GSMA Intelligence

The 5G FWA opportunity

A TCO model for a 5G mmWave FWA network

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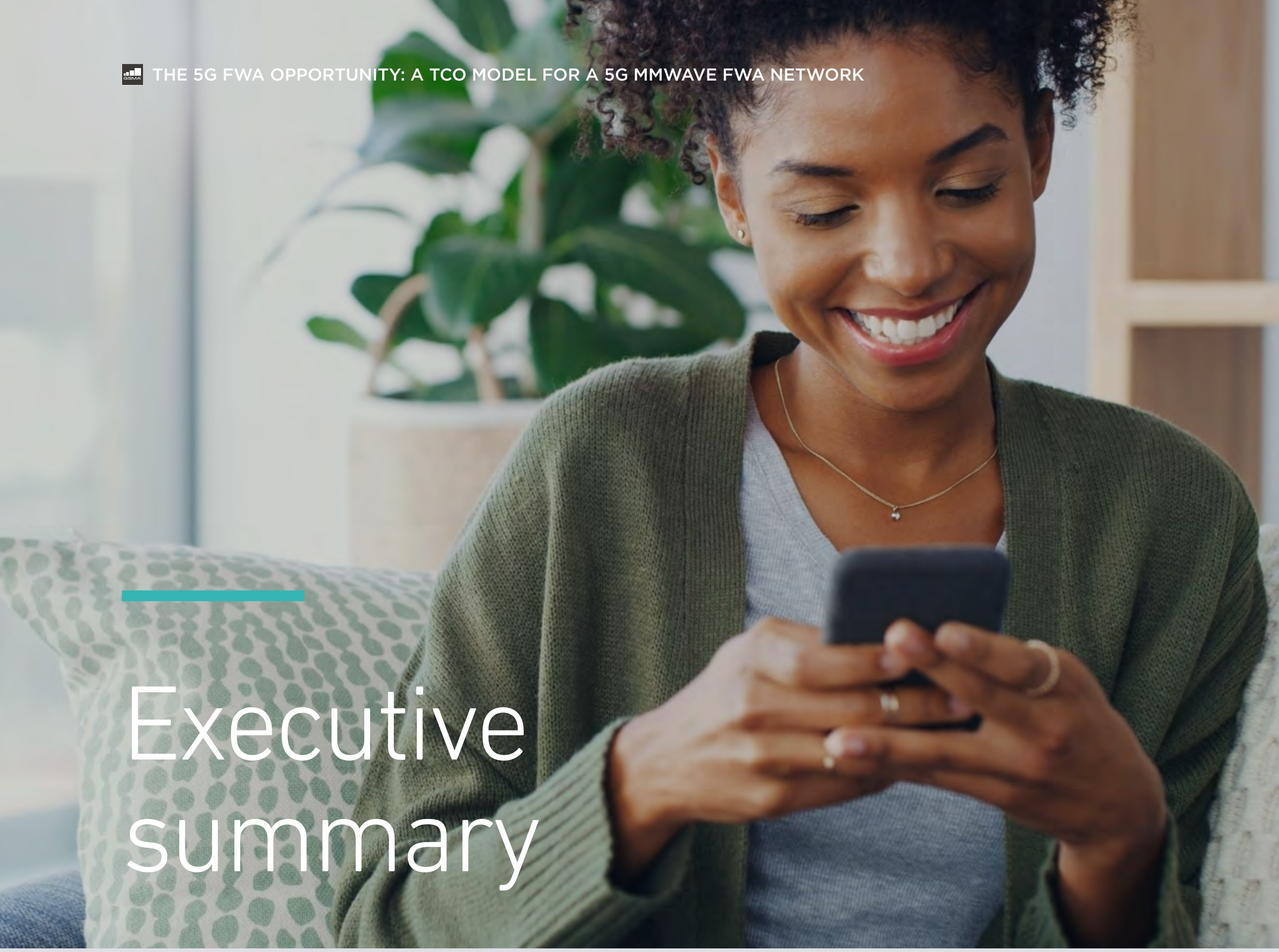
Contents



Executive summary

About this research

This is the second in a series of research reports examining the conditions under which 5G fixed wireless access (FWA) can be a cost-effective means to deliver broadband services (with download speeds of at least 100 Mbps), compared to alternative wireline technologies and according to different deployment strategies.

In the first report, we provided an overview of the global fixed broadband market, the technologies used and recent developments in 5G FWA networks. We also outlined the cost drivers of each technology, as well as the unique total cost of ownership (TCO) model we use to inform our findings.

