GSMA Intelligence

Mobile Investment Gaps: Caribbean islands (annex)

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Introduction

To undertake the quant analysis in our report we built an economic supply-and-demand model for the Caribbean islands that estimates the investment gap by 2030. It considers the expansion of 4G coverage and the accomplishment of 4G adoption targets, as 4G is widely expected to be the minimum standard of meaningful connectivity needed to access basic services. It also quantifies the 5G investment gap i.e. the investment needed to speed up 5G deployment and adoption and accelerate regional digital transformation.

The model also quantifies the impact of three market reform scenarios that would lead to an increase in adoption, accelerating progress towards digital transformation and inclusion targets in the region.

The model considers the aggregate effects for the following countries: Aruba; Anguilla; Antigua and Barbuda; Bahamas; Barbados; Bonaire; Sint Eustatius and Saba; Cayman Islands; Curaçao; Dominica; Dominican Republic; Grenada; Guadeloupe; Haiti; Jamaica; Martinique; Montserrat; Puerto Rico; Saint Barthélemy; Saint Kitts and Nevis; Saint Lucia; Saint Martin; Saint Vincent and the Grenadines; Sint Maarten; Trinidad and Tobago; Turks and Caicos Islands; British Virgin Islands; and the US Virgin Islands.

Our assessment does not account for impacts in Cuba, since the market dynamics and solutions considered as part of the analysis are not viable under the country’s economic and political system.

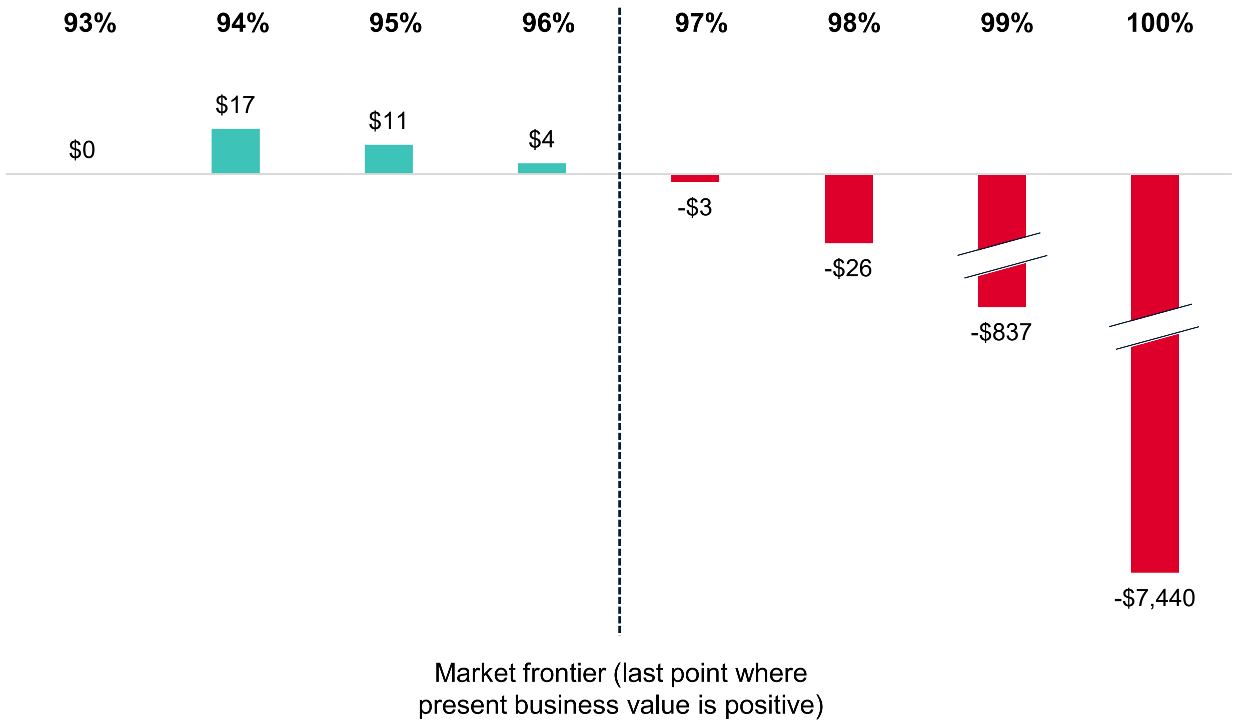
1. 4G coverage gap

The model takes into consideration the current coverage figures and number of sites by technology (2G, 3G, 4G). Of the three technologies, the model picks the one with the highest number of sites. If this is 4G, the model estimates the deployment of new 4G sites. If the highest number is 2G or 3G, the difference between those sites and 4G sites is the amount of sites available for technology upgrade. Once all upgrades are made, the model deploys 4G sites until the desired population is covered.

The model then increases 1 percentage point of coverage until it reaches 100% in 2030. The calculation of the total cost required to cover 100% of the population considers the maximum coverage that is profitable for operators (market frontier). Given the incremental difficulty of the last percentile, this model considers that all countries cover their last 1% by deploying satellite-enabled backhaul.

Figure 1: Market frontier estimation (conceptual approach)
Net present value (million), coverage value (percentage of population)

Source: GSMA Intelligence



To estimate the number of sites required to increase coverage, the model uses geographical data provided by the European Commission Joint Research Centre,[1] with a 1 km spatial resolution.

[1] GHSL Data Package 2022, European Commission Joint Research Centre.

The data enables us to classify clusters according to rural/urban categories, as follows:

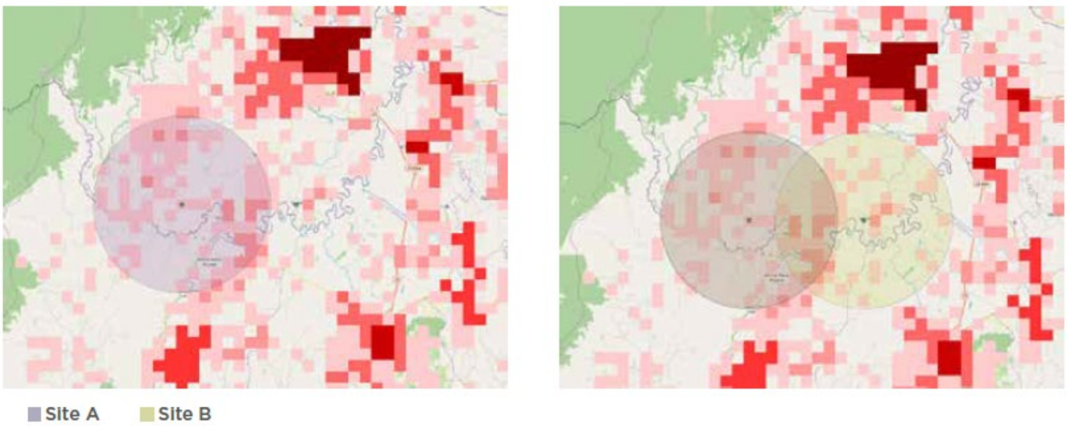
- **Urban centre:** An urban centre consists of contiguous grid cells (4-connectivity cluster) with a density of at least 1,500 inhabitants per km^2 of permanent land and has at least 50,000 people in the cluster.
- **Dense, urban cluster:** A dense, urban cluster consists of contiguous cells (4-connectivity cluster) with a density of at least 1,500 people per km^2 of permanent land and has between 5,000 and 50,000 people in the cluster.
- **Semi-dense, urban cluster:** A semi-dense, urban cluster consists of contiguous grid cells (8-connectivity cluster) with a density of at least 300 people per km^2 of permanent land, has at least 5,000 people in the cluster and is at least 3 km away from other urban clusters.
- **Rural cluster:** A rural cluster consists of contiguous cells (8-connectivity cluster) with a density of at least 300 people per km^2 of permanent land and has between 500 and 5,000 people in the cluster.
- **Suburban or peri-urban grid cells:** These are all the other cells that belong to an urban cluster but are not part of an urban centre; a dense, urban cluster; or semi-dense, urban cluster.
- **Low-density, rural grid cells:** These are rural grid cells with a density of at least 50 people per km^2 of permanent land and are not part of a rural cluster.
- **Very low-density, rural grid cells:** These are cells with a density of less than 50 people per km^2 of permanent land.
- **Water grid cells:** The GHSL SMOD classifies water grid cells as all cells with more than 0.5 share covered by permanent surface water that are not populated or built on.

