11,629	15,815
CAGR (2023-2035)	36%											

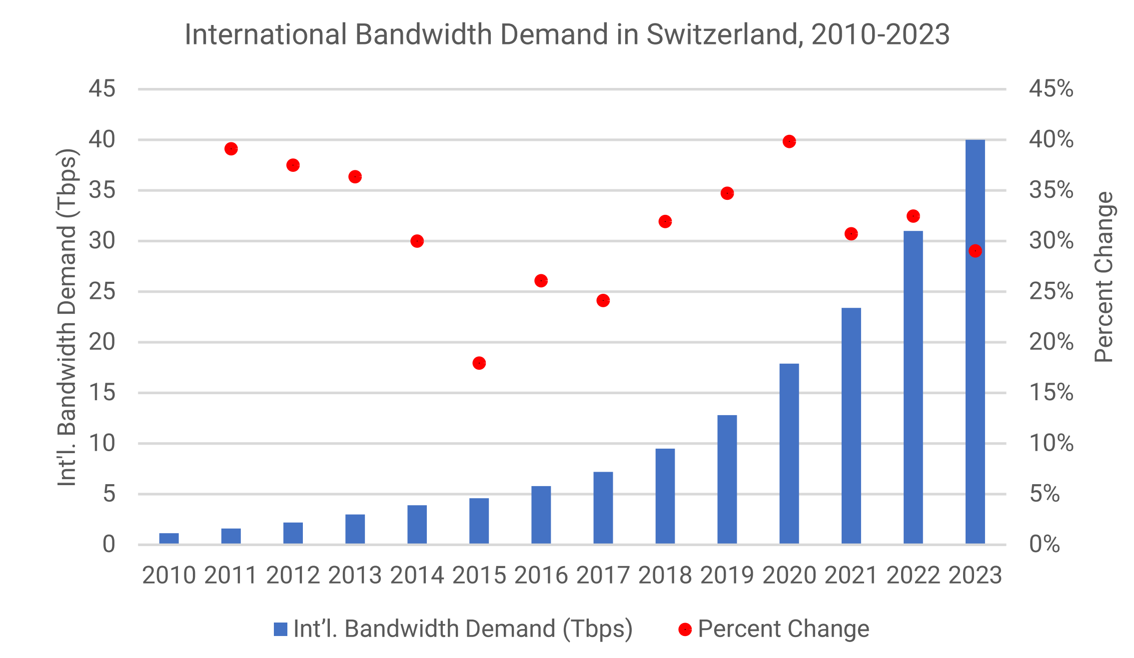


e. Switzerland Bandwidth Demand

As a landlocked country, Switzerland is primarily dependent on submarine and transit bandwidth from its neighbors Germany, France, and Italy. Consequently, it is considered to be an addressable market in the catchment area of Dutch submarine cables, particularly via terrestrial transit paths via North Rhine-Westphalia and Hesse.

Figure 14: Historical International Bandwidth Demand in Switzerland (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	1.2	1.6	2.2	3.0	3.9	4.6	5.8	7.2	9.5	13	18	23	31	40
Percent Change		39%	38%	36%	30%	18%	26%	24%	32%	35%	40%	31%	32%	29%
CAGR (2020-2023)	31%													
CAGR (2018-2023)	33%													
CAGR (2010-2023)	31%													



Switzerland's Gigabit Strategy, which was mandated by the Federal Council in 2023 to be developed by the Federal Department of the Environment, Transport, Energy and Communications (DETEC), focuses on the development of broadband in Swiss rural areas, which is home to one-fourth of the country's population. It would be funded through the proceeds of future spectrum auctions.

Switzerland's dozen internet exchange points connect approximately 1,200 networks with a collective 9 Tbps of capacity, including 6 Tbps of connected port capacity at SwissIX in Zurich.

The total data center market in Switzerland is estimated at 250 MW, including the data center facilities of two of the ten largest hyperscalers: specifically, Amazon in Zurich and Microsoft in Zurich and Geneva.

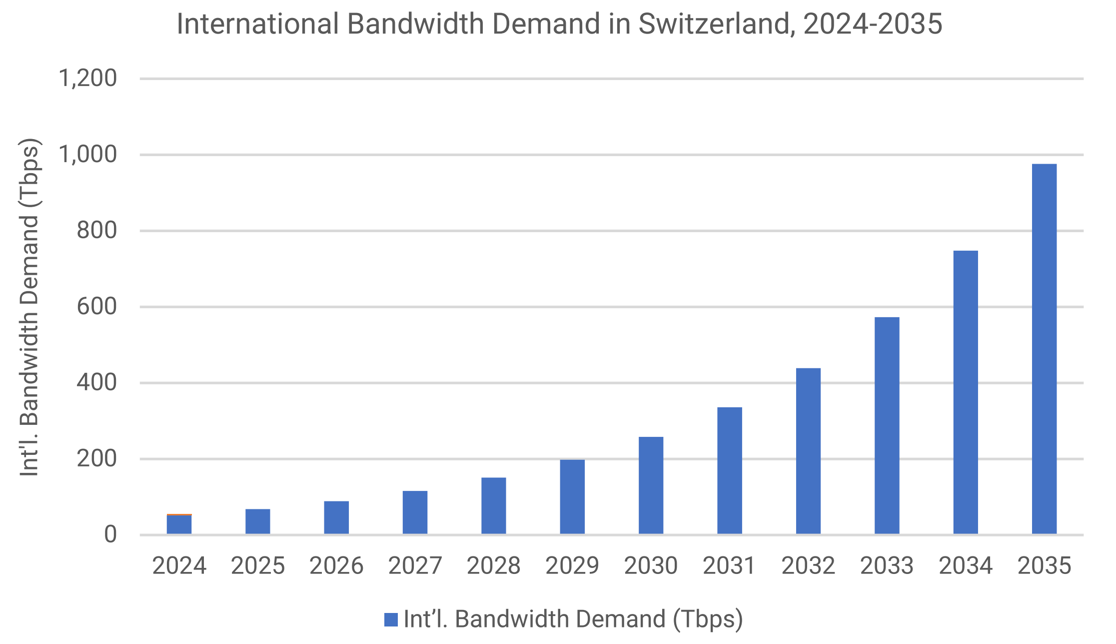
Figure 15: Switzerland Bandwidth Demand Growth Factors: Key Metrics

	Switzerland, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	Gigabit Strategy (2024)	neutral
IXP Connected Capacity (Tbps)	9	neutral
Data Center Market (MW)	250	neutral
Hyperscaler Data Centers	Amazon – Zurich Microsoft – Zurich, Geneva	+0.5%

Switzerland's bandwidth demand growth factors are for the most part considered to be neutral; only the presence of an Amazon data center significantly differentiates the Swiss bandwidth ecosystem from other European markets. Consequently, the forecasted CAGR of Swiss international bandwidth demand is expected to be only 0.5 percent higher than the European baseline forecast, i.e. 30.5 percent for the period 2024-2035.

Figure 16: Forecasted International Bandwidth Demand in Switzerland (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	52	68	89	116	151	198	258	336	439	573	748	976
CAGR (2023-2035)	31%											

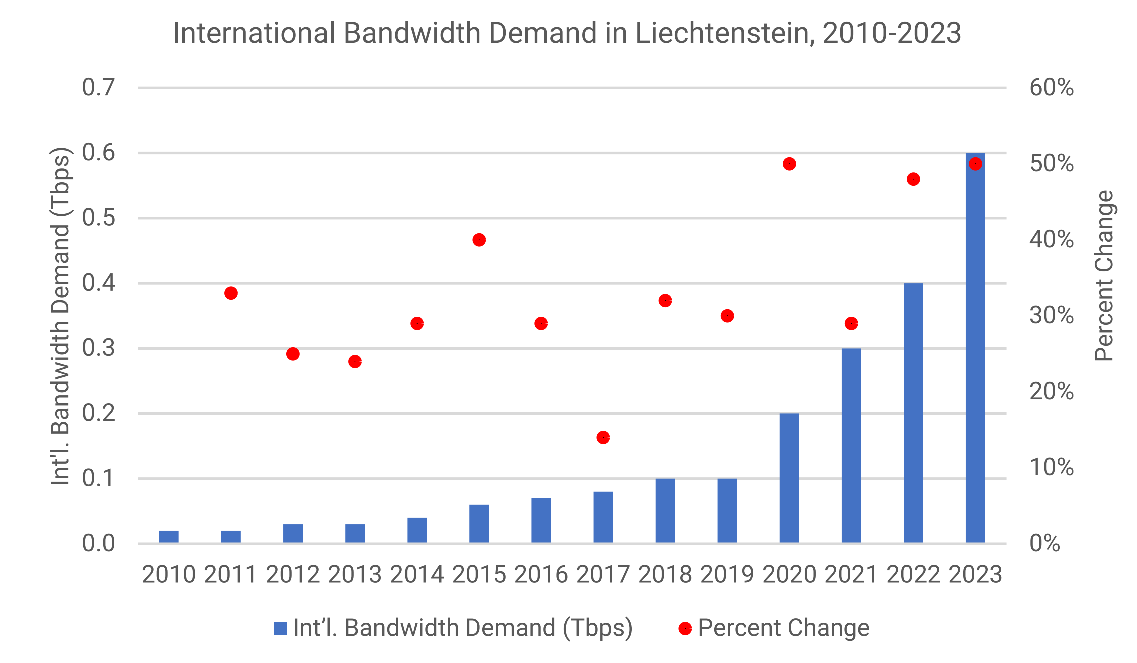


f. Liechtenstein Bandwidth Demand

Liechtenstein, one of only two doubly-landlocked countries in the world, relies exclusively on its landlocked neighbors Switzerland and Austria for international fiber capacity. Consequently, the microstate of approximately 39,000 people is considered to be an addressable market for Dutch submarine bandwidth and international IP transit capacity via Amsterdam. However, Liechtenstein's total international bandwidth requirements are currently less than 1 Tbps.

Figure 17: Historical International Bandwidth Demand in Liechtenstein (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	0.02	0.02	0.03	0.03	0.04	0.06	0.07	0.08	0.1	0.1	0.2	0.3	0.4	0.6
Percent Change		33%	25%	24%	29%	40%	29%	14%	32%	30%	50%	29%	48%	50%
CAGR (2020-2023)	42%													
CAGR (2018-2023)	41%													
CAGR (2010-2023)	33%													



The Liechtenstein government is promoting broadband development through its FTTB Buildup for Everyone in Liechtenstein plan, which is targeting universal ultra-high-speed broadband availability. Liechtenstein's two IXPs have a total connected port capacity of approximately 300 Gbps. There are no major data centers in the country, and none of the major hyperscalers operate data center facilities.

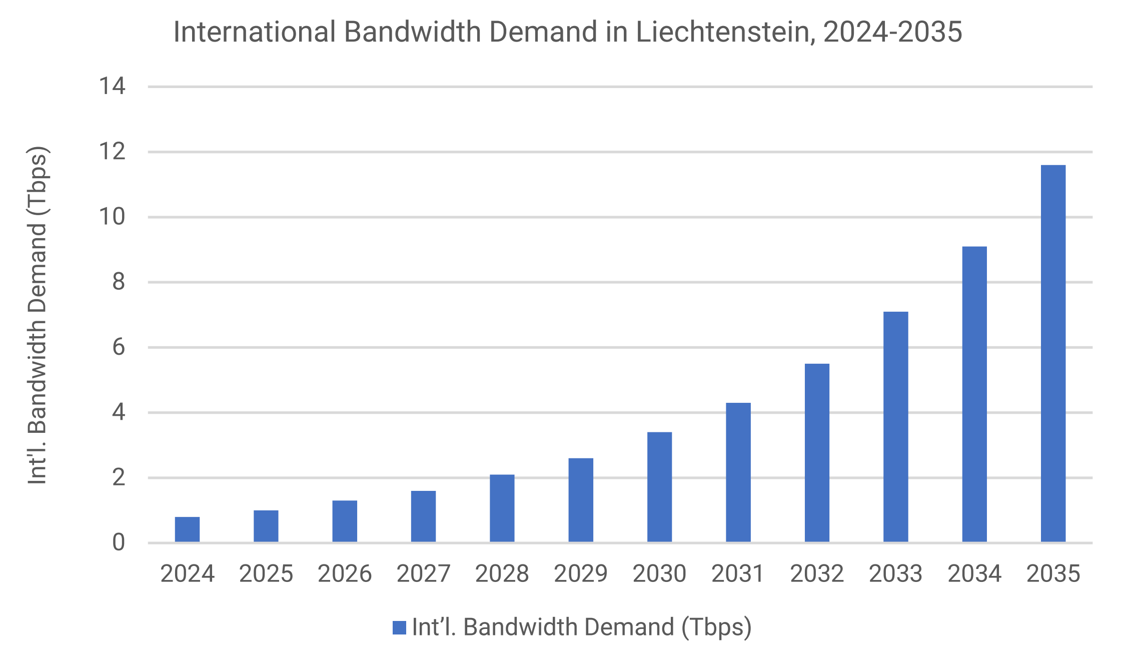
Figure 18: Liechtenstein Bandwidth Demand Growth Factors: Key Metrics

	Liechtenstein, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	FTTB Buildup for Everyone in Liechtenstein	+1%
IXP Connected Capacity (Tbps)	0.3	-1%
Data Center Market (MW)	1	-1%
Hyperscaler Data Centers	None	-1%

Despite robust growth in Liechtenstein in recent years, based on an analysis of key metrics influencing bandwidth demand growth, Terabit forecasts that Liechtenstein's international bandwidth will grow at 2 percentage points lower than the European benchmark; bandwidth growth in Liechtenstein is consequently forecasted to be 28 percent over the 2024-2035 period.