In this report, we focus on the scenario of a mobile operator that has an existing 5G network for mobile services and is looking to deploy a fixed broadband offering. The operator has limited sub-6 GHz spectrum available (40 MHz) and a reasonable amount of mmWave spectrum in the 26–28 GHz bands (400 MHz). This is representative of many operator situations around the world, including in countries such as Italy,[1] Chile[2] and Germany,[3] and will be representative of more in the future as mmWave bands continue to be assigned. The scenario is relevant to mid-band constrained mobile operators that do not have a fixed offering, or mid-band constrained converged operators looking to complement or upgrade their wireline networks in underserved areas.

1 40 MHz per operator of spectrum in the 3.5 GHz band on average and 200 MHz in the 26 GHz band per operator on average auctioned as of December 2021.
2 50 MHz of spectrum in the 3.5 GHz band per operator on average and 400 MHz in the 26 GHz band per operator on average auctioned as of December 2021.
3 75 MHz of spectrum in the 3.5 GHz band per operator on average auctioned as December 2021; mmWave spectrum in the 26 GHz band available for 5G services upon application.

We use our unique TCO model to establish under what conditions deploying 5G FWA can be a cost-effective connectivity option. We focus on three geographies (Europe, the US and Latin America) over a 10-year period in three area types (an urban area, suburban area and rural town), which are constructed using real-world data on surface area and population, and building and road density. Since the hypothetical operator has low availability of sub-6 GHz spectrum and is constrained in mid-band capacity, we study the economics of a deployment strategy that involves using mmWave spectrum to provide the coverage and capacity required for 5G FWA services. We refer to this deployment as a 5G mmWave FWA network.

Key findings

Mobile operators in Europe, the US and Latin America that are constrained in their mid-band holdings and looking to deploy FWA services can consider a 5G mmWave FWA network a cost-efficient alternative to fibre to the home (FTTH) in several instances:

- In rural towns, a 5G mmWave FWA network is the most cost-effective solution for delivering future-proof, next-generation broadband services where fibre cables cannot be deployed using existing infrastructure that can be rented or shared. According to baseline assumptions, a 5G mmWave FWA network could deliver cost savings of up to 55% in Europe, 45% in the US and 65% in Latin America.
- 5G mmWave FWA can also be a cost-efficient connectivity option in suburban areas lacking ducts or poles that can be rented or shared. In this case, according to baseline assumptions, cost savings could amount to 30% in Europe and the US, and 45% in Latin America.
- In some urban areas, 5G mmWave FWA can be cost-effective compared to FTTH where new ducts need to be built to deploy fibre cables. According to baseline assumptions, 5G FWA could deliver cost savings of 25% in Latin America and would cost as much as FTTH in Europe and the US.
- FTTH would be a cost-effective option versus 5G mmWave FWA where fibre cables can be deployed in aerial or underground infrastructure that can be shared or rented.