Based on this expansion model, we estimated the number of sites needed to achieve the established coverage in the region. Given the existing levels of 4G coverage, we assume that all urban areas are covered; the remaining uncovered areas are therefore rural.

A hypothetical network is then built, and a mobile site is placed at the centre of each rural cluster (or each rural 'network'). This means that the site has an 8.5 km reach, in line with access to 700 MHz spectrum.[2]

Figure 2: Deployment of new sites in rural clusters

Source: GSMA Intelligence



[2] Uplink coverage comparison of typical scenarios, ZTE

The figure shows the deployment of new sites in rural clusters. The installation of a site in the middle of a rural cluster is shown by the green dot in the left image of Figure 2. The circled area reflects coverage. All population clusters inside the circle (in red) are therefore supposed to be covered. We then did the same for all population grids.

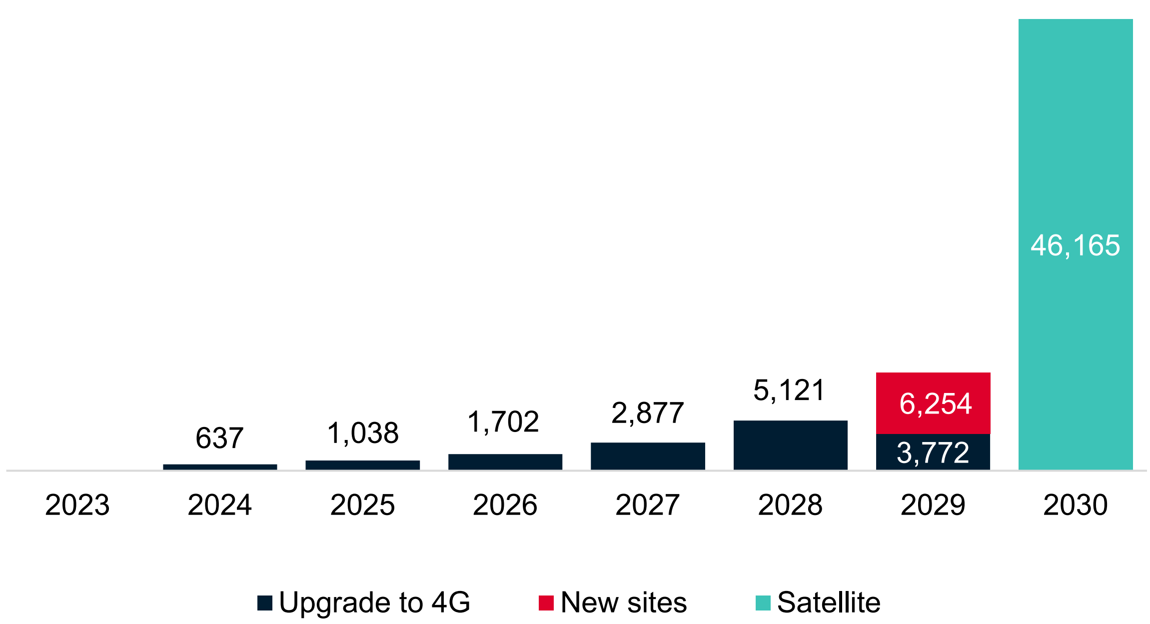
Several sites may overlap. Initially, the model deploys the one that would cover the highest number of people. In Figure 2, site A covers more people, so it is the one that will be built first. Then, site B is deployed, with this one covering people in the green area but not in the overlapped area, as these populations are already covered by site A.

Once all populations are covered by these sites, we classify them by number of people per site. It is stipulated that operators must implement sites in descending order, from the one with the most coverage to the one with the least coverage. The site with the most coverage is site A. All populations covered by site A are then eliminated and population coverage is estimated again for each remaining site. This means that covered populations are eliminated to avoid counting them twice. The algorithm is used until we reach the last site, which should cover very few people. In this way, it is possible to calculate the number of sites needed to extend coverage to each incremental 1% of the population. The number of required sites goes up with every increase, thus becoming exponential when population clusters are remote and scarce.

The increase in the number of 4G sites is based on the current number of 2G or 3G sites, depending on the highest. In this way, if there are any sites that need upgrades, the model considers the first deployments as technology upgrades. This procedure continues until there are no sites left to upgrade. New physical sites then start to be deployed. For the last portion of population to cover, for all scenarios, satellite backhaul is assumed to be needed after a certain point, where physical deployments become too expensive or unfeasible, as locations are too remote.

Figure 3: Incremental number of sites by type of deployment (conceptual approach)

