NEUTRAL HOST NETWORKS: A SOLUTION TO GREENER AND COST-EFFECTIVE DEPLOYMENTS

Research report

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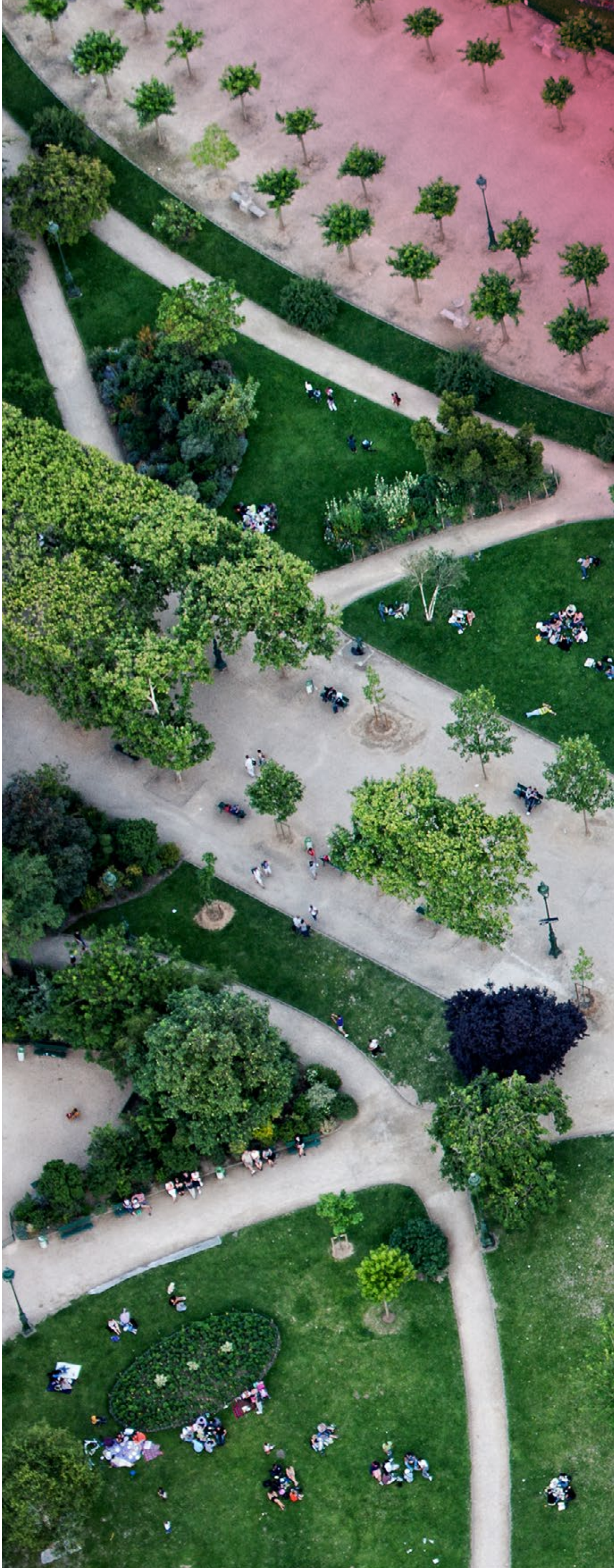

About this research

The arrival of 5G has transformed connectivity for businesses and consumers alike. But as network demands grow and environmental concerns take center stage, the path to a truly interconnected future has new challenges and demands new solutions.

To better understand the most effective approaches, Boldyn Networks commissioned ABI Research to conduct an independent research comparing traditional standalone 5G networks with neutral host 5G networks.

The study modelled real-world network scenarios to ensure the results reflect the practical realities operators face. The models considered a range of deployment conditions, tenancy rates, and network architecture preferences. ABI Research used data from their own primary research around 5G SA deployments, combined with Boldyn's data around real-life deployments in New York City and Rome, to create the comparison model.

