Fibre:

the most energy-efficient solution to Europe's bandwidth needs

White Paper

Brussels, July 2022

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Contents

More Information

For the full studies, including detailed information on how they were set up and carried out, please visit the Europacable website.

Executive Summary

Vast data traffic growth in an increasingly connected Europe is leading to greater energy demand. Significantly more connectivity is needed, while time, cost, and environmental impact of energy consumption must be taken into account.

With this White Paper, Europacable, the voice of Europe's leading wire and cable producers, aims to demonstrate the energy-saving properties of connectivity over different types of broadband access technologies. The paper is intended to provide an impetus for careful consideration and assessment of the various technologies' energy requirements. The findings, based on the outcome of three studies commissioned by Europacable, clearly demonstrate the energy saving potential of fibre-based networks across all practical and realistic rollout scenarios for fixed and wireless networks.

Overall conclusion

Fibre significantly saves energy, increases bandwidth and contributes to a sustainable Europe.

Out of all access technologies, Fibre GPON is the most energy-efficient due it its relatively low energy consumption, long lifespan, and future-proof capabilities.

Fibre is the ideal enabling technology for Radio Access Networks (RAN) and Cloud Radio Access Networks (C-RAN).

As fiberization of the RAN or C-RAN takes place, this triggers further network power efficiency. By using fibre for fixed connections as well as wireless connection, less energy is required and investment costs can be significantly reduced.

Although network installation and operation account for a large proportion of telecom sector greenhouse gas emissions, fibre enables energy efficiency across several areas: for example, power efficiency improves and CO_2 emissions are far lower per data bit transferred, less cooling is required, and the use of electronic components can be reduced.

Study 1: "Energy consumption of telecommunication access networks."