Source: GSMA Intelligence

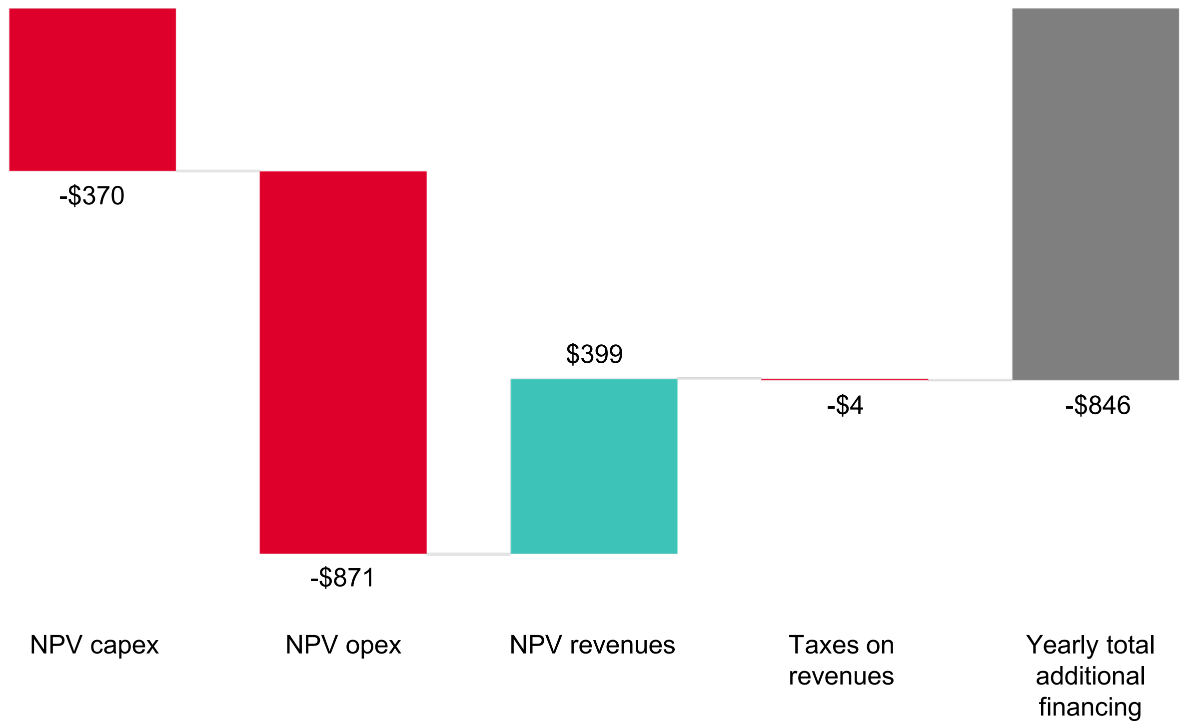


Additional financing required to close the coverage gap

For each percentage point of additional coverage, the model estimates the number of stations that need upgrades and the number of new sites that need to be deployed (4G or satellite). To do this, capex, opex and revenues are forecast.

Figure 4: Supply-side yearly additional financing estimate (conceptual approach)
Million

Source: GSMA Intelligence



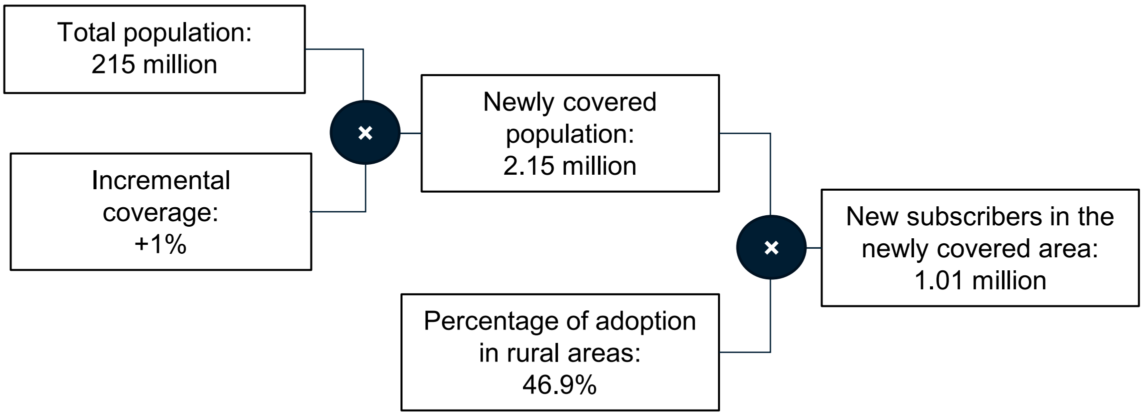
Subscribers are estimated based on the extension of coverage for each year, the newly covered population and the level of adoption in newly covered areas (remote areas with low purchasing power). This figure varies from country to country and is affected by the impact on adoption from price changes.[3]

Adoption levels in remote areas – target populations of coverage extension – are based on the assessment of 'Rural Connectivity in Latin America and The Caribbean: A Bridge for Sustainable Development in a Time of Pandemic'[4] by the Inter-American Institute for Cooperation on Agriculture, the Inter-American Development Bank and Microsoft, as a source of information. This report created the Substantial Rural Connectivity Index, which was used as a proxy in this model to determine the level of adoption mobile broadband services will have in newly covered areas.

[3] An elasticity analysis can be found in Chapter 4.
[4] See https://repositorio.iica.int/handle/11324/12896v

Figure 5: Estimate of yearly adoption levels in remote areas (conceptual approach)

Source: GSMA Intelligence



The present value of final costs to increase coverage by 1 percentage point includes three elements. The first is the capex required to deploy all the sites. The second is the opex of deployed sites during their operation. The third is revenue, calculated by applying the ARPU to the number of new subscribers based on the estimated level of adoption, which is also measured considering the period a site has been operating for.

This way, the yearly additional financing required is estimated for each year (free cash flow = revenue − capex − opex). Finally, the number is deducted by applying a weighted average cost of capital (WACC), which varies between countries. This defines the present value of financing required to close the coverage gap and, in the process, identifies the market frontier for each different scenario.

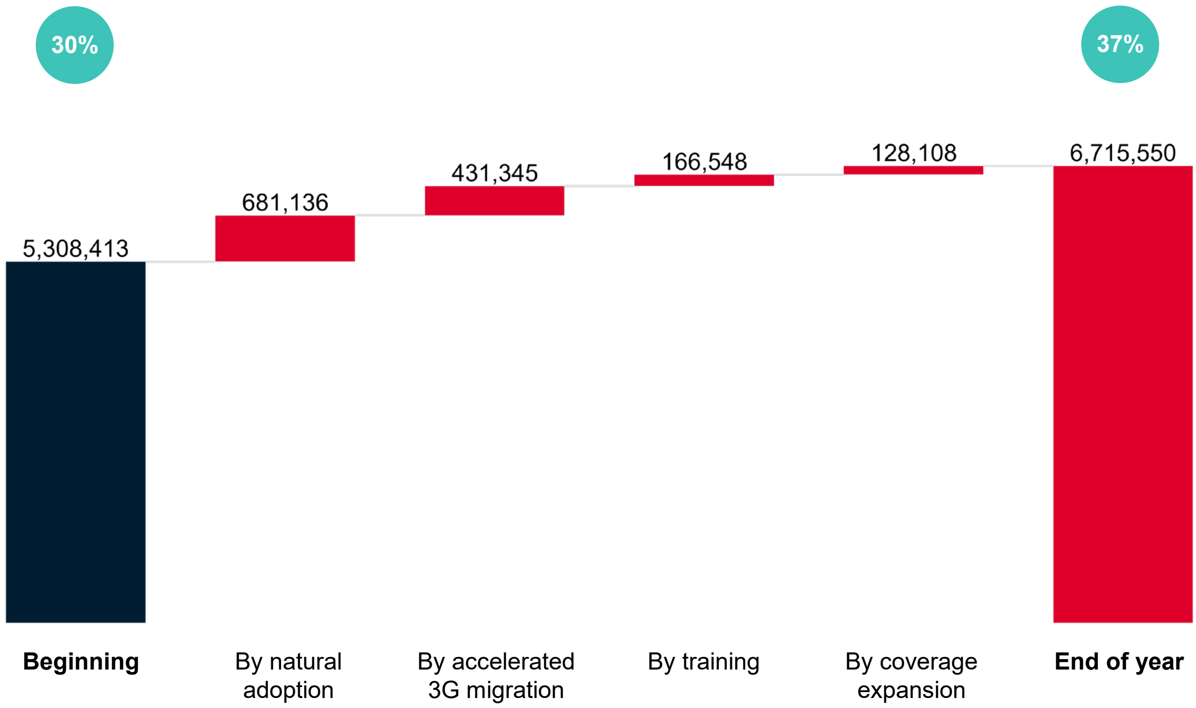
2. 4G usage gap

Estimating the usage gap begins with defining a goal to reach a certain number of total subscribers by 2030 (adoption goals). The goal is set to select the maximum between 90% of the total population connected[5] and the market frontier estimated in the coverage gap.