The results, which are entirely fruit of ABI Research's own conclusions and unbiased, demonstrate that neutral host networks offer a more sustainable, cost-effective, and efficient solution for delivering 5G coverage.

We invite you to explore the findings of this insightful report, authored by ABI Research's expert team:

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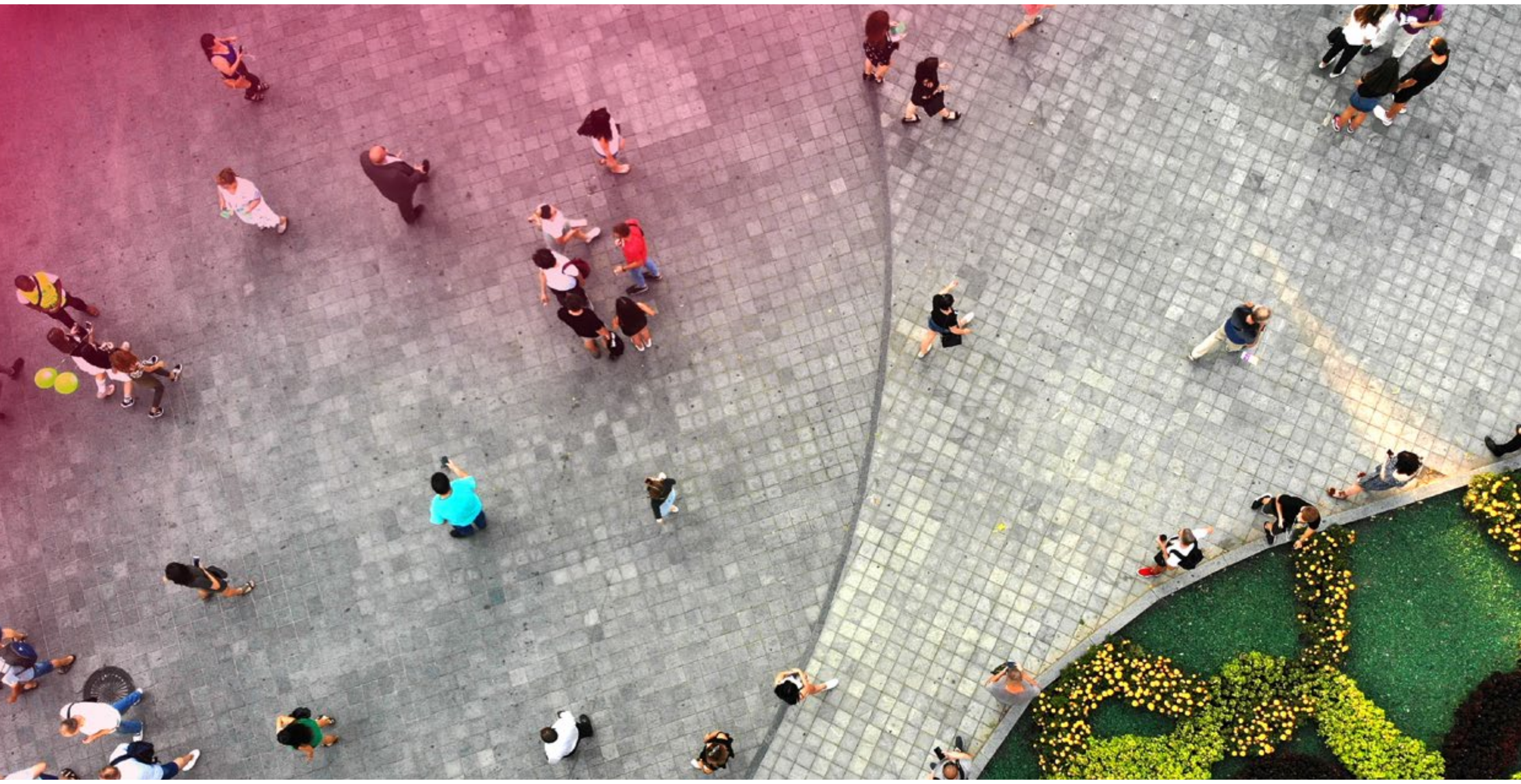
Executive summary