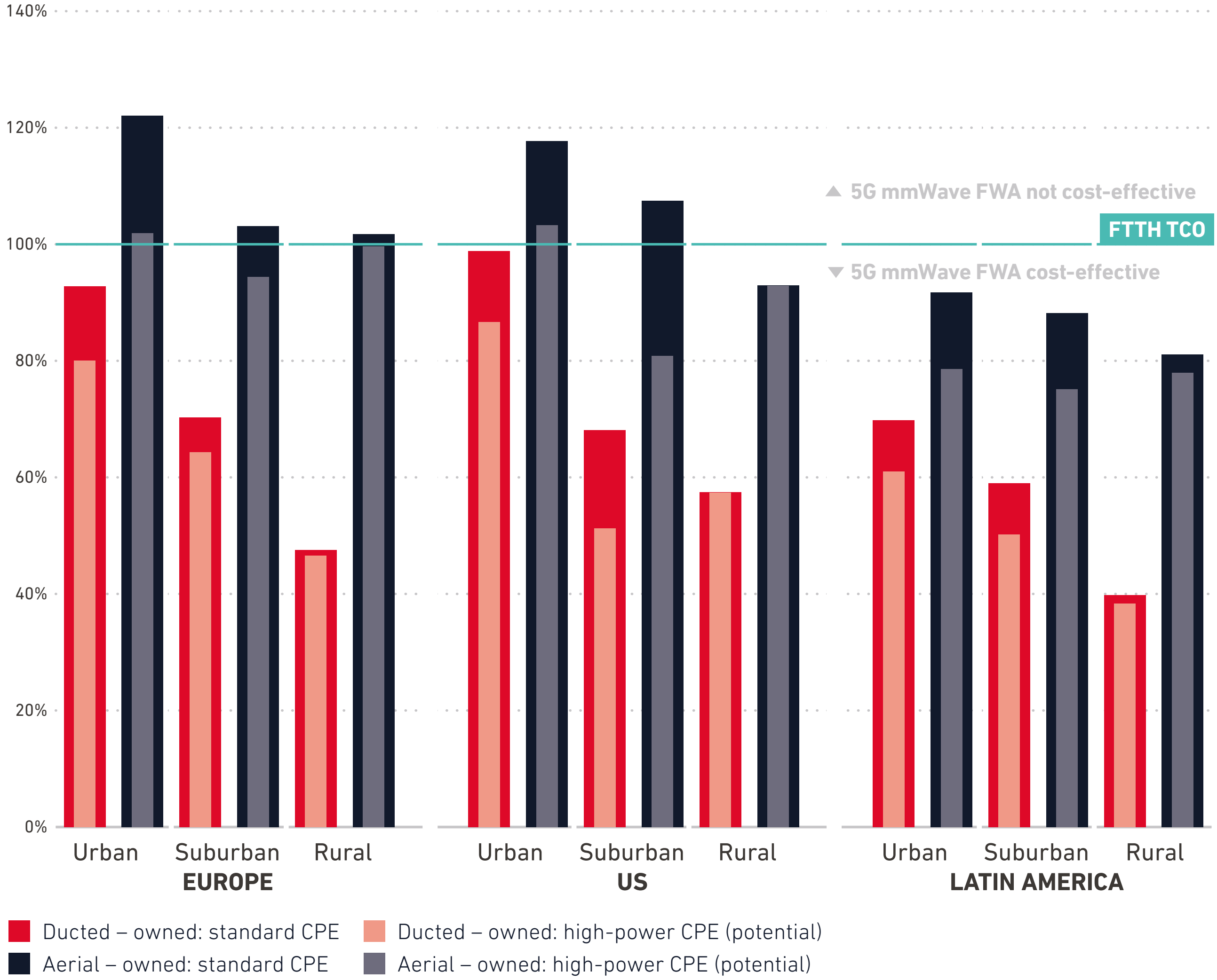
An important factor cost models do not generally capture is the opportunity cost of the longer time to market associated with FTTH deployments. Operators should consider this when weighing up the different deployment strategies. They should also consider the first-mover advantage that arises when faster broadband options initially become available in underserved areas. 5G FWA's faster time to market means operators can deploy improved broadband services in underserved areas before the arrival of FTTH, appealing to potential subscribers eager for improvements in network performance. 5G FWA is also an agile solution; mobile operators with an existing infrastructure base can scale 5G FWA services according to data traffic growth, by adding bandwidth and equipment to existing infrastructure.

The baseline scenario is based on the most common network configuration in the market today, with mmWave transmitters connecting with subscribers equipped with standard, indoor, self-mounted CPE. We have examined whether alternative solutions such as rooftop-mounted antennas or new technology trends such as high-power, indoor, self-mounted CPE solutions could improve the cost savings for 5G mmWave FWA versus FTTH. The former, depending on the propagation characteristics of the area and precise site locations, can improve coverage and performance but requires a truck roll. The latter does not require a truck roll and has shown promising results in boosting mmWave coverage.

- We estimate that for 5G mmWave FWA deployments in urban and suburban areas in Europe, the US and Latin America, high-power, indoor CPE solutions could provide benefits over standard indoor CPE, boosting cost-effectiveness of 5G mmWave FWA versus FTTH by 10 to 20 percentage points.
- We estimate that a hybrid approach that involves providing subscribers located far away from base stations with outdoor antennas, and the remainder with indoor CPE, can improve the cost-effectiveness of 5G mmWave FWA by between 10 and 15 percentage points.

Figure 1

Net present value (NPV) of 5G mmWave FWA TCO as a percentage of NPV of FTTH TCO, according to baseline assumptions – high-power indoor CPE versus standard indoor CPE



Main assumptions: 400 MHz in the 26–28 GHz band, 40 MHz in the 3.5 GHz band, 30% market share, 10% busy hour share of traffic, 85% DL share of total residential traffic, indoor self-mounted CPE, 1:32 fibre cables split ratio.
Source: GSMA Intelligence analysis

Of course, there are other strategies available to operators with different spectrum portfolios. These are explored in the next report in this series.

1 The TCO model

In our model, we compare the TCO of 5G FWA with the cost of deploying three wireline technologies that involve optical fibre infrastructure but differ at the last mile of the access network: full fibre (FTTH), copper-based G.fast, and hybrid fibre-coaxial (HFC).