Figure 19: Forecasted International Bandwidth Demand in Liechtenstein (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	0.8	1.0	1.3	1.6	2.1	2.6	3.4	4.3	5.5	7.1	9.1	11.6
CAGR (2023-2035)	28%											

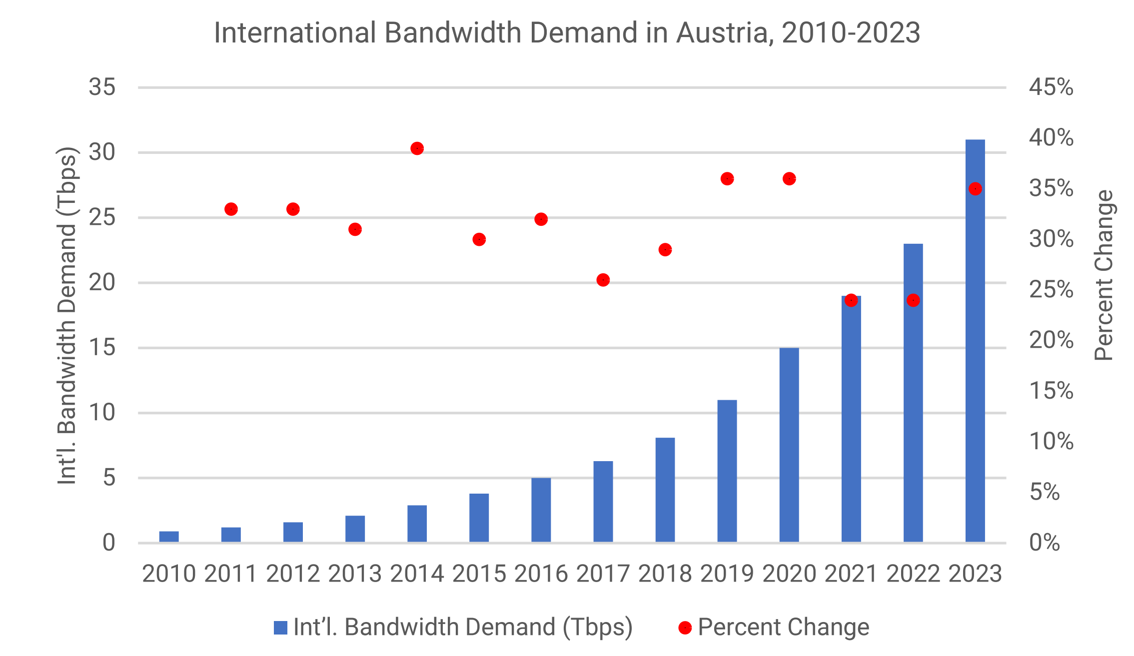


g. Austria Bandwidth Demand

Austria accesses submarine capacity via transit networks through Italy and Germany and is consequently considered to be an addressable market for international submarine bandwidth, particularly transatlantic bandwidth, via Dutch cable landing stations.

Figure 20: Historical International Bandwidth Demand in Austria (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Int'l. Bandwidth Demand (Tbps)	0.9	1.2	1.6	2.1	2.9	3.8	5.0	6.3	8.1	11	15	19	23	31
Percent Change		33%	33%	31%	39%	30%	32%	26%	29%	36%	36%	24%	24%	35%
CAGR (2020-2023)	27%													
CAGR (2018-2023)	31%													
CAGR (2010-2023)	31%													



Austria's Broadband Strategy 2030 was implemented in 2019 and has contributed to significant progress in the share of Austrian households with gigabit connections, rising from 13 percent in 2019 to 69 percent in 2023. The country is home to a half-dozen internet exchange points linking 200 networks with a collective connected capacity of approximately 9 Tbps (of which 8 Tbps is via the Vienna Internet Exchange).

The data center market is estimated at 150 MW, although none of the ten largest hyperscalers are present with their own facilities.

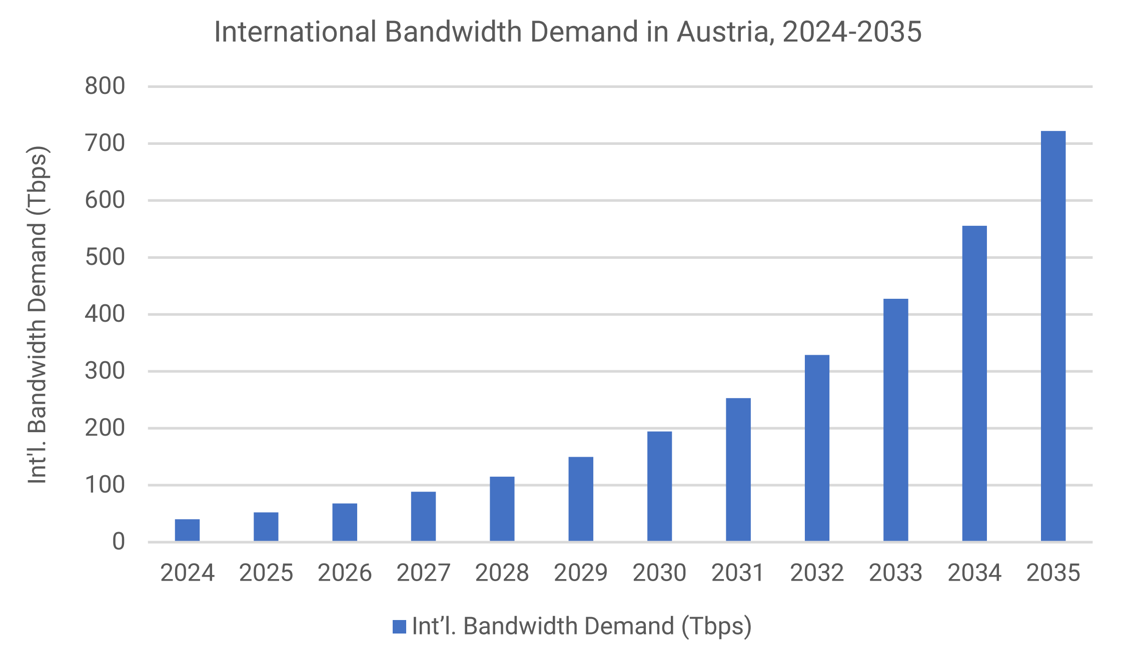
Figure 21: Austria Bandwidth Demand Growth Factors: Key Metrics

	Austria, 2024	Quantitative Impact (Adjustment to Forecasted CAGR)
Connectivity Policy(-ies)	Broadband Strategy 2030	+1%
IXP Connected Capacity (Tbps)	9	neutral
Data Center Market (MW)	150 MW	neutral
Hyperscaler Data Centers	None	--1%

Based on Austria's bandwidth demand growth factors, the country's bandwidth demand is forecasted to grow at the European benchmark of 30 percent CAGR for the period 2024 to 2035.

Figure 22: Forecasted International Bandwidth Demand in Austria (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Int'l. Bandwidth Demand (Tbps)	40	52	68	89	115	150	195	253	329	427	556	722
CAGR (2023-2035)	30%											



h. Total Bandwidth Demand in the Netherlands' Catchment Area & Translation into Submarine Demand

Total historical demand across the Netherlands' catchment area is shown in Figure 23, and historical growth rates are shown in Figure 24. [Note: The study classifies only a subset of this catchment-area demand as "addressable by Dutch submarine cables," as shown in Figures 28 and 29.]

Figure 23: Historical International Bandwidth Demand in the Netherlands' Catchment Area (Tbps), 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Netherlands	4.0	5.2	7.0	9.2	12	16	21	28	37	48	68	89	121	164
Belgium	1.6	2.0	2.4	3.0	4.0	5.3	7.2	9.3	13	17	25	32	43	56
Luxembourg	0.2	0.3	0.4	0.5	0.6	0.9	1.2	1.5	2.0	2.6	4.0	5.2	7.2	10
Germany	9.1	12	16	20	26	33	45	61	83	115	161	213	291	395
Switzerland	1.2	1.6	2.2	3.0	3.9	4.6	5.8	7.2	10	13	18	23	31	40
Liechtenstein	0.02	0.02	0.03	0.03	0.04	0.06	0.07	0.08	0.1	0.1	0.2	0.3	0.4	0.6
Austria	0.9	1.2	1.6	2.1	2.9	3.8	5.0	6.3	8.1	11	15	19	23	31
Total (Tbps)	17	22	30	38	50	64	85	113	152	207	291	381	517	697
CAGR (2020-2023)	34%													
CAGR (2018-2023)	36%													
CAGR (2010-2023)	33%													

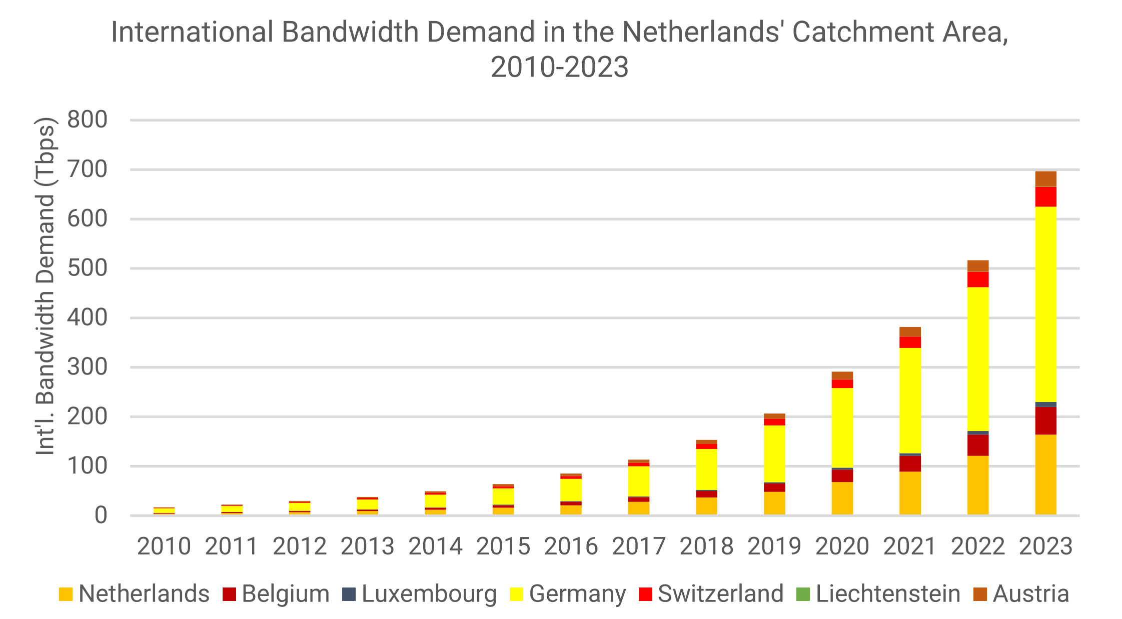
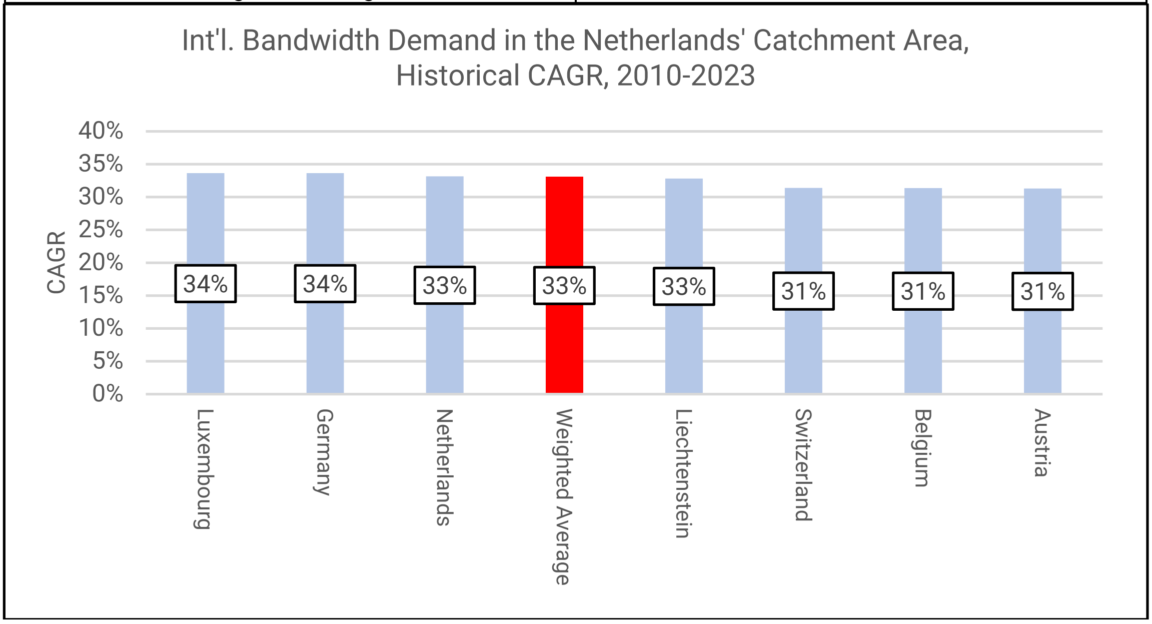