5G is the technological advancement that meets the growing demand for increased mobile data speeds, enhanced signal reliability, better coverage, lower latencies, and improved network efficiencies. However, catering to increased network traffic and higher frequencies used for 5G technology requires higher densification of base station sites to support 5G network rollouts. This creates a host of new issues for Communication Service Providers (CSPs), which will need to incur additional costs to build and maintain the increasing number of new 5G base station sites. Additionally, the increased densification of base station sites is also expected to impact the power grids of cities and countries. This research delves deeper into network sharing models, in particular the concept behind Neutral Host Networks (NHNs), to understand the benefits that such models can offer operators.

In modelling Neutral Host Networks (NHNs) against traditional standalone 5G small cell deployments across New York, United States, and Rome, Italy, ABI Research has observed that NHNs can help reduce overall deployment costs and energy consumption by up to 47% and 38%, respectively. These costs and energy savings are mainly driven by the consolidation of telecoms equipment and the sharing of site installation costs, including but not limited to small cell radios, fibre and power trenching, site maintenance, site lease, etc. In addition, other non-quantifiable benefits of NHNs, such as preserving city landscape aesthetics and site rollout duration, were also considered in the network model.

Given these benefits and the expected continuing densification of base station sites as operators move toward 5G and beyond networks, it is important for cities and operators to consider how they can augment existing networks with NHNs to adequately address the issues associated with such densification.



1

5G trends and developments

The International Telecommunications Union (ITU) has established three main 5G connectivity scenarios that can satisfy a diverse scope of use cases and specific communication requirements of consumers and enterprises. These three scenarios are Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communications (URLLC), and Massive Machine Type Communications (mMTC).

eMBB focuses on the data-driven use cases that require high rates of data across a large coverage area by mobile devices, wearables, laptops, Mobile Broadband (MBB) devices, etc. **URLLC** can be seen as the key enabler for 5G to support near real-time use cases for enterprise verticals and smart city applications (e.g., intelligent traffic management, infrastructure monitoring, coordinated emergency response, etc.). **mMTC** plays a key role in providing affordable and reliable connectivity to an exponentially larger number of small Narrowband Internet of Things (NB-IoT) devices and modules, thereby supporting infrastructure monitoring applications via widespread sensor data collection.

1.1. 5G Subscriber and traffic trends

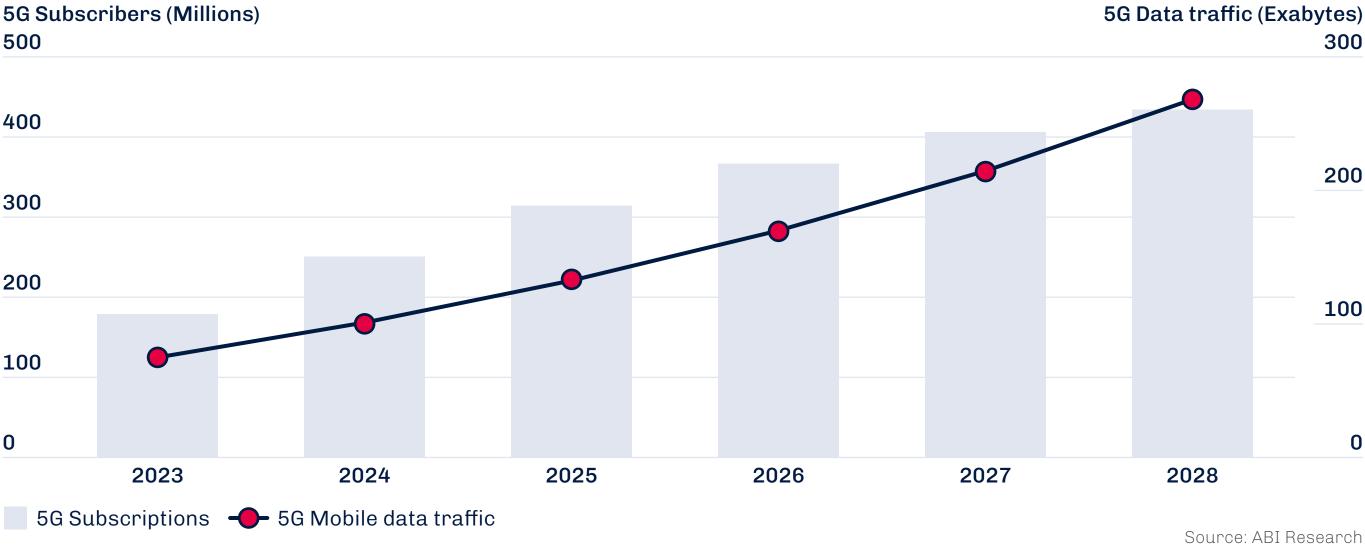
Adoption of 5G has grown steadily since commercial networks were first launched in different countries.