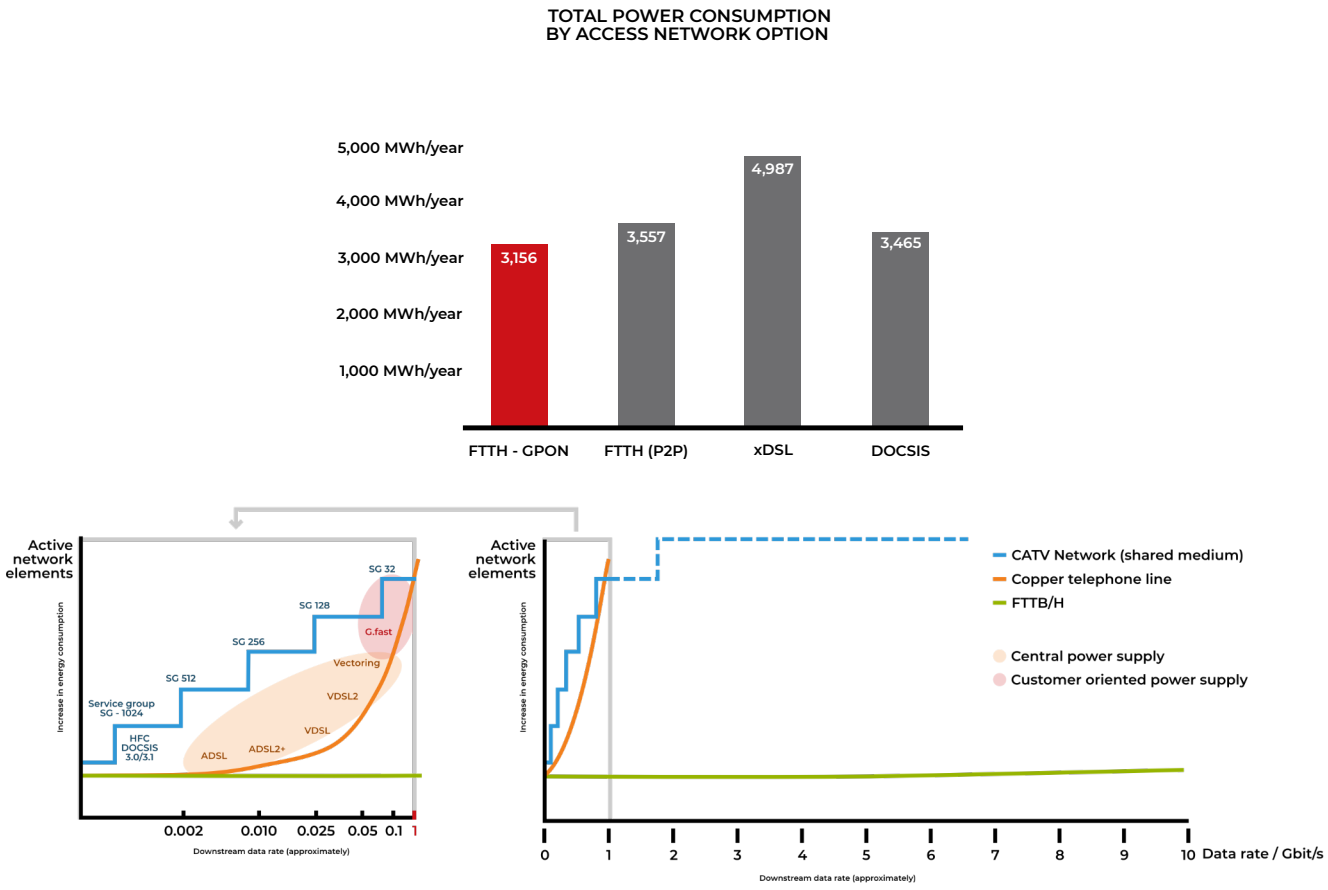
I.B.M.T, Meschede, October 2018

Objective

The aim of the first study, commissioned by Europacable in 2018, was to compare energy consumption figures for a variety of access technologies and answer the following question: "How much electrical energy is needed by different access technologies to provide a minimum of 50 Mbit/s for every subscriber in a specified area?".

Main conclusion

FTTH GPON consumes **3,156 MWh/year**, and is the most energy-efficient access network option, with energy consumption more than three times lower than Fixed Wireless Access. What's more, energy consumption does not increase as bandwidth grows. With other access technologies, increased bandwidth means greater energy consumption. Energy consumption of other Fixed access technologies is significantly higher: **3,557 MWh/year** for FTTH (P2P), **4,987 MWh/year** for xDSL, and **3,465 MWh/year** for DOCSIS.



Study 2:

I.B.M.T, Meschede, March 2022

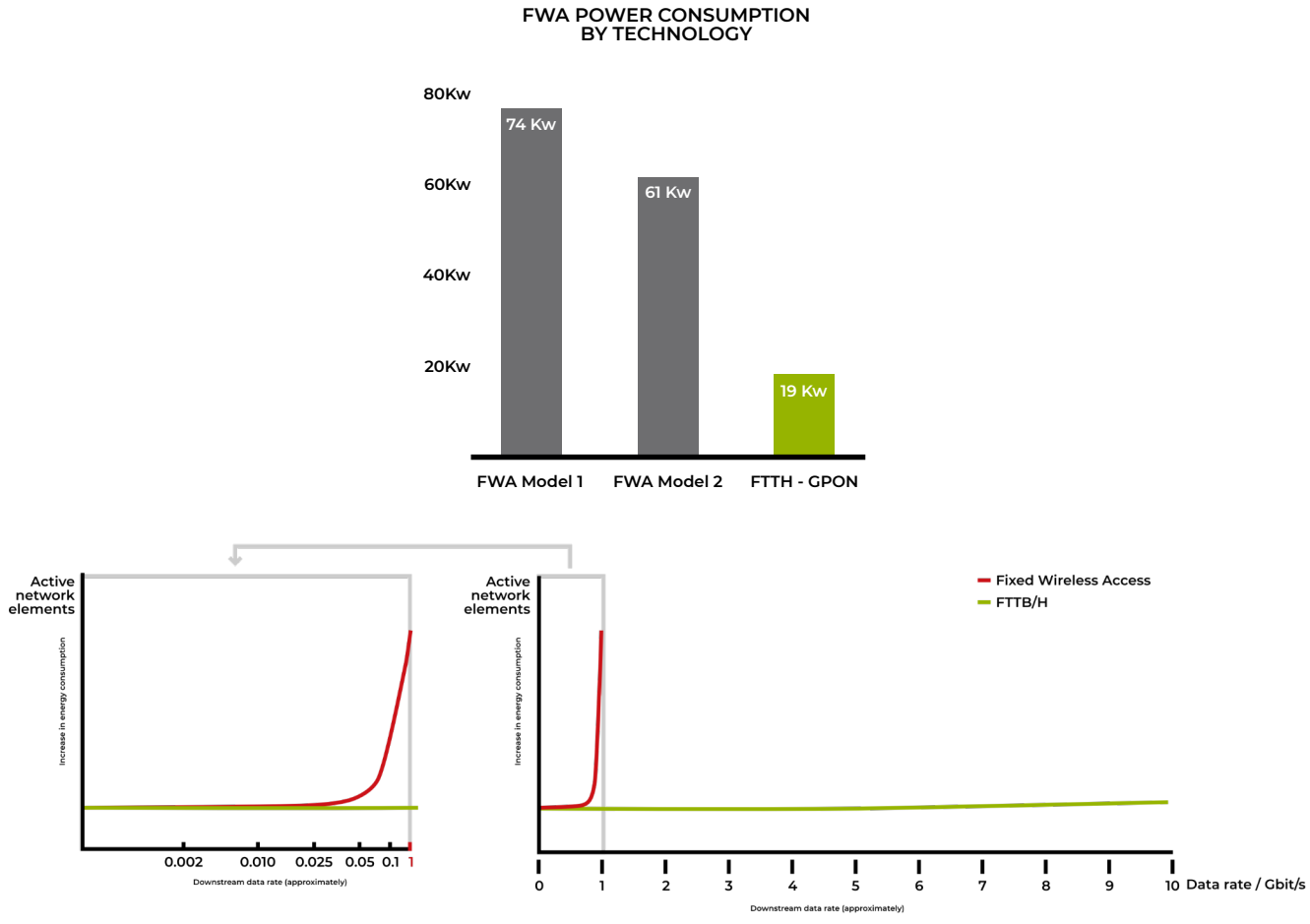
"Considerations on the energy consumption of Fixed Wireless Access (FWA) operation."

Objective

Following the conclusion of Study 1, Europacable commissioned a second study to examine the energy consumption of Fixed Wireless Access (FWA) in 2022. By introducing radio links between two fixed points FWA provides wireless broadband to end users.

Main conclusion

FWA power consumption is more than three times higher than that of FTTH GPON. The first of two models used in the study consumes **74 Kw** and the second model consumes **61 Kw**, whereas Fibre GPON consumes just **19 Kw**.



Study 3:

Politecnico di Milano, January 2022

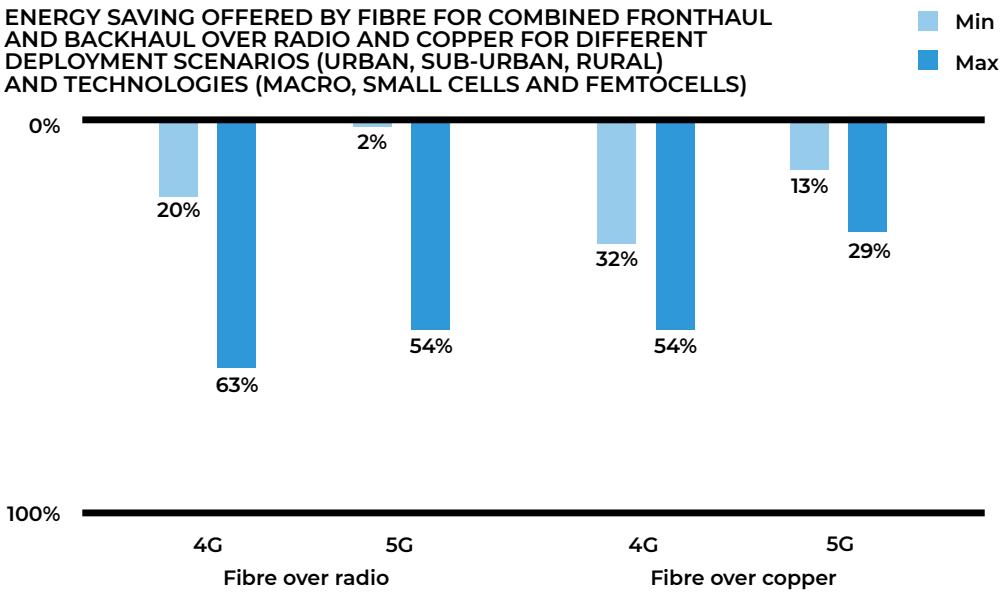
"Energy efficiency of fibre versus microwave, mmWave, copper, satellite and laser for the transport of the fronthaul and backhaul in 4G and 5G mobile networks."