Figure 24: International Bandwidth Demand in the Netherlands' Catchment Area, Historical CAGR, 2010-2023

	CAGR, 2010-2023
Netherlands	33%
Belgium	31%
Luxembourg	34%
Germany	34%
Switzerland	31%
Liechtenstein	33%
Austria	31%
Weighted Average	33%



Forecasted growth rates of demand across the Netherlands' catchment area are shown in Figure 25, while forecasted demand levels are shown in Figure 26.

Figure 25: International Bandwidth Demand in the Netherlands' Catchment Area, Forecasted CAGR, 2023-2035

	CAGR, 2023-2035
Netherlands	35%
Belgium	31%
Luxembourg	29%
Germany	36%
Switzerland	31%
Liechtenstein	28%
Austria	30%
Weighted Average	35%

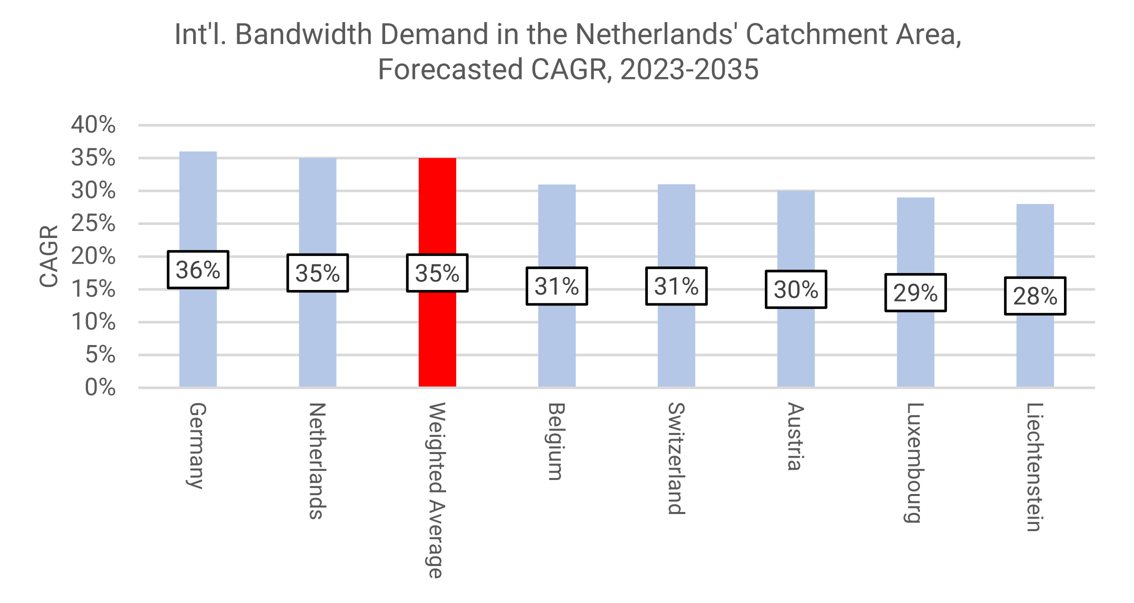
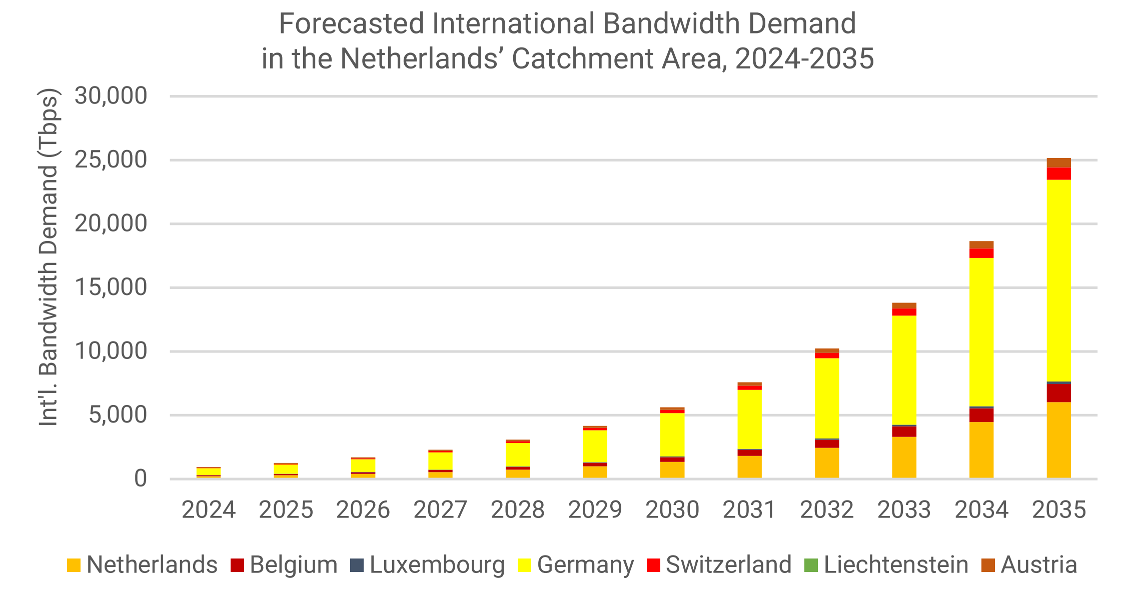


Figure 26: Forecasted International Bandwidth Demand in the Netherlands' Catchment Area (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Netherlands	222	300	405	546	738	996	1,344	1,815	2,450	3,307	4,465	6,027
Belgium	73	95	125	163	214	280	367	481	631	826	1,082	1,418
Luxembourg	13	17	21	27	35	45	58	74	96	123	158	203
Germany	537	731	994	1,351	1,838	2,499	3,399	4,623	6,287	8,550	11,629	15,815
Switzerland	52	68	89	116	151	198	258	336	439	573	748	976
Liechtenstein	0.8	1.0	1.3	1.6	2.1	2.6	3.4	4.3	5.5	7.1	9.1	12
Austria	40	52	68	89	115	150	195	253	329	427	556	722
Total – Netherlands Catchment Area	938	1,264	1,703	2,295	3,093	4,170	5,624	7,587	10,236	13,814	18,645	25,172



Within the catchment area, Germany is the largest market in terms of volume, followed by the Netherlands. Together, Germany and the Netherlands account for more than 80 percent of demand (more than 86 percent by the end of the forecast period), and the combined demand from the two countries will consequently be the primary driver of future submarine cable deployment in the Netherlands.

In order to refine total bandwidth demand into addressable bandwidth demand, Terabit Consulting employed a two-step process which first evaluated the direction of bandwidth traffic flows for each of the seven countries in the Netherlands' catchment area, then determined which of those flows, and how much of each flow, would be considered addressable by the Netherlands' submarine cable infrastructure. For example, most demand from catchment area countries to European destinations was excluded from consideration in the calculation of addressable traffic, because those traffic flows would almost always be more efficiently served by terrestrial infrastructure (for example, there is virtually no possibility that Dutch submarine cables would address bandwidth demand between Switzerland and Germany).

1. Direction of Traffic

For each country in the catchment area, a representative internet service provider was selected: KPN in the Netherlands, Belgacom International Carrier Services (BICS) in Belgium, POST Luxembourg, Deutsche Telekom in Germany, Swisscom in Switzerland, Telecom Liechtenstein (FL1), and Telecom Austria (A1).

For each representative ISP, an analysis of peers was undertaken for both IPv4 and IPv6 (with each protocol weighted according to the observed AS paths of each ISP). Each peer was assigned a primary geographical location based on its network and operations, then weighted according to that peer's percentages of the representative ISP's adjacencies. This allowed for an assignment of adjacency percentages to each location: the United States, Continental Europe, the United Kingdom, South America, Africa, Australia, Asia, and Russia. A weighted average for the entire Netherlands Catchment Area was calculated based on each market's share of international bandwidth.

Figure 27: Representative ISPs' Direction of Traffic Flow, Netherlands' Catchment Area

	Nether-lands	Belgium	Luxem-bourg	Germany	Switzer-land	Liechten-stein	Austria	Weighted Average
	AS1136 KPN	AS6774 BICS	AS6661 POST	AS3320 DT	AS3303 Swisscom	AS20634 FL1	AS8447 A1	
USA	39.8%	36.4%	39.9%	67.3%	86.7%	71.4%	59.6%	**58.7%**
Continental Europe	39.3%	37.5%	32.9%	32.1%	12.4%	27.8%	13.1%	**32.3%**
UK	18.9%	0.3%	10.9%	0.6%		0.8%		**5.0%**
South America		12.7%	3.6%		0.9%		6.7%	**1.4%**
Asia		12.9%					6.6%	**1.3%**
Russia	0.5%						13.8%	**0.7%**
Africa	1.0%	0.2%	12.7%					**0.4%**
Australia	0.5%						0.2%	**0.1%**

The analysis indicates that the majority of international bandwidth demand in the Netherlands' Catchment Area (58.7 percent) is directed toward the US; this is indicative of the United States' robust content development, particularly of real-time platforms, as well as its massive data center hosting capacity and low-cost international connectivity. Meanwhile, destinations in Continental Europe account for approximately one-third (32.3 percent), and the United Kingdom accounts for 5 percent. South America and Asia account for 1.4 percent and 1.3 percent respectively, while Russia, Africa, and Australia each account for less than 1 percent.

It is important to note that the because the analysis is based on representative ISPs in each catchment-area market, significant variations can occur due to commercial relationships between the ISPs which impact the traffic flows between peers.

Additionally, although the Netherlands has strong political, economic, and cultural ties to the Caribbean, particularly through the constituent countries of Aruba, Curaçao, and Sint Maarten, as well as the special municipalities of Bonaire, Sint Eustatius, and Saba, the Caribbean does not currently have significant direct connectivity to Europe users due to the configuration of data center installations and existing submarine cables (content delivery to Caribbean users is primarily via medium-haul submarine cables accessing data centers in Miami). An economic and political case may be made, however, for direct transatlantic connectivity linking the Netherlands to the Caribbean.

2. Addressability of Netherlands' Catchment Area Demand by Dutch Submarine Cables

An analysis was undertaken to estimate the share of each country's forecasted demand that is addressable by Dutch submarine cables, taking into account the geographical position, direction of traffic, and terrestrial and submarine infrastructure of each market. Demand was partly or entirely excluded from consideration primarily due to the existence of other network paths which were more technically efficient or cost-effective.

Netherlands

68.6 percent of the Netherlands' total international bandwidth demand is considered to be addressable by the country's submarine cable infrastructure. The excluded bandwidth demand comprises four-fifths of the traffic to continental European destinations, particularly Germany and France, that will inevitably remain served by terrestrial infrastructure.

Belgium

62.2 percent of Belgium's international bandwidth demand is estimated to be addressable by Dutch submarine cables. This figure excludes all of the country's demand to Continental Europe and the United Kingdom, which are more efficiently served by terrestrial networks and the country's own Belgium-UK submarine cables, respectively.