1.1.1. United States

In the United States, commercial 5G services were launched back in 2019. Since then, total 5G subscriptions in the country have grown to over 170 million in 2023 and are forecast to further increase to 430 million in 2028 (at a Compound Annual Growth Rate (CAGR) of 20%). Accordingly, 5G mobile data traffic reached 74 exabytes[1] in 2023, and is expected to surge to more than 260 exabytes by 2028 (at a CAGR of 29%). This translates to an average 5G usage rate of 34 Gigabytes (GB) per user per month in 2023 to over 50 GB per user per month by 2028.

In addition, despite cities like New York already being one of the densest cities in the United States, reports indicate that over 1 million workers commute into the city daily. As a result of such high human traffic and increasing demand for 5G resources, significant stress is inevitable on existing mobile infrastructure.

5G Subscriptions and mobile data traffic United States: 2023 to 2028



Source: ABI Research

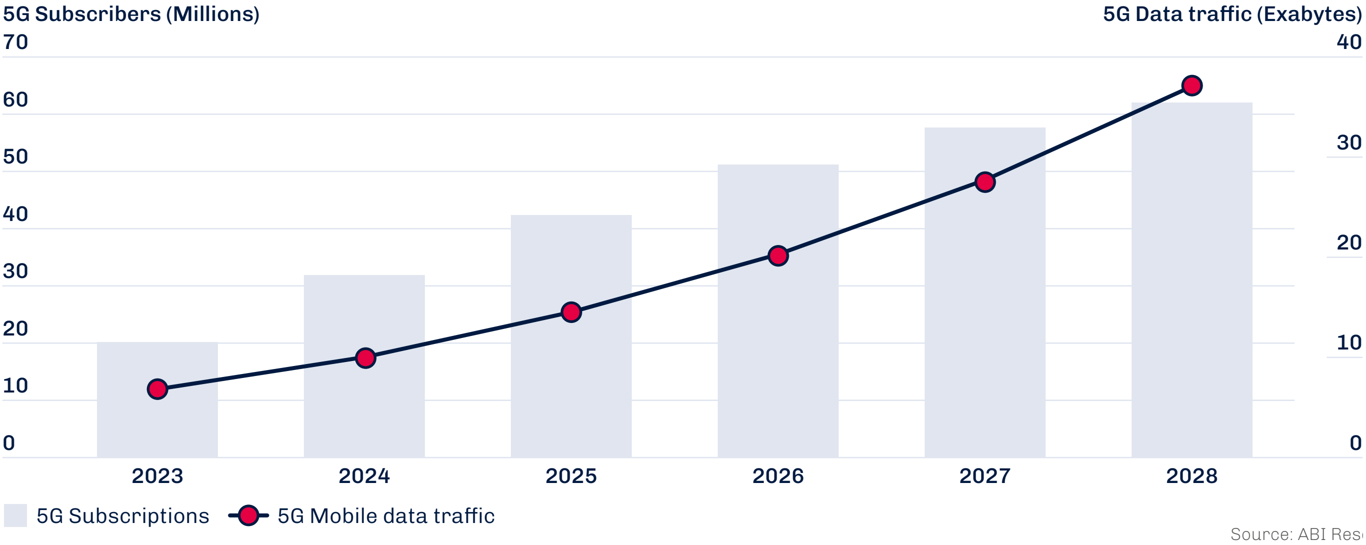
1. 1 Exabyte = 1,000,000,000 Gigabytes.