Objective

The aim of the third study, commissioned by Europacable in 2022, was to determine which of several technologies used in cellular communication to provide connectivity to the Network Access Point (NAP) in modern cellular communication offers the best energy consumption performance.

Main conclusion

Optical fibre is the optimal technology for both backhaul and fronthaul across all considered scenarios and architectures. Fibre brings considerable power savings across all studied architecture and population density scenarios.



In fact, both 4G and 5G, with gains between **2-54%** (5G Sub-6GHZ and 5G mmWave) and **20-63%** (4G) compared to radio link technology, while in comparison to copper fiber reduces power consumption of a term between **32-54%** (4G), **13-29%** (5G Sub-6GHZ and 5G mm Wave), depending on the scenario and technologies.

A closer look at Study 1

“Energy consumption of telecommunication access networks.”

I.B.M.T, Meschede, October 2018

The study examined power consumption of four wired broadband access technologies.

- **VDSL2 Vectoring**
- **DOCSIS 3.0 in HFC (Hybrid Fibre-Coax) networks at 864 MHz**
- **FTTH – P2P Ethernet**
- **FTTH – GPON**

Each of these access technologies can theoretically satisfy data rates demanded by subscribers. But which method is best in a given situation? Apart from technical specifications related to data transfer performance (such as speed and latency) power consumption and energy efficiency are key to making this decision.

Key findings

- **In all urban, rural and suburban scenarios studied, FTTH GPON proved to be the most Energy-Efficient Access Network.**

- FTTH GPON energy consumption is **more than three times lower** than Fixed Wireless Access.

- Per capita consumption of FTTH GPON is between **56 kWh/year and 88 kWh/year.**

- FTTH P2P can offer the highest (up and down) data rates and can, therefore, transmit the greatest amount of data with the least power consumption.

- Using average energy consumption of a 4-person-houshold as a reference, energy consumption of the different access technologies is between **5% and 8%.**

- DSL and FWA performance are almost identical.

The study demonstrates the superior power efficiency of fibre-based networks in comparison to all other technologies, including fixed wireless access. Power consumption of fibre compared to other solutions is more than three times lower across a wide range of real-life scenarios, at every stage of its functional lifetime. All of the researched access technologies require a certain number of network elements to realize a given level of subscriber internet access. However, the number of active network elements and network structure develops very differently when the data rate is increased. This has a direct effect on overall energy consumption.

A closer look at Study 2

“Considerations on the energy consumption of Fixed Wireless Access (FWA) operation.”

I.B.M.T, Meschede, March 2022

In addition to the four technologies covered in Study 1, the power consumption of FWA technology, which replaces the last section of wired link with a wireless connection, was studied.

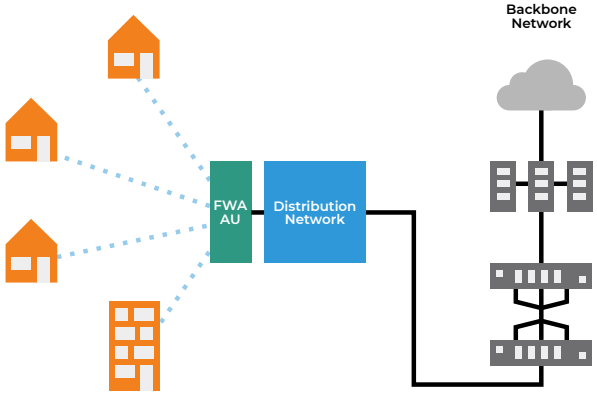
Key findings

- FWA power consumption is **three times higher** than that of fibre GPON.
- FWA power consumption was **74 Kw (type 1)** or **61 Kw (type 2)**.
  With FTTH GPON this was merely 19 Kw.