With these targets for 2030, the deployment process initially requires analysis of subscriber evolution by year, which would cushion the impact created by price changes in each scenario (elasticity analysis).

Figure 6: Breakdown of growth in yearly 4G adoption (conceptual approach)
Number of 4G subscribers, percentage of population

Source: GSMA Intelligence



This subscriber evolution begins with data on 4G mobile internet unique subscribers, which was developed through mobile internet unique subscriber data, split by 3G and 4G unique subscribers based on the share of connections by technology. After defining the number of 4G mobile internet unique subscribers, this is analysed according to the impact of elasticity in each scenario and with a coverage limit defined by market frontiers.

For each year, the 4G mobile data usage gap is estimated by comparing 4G coverage figures, number of 3G subscribers and 4G mobile internet adoption levels. The 4G mobile data usage gap

[5] In line with two ITU objectives: Achieving universal and meaningful digital connectivity in the decade of action: Aspirational targets for 2030, ITU and Connecting humanity: Assessing investment needs of connecting humanity to the Internet by 2030, ITU

includes both 3G mobile data users[6] and people who live in covered areas but are not subscribed to any services.

The end goal is to estimate the present value of additional financing required to close the usage gap pursuant to the initial connectivity goals. This requires contributions to purchase new handsets, make monthly plan payments and train new users. The incremental revenues generated by these new additions are then deducted for the duration of the service.

The first measure to close the usage gap is 4G adoption by users already subscribed to the service but using previous technologies (3G). The model assumes that all mobile internet subscribers will have migrated to 4G by 2030. Based on this new migration rate, the model recalculates the usage gap. With this new figure in mind, the model defines a training and adoption rate to meet the 2030 target. If it reaches that figure naturally, the training rate should be minimal.

This provides a modelled subscriber evolution curve for 4G mobile internet service, considering the impact of narrowing the coverage gap, accelerated 3G user migration and the training of covered yet unconnected people to narrow the usage gap in line with predefined goals.

Additional financing required to close the usage gap

Given the existing adoption, the model assumes that estimated new additions come from those in the first-to-third income quintiles,[7] where purchasing power is a barrier to adoption and where additional financing may be needed to add new subscribers to the base.

The additional financing for each quintile is estimated in the same manner, both for 3G migrated users and trained users. For the first year of adoption, this financing is thought to be needed for both acquiring new handsets and paying for a full year of service. For subsequent years, it is needed to cover service prices for each new year only.

The starting point for calculating the amount is an affordability threshold of 2% of monthly gross national income per capita, as defined by the Broadband Commission for Sustainable Development.[8] To estimate the GDP per capita for each quintile, the starting point is the total GDP, which is broken down into GDP contributions made by income quintiles. This information is sourced from the World Bank database.[9]

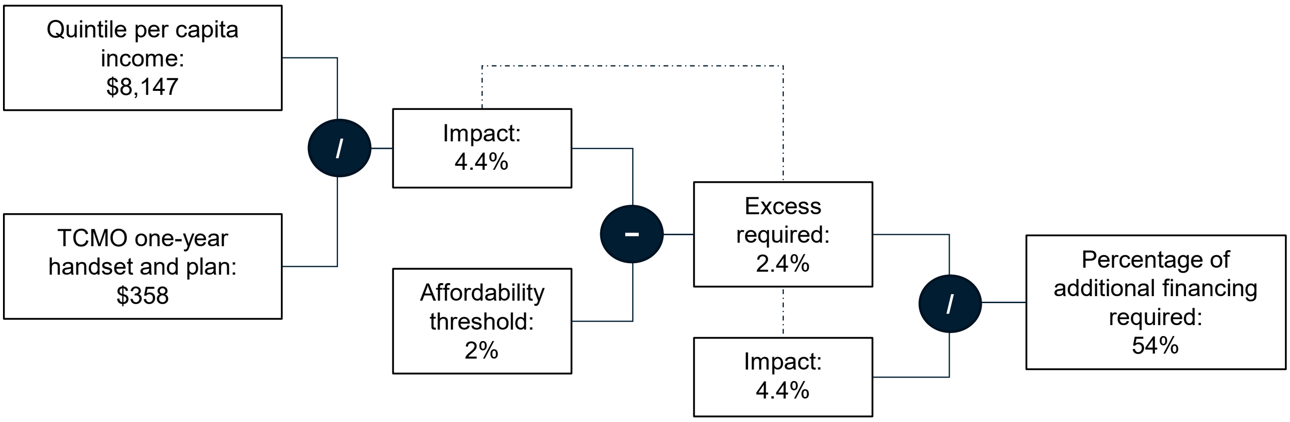
Comparing the required costs (in the first and subsequent years by groups of new additions) with income levels by quintile, the result is the impact of a service on income. This last factor is

[6] 3G to 4G user migration requires less investment, as users are already in the sector's customer base. Additional financing would therefore only include a portion of handsets and new plans. In addition, such customers are already subscribed to mobile services, so the sector does not need to train them.
[7] This was classified by using Gallup's internet access survey for 2022, which classifies respondents into income quintiles and then provides a detailed breakdown of their answers.
[8] 2025 Targets: "Connecting the Other Half", Broadband Commission for Sustainable Development
[9] GDP per capita for each quintile is derived from total GDP, segmented by income quintiles. The subsidy percentage is determined by comparing costs with income levels and considering the impact of the service on income, ensuring affordability. The income share per quintile data source is the World Bank's Poverty and Inequality Platform. Data is based on primary household survey data obtained from government statistical agencies and World Bank country departments. Data for high-income economies are mostly from the Luxembourg Income Study database. For more information and methodology, see https://pip.worldbank.org/home.

compared to the affordability threshold. The additional financing percentage is the remainder of the 2% threshold in relation to quintile income.

Figure 7: The dynamics of additional financing on the demand side by income quintiles (conceptual approach)

Source: GSMA Intelligence



This model allows us to determine the additional financing percentage needed, ranging from 0% to 100%. Additionally, for trained users,[10] it considers investments in training programmes only during the first year of adoption by new users. With accelerated user migration, such an amount is not included, as industry best practices recommend financing handsets when they are purchased, which is already provided for in our model.