1.1.2. Italy

Similarly, in Italy, the number of 5G subscribers topped 20 million in 2023, with ABI Research expecting this number to reach 60 million by 2028 (at a CAGR of 25%). 5G mobile data traffic is also forecast to grow from almost 7 exabytes in 2023 to 37 exabytes in 2028 (at a CAGR of 41%). This translates to an average 5G usage rate of 27 GB per user per month in 2023 to almost 50 GB per user per month by 2028.

Cities like Rome also face a big challenge of meeting the connectivity needs of tourists. According to reports, 35 million tourists visited the city in 2023. This number is expected to remain high as the city prepares for the Jubilee 2025 celebrations. 5G infrastructure in Rome will need to be upgraded substantially to not only meet the impending wave of human traffic, but also to support smart city applications, such as surveillance and infrastructure monitoring.

5G Subscriptions and mobile data traffic Italy: 2023 to 2028



Source: ABI Res

1.2. 5G Deployment trends

Catering to increased network traffic and higher frequencies used for 5G technology (>3 Gigahertz (GHz)) requires higher densification of base station sites to support 5G network rollouts. However, this creates a host of new issues for CSPs, which will be required to incur both Capital Expenditure (CAPEX) and Operating Expenditure (OPEX) to build and maintain the increasing number of new 5G base station sites. The densification of base station sites also increases overall power requirements needed to power all of the additional base station equipment.

This site densification can be observed in New York City, for example, where data from the Office of Technology and Innovation (OTI) shows that there are more than 6,000 poles installed for the installation of small cells, with a further 5,000 either approved or pending approval. Additionally, in Rome, the #Roma5G project was launched, which will see more than 2,200 5G small cells installed across the city.

2

Network sharing models

In order to overcome the issues with 5G network densification, new deployment modes are now being introduced to enable the sharing of infrastructure, such as the Core Network (CN), Radio Access Network (RAN), backhaul, tower infrastructure, etc., to reduce both CAPEX and OPEX costs for deployments.

2.1. Shared infrastructure

At the moment, there are various different modes of sharing arrangements These include passive and active sharing. These network sharing models can be implemented by a variety of players, such as by a lead CSP, a joint-deployment agreement between multiple CSPs, or via a neutral third-party, which is also known as a Neutral Host (NH). A breakdown of these different sharing models is shown in Table 1.

Table 1: Network Sharing Models

	Active			Passive	
Network Sharing Models	Multiple Operator RAN (MORAN)	Multiple Operator CN (MOCN)	CN Sharing	Site Sharing	Backhaul Sharing
Core Network			X		
Backhaul	X	X	X		X
Radio Access Network	X	X	X		
Site	X	X	X	X	X
Access Spectrum		X	X		

2.2. Shared spectrum

Beyond infrastructure sharing, spectrum sharing models are emerging around the world. The general intent behind spectrum sharing is to provide CSPs and non-CSPs with easier access to mid-band spectrum to support new innovations. These can include deploying private networks for manufacturing, logistics, or smart city applications, and extending mobile coverage for indoor and/or rural areas.