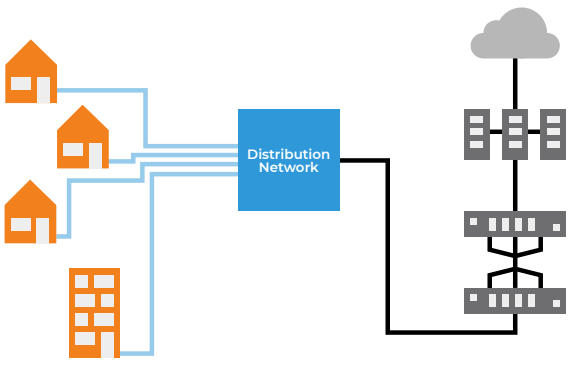
A closer look at results for access technologies from study 1 and 2

Power consumption of the HFC and VDSL2 Vectoring access networks is 1.8 to 2.2 times higher than that of FTTH – Point-to-Point and up to 7.5 times more than the FTTH – GPON access network. This is largely because the number of required active network elements and locations differ considerably for each access network. The HFC network needs the most active network elements (794 fibre nodes and 12 CMTS). In second place is VDSL2 Vectoring (538 active street cabinets (DSLAMs) and six central offices). FTTH requires the smallest amount of active network elements (36 PoPs).

An especially important point: Customer Premises Equipment (CPE) is responsible for over ¾ of the total power consumption. VDSL2 Vectoring network CPE is the most energy efficient. Energy efficiency can be improved considerably: by increasing radio range and distance between sites, the number of FWA AUs can be reduced and the number of subscribers can be increased. However, as soon as the required data rate per subscriber increases more AUs and possibly PoPs are necessary.



Wireless access network



Wired access network

A closer look at Study 3

"Energy efficiency of fibre versus microwave, mmWave, copper, satellite and laser for the transport of the fronthaul and backhaul in 4G and 5G mobile networks."

Politecnico di Milano, January 2022

The study considered both 4G and 5G networks with all the possible options that the technologies may offer. Fibre, radio and copper connection options were examined across rural, urban and suburban scenarios. The study shows that optical fibre is the optimal technology for both backhaul and fronthaul across all considered scenarios and architectures. Fibre brings considerable power savings across all studied architecture and population density scenarios.

FIBRE FRONT/BACKHAUL

COPPER/xDSL FRONT/BACKHAUL

POINT TO POINT RADIO FRONT/BACKHAUL using mmWave and microwave frequencies. From here on, this will be referred to as 'Radio'

For 4G and 5G, optical fibre provides the best performances in terms of energy consumption in all the considered scenarios compared to equivalent technologies on backhaul and fronthaul access networks. Power savings specifically for backhaul are **21% to 77%**.

In comparison to copper, fibre reduces power consumption by **32-54%** (4G), **16-22%** (5G) and **13-29%** (5G mmWave), depending on the scenario. Regardless of cell dimension, optical fibre is the most energy efficient technology in every scenario. If cell dimension can be reduced, fibre may allow power savings from **7% to 65%** on the overall network deployment.

An optical fibre network consumes **21%, 39% and 36%** less power than radio in macro, micro, and femtocell scenarios, respectively. Radio has the highest average consumption, similar to copper. Optical fibre consumes **21%** less power than radio in a macrocell scenario. Whatever the level of traffic in the network, optical fibre is always the winning technology while radio is less efficient.

Considering backhaul, optical fibre is 2 to 3 times more efficient than radio in macro and microcell scenarios, saving up to **67%** and **54%** power. Fibre is also 8+ times more efficient than both radio and copper in femtocell scenario, saving up to **89%** of power.

The results show that for 4G, optical fibre provides the best performances in terms of energy consumption in all considered scenarios, with gains between **20% - 39%** compared to microwave technology in macro- and microcell scenarios, peaking to **63%** compared to radio in femtocell scenarios. Adopting optical fibre allows for power savings from **54%** to **87%** on the backhaul deployment.