Regarding revenues, the assessment considers the incremental revenue generated by the migration from 3G ARPU to 4G ARPU due to the technology upgrade.[11] For trained users, incremental revenues are the total amount of 4G ARPU, as new additions come from a pool of potential users who were not subscribed to other mobile services.

Having determined those figures, the model estimates the additional financing needed to narrow the usage gap in each year, applying the following formula:

$$\boxed{Additional\ financing_{year\ i} = Revenues_{year\ i} - Device\ financing_{year\ i} - Plan\ financing_{year\ i} - training\ cost_{year\ i}}$$

Based on that, it builds a financing cash flow to 2030, which is later discounted by applying a regional discounted rate. Using this methodology, the model estimates the present value of the total additional financing needed to close the usage gap in line with the selected connectivity goals.

[10] Connecting Africa Through Broadband, Broadband Commission for Sustainable Development, 2019
[11] 4G ARPU is assumed to increase by 5% when compared to 3G ARPU. See "South Korea's high-speed 5G mobile revolution gives way to evolution", Reuters, May 2022

3. 5G investment gap

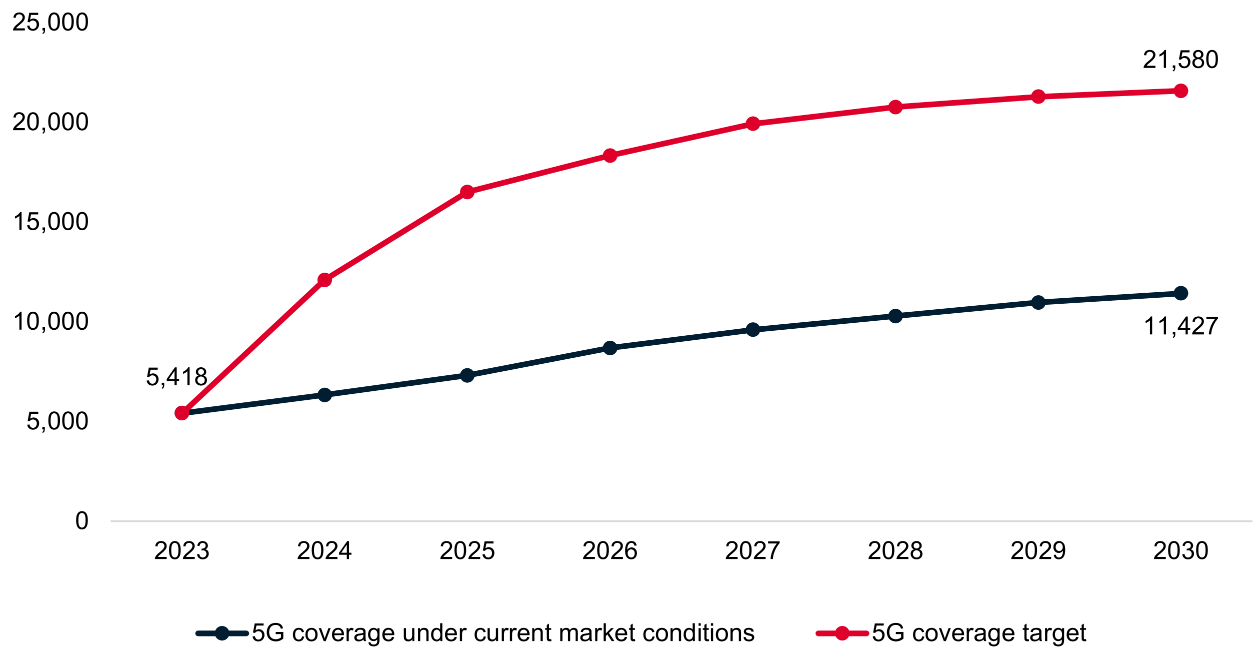
To estimate the 5G investment gap, we consider the investment needed to eliminate the difference between the levels of 5G coverage and adoption that are feasible under current market conditions and those that would be required under an alternative scenario where 5G for the region on average will reach the same levels of coverage and adoption that are expected in leading countries in the region by 2030.[12] The first scenario is called ‘5G coverage under current market conditions’, and the second scenario is called ‘5G coverage target’.

The 5G investment required in each scenario includes three elements: the capex required to deploy 5G sites; the opex of deployed sites during their operation; and the incremental revenues tied to 5G adoption.

For the 5G sites deployment, the model takes into consideration the current 4G and 5G coverage metrics and number of sites. The model picks 4G sites, where they are the sites available for technology upgrade. To estimate the number of 5G sites required to increase the coverage in each scenario, the model replicates the 4G sites evolution. Based on this forecast, the model estimates the capex and opex of deployed sites during their operation.

Figure 8: Evolution of number of 5G sites

Source: GSMA Intelligence



[12] 5G coverage of 94% and 5G adoption of 46% by 2030

The revenue is calculated by applying an incremental ARPU produced by the upgrade from 4G to 5G to the number of new subscribers in each scenario.[13] Subscribers are estimated based on the adoption forecast in each scenario and are also affected by the impact on adoption from price changes (elasticity).