In the United States, the Citizens Broadband Radio Service (CBRS) is a frequency range between 3,550 Megahertz (MHz) and 3,700 MHz that can be used to deploy 5G or 4G private networks. The CBRS is divided into three tiers, namely: 1) incumbent users; 2) Priority Access License (PAL); and 3) General Authorised Access (GAA).

- **Incumbent Access:** Highest priority access granted to incumbent users in this frequency range, namely the military and fixed satellite stations.
- **PAL:** Second-highest priority given to users who have purchased CBRS spectrum via auction.
- **GAA:** Third-highest priority, which is free for enterprises to use. However, GAA users must ensure that deployments do not cause interference to incumbent access or PAL users.

Elsewhere, there are also different shared access spectrum models being implemented. For example, in the United Kingdom, the 1800 MHz and 2300 MHz spectrum bands have been allocated as shared access bands. Likewise, in Italy, CSPs that are allocated at least 80 MHz nationally within the 3,400 – 3,800 MHz frequency band have a license obligation to lease access spectrum to other operators, without these frequencies, on a commercial basis. Additionally, a "club use" framework has been implemented for the 26 GHz spectrum band in Italy, where CSPs are able to lease unused spectrum from other licensees.

2.2.1. MORAN versus MOCN

To consider if a MORAN or MOCN sharing model is to be used, it is important to consider the benefits and drawbacks of both approaches. Again, the key difference between MORAN and MOCN is the sharing of spectrum resources.

- **MOCN** is widely regarded as a more efficient mode of sharing, as it supports the dynamic allocation of spectrum resources. However, higher coordination and complexity is involved between sharing operators to maintain service-level assurance for their customers.
- In the **MORAN** sharing model, spectrum resources are not shared between different operators. As a result, operators are able to maintain control over the quality of service for their own customers. Less complexity and coordination are required between operators. However, spectrum efficiency is not maximised.

Both sharing models bring about their own pros and cons. The choice between MORAN or MOCN ultimately depends on the requirements of each sharing operator.

3

Neutral host networks

Earlier, we introduced the issues associated with 5G and network densification. The NHN was suggested as one network sharing model that can be used to reduce overall network deployment costs for CSPs, while also decreasing energy consumption as a result of the consolidation of equipment.

In this section, ABI Research intends to quantify the amount of cost and energy savings that NHNs can bring about for CSPs, as compared to traditional standalone deployments by individual operators. In particular, the assessment focuses on 5G outdoor small cell deployments used by NHNs to support increased data traffic and smart city applications within cities.

3.1. Methodology

The model will focus on simulating real-world environments where NHN deployments have been observed. This will include cities such as 1) New York, which has begun the construction of Link5G towers to support multi-operator tenancy and extend 5G coverage across the city, and 2) the city of Rome, which has made plans to introduce a shared 5G network with over 2,200 5G small cells being installed across the city via an NHN to provide underlay 5G coverage to consumers and support smart city applications.

3.1.1. Modeled city parameters

Some of the key city parameters used are shown in Table 2.