We assume that the 5G FWA network would be deployed using existing 5G infrastructure. Since our hypothetical operator has limited sub-6 GHz spectrum available, the 5G FWA network would primarily be enabled by mmWave spectrum, except for a limited share of premises that would not receive a sufficient mmWave signal because of the deployment constraints associated with leveraging existing site locations and the different propagation characteristics of these bands.[4]

4 We are aware that new mmWave repeater solutions could boost mmWave coverage, reducing coverage gaps in the network.

We estimate the TCO of each wireline technology according to different deployment modes (in order of increasing cost):

- **ducted – rented:** fibre and coaxial cables are deployed underground in existing ducts rented from a utility provider or local authority
- **aerial – rented:** fibre and coaxial cables are deployed overground using existing poles rented from a utility provider or local authority
- **aerial – owned:** fibre and coaxial cables are deployed overground, with the poles built by the operator
- **ducted – owned:** fibre and coaxial cables are deployed underground in ducts, with the ducts deployed and owned by the operator.

The choice of deployment mode depends on factors specific to each local area. Ducts or poles that can be shared or rented may not be available, particularly in rural areas and some suburban areas. Certain terrain can make the costs of trenching prohibitive, while overground deployment is less reliable than underground deployment since it exposes cables to external forces; areas that are prone to harsh climate events are not well suited to this type of deployment. Finally, operators are usually constrained in their deployment choice by local authorities, who generally prefer one deployment type over another.

2 Main results

According to our baseline case, we find that G.fast and HFC have a TCO that is similar to or higher than that of FTTH. We therefore focus our comparison on FTTH versus 5G FWA.

Many rural towns do not provide sufficient business rationale for FTTH deployment, due to low population density and, in some areas, dispersed housing. Moreover, ducts or poles that can be shared or rented are not generally available, so operators need to build them in the first place. These factors, along with the associated need to obtain permissions, increase the cost per home passed and the time to market of wireline technologies. Wireless technologies, meanwhile, are well suited to rural towns since they remove the need for capital-intensive infrastructure works. In rural towns, we find that a 5G mmWave FWA network is the most cost-effective solution for delivering download speeds of at least 100 Mbps if there are no existing ducts or poles that can be shared or rented.

Suburban areas vary significantly in terms of broadband availability. Some suburbs are well served by FTTH or DOCSIS, while others are underserved with legacy technologies such as ADSL. We find that in suburban areas where operators need to trench and build ducts, 5G mmWave FWA is a cost-effective solution even when the operator has a high market share and high busy hour share.[5] In some instances, a 5G mmWave FWA network will also deliver cost savings under the aerial deployment mode. However, where fibre cables can be deployed using existing ducts or poles that can be rented or shared, 5G mmWave FWA is only a cost-effective alternative if the FWA operator faces relatively low peak hour traffic and market share.

5 Traffic in the peak hour as a percentage of total daily traffic.

In urban areas, high population density and the availability of existing infrastructure make FTTH the main connectivity solution, particularly in developed countries. Underground deployment is generally adopted in cities in Europe and the US, while in some Latin American cities aerial solutions can also be an option. In some cities, local authorities and national regulators encourage fibre deployments by making available existing ducts or facilitating sharing agreements. In other cities, regulatory red tape and/or difficult terrain can inflate the cost of deploying fibre and result in sizeable time-to-market delays.

Mobile infrastructure is generally dense in cities, so operators with an existing 5G offering for mobile services can reuse site locations for mmWave equipment targeting neighbourhoods that do not have FTTH access. In urban areas in Europe, the US and Latin America, we find that a 5G mmWave FWA network would be cost-effective compared to FTTH under the ducted deployment mode at sizeable levels of market share, and under the aerial deployment mode at moderate levels of market share. Where FTTH can be deployed in ducts or on poles that can be rented or shared, a 5G mmWave FWA network would be cost-effective only at relatively low levels of market share.

3 Sensitivities

In our model, the precise value of cost savings that can be delivered by a 5G FWA network depends on several factors, including traffic, civil works and CPE choice.

Traffic

FTTH can generally support more traffic than 5G FWA, making 5G FWA less cost-effective compared to FTTH for the highest traffic demand scenarios. For a 5G mmWave FWA network, the impact of higher levels of traffic demand on cost savings is mainly driven by our assumption that a proportion of premises would not receive a good mmWave signal and so would be served by mid-band spectrum. Traffic demand is driven by data consumption, the busy hour share of traffic and operator market share. In our baseline case, we assume that data consumption continues to grow according to past growth rates; we set a target market share at the end of the period at 30%; and we assume that the busy hour share of traffic stands at 10% for residential customers. Assuming data consumption per subscriber grows according to past growth rates, the higher the busy hour share of traffic and operator market share, the lower the 5G FWA cost savings, as more base stations would need to be deployed to support higher traffic levels.