Figure 9: 5G coverage by 2030
Percentage of population

Source: GSMA Intelligence

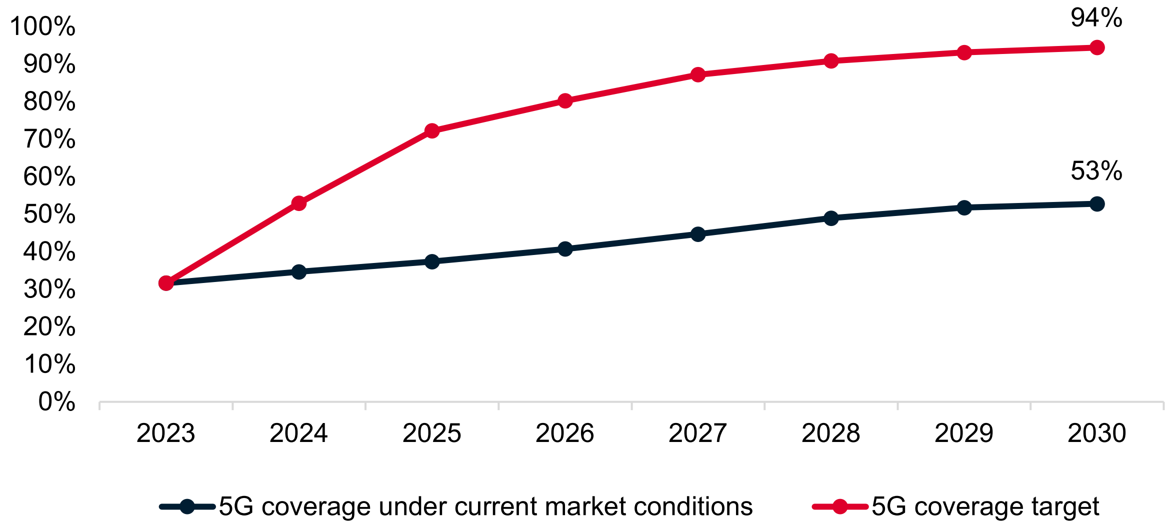
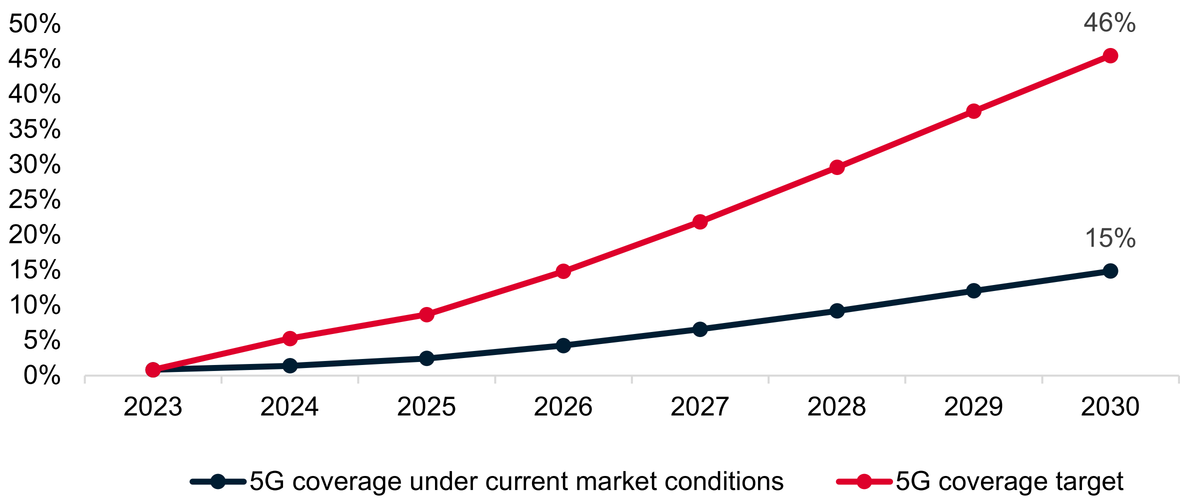


Figure 10: 5G adoption by 2030
Percentage of population

Source: GSMA Intelligence

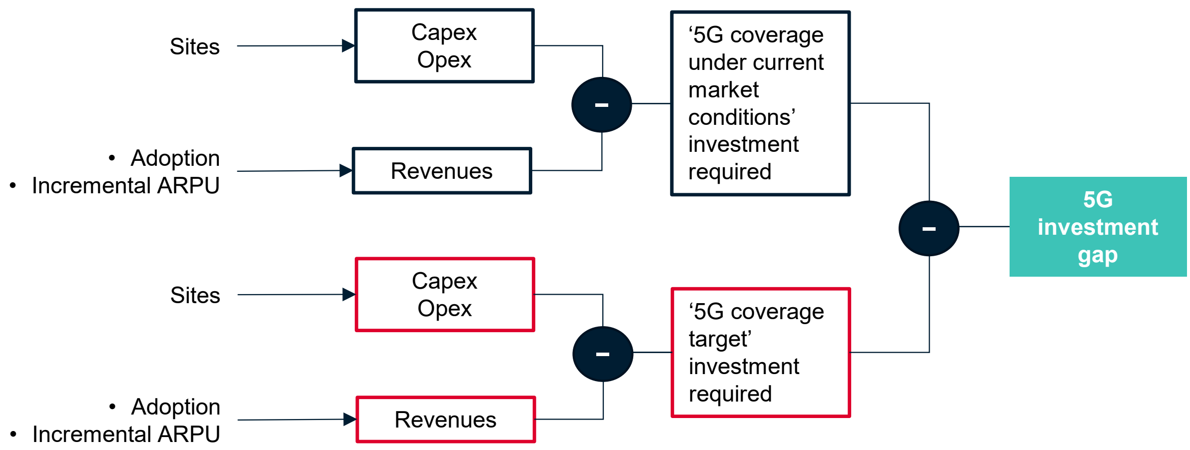


[13] A GSMA Intelligence report indicates that consumers who intend to upgrade to 5G are willing to pay an uplift for their mobile subscription versus what they pay for their current 4G subscription. The uplift´s median across the surveyed countries is 5%. See Consumer 5G: user behaviour offers new opportunities, but monetisation at scale is still a work in progress, GSMA Intelligence, 2023

This way, the investment required per year is estimated (revenue – capex – opex). Finally, that value is brought to present value using the WACC in the region.

Figure 11: 5G investment gap: calculation flow

Source: GSMA Intelligence



This defines the present value of the investment required to reach the scenarios´ coverage and adoption. The 5G investment gap is the difference among the present value of '5G coverage under current market conditions' and '5G coverage target'.

4. Market reforms to boost adoption and investment

Elasticity analysis

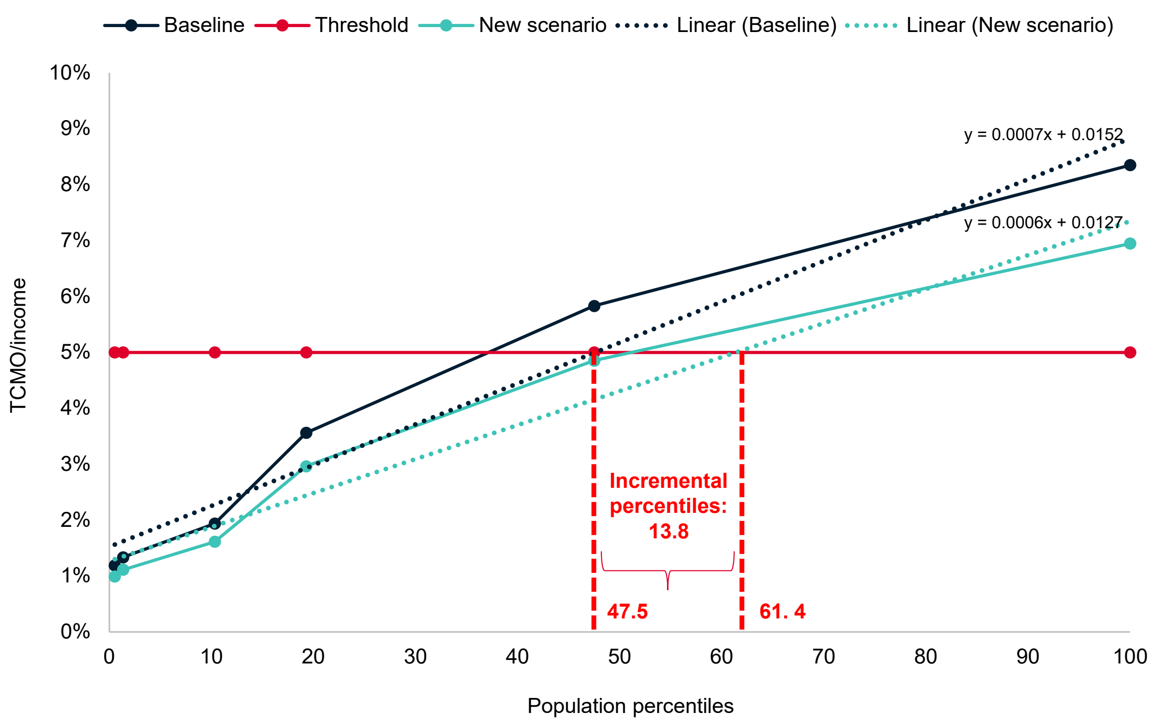
Elasticity analysis plays a fundamental role in the impact of alternative public policy scenarios to stimulate the adoption of mobile broadband services. Given that different scenarios introduce measures affecting the prices of services and devices, this translates into cost reductions that produce new levels of service adoption by the population, as they improve affordability conditions.