Luxembourg

58.9 percent of the international bandwidth demand of Luxembourg is considered to be addressable by the Netherland's submarine cable infrastructure. The excluded bandwidth comprises all traffic to Continental European destinations (which is expected to be captured by terrestrial networks), as well as three-fourths of demand to the United Kingdom, which will likely be captured by the submarine cable infrastructure of its adjoining neighbors Belgium and France.

Germany

34.2 percent of Germany's international demand is considered to be addressable by Dutch submarine cables. This figure is based on the conservative assumption that over the long term, Germany may eventually be served by its own direct transatlantic cables, which could exclude half of the country's transatlantic demand from Dutch submarine cables' addressable market opportunity (however, there is no credible intelligence that any transatlantic cables landing in Germany are currently under development). All Continental European demand is excluded as well.

Switzerland

43.8 percent of Switzerland's international demand, which comprises one-half of the country's intercontinental (primarily transatlantic and South American) traffic, is considered to be addressable by Dutch submarine cables. Continental European traffic is excluded from addressable demand.

Liechtenstein

36.5 percent of Liechtenstein's international bandwidth demand is considered to be addressable by Dutch submarine cables. Excluded traffic comprises all Continental European demand and half of transatlantic demand.

Austria

43.4 percent of Austrian demand is considered addressable by Dutch submarine cables. This figure excludes one-half of Austrian transatlantic demand as well as all demand to Continental European and Russian destinations.

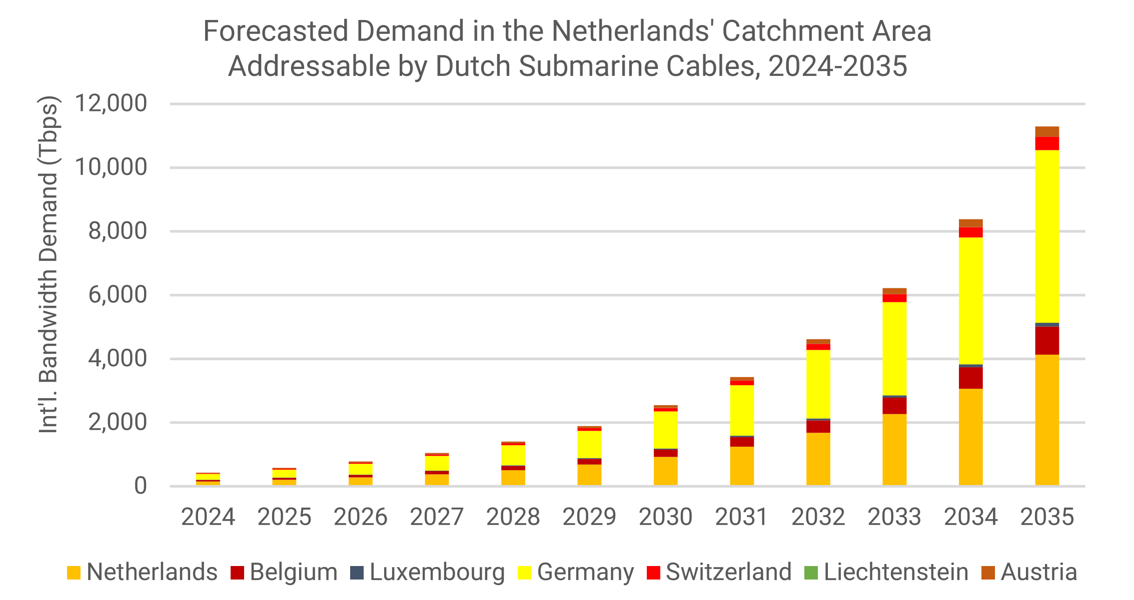
Figure 28: Percentage of Netherlands' Catchment Area Demand Addressable by Dutch Submarine Cables

	Nether-lands	Belgium	Luxem-bourg	Germany	Switzer-land	Liechten-stein	Austria
Percentage of Demand Addressable by Dutch Submarine Cables	68.6%	62.2%	58.9%	34.2%	43.8%	36.5%	43.4%

The analysis indicated that a total of 430 Tbps of "addressable" bandwidth demand could be served by Dutch submarine cables as of year-end 2024, increasing to 11.3 petabits per second (Pbps) by 2035.

Figure 29: Forecasted Demand in the Netherlands' Catchment Area Addressable by Dutch Submarine Cables (Tbps), 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Netherlands	152	206	278	375	506	683	922	1,244	1,680	2,268	3,062	4,133
Belgium	45	59	78	102	133	175	229	300	392	514	673	882
Luxembourg	7.6	10	13	16	21	27	34	44	56	72	93	119
Germany	184	250	340	463	629	856	1,164	1,582	2,152	2,927	3,981	5,413
Switzerland	23	30	39	51	66	86	113	147	192	251	327	427
Liechtenstein	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.6	2.0	2.6	3.3	4.2
Austria	17	23	30	38	50	65	84	110	143	185	241	313
Total – Netherlands Catchment Area	430	578	777	1,045	1,406	1,892	2,546	3,429	4,617	6,220	8,380	11,293

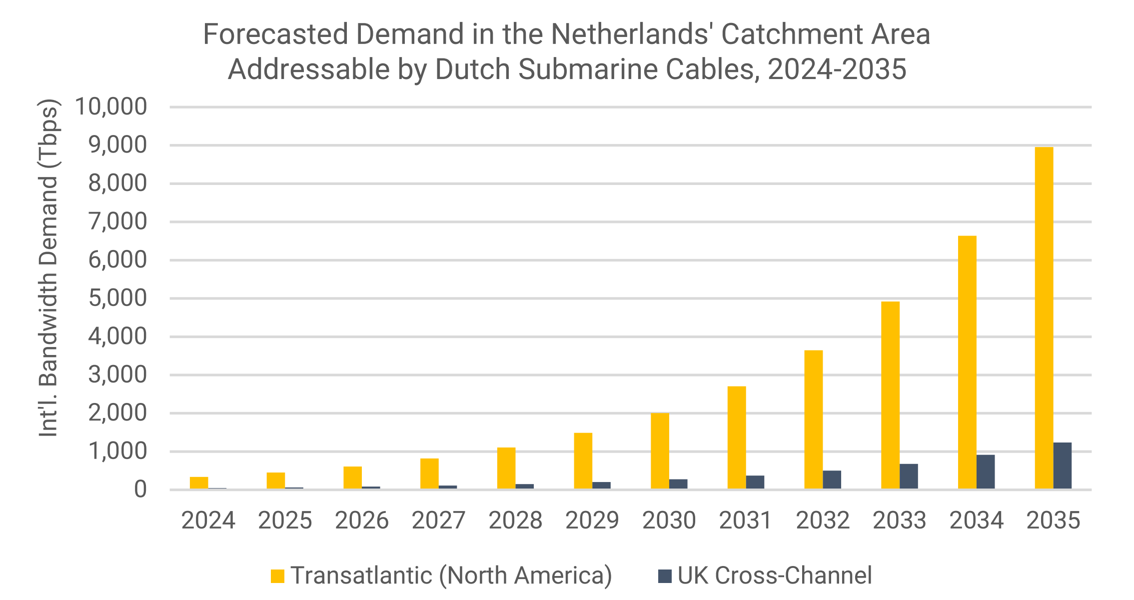


As is the case with overall forecasted bandwidth demand, Germany and the Netherlands account for the vast majority of demand that is addressable by Dutch submarine cables: specifically, 78 percent at the beginning of the forecast period and 85 percent at the end of the forecast period.

Although total demand could theoretically be served by the Netherland's existing submarine systems (which will comprise 444 fiber pairs to European destinations as of year-end 2024), in practicality there is a strong case for the continued physical and commercial development of the country's submarine cable infrastructure, as demand grows 26-fold over the forecast period. In particular, the massive growth of transatlantic demand to almost 9 petabits per second (Pbps) supports a strong business case for the development of direct US-Netherlands submarine connectivity.

Figure 30: Forecasted Demand in the Netherlands' Catchment Area Addressable by Dutch Submarine Cables (Tbps), by Route, 2024-2035

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Transatlantic (North America)	336	452	608	820	1,104	1,488	2,006	2,705	3,647	4,920	6,638	8,957
Europe-UK Cross-Channel	45	61	83	112	151	204	276	372	503	679	917	1,238
Continental European Regional	17	24	32	43	58	78	106	143	192	260	351	474
Latin America	13	16	22	28	37	48	63	82	107	140	183	240
Asia	12	16	21	27	35	46	60	79	103	135	177	231
Russia	1	2	2	3	4	5	7	9	13	17	23	31
Africa	4	5	7	9	12	16	22	29	38	51	68	90
Australia	1	2	2	3	4	5	7	10	13	18	24	33



IV. Benchmarking of Bandwidth Demand

To gain insight into the positioning and development of the Netherlands' submarine cable market and future demand requirements, the growth of international bandwidth demand in the catchment area of Dutch submarine cables was benchmarked against other European and global markets and routes, as shown in Figures 31 and 32.

Figure 31: Int'l. Bandwidth Demand in the Netherlands' Catchment Area vs. Peer European Markets and Global Submarine Cable Routes, Historical CAGR, 2010-2023

	CAGR, 2010-2023
Netherlands' Catchment Area (Weighted Avg.)	33%
European Peer: Ireland	36%
European Peer: Spain	33%
European Peer: Norway	32%
Transatlantic Submarine	41%
Transpacific Submarine	36%
Latin America-North America Submarine	43%
Europe-Asia Submarine	47%
East Asian Regional Submarine	37%
African Intercontinental Submarine	49%
Australia Intercontinental Submarine	38%

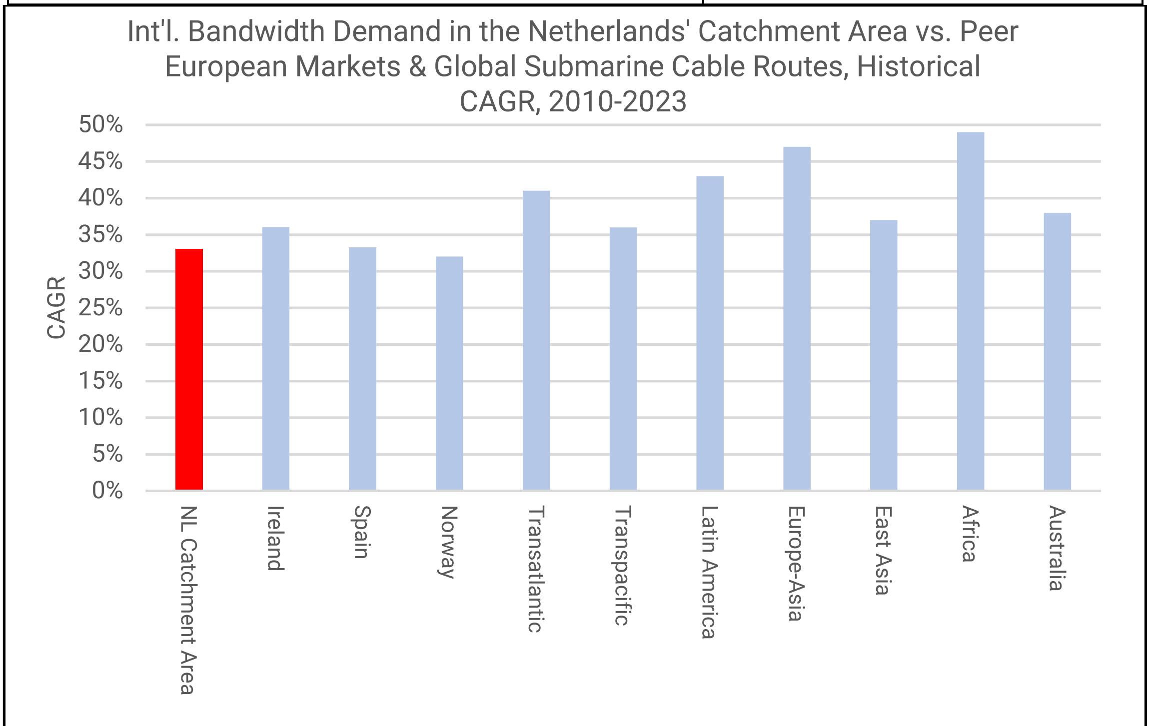
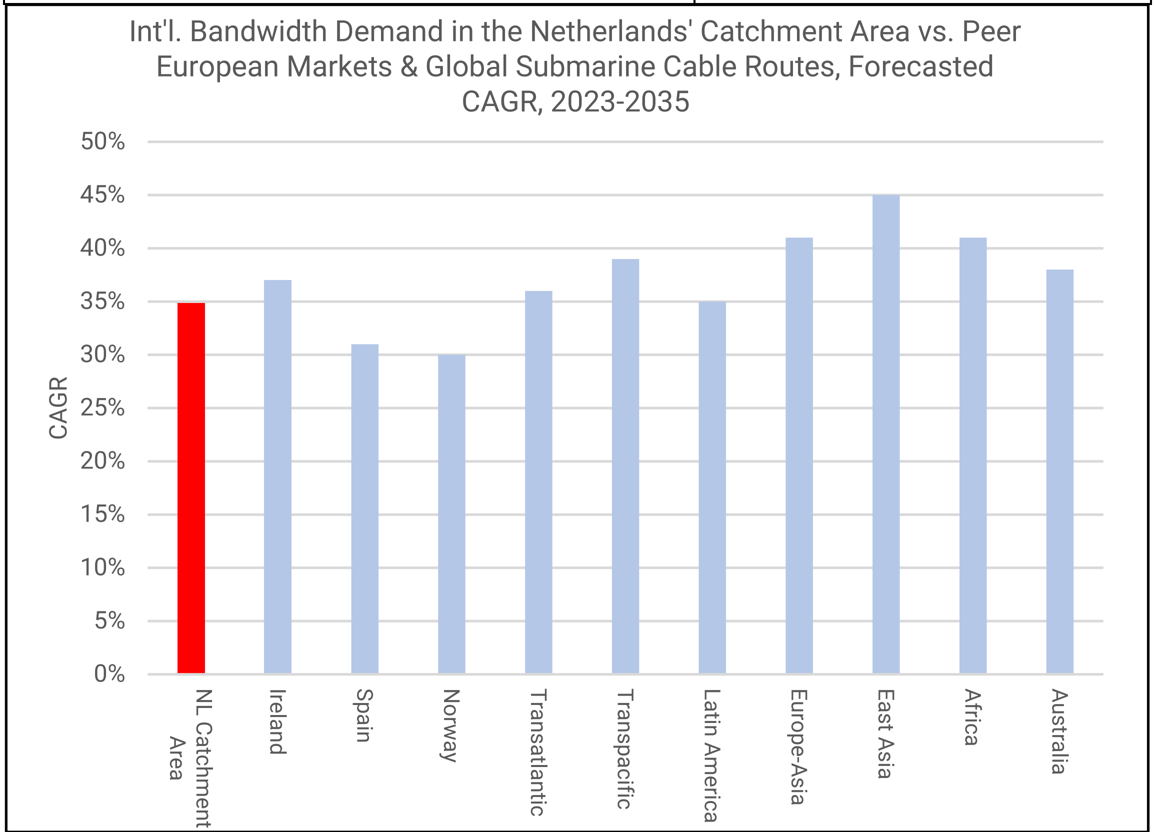