Given the relatively higher traffic demand in urban areas compared to suburban areas and in suburban areas compared to rural towns, the impact of higher traffic demand is lowest in rural towns and greatest in urban areas. In the latter, we estimate that adding more mmWave bandwidth (e.g. 800 MHz) would improve 5G mmWave FWA cost savings compared to

FTTH when traffic demand is very high. For instance, for 50% market share and 20% busy hour share in urban areas in the US and Europe, the 5G mmWave FWA TCO would improve by 7 and 5 percentage points respectively versus the TCO for FTTH.

While our hypothetical areas have different characteristics so are not directly comparable, we estimate that average data consumption per subscriber is highest in the US and lowest in Latin America. This is an important factor driving the differences in the results by region below.

Table 1 shows the levels of market share and busy hour share where a 5G mmWave FWA network would be cost-effective in a rural town, urban area and suburban area in Europe, the US and Latin America:

- Where fibre cables need to be deployed underground in ducts or trenches built by the operator, a 5G mmWave FWA network is generally cost-effective in rural towns at high levels of busy hour share of traffic and market share. In suburban areas, it is generally cost-effective at 50% market share or below when the busy hour share of traffic stands at 10% or below. In urban areas, it is cost-effective where, for instance, busy hour share stands at 10% and market share is less than 30% in Europe and the US, and 50% in Latin America.
- Assuming fibre cables are deployed overground on poles built by the operator, a 5G mmWave FWA network would be cost-effective in rural towns assuming 10% busy hour share at market shares below 30% in Europe and the US. In suburban areas, it would be cost-effective at market shares below 20% in Europe and the US, and less than 50% in Latin America. In urban areas, it would be cost-effective at market shares below 10% in Europe, 20% in the US and 30% in Latin America.
- If fibre cables can be deployed using existing ducts or poles that can be shared or rented, 5G mmWave FWA would be cost-effective at relatively low levels of market share and busy hour share in urban and suburban areas, and would not be a cost-effective solution at any level of market share and busy hour share in rural towns. However, existing ducts or poles that can be rented or shared to deploy an access network within rural towns are not generally available.

Table 1

5G mmWave FWA TCO versus FTTH TCO by market share, busy hour share of traffic and deployment mode

			RURAL TOWN				SUBURBAN AREA				URBAN AREA			
			Owned civil infrastructure		Rented or shared civil infrastructure		Owned civil infrastructure		Rented or shared civil infrastructure		Owned civil infrastructure		Rented or shared civil infrastructure	
	Market share	Busy hour share	Ducted	Aerial	Ducted	Aerial	Ducted	Aerial	Ducted	Aerial	Ducted	Aerial	Ducted	Aerial
Europe	10%	10%	■	■	□	□	■	■	■	■	■	■	▨	▨
		15%	■	■	□	□	■	■	▨	▨	■	▨	▨	▨
		20%	■	■	□	□	■	■	▨	▨	■	▨	▨	▨
	20%	10%	■	■	□	□	■	■	□	▨	■	▨	▨	▨
		15%	■	■	□	□	■	▨	□	□	■	□	□	□
		20%	■	□	□	□	■	□	□	□	□	□	□	□
	30%	10%	■	■	□	□	■	□	□	□	■	□	□	□
		15%	■	□	□	□	■	□	□	□	□	□	□	□
		20%	■	□	□	□	□	□	□	□	□	□	□	□
	40%	10%	■	□	□	□	■	□	□	□	□	□	□	□
		15%	■	□	□	□	□	□	□	□	□	□	□	□
		20%	■	□	□	□	□	□	□	□	□	□	□	□
	50%	10%	■	□	□	□	■	□	□	□	□	□	□	□
		15%	■	□	□	□	□	□	□	□	□	□	□	□
		20%	■	□	□	□	□	□	□	□	□	□	□	□
US	10%	10%	■	■	□	□	■	■	□	□	■	■	■	■
		15%	■	■	□	□	■	■	□	□	■	■	▨	▨
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	40%	10%	■	□	□	□	■	□	□	□	□	□	□	□
		15%	■	□	□	□	■	□	□	□	□	□	□	□
		20%	■	□	□	□	■	□	□	□	□	□	□	□
	50%	10%	■	□	□	□	■	□	□	□	□	□	□	□
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		20%	■	□	□	□	□	□	□	□	□	□	□	□
Latin America	10%	10%	■	■	□	□	■	■	▨	■	■	■	▨	■
		15%	■	■	□	□	■	■	▨	■	■	■	▨	▨
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	40%	10%	■	■	□	□	■	■	□	□	■	▨	□	□
		15%	■	■	□	□	■	▨	□	□	■	□	□	□
		20%	■	■	□	□	■	□	□	□	■	□	□	□
	50%	10%	■	■	□	□	■	□	□	□	■	□	□	□
		15%	■	■	□	□	■	□	□	□	■	□	□	□
		20%	■	■	□	□	■	■	□	□	□	□	□	□