The elasticity analysis establishes an affordability threshold, which is the maximum proportion of income that should be spent on the service. It helps to determine the last percentile of the population accessing the service given an established total cost of mobile ownership (TCMO). If the threshold is very demanding (very low), adoption becomes more difficult, particularly in developing countries with low-income levels, such as the Caribbean islands. By defining a more moderate threshold (higher), the model has a greater margin to produce more evident changes in adoption in response to a modification in the price level generated by public policy reforms.

The analysis establishes an affordability threshold of 5% for the region. Its objective is to show a greater incentive to increase adoption among the population when services become more affordable. We use a linear regression to fit a relationship between the TCMO/income ratio and adoption. Based on this, we calculate population percentiles where impacts are below this new affordability threshold.

Figure 12: Elasticity analysis (conceptual approach)

Source: GSMA Intelligence



For each scenario, the curve of linear regression is then recalculated, considering public policy impacts on handset and plan prices. Finally, we recalculate population percentiles where impacts are below this new affordability threshold.

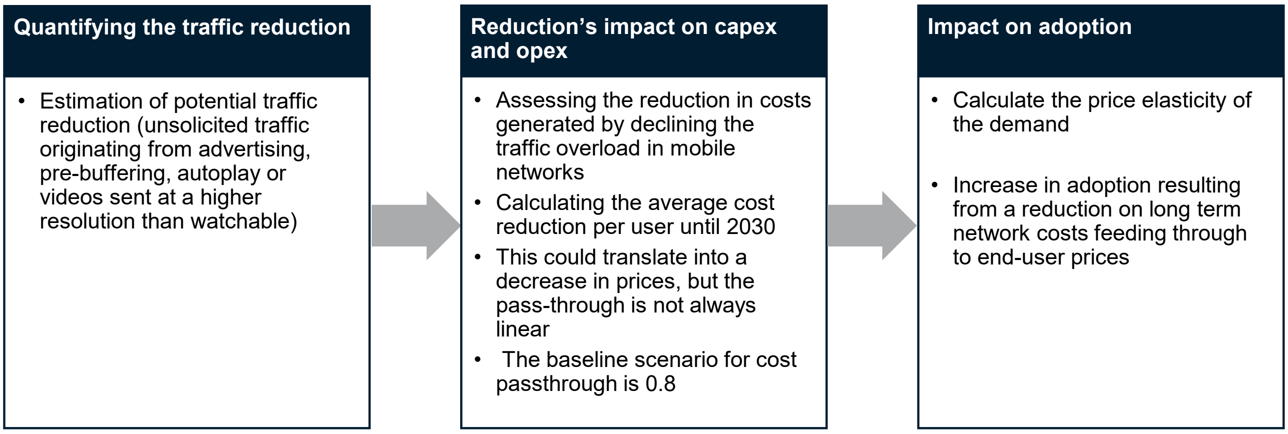
The difference between the first and second linear regressions enables us to quantify incremental percentiles that would be added to the service if a new policy was implemented, which allows us to estimate the number of new additions, elasticity and demand prices for each scenario.

Efficient network use

The objective is to determine the impact that a more efficient use of the network could have.

Figure 13: Efficient network use: flow of impact on adoption

Source: GSMA Intelligence



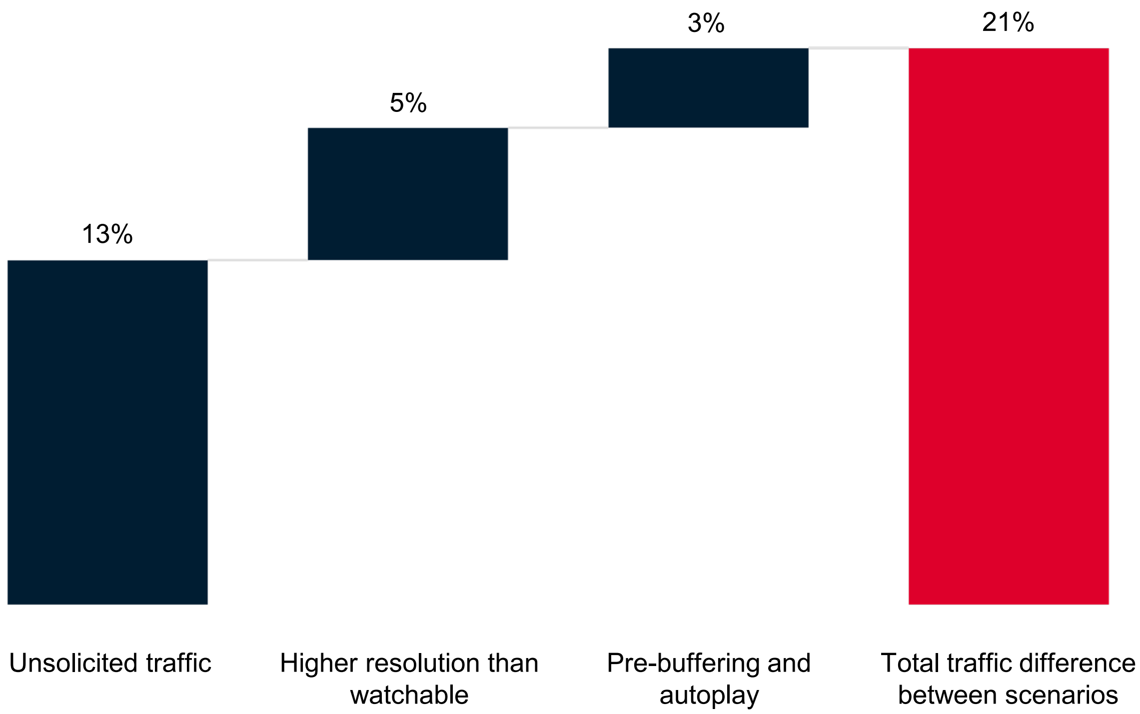
The analysis considers the potential effects of a slowdown in the growth of network traffic on long-term costs to estimate the volume of non-required traffic by users. This consists of three elements: unsolicited traffic (ads); pre-buffering and autoplay; and higher-than-watchable resolution content.

The estimated volume of unsolicited traffic ranges from 15% to 30% of the total traffic generated by leading social media apps.[14] The result of applying these values to the region enables a reduction of around 13% of total traffic.