Figure 32: International Bandwidth Demand in the Netherlands' Catchment Area vs. Peer European Markets and Global Submarine Cable Routes, Forecasted CAGR, 2023-2035

	CAGR, 2023-2035
Netherlands' Catchment Area (Weighted Avg.)	35%
European Peer: Ireland	37%
European Peer: Spain	31%
European Peer: Norway	30%
Transatlantic Submarine	36%
Transpacific Submarine	39%
Latin America-North America Submarine	35%
Europe-Asia Submarine	41%
East Asian Regional Submarine	45%
African Intercontinental Submarine	41%
Australia Intercontinental Submarine	38%



The figures show that historic CAGR on intercontinental routes since 2010 has ranged from 36 to 49 percent; in mature European markets the CAGR has been in the 30s. Consequently, the Netherlands' catchment area growth rate of 33 percent is in line with

European averages but generally lower than global intercontinental growth rates, which have been driven in part by the development of emerging markets that were historically underserved.

Going forward, the model forecasts growth that is generally within 5 percent of historical rates, with the exception of Latin America, Europe-to-Asia, and Africa, where growth will cool after having been driven by rapid broadband adoption rates in emerging markets, and the East Asian regional market, which will be driven by geopolitical developments that have prevented the construction of direct connectivity between the United States and China, thereby necessitating the rapid reconfiguration of the region's submarine infrastructure.

In the Netherlands' catchment area itself, continued improvements in broadband as well as data center investment will drive an increase in CAGR from 33 percent during the 2010-2023 period to 35 percent in 2023-2035. This is in line with European peers, although some other key hyperscaler data center markets such as Ireland are forecasted to show modestly higher growth.

V. Existing & Planned European Submarine Cable Systems

As of mid-2024, the Netherlands was served by eight submarine cable systems, comprising one transatlantic cable and seven regional European cables. In addition, one project is under construction (Iceni, linking the Netherlands to the UK), and one credible project is under development (IOEMA, which would connect the UK, the Netherlands, Germany, Denmark, and Norway).

Figure 33: Existing & Planned Submarine Cable Systems Serving the Netherlands

Cable System	RFS	Status	Route KM	Ownership / Financing	Owner(s)	Design Architecture
Farland (UK-Netherlands)	1998	Active	150	Carrier	BT (originally through its Farland BV subsidiary)	12 fiber pairs
Ulysses (UK-Netherlands)	1998	Active	200	Carrier	Verizon Business (acquired following Worldcom bankruptcy)	24 fiber pairs
Atlantic Crossing-1 (AC-1)	1999	Active	14,000	Carrier	Colt (Originally Global Crossing / CenturyLink / Lumen)	8 fiber pairs (4 north and 4 south) x 1 Tbps
Circe North (UK-Netherlands)	1999	Active	218	Whole-salers	euNetworks (50%) / Zayo (50%) (Originally Viatel)	24 fiber pairs
Concerto (UK-Netherlands)	1999	Active	200	Whole-saler	Exa Infrastructure (Originally Flute / Interoute)	48 fiber pairs
COBRAcable (Netherlands-Denmark)	2019	Active	325	Power company	TenneT NSO / Energinet (dark fiber commercialized via their joint venture Relined Fiber Network)	48 fiber pairs
Scylla (UK-Netherlands)	2021	Active	211	Whole-saler	euNetworks	96 fiber pairs
Zeus (UK-Netherlands)	2022	Active	200	Whole-saler	Zayo	96 fiber pairs
Iceni (BT North Sea)	2024	Under construction	210	Carrier	BT	96 fiber pairs (est.)
IOEMA	TBD	Pro-posed	1,371	Investor	IOEMA	48 fiber pairs

The Iceni system is expected to enter service in 2024. The IOEMA systems is still in planning stage through it had not confirmed its financing as of mid-2024. Additionally, the developers of the PISCES cable, with proposed landings in France, Spain, Portugal, and Ireland, are also reportedly considering a Dutch landing point for the system, as are the developers of the Europe-North America-Asia/Arctic Sea system Far North Fiber (FNF).

The following retired cables served the Netherlands in the past:

- TAT-10 (1992-2003 for transatlantic segment; 1992-2007 for Germany-Netherlands segment) (2 transatlantic fiber pairs, 4 Germany-Netherlands fiber pairs)
- TAT-14 (2001-2020) (4 fiber pairs x 2 cables)
- UK-Netherlands-12 (1989-2005) (6 fiber pairs)
- Odin (Netherlands-Denmark-Norway-Sweden) (1995-2006) (2 fiber pairs)
- Rioja (Netherlands-Belgium-UK-Spain) (1995-2006) (3 fiber pairs)
- Hermes North (UK-Netherlands) (1997-2009) (12 fiber pairs)
- UK-Netherlands-14 (1997-2018) (16 fiber pairs)
- Rembrandt-1 (UK-Netherlands) (1999-2014) (12 fiber pairs)
- Pangea South (UK-Netherlands) (2000-2000) (6 fiber pairs)
- TGN Northern Europe (2002-2023) (8 fiber pairs)

There are currently eight active fiber pairs providing transatlantic connectivity to the Netherlands, via the north and south cables of the Atlantic Crossing-1 (AC-1) system. However, AC-1 has already exceeded its forecasted lifespan.

All but one of the Netherlands' existing and planned cable systems are repeaterless, i.e. lacking submerged electronics, which allows for significant increases in cable capacity as technological capabilities advance; however, the older repeaterless systems such as Farland, Ulysses, Circe North, and Concerto are likely to encounter limitations in capacity increases due to the limitations of their older fiber as well as the physical aging of the cable itself. Although past estimates placed the lifespan of submarine cables at 20-25 years, many existing cables that have not encountered reliability issues are now being kept in service past their original forecasted technical lives, especially repeaterless systems, making it impossible to accurately forecast end-of-life.

As the Netherlands' lone repeatered system, AC-1 is currently operating at or near its design capacity of 8 Tbps between its northern and southern transatlantic segments; it was originally expected to be removed from service in 2024 but as of mid-2024 its operator Colt had not filed any notification with the Federal Communications Commission related to its expected retirement, and sources indicated that it is likely to remain in service until 2025 or 2026.

Figure 34: Map of Submarine Cables and Primary Long-Haul Terrestrial Fiber Networks in the Netherlands Region