■ 5G FWA cost-effective ▨ 5G FWA potentially cost-effective with high-power CPE □ FTTH cost-effective

Main assumptions: 400 MHz in the 26–28 GHz band, 40 MHz in the 3.5 GHz band, 85% DL share of total residential traffic, indoor self-mounted CPE, 1:32 fibre cables split ratio.
Source: GSMA Intelligence

Civil works

Our research highlights considerable variation in the costs incurred in deploying civil infrastructure (ducts or poles) to support FTTH networks. Aside from whether the infrastructure can be shared or rented, variation is driven by factors such as the characteristics of the terrain (e.g. rocky versus sandy, flat versus uneven), the cost of obtaining local permits, the cost of labour in the area, and the choice of duct size. We have looked at different values of these costs to understand under what conditions a 5G FWA deployment would be cost-effective.

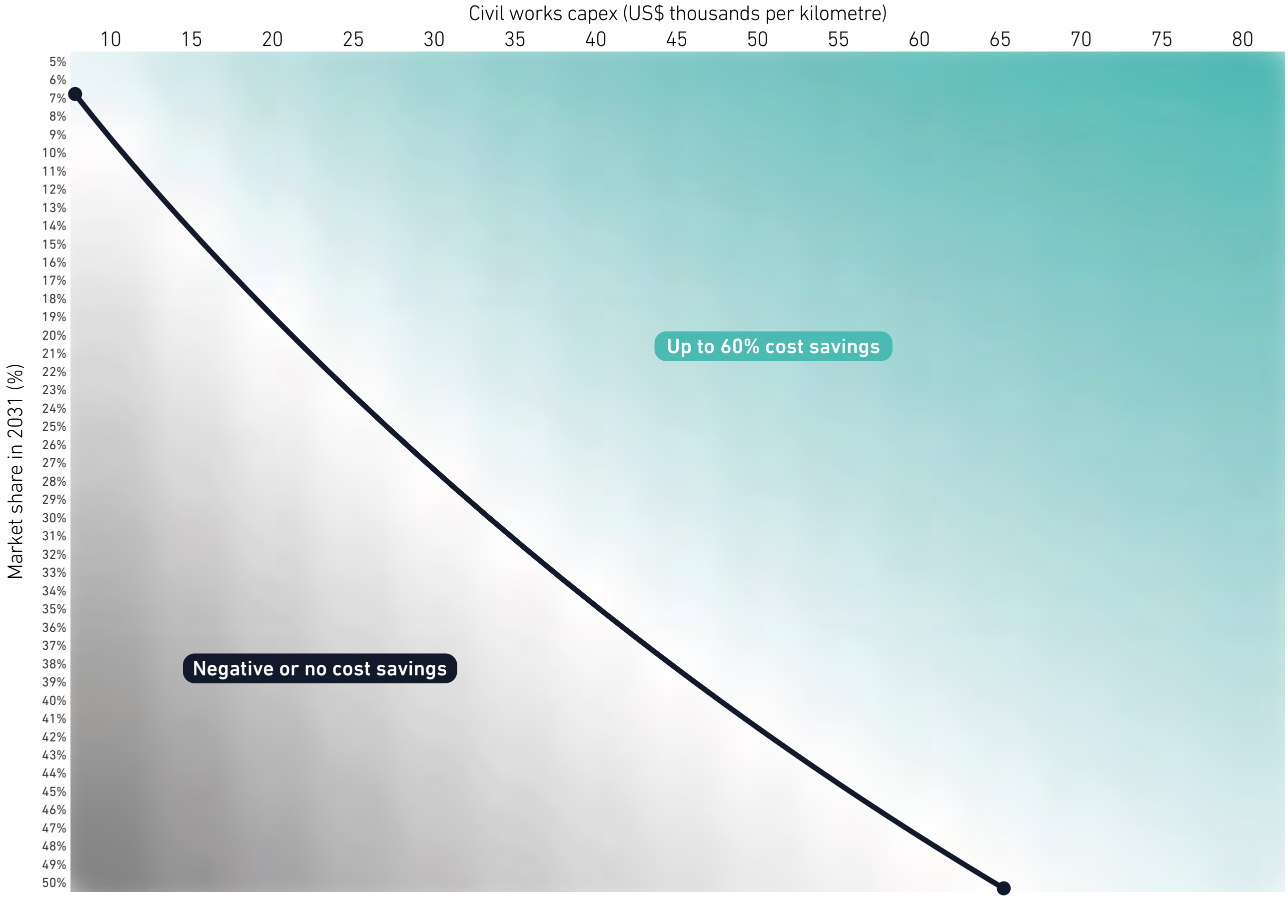
We estimate that a 5G mmWave FWA network would be cost-effective where civil works capex is above $35,000, $50,000 and $25,000 per kilometre in Europe, the US and Latin America respectively, and market share is below 50% in rural towns, 30% in suburban areas and 15% in urban areas.