For 5G technology, optical fibre is still the optimal solution in terms of energy consumption savings, with an overall reduction of **2% to 15%** in macro and microcells. When considering femtocells, power consumption turns out to be tens of times higher. Optical fibre allows a reduction in the ranges of **8% to 45%** compared to copper and microwave solutions.

Fibre roll-out in Europe

High-speed connectivity, enabled by broadband technology, has become essential to a broad range of professional and private services. Broadband access networks can connect users with a variety of technologies, such as DSL or DOCSIS, and infrastructures, such as hybrid fibre coax networks.

As technologies such as 5G, IoT, and edge computing continue to grow, users expect high-speed, low-latency, always-available bandwidth everywhere, at all times. This requires significant amounts of backhaul cabling, connecting end-users to fibre-optic core networks, and network densification, in order to offer a greater number of access points.

The studies discussed in this White Paper support the idea that widespread deployment of fibre can help realize the European Commission's Digital Compass targets, by promoting growth, jobs and competitiveness through targeted infrastructure investment. This will benefit from fibre's virtually unlimited bandwidth and energy savings.

As part of the EU digital ambition:

- all European households are to be covered by a Gigabit network by 2030
- all populated areas are to be covered by 5G by 2030

The European Green Deal aims to transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use

Achieving these targets will require reductions in emissions across several sectors.

Fibre allows for the realization of extended high-speed broadband networks without jeopardizing environmental objectives, including CO_2 reduction goals. As shown in the studies, full-fibre networks consume significantly less electricity than copper-based broadband networks and enable energy savings, helping achieve the twin transitions of Digital Europe and European Green Deal.

Glossary

Backhaul
Connection between mobile and wired network, moving traffic from cell sites.

CO / central office
The building to which subscribers are connected on a local loop. From here, an optical signal is distributed over an optical distribution network.

DOCSIS 3.0 in HFC (Hybrid Fibre-Coax) networks at 864 MHz
Data Over Cable Service Interface Specification (DOCSIS) enables high-bandwidth data transfer via coaxial cable originally used for Cable TV. DOCSIS 3.0 can reach speeds up to 340 Mb/s (DOCSIS) or 440 Mb/s (EuroDOCSIS).

Fronthaul
Fibre-based connection to the Cloud Radio Access Network (C-RAN).

FTTH – GPON
Gigabit-Capable Passive Optical Network is a point-to-multipoint infrastructure, offering relatively high speeds at a limited cost. Signal passes through a splitter so it can be shared by multiple end users.

FTTH – P2P Ethernet
FTTH Point-to-Point (P2P) networks provide one dedicated optical fibre to each subscriber. Because bandwidth is not shared, each port offers uninterrupted high speeds.

FWA
FWA links wired infrastructure to the subscriber premises by bridging the last metres by a cost-effective radio link, lowering / postponing investments and reducing time to market. Radio technologies vary from WLAN and proprietary systems to 5G.

Node
Shared network box: at this point, fibre optic cables are connected to a trunk and distribution system.

PoP / point of presence
The interface point between communicating entities, such as the local access point that allows users to connect to the Internet with their Internet service provider (ISP).

VDSL2 Vectoring
Very high speed digital subscriber line (VDSL) offers faster data transfer than asymmetric digital subscriber line (ADSL). It works over smaller distances using copper wire. Speed drops off with distance.

Europacable is committed to helping achieve the digital and green transitions

Founded in 1991, Europacable is the voice of Europe's leading wire and cable producers. Europacable members include the largest cable makers in the world, providing global technology leadership, as well as highly specialized small and medium sized businesses from across Europe. The product scope of our members covers the full range of energy and communication cables.

Telecommunication networks will be the backbone of Europe's digitalization. Fibre-based networks offer the opportunity to meet the increase in demand through unlimited bandwith and reduce telecommunication networks' energy consumption through higher efficiency. Hence, fibre-based networks are a core technology to achieving Europe's Gigabit Society in an efficient, sustainable manner.

Europacable and its member companies are committed to continued investments in the research, development and production of reliable and energy-efficient fibre-based network technologies in their facilities across Europe.

Europacable

58, Rue Marie Bourgogne
B – 1000 Brussels

contact@europacable.eu

https://europacable.eu

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