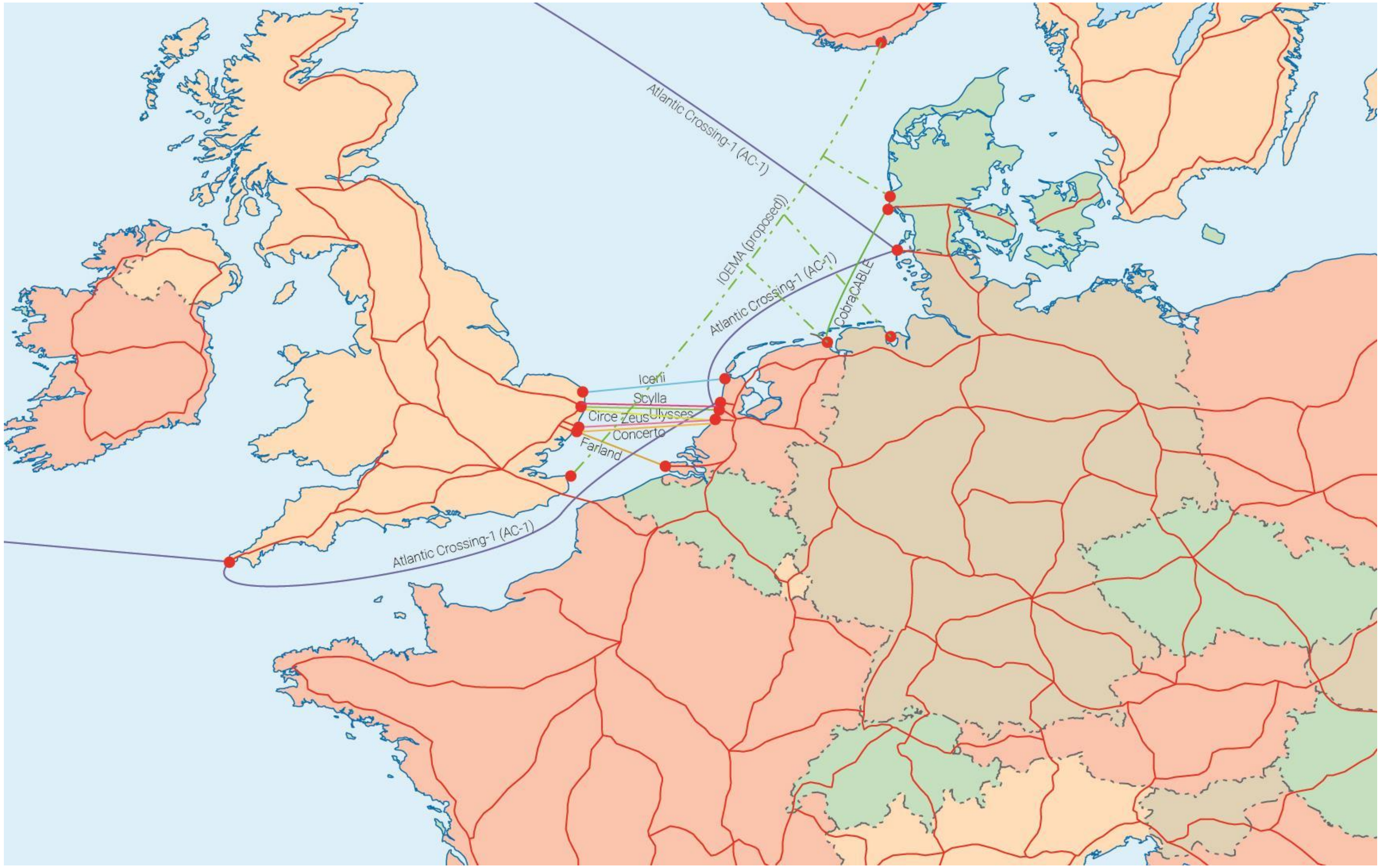
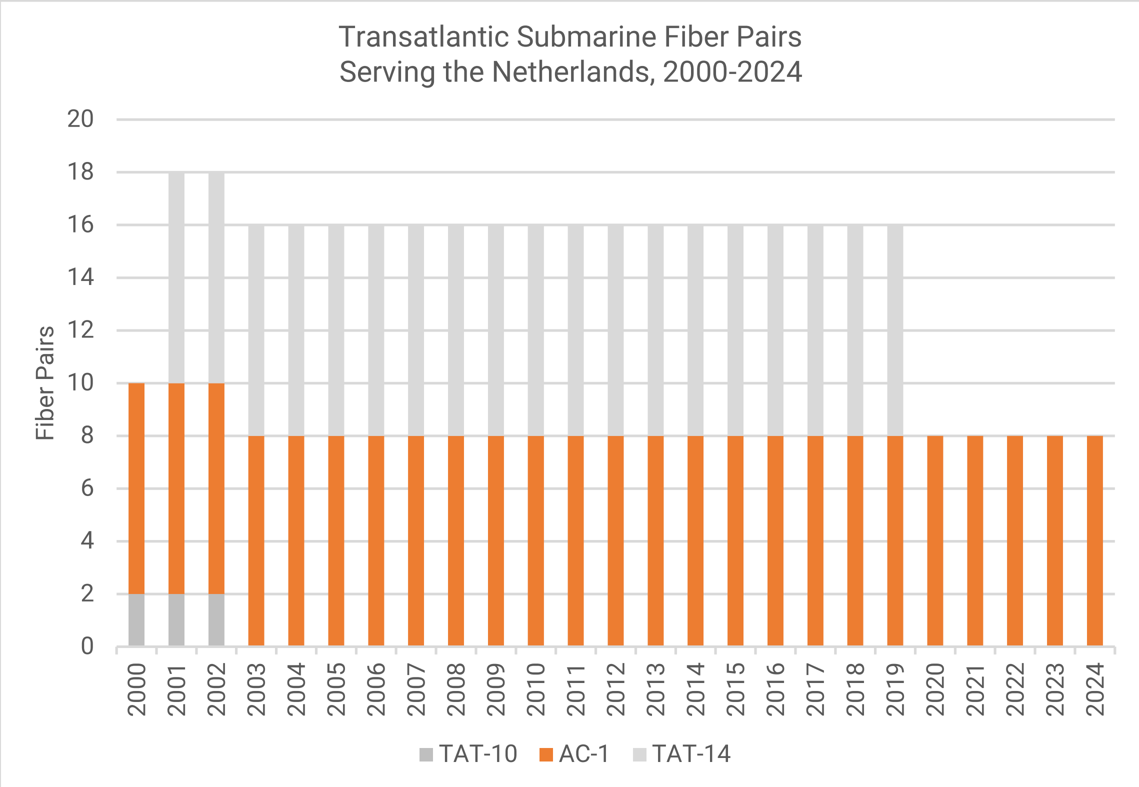
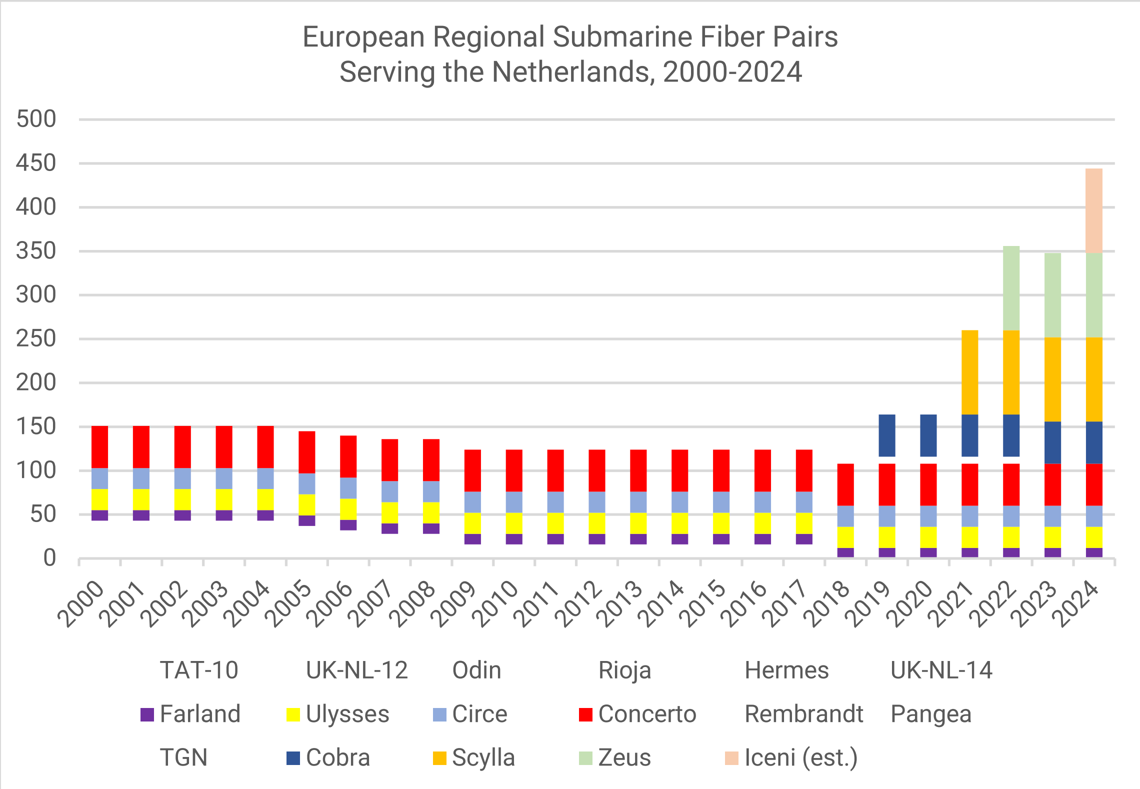


Figure 35: Transatlantic Submarine Fiber Pairs Serving the Netherlands, 2020-2024



As of year-end 2024 (following the completion of Iceni), there will be a total of 444 available fiber pairs in active submarine cable systems connecting the Netherlands to European destinations (although 396 fiber pairs link to the United Kingdom exclusively, with the remaining 48 on the COBRACable to Denmark). Notably, following the retirement of TAT-14 in 2020, the Netherlands has had only eight transatlantic fiber pairs (via AC-1, which are likely to be retired within the next two to three years).

Figure 36: European Regional Submarine Fiber Pairs Serving the Netherlands, 2020-2024



VI. Recommendations for New Submarine Cable Investment in the Netherlands

Terabit Consulting's continuous modeling and forecasting of international submarine cable markets indicates that at least 12 new transatlantic cables, eight new Europe-to-Asia cables, five new South American intercontinental cables, and one new African intercontinental cable will be required during the period 2025 to 2032.

Figure 37: Minimum Number of New Systems Required on Intercontinental Routes Applicable to Europe, 2025-2032 (Terabit Consulting Forecast)

	Minimum New Systems Required, 2025-2032
Transatlantic (North America-Europe)	12
Europe-Asia	8
South American Intercontinental	5
African Intercontinental	1

a. Transatlantic (North America-Europe)

The transatlantic route has historically been the leading market in the global submarine cable industry with respect to investment, capacity, and technology. As of 2024 it remains so, with 15 systems expected to be in service as of year-end, providing more than 2 petabits per second of design capacity, representing total investment of more than $7 billion. On the demand side, the transatlantic market has been driven by the strong economic integration of North America and Europe, and more recently, the data center-to-data center traffic of major tech companies including Google, Microsoft, Meta, Amazon, and Apple. Even with the continued improvement of upgrades to existing transatlantic systems, the transatlantic market is expected to have a shortfall of three times the evolved design capacity of existing and under-construction systems. In the eight-year period from 2025 to 2032, Terabit Consulting's modeling forecasts that this will necessitate the installation of a bare minimum of 12 new North America-to-Europe systems, an average of 1.5 new systems per year.

Terabit's forecast of forecasted outgoing demand in the Netherland's catchment area addressable by Dutch submarine cables, which conservatively includes only half of the transatlantic demand in Germany, Switzerland, Liechtenstein, and Austria, represents an average of 22.7 percent of total forecasted transatlantic demand. Consequently, the forecasted addressable market for international bandwidth in the Netherlands' catchment area justifies the construction of at least two new transatlantic systems serving the Netherlands by 2032.

b. Europe-Asia

Terabit Consulting's model forecasts that a minimum of eight new Europe-to-Asia systems will be required between 2025 and 2032, driven by demand volumes approaching 100 Tbps in India and continued growth in Southeast Asian and Middle Eastern markets, as well as data center-to-data center traffic from Chinese tech giants with significant data center investments in Europe, including China Mobile (present in Frankfurt), Alibaba (also present in Frankfurt), Huawei (present in Amsterdam and Paris), and Tencent (present in Frankfurt).

Although Europe-to-Asia submarine cables had historically passed through the Straits of Gibraltar to landing points on the Atlantic coasts of Portugal, Spain, France, the United Kingdom, and Belgium, in the last quarter-century almost all systems have terminated on the Mediterranean shores of France or Italy (with one exception, the Europe-India Gateway system of 2011). Consequently, Marseille has effectively become yet another "choke point" of the already extremely-vulnerable Europe-to-Asia submarine cable infrastructure, which suffers from elevated political risk due to its concentration in the Suez region.

Consequently, the business case for a Dutch landing point in a planned Europe-to-Asia submarine cable (especially via the Arctic Sea) is threefold. First, the route could promoted as a logical source of diversity for Europe-to-Asia submarine infrastructure. Second, it would serve as an efficient path for the growing data center-to-data center traffic of the major Chinese investors present in Northern Europe. Third, it could be paired with the attraction of new direct transatlantic connectivity to the Netherands that could provide efficient interconnection for the large volumes of traffic from the South Asia and the Middle East to the United States.

c. South American Intercontinental & African Intercontinental

Although Terabit Consulting forecasts healthy bandwidth growth in South American and African markets, supply-and-demand modeling indicates lower saturation rates on the intercontinental routes serving these two continents compared to the transatlantic and Europe-to-Asia routes.

This is particularly true of Africa, where Google's new Equiano system, the consortium-led Africa-1 cable, and the 2Africa project led by Meta, China Mobile, Orange, Vodafone, Saudi Telecom, and others will collectively provide over 400 Tbps of design capacity over three dozen fiber pairs. Along the North America-South America submarine cable route, meanwhile, Google's recent investments (Curie and Firmina) have added more than 250 Tbps.

Nevertheless, Terabit Consulting does forecast new investment in both the South American intercontinental and African intercontinental routes, albeit significantly lower than in the transatlantic and Europe-to-Asia markets. The traffic flows of both lend themselves to direct connectivity to the Atlantic coasts of Europe; this has been demonstrated by the 2Africa cable, which lands in England, and the EllaLink cable, which directly connects Brazil to Portugal. The inclusion of the Netherlands in intercontinental submarine projects serving Africa and South America would provide those markets with efficient, low-latency, cost-effective interconnection to the IXP and data center hubs of Amsterdam and Frankfurt, an increasingly attractive option given the convergence and integration of submarine cable and data center infrastructure.