Civil works costs can be much higher in urban and suburban areas suffering from difficult terrain and/or regulatory red tape. In such cases, 5G FWA can be even more cost-effective. Assuming that civil works capex is above $70,000, $100,000 and $50,000 per kilometre in Europe, the US and Latin America respectively, 5G mmWave FWA would be cost-effective at market shares below 30% in urban areas and below 50% in suburban areas.

Figure 2 presents the 5G mmWave FWA cost savings according to different values of civil works capex and market share in a suburban area in Europe. While the relative changes are different for rural towns, suburban areas and urban areas in the US and Latin America, and for the urban area and rural town in Europe, civil works capex and market share have a similar impact in these areas.

Figure 2

5G mmWave FWA cost savings according to different values of civil works capex and market share, for a suburban area in Europe



Main assumptions: 400 MHz in the 26–28 GHz band, 40 MHz in the 3.5 GHz band, 10% busy hour share of traffic, 85% DL share of total residential traffic, standard indoor self-mounted CPE, 1:32 fibre cables split ratio.
Note: Civil works opex is reduced proportionally to the percentage reduction in baseline civil works capex.
Source: GSMA Intelligence analysis

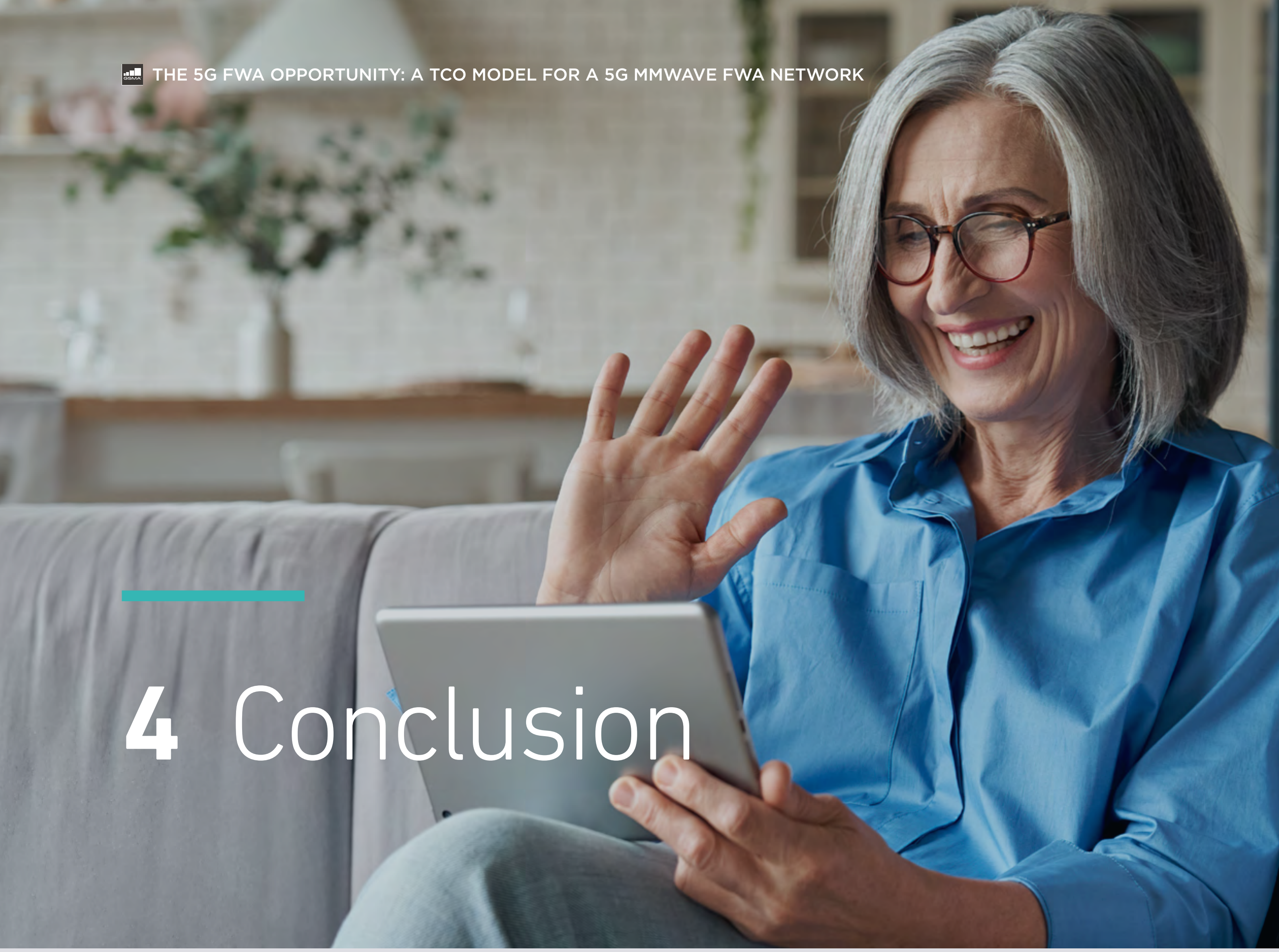
CPE and performance requirements

In our baseline case, we assume subscribers would be equipped with indoor, self-mounted 5G FWA CPE. However, there are alternative solutions, such as outdoor, rooftop-mounted antennas and new technology trends such as high-power, indoor, self-mounted CPE that operators can leverage in their deployment strategies.

Providing subscribers with outdoor, rooftop-mounted antennas can improve mmWave coverage and performance but requires a truck roll. We estimate that a hybrid deployment strategy that involves providing eligible subscribers located far away from base stations with outdoor antennas, and the remainder with standard, indoor, self-mounted CPE, would make the 5G mmWave FWA network more cost-effective. Whether installing outdoor antennas at the customer premises delivers additional cost savings will largely depend on the propagation characteristics of each area and the precise site locations. In our TCO model, we find that when 20% of premises are equipped with an outdoor antenna, 5G mmWave FWA cost-effectiveness increases by between 10 and 15 percentage points depending on the region and the area type.

High-power, indoor, self-mounted CPE does not require a truck roll and has shown promising results in boosting mmWave coverage. We estimate that for 5G mmWave FWA deployments in urban and suburban areas in Europe, the US and Latin America, these solutions could provide benefits over standard indoor CPE, boosting the cost-effectiveness of 5G mmWave FWA versus FTTH by 10 to 20 percentage points.