[14] Characterisation of unsolicited traffic advertisements in mobile devices, Silva, J. P. V., Carvalho, P. and Lima, S. R., September 2020

Figure 14: Difference in traffic between the two scenarios in the Caribbean islands
Percentage of total traffic

Source: Silva et al. (2020), mobile operator data, GSMA Intelligence



Moreover, there is compelling evidence indicating inefficiencies in video delivery: it has been shown that optimising video traffic has the potential to reduce overall traffic by 15–25% while maintaining the same user experience.[15] For modeling purposes, we apply the lower limit of this range (15%).

Once the difference in traffic is estimated, the decrease in costs resulting from this is quantified, in terms of both capex and opex. The quantitative assessment is based on the model for costing digital infrastructure investments developed in 'Estimating Digital Infrastructure Investment Needs to Achieve Universal Broadband'.[16] Since this method includes different countries, only those belonging to the region under study in our report were considered[17]. According to the modelling, a difference in traffic growth of 20% between scenarios in the Caribbean islands leads to a 10% cost difference between scenarios.

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[15] Based on tests carried out by Telefónica and a CAP consisting of limiting the maximum bitrate of video connections up to the maximum level possible. This was not noticeable on smartphones (small screens), thus having no impact on perceived quality of experience while resulting in relevant network resource savings.

[16] Estimating Digital Infrastructure Investment Needs to Achieve Universal Broadband, Oughton, E.J., Amaglobeli D. and Moszoro M., 2023

[17] Barbados, Haiti, Dominican Republic, Jamaica, and Trinidad and Tobago

The total cost is then projected for the baseline scenario and the scenario with market reform. The difference between the two is the difference in cost produced by an improvement in the efficiency of data traffic transmission over mobile networks.

The average difference in costs per user until 2030 is calculated. The model then regulates the cost pass-through of these impacts (reductions), from complete appropriation by operators (pass-through = 0) to complete price reduction (pass-through = 1).[18] The baseline scenario for cost passthrough is 0.8, based on previous GSMA analysis.[19]

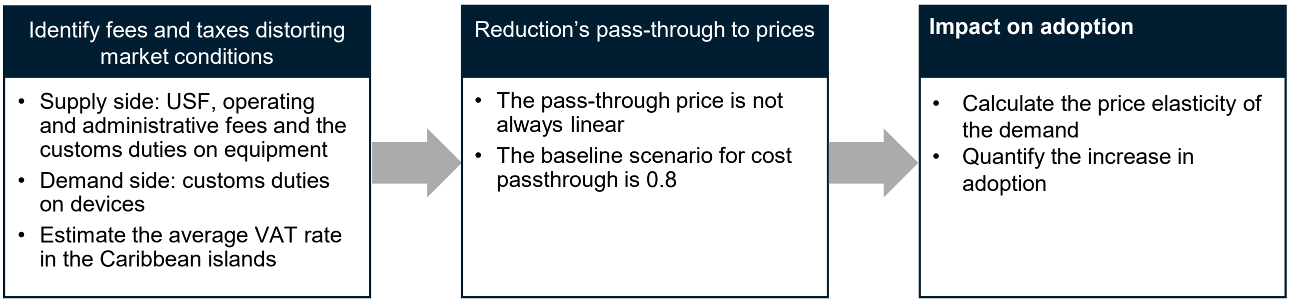
Then, based on the price reduction and the price elasticity of demand, the model quantifies the increase in adoption resulting from a reduction in long-term network costs.

Modernisation of the fiscal framework of the mobile sector and VAT exemption for low-income groups

The objective is to determine the adoption impact of reducing fees and taxes that distort market conditions.

Figure 15: Fiscal and regulatory modernisation and VAT exemption: flow of impact on adoption

Source: GSMA Intelligence



On modernisation of the fiscal framework of the mobile sector, mobile operators reported the fees, customs duties, universal service funds and VAT rates by country in the Caribbean islands. Afterwards, we classified them in terms of affecting supply or demand and we calculated the regional average by concept, which is the number included in the model.

[18] Pass-through = 0 means that device and plan prices do not change in relation to the baseline scenario. Pass-through = 1 means that all reductions caused by tax/fee reductions translate into an identical reduction in device and plan prices.
[19] Mobile taxation studies, GSMA, 2020

Figure 16: Average rates in the Caribbean islands

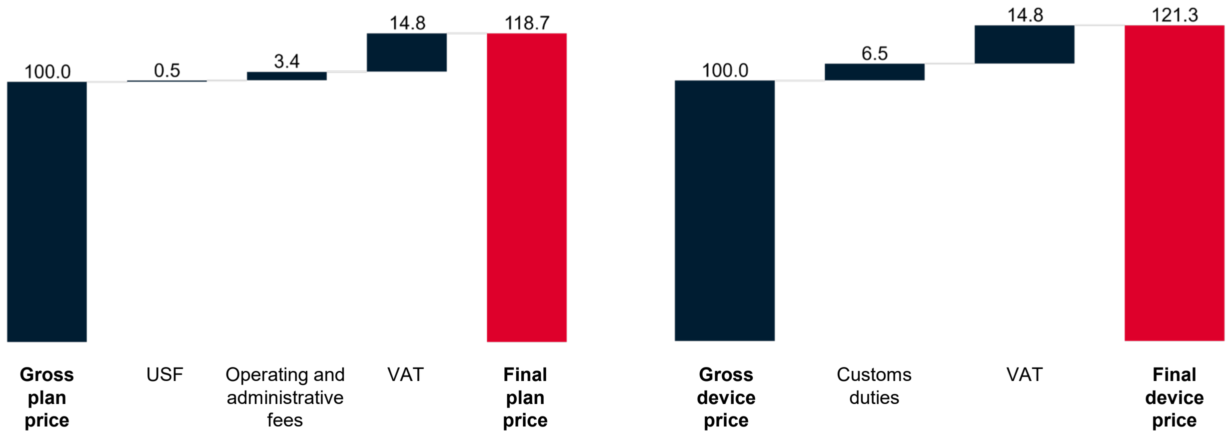
Source: Mobile operator data, GSMA Intelligence

	Average rate	Public policy reform
Affecting supply side		
USF	0.5%	Reduce to 0%
Operating and administrative fees	3.4%	Reduce to 0%
Customs duties on equipment	6.5%	Reduce to 0%
Affecting demand side		
Customs duties on devices	6.5%	Reduce to 0%
VAT		
VAT exemption	14.5%	Reduce to 0% on plan and devices

The fee and VAT impact in the final service price is around 20%, affected mostly by the VAT. Something similar happens to devices, where the VAT still affects, but also the custom duties have a relevant impact on the device´s final price.

Figure 17: Impact of fees, duties and taxes on prices (plans and devices)
Index (gross price = 100)

Source: GSMA Intelligence



The cost reduction generated by both modifications is calculated, which then translate into a decrease in price for both plans and devices.

Then, based on the calculated price reduction and the price elasticity of demand, the model quantifies the increase in adoption resulting from a reduction produced by the fiscal and regulatory modernisation or the VAT exemption policy reform.

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