It is important to note that although the Netherlands has strong ties to the Caribbean, particularly through the constituent countries of Aruba, Curaçao, and Sint Maarten, as well as the special municipalities of Bonaire, Sint Eustatius, and Saba, direct data flows between the Netherlands and the Caribbean region are currently limited in volume, as none of the markets are a significant source of high-bandwidth content accessed by Dutch internet users. Although most of the region's demand is directed toward data center infrastructure in Miami, an economic case may be made for direct connectivity between Europe and Caribbean markets.

d. European Regional

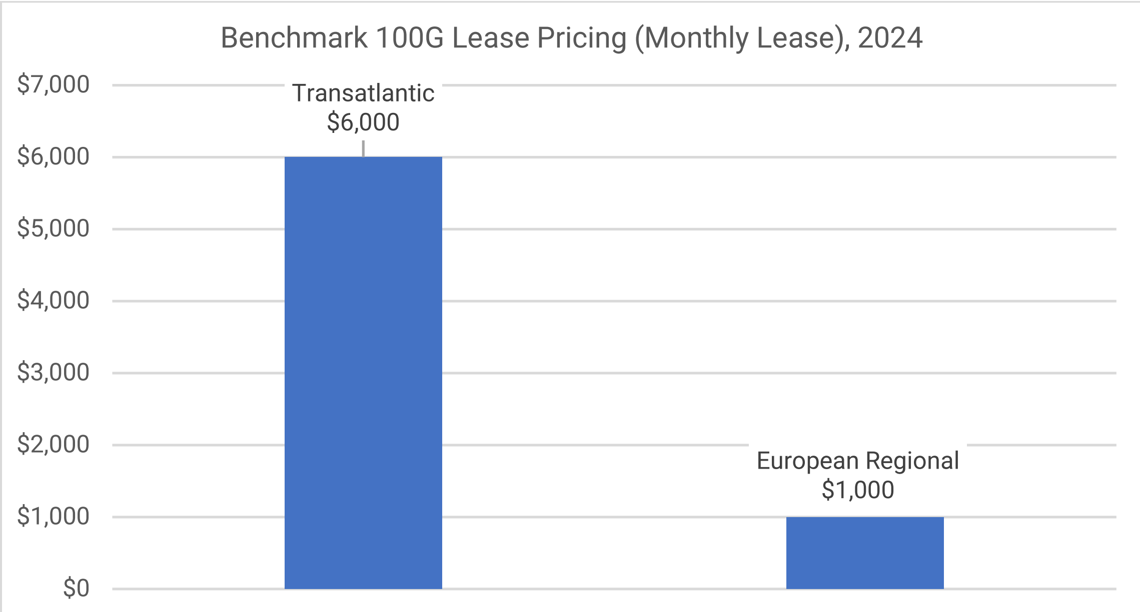
As of the end of 2024, nine submarine cables will be in service in the Netherlands. However, five of these cables, including the 25-year-old Atlantic Crossing-1 transatlantic cable, have already exceeded their originally planned technical lifespans. Of the four other systems, three are owned by single operators (euNetworks, Zayo, and BT), and the fourth is owned by a joint venture of two power companies. As such, ownership of next-generation submarine infrastructure in the Netherlands is extremely concentrated, thereby increasing vulnerability of the country's critical data infrastructure and dependency on the financial and technical stability of a very limited number of investors.

Although a strong business case can be made for new investments in intercontinental submarine cable systems serving the Netherlands, particularly on the transatlantic and Europe-to-Asia routes, the execution of such investments will ultimately depend on the role and participation of Dutch or Northern European investors in the development of proposed intercontinental projects. In the meantime, continued investment in regional infrastructure connecting the Netherlands to the United Kingdom and other European markets will be crucial, in order to accommodate near-term bandwidth demand as well as for the continued leadership of the Netherlands' IT sector. This includes the continued promotion of proposed cable projects such as IOEMA, PISCES, and Far North Fiber (each of which could provide much-needed diversity for the Netherlands' submarine cable infrastructure) as well as continued medium-term expansion of connectivity to other transatlantic gateways such as Ireland and Spain.

VII. Submarine Capacity & Fiber Pair Pricing

As of mid-2024, benchmark pricing for transatlantic and European bandwidth is as follows:

Figure 38: Benchmark 100G Pricing (Monthly Lease), 2024



Sources reported a range of between $5,500 and $7,500 per transatlantic 100G wavelength. They asserted that prices had converged for most major city pairs, be it New York or Ashburn on the American side, or London, Paris, Amsterdam, or Frankfurt on the European side.

Similarly, the $1,000 benchmark for European bandwidth was considered by sources to be relatively uniform for all major city pairs in Western Europe.

Consequently, with respect to pricing, there are no competitive advantages or disadvantages of the Netherlands' submarine bandwidth market vis-à-vis other major European markets.

A 100 Gbps wavelength lease is priced at approximately five times a 10 Gbps circuit; the 100G-to-10G multiple had been as high as 7.5 in recent years but cable operators have indicated that the multiple has stabilized at 5.0 as 100 Gbps wavelengths have become the predominant product along most routes.

Fifteen-year indefeasible rights-of-use (IRUs) are priced at approximately 36 times the monthly price of a lease. This multiple had also been higher in recent years, frequently in the 40x- to 50x-range, but has similarly stabilized in the mid- to high-30s.

Sources have indicated that some transatlantic fiber pairs have changed hands for as little as $20 million, and that cross-channel fiber pairs in Europe could be acquired for as little as $4 million. However, compared to lit bandwidth products (e.g. wavelengths) for which price quotations are freely shared, the fiber pair market is relatively opaque. Many fiber pair transactions, particularly in transoceanic systems, occur at the investor level prior to the execution of a cable's construction and maintenance agreement, and the few transoceanic fiber pairs that have changed hands post-C&MA have often been sold under financial duress at a price function closely equated to the fiber pair's construction cost. Some government clients have acquired fiber pairs on submarine systems, however these transactions are not considered to be indicative of market price because the government customers often have strict requirements with respect to geography, security, service level agreements, restoration, and supplier nationality and therefore demonstrate low price sensitivity.

Bandwidth price erosion averaged 25.4 percent annually during the "SDH (Synchronous Digital Hierarchy) era" up to and including 2008 (when most capacity sales and leases took place in STM units ranging from 155 Mbps to 10 Gbps), then 22.1 percent during the "wavelength era" from 2009 to present (when most sales and leases took place in the form of 10 Gbps or 100 Gbps wavelengths). The most severe price erosion has often coincided with, or followed, the announcement or activation of new cable systems.

Terabit forecasts that long-term erosion of the market price of capacity will continue to be a function not only of competition in the marketplace, but technological advancements and their resulting impact on unit construction costs. Based on its engagement with industry engineers, Terabit forecasts an average 18.9 percent annual increase in the maximum design capacity of new transoceanic systems as the industry moves toward technical limitations (including the Shannon Limit, which defines the maximum physical properties of the fiber and the signal-to-noise ratio) as well as the expected design-capacity milestone of 24 fiber pairs of 25 Tbps available in new systems by 2030, after which technological advancements in capacity are expected to slow significantly.

By comparison, the historical rate of technological evolution, measured by the maximum design capacity of new systems, has been 28.8 percent. Terabit therefore forecasts that overall long-term price erosion in the transoceanic marketplace, subject to irregular oscillations as a function of the announcement and activation of new systems, will be approximately two-thirds of historical averages.

Ultimately, Terabit's model forecasts an average compound annual price erosion in the transoceanic market of as low as 5 percent in years with no forecasted new cable deployment, to as high as 15 percent in years when multiple new cable systems are forecasted to enter service. As is the case with actual market bandwidth pricing, there are not expected to be any geographical differences in price erosion between the major European bandwidth hubs, including the Netherlands.

VIII. Cable Construction Costs

a. Introduction

In the case of repeatered systems, a submarine cable system encases several optical fibre pairs (transmission is unidirectional on a single fibre); this number can currently reach up to 24 fibre pairs. Each fibre is regularly amplified by repeaters (submerged equipment typically positioned every 100 kilometers) that are electrically powered via a conductor in the cable. Depending upon the cable system length, equalizers may also be needed to adjust the optical signal along the line.

The installation of the cable onto the seabed is performed by specialized vessels (cable ships) which lay and in some cases bury the cable on a route that had previously been surveyed by ships using various electronic devices such as multi-beam echo sounder and side scan sonar, and suitability for burial had been assessed where plough burial is planned.

The optical signal is provided by Submarine Line Terminal Equipment (SLTE) which convert standard terrestrial protocols in modulation formats more robust to long-haul transmission.

Submarine cable land infrastructure includes CLS (Cable Landing Stations), where the power feeding equipment (PFE) for the repeaters is installed and potentially part or whole the SLTE. More recently, SLTE have been mainly installed in Point of Presence (PoP) or data center to facilitate interconnection with other submarine or terrestrial networks, thus requiring terrestrial optical fibre networks between CLS and SLTE location.

b. Construction Costs

The overall construction budget of a submarine cable system takes into account the supply contract costs as well as other CAPEX which are not included and which altogether will represent the project construction cost.

1. Supply Contract Costs

Submarine systems are usually procured through turnkey contracts, which include the design, manufacture, and integration of all equipment, as well as their installation on the seabed up to the Purchaser's CLS where systems access equipment is installed for onward connectivity. Hence the supplier scope-of-work typically includes inter-alia:

- The design, engineering, planning, manufacture and implementation (including management and coordination) of the System
- The manufacture and testing of submarine cables and submersible plants including spares

- Obtaining all required approvals and permissions from all bodies, authorities, committees as may be required for cable laying in Territorial waters or EEZ, and its landing at each applicable landing point
- The laying operations including remedial post lay cable burial as required
- Pipeline and cable crossings, including all necessary agreements and permits
- The integration and testing of the System, proving the Design Capacity
- The training of the Purchasers' staff
- The provision of long-term support and maintenance during the System Design Life (25 years).

The supply contract which represents the bulk part of the capital expenditure.

For general information purposes, drawing on its experience and the existing cables landing in the region and possible future ones, AXIOM has considered several system configurations for cable systems linking Netherlands to its neighbouring countries and have estimated the costs of those. They can be found in Annex 1.

2. The Non-Supply Contract Cost Elements of Initial CAPEX

In addition to the cost of the turnkey supply contract to engineer, procure and construct the system (i.e. the lion's share of CAPEX), other costs as follows are to be considered for items that are not part of the supply contract list or that are the responsibility of the Purchaser.

- Costs for the Purchaser's project team to follow up the supply contract execution, which includes third parties' costs such as technical, technology and marine experts as applicable.
- Custom Duties & Import Taxes and VAT as applicable, for delivery of items in-country which includes country's land and Territorial Waters.
- Licensing fees for the cable owner to acquire the ad-hoc licenses in each terminal country in order to have all the legal authorizations to land and operate the system.
- Training fees to enable the Purchaser's staff to follow training sessions, mainly when abroad.
- Some O&M costs applicable prior to RFS (Ready For Service) date such as cable depot costs from the end of the marine operation (final splice at sea) and costs for drafting the System Maintenance Document (SMD). SMD is a Purchaser's guide that lists and defines the standard 0&M procedures to administer and operate the system on a day-to-day basis in all circumstances that may arise.
- Other legal fees for the cable company management and drafting legal documents such as capacity lease/purchase agreements. These costs will have to be defined by the system owner(s).
- A contingency amount to anticipate some unforeseen limited variations in the supply contract or other activities.
- The delivery of CLS buildings that is not included in the standard supply contract (it could however be an option) and it is usually the responsibility of the Purchaser

to provide a fully equipped CLS to receive and operate the system equipment in standard telecom conditions over the system lifetime.
- Initially, we have not taken into account any costs for the connection to the data centers. These costs are supposed to be re-invoiced at cost plus. However financial charges may be applicable to reflect time lag between cost incurred and resale.

Annex 1 also presents the resulting capital expenditures for the examples of systems considered by AXIOM for this exercise.

3. Cost Comparison of Cable Systems Landing in the Netherlands vs. Other Countries

In the current state-of-the-art repeatered cable configuration scenario (i.e. 24 fiber pairs), the main contributors to the supply contract cost (and thus the overall project cost) are:

- The wet plant (i.e. the cable itself and the repeaters/equalizers)
- The marine installation (from route survey to installation and post-lay activities such as ROV (Remove Operated Vehicle) inspection

Therefore, for cable systems with the same design capacity (i.e. fiber count and ultimate capacity in Tbps), it is easy to understand that the systems length and burial requirements are the key differentiators from a cost perspective. Otherwise, there is no material difference in the cost of landing cables in the Netherlands compared to other European countries, so the country is neither competitively advantaged nor competitively disadvantaged in attracting submarine cable investment from a cost perspective.

Countries like Ireland, England and France offer the possibility for the cross-Atlantic cable systems to land on their Atlantic, Celtic or Channel coasts. Extending to Netherlands will increase the distance by several hundreds of kms in the case of a mid-Atlantic route. Additionally, reaching the Netherlands coast (either West or North) will cause the cable systems to cross the English Channel or partly the North Sea where the seabed is very crowded. Indeed, there are many existing assets to be crossed or taken care of, leading to a more expensive marine implementation. Moreover, the Channel and North Sea routes are very shallow and will require the cable to be entirely buried on that portion, which will further increase the marine operations.