Finally, we assume that the 5G mmWave FWA network would provide for at least 100 Mbps download (DL) and 20 Mbps upload (UL) speeds. Increasing the performance requirement to at least 200 Mbps DL and 50 Mbps UL, and keeping everything else constant, we estimate that in rural towns the 5G mmWave FWA network would deliver cost savings of up to 45% in Europe, 40% in the US and 60% in Latin America, and would cost as much as FTTH in suburban areas in Europe and Latin America.



4 Conclusion

Mobile operators in Europe, the US and Latin America that are constrained in their mid-band holdings and looking to deploy FWA services can consider a 5G mmWave FWA network a cost-efficient alternative to FTTH in several instances.

In rural towns in Europe, the US and Latin America that lack the underlying FTTH civil infrastructure that operators could rent or share, a 5G mmWave FWA network is the most cost-effective solution to provide future-proof, next-generation broadband speeds – and could deliver cost savings of up to 65%.

Many suburban areas in these regions would also benefit from a 5G mmWave FWA network. This would be a cost-effective deployment strategy versus FTTH in several instances where traffic demand is moderate or civil works costs are high. In our baseline case, 5G FWA could deliver cost savings of up to 45% in suburban areas.

In urban areas that suffer from difficult terrain characteristics and regulatory red tape, a 5G mmWave FWA network could provide cost savings of up to 25% where fibre cables need to be deployed in ducts built by the operator, and the provider expects a market share of less than 30%.

We estimate that for 5G mmWave FWA deployments in urban and suburban areas in Europe, the US and Latin America, high-power, indoor, self-mounted CPE could provide benefits over standard indoor CPE, boosting the cost-effectiveness of 5G mmWave FWA versus FTTH by 10 to 20 percentage points. We also estimate that a hybrid strategy that involves equipping subscribers located far away from base stations with outdoor antennas, and the remainder with indoor CPE, could improve the 5G mmWave FWA cost-effectiveness by 10 to 15 percentage points.

In this report, we have focused our comparison of FTTH versus 5G FWA for a mid-band constrained operator, assuming that the 5G FWA network would primarily be enabled by mmWave spectrum bands. However, as more mid-band spectrum is made available for 5G services, the situation faced by mobile operators in some markets is likely to be different. In the next report of this series, we study how the 5G FWA economics change when the mobile operator has good availability of mid-band and high-band spectrum.

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