As for a more northerly Atlantic route which bypasses Scotland and will then head South to enter the North Sea, the cable systems length is obviously shorter to arrive in England, Norway or Denmark. The same extra costs than those presented just before will be faced. Based on the explanations given in Sections 1 and 2 (and further described in Annex 1), and for a US – UK cable system versus a US – NL cable system, AXIOM has estimated the CAPEX difference will be in the range of USD30m. This represents an approximate increase of 15 percent.

c. Annex 1

Without any suitable Desk Top Study, AXIOM has developed a preliminary wet cable route engineering as follows for the considered configurations:

#	From	To
1	Eemshaven (NL)	Newcastle (UK)
2	Haarlem (NL)	Lowesoft (UK)
3	Haarlem (NL)	Veusles Les Roses (FR)
4	Haarlem (NL)	Cayeux sur Mer (FR)
5	Eemshaven (NL)	Stavanger (N)
6	Dokkum (NL)	Kristiansand (N)
7	Dokkum (NL)	Esbjerg (DK)
8	Haarlem (NL)	Esbjerg (DK)
9	Haarlem (NL)	Cork (IRL)
10	Haarlem (NL)	Kilmore (IRL)

With regard to the systems' transmission capacity, AXIOM has looked at the latest technology currently available and implemented in 2024 i.e. cables fitted with 24 fibre pairs for repeatered systems.

Pricing of the 24 fiber pair configurations was assessed through benchmarking with prices of actual offers for systems currently under implementation.

Market prices being currently highly volatile, we consider such price estimates are applicable to a supply contract that would be signed within the next 12 months. In practice, the price achieved strongly depends on negotiation and balance of power of the moment between vendor and purchaser.

This leads to turnkey supply contract costs estimates as shown in the table hereafter.

Cable Route

The main feature of these possible cable systems is the cable route is entirely in shallow waters and the encountered depths may barely reach 500m off Norway. The assumption taken was therefore that the systems be entirely armoured and fully buried. SA (Single Armour) cable has been selected all over the route, with the exception of sections of DA (Double Armour) cable down to 20m water depth at each landing site.

The cable routes and cable engineering established by AXIOM are adequate for figuring out the systems supply contract costs. Fine tuning, that will result from a full DTS (Desk

Top Study) or CRS (Cable Route Study) to be undertaken during their implementation, will lead to marginal variations.

CLS (Cable Landing Station) locations are not known precisely but for pricing considerations a land cable route 5km long was assumed between each BMH and the CLS.

For the pricing exercise, the same fibre count has been considered for the repeaterless systems, but the extra cost for a potential higher count has been compensated by keeping the same cable design (cable for unrepeated systems are less expensive than that for repeatered systems). The costs have been established based on the current prevailing market prices for equivalent systems. The assumptions made for each of the constitutive price schedule sections are detailed hereafter.

	Eems-haven – New-castle	Haarlem – Lowe-soft	Haarlem - Veusles Les Roses	Haarlem - Cayeux Sur Mer	Eems-haven – Stav-anger	Dokkum – Kristian-sand	Dokkum - Esbjerg	Haarlem - Esbjerg	Haarlem - Cork	Haarlem - Kilmore
Section 1 - PM & Support	$2.6m	$1.4m	$2.4m	$2.3m	$3.0m	$2.8m	$1.7m	$2.6m	$4.4m	$4.6m
Section 2 - Submersible Plant	$20.0m	$6.2m	$14.8m	$14.3m	$23.5m	$20.0m	$8.7m	$19.0m	$38.8m	$40.2m
Section 3 - Land Cable Plant	$1.0m	$0.8m	$1.0m	$1.0m	$1.0m	$1.0m	$0.8m	$1.0m	$1.0m	$1.0m
Section 4 - Marine Operations	$18.0m	$10.2m	$17.4m	$16.5m	$22.4m	$20.1m	$15.3m	$18.7m	$35.0m	$35.8m
Section 5 - Terminal Station Equipment	$8.9m	$4.9m	$8.9m	$8.9m	$8.9m	$8.9m	$4.9m	$8.9m	$8.9m	$8.9m
Total	$50.5m	$23.5m	$44.4m	$43.0m	$58.9m	$52.7m	$31.5m	$50.2m	$88.2m	$90.5m

Section 1 (General)

The following price items are included in this section, assumed to represent 5% of the other contract costs:

- Project Management by the Contractor
- System Commissioning & Testing

Section 2 (BMH-to-BMH Wet Plant)

The following price items are considered in this section:

- 24fp cable
- Wet plant is made of SA cable except for 15km of DA down to 20m water depth at Landing Points shore-end

- Repeaters (no equalizers given the short distances)
- System assembly and loading on-board the laying cable ship(s)
- Spare plant as follows:
  - Spare cable. Such a sparing level is rather low (about 3% of the total line cable length) compared to standards because line cable is intended to be fully buried by 1.5m trench depth (3m for specific areas) and because any cable repair will be a shallow water repair
  - One spare repeater with ad hoc amp-pair count

This wet plant is the lion share of the supply contract.

Section 3 (BMH-to-CLS Land Cable Plant)

The following price items are included in this section:

- 24fp land cables (5km assumed at each Landing Point)
- Systems earth for the repeatered systems ("Ocean Sea Ground" made up of buried electrodes or buried/submerged sea plates)
- Cable pulling, splicing and testing
- Civil works for the "front haul" plant are not included in the supply contract cost estimate (they are usually included in the station cost), i.e. for each landing site:
  - BMH (Beach Manhole) construction
  - Land Cable Route including intermediate pulling manholes
  - Full ducting from BMH to CLS

Section 4 (Marine Operations)

The following price items are included in this section:

- Geophysical and geotechnical surveys over the whole wet cable route. An USD$1m allowance is included for a limited UXO survey as the latter is generally required in this Region
- Cable Route Clearance and Pre-Lay Grapnel Run on the whole wet cable route
- Pre-Lay Shore End (PLSE) installation expected to be required for one of the 2 landing sites
- Horizontal Directional Drilling (HDD) expected to be required for the second landing site
- Except for the part subject to PLSE, marine installation of the whole system by one single Main Laying Vessel (MLV), including a full cable burial except at the crossing points with O&G pipes or other cables
- O&G pipeline crossing operations requiring bottom and/or top rock dumping
- Post-Lay Burial (PLB) and PLI (Post-Lay Inspection) on 3% and 1% respectively of the overall buried sections to ensure burial quality and compliance to contractual requirements assumed to be performed by the MLV as a conservative approach
- PLI at each pipeline crossing to ensure to crossing requirements assumed to be performed by the MLV equipped with her ROV (yet precautionary approach as other less expensive marine spread could perform this activity)

- Spares offloading at a cable depot of the selected Maintenance Agreement. A 3-day MLV allowance is accounted for in the pricing exercise

The above assumptions are derived from actual requirements for existing systems in the Region where there are well known threats (fishing), constraints (marine protected areas), a lot of offshore activities and numerous assets to be crossed which results in a costly marine installation for the systems.

Section 5 (TSE & Related Installation and Testing Services, including CLS staff training)

For the pricing exercise, an initial equipage of 18Tbit/s on one (1) fibre pair has been considered. To reach such capacity, both systems linking Netherlands to France have been engineered as repeatered systems. Indeed, given the length of these links, the maximum capacity would not be greater than 5Tbit/s to 7Tbit/s per fibre pair if they were unrepeated systems.

As regards Terminal Station Equipment (TSE), the pricing exercise includes the following price items in this section, for both CLS:

- 3kW PFE (Power Feeding Equipment) in cable stations for repeatered systems
- Raman pump for the repeaterless systems
- SLTE in all terminal stations (racks and boards) equipped with an initial capacity of 18To on one fibre pair
- Standard Portal Interfaces in all terminal stations enabling to terminate additional line fibre pairs for further connection of SLTE (i.e. the wavelength transponders).
- Computerized Supervision System (CSS)
- TSE installation, connecting to AC and DC power plants as applicable and stand-alone testing prior being connected to the line plant
- Purchaser's staff training sessions: general training type A in supplier's facilities and practical training type B in CLS (“hands-on equipment" training) for the delivered equipment)
- TSE spares as required.

The price components here below are not included in Section 5:

- A general supervision and network management system, (including a NOC, Network Operating Center) at a location to be determined. Most cable systems are managed and supervised by such a central office, in permanent remote communication with all CLSs and possibly DCs (Data Centers). This NOC may be located in a selected CLS or at another remotely connected site. Main NOC functions consist in coordinating the activities of the CLSs and possibly DCs with regard to routine maintenance operations and circuit activation and liaise with the cable systems owners and capacity customers.
- Cost for acquiring a piece of land for setting up the relevant CLSs, as applicable
- Cost of CLS building (permanent building or prefabricated shelters) and/or equipment room rehab or refitting in existing facilities. A cost estimate is however provided.

- Cable station ancillary equipment:
  - Electrical AC panel for connection to the public power grid
  - Uninterruptible DC 48V and AC power supplies, including DC and AC power distribution lines and boxes
  - Central 48V DC stationary batteries
  - Back up DEG (Diesel Engine Generators)
  - ACS (Air Conditioning System)
  - General facilities for cable station monitoring and security (access control, station alarm system, automatic fire extinguisher system, etc.)

Subsequent Construction Costs

As described above, the non-supply contract costs have been established on the following hypothesis:

- Purchaser's project team costs: in CAPEX pricing exercise, this is assumed to represent 2% of the supply contract cost.
- Custom Duties & Import Taxes and VAT as applicable: in CAPEX pricing exercise, the applicable asset is roughly taken at 0% of Section 1, 20% Sections 2 and 3, and 100% of Sections 4 and 5 for an average tax rate of 10% of the cost of imported equipment and services.
- In CAPEX modelling, a US$1m allowance has been considered for the licensing fees.
- Provisions of US$300k are included in CAPEX pricing exercise for training expenditures
- As explained earlier, the SMD is a Purchaser's guide that lists and defines the standard 0&M procedures to administer and operate the system on a day-to-day basis such as:
  - routine and corrective maintenance
  - procedure for triggering any O&M activity operation and organizing the required coordination of the parties to be part of
  - repair operations at sea
  - procedures for capacity activation, transmission plan management and Portal and SLTE upgrade procurement
  - setting up and implementation of a contingency plan in the event of a fault, etc.

An allowance of US$650k has been assumed for such O&M pre-RFS activities.

- As a standard rule, it is proposed to consider an amount equal to 5% of the supply contract cost for contingencies. Should it be agreed, rules must be developed for Purchaser's project team to access the contingency amount.
- The Cable Landing Station are the Purchasers responsibility. Each building shall be able to safely receive and operate the system equipment whose quantity, footprint, power consumption and air conditioning requirements vary over time depending, in particular, on portal and SLTE upgrades to be purchased over time to adapt the system to the ever-increasing traffic. Some of the ancillary equipment

may itself be subject to regular upgrades (e.g. AC and DC power plants, ACS, etc.), however a number of characteristics must be present from the systems start of life (land area, in-CLS space, etc.). Recently (in the last fifteen years or so), many system owners decided to implement prefabricated solutions, cheaper and more scalable than a permanent building. Through AXIOM's recent experiences, we can estimate the initial cost of such solutions. Based on traffic forecasts, we distinguish between large and smaller stations:
- Large stations (100m2) which initial turnkey cost per CLS is estimated at US$2m
- Smaller CLSs (60m2) which initial turnkey cost per CLS is estimated at US$1.25m

All these assumptions lead to the constructions costs in the following table:

	Eems-haven – New-castle	Haarlem – Lowe-soft	Haarlem - Veusles Les Roses	Haarlem - Cayeux Sur Mer	Eems-haven – Stav-anger	Dokkum – Kristian-sand	Dokkum - Esbjerg	Haarlem - Esbjerg	Haarlem - Cork	Haarlem - Kilmore
Supply Contract	$50.5m	$23.5m	$44.4m	$43.0m	$58.9m	$52.7m	$31.5m	$50.2m	$88.2m	$90.5m
Non Contract Costs										
PM Costs	$1.0m	$0.5m	$0.9m	$0.9m	$1.2m	$1.1m	$0.6m	$1.0m	$1.8m	$1.8m
Customs Duties & Taxes	$3.1m	$1.7m	$2.9m	$2.8m	$3.6m	$3.3m	$2.2m	$3.2m	$5.2m	$5.3m
Licence Fees	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m	$1.0m
Trainees Fees	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m	$0.3m
Pre-RFS O&M	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m	$0.7m
Cable Company legal Fees Estimate	$0m	$0m	$0m	$0m	$0m	$0m	$0m	$0m	$0m	$0m
Continge-ncy	$2.5m	$1.2m	$2.2m	$2.2m	$2.9m	$2.6m	$1.6m	$2.5m	$4.4m	$4.5m
Station Costs Estimate	$2.0m	$1.3m	$1.3m	$1.3m	$2.0m	$2.0m	$1.3m	$2.0m	$2.0m	$2.0m
Total	$61.1m	$30.0m	$53.6m	$52.1m	$70.5m	$63.7m	$39.1m	$60.8m	$103.5m	$106.1m