Table 2: City Simulation Parameters

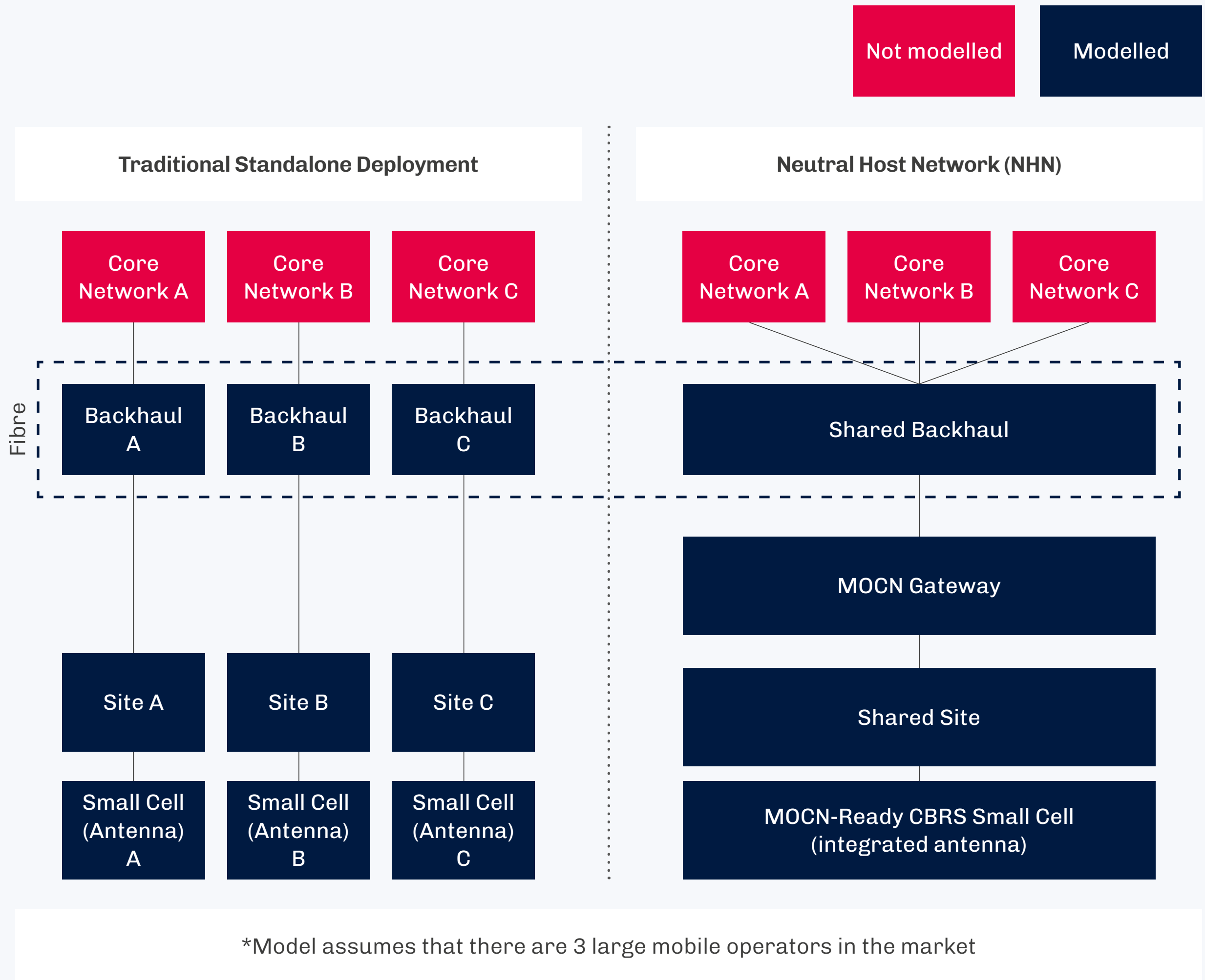
Cities	Manhattan	Brooklyn	Bronx	Rome Capitale (Municipio I,II,IV,V,VII)	Rome Capitale (Municipio III,VI,VIII–XV)
Est. Population (2023)	1.6 million	2.6 million	1.4 million	1.0 million	1.7 million
Land Area (km^2)	60	180	110	160	1,100
Population Density (/km^2)	26,600	14,400	12,700	6,280	1,500
City Designation	Dense Urban	Urban	Suburban	Urban	Suburban

3.1.2. Modeled network architecture

The model will specifically focus on 5G NHNs via the use of small cells. In the United States, the model will assume a 5G CBRS spectrum sharing model, whereas in Italy, a C-band (i.e., 3,600 – 3,800 MHz) sharing model is assumed. Based on ABI Research's understanding of the NHN market, the model assumes a MOCN sharing model, as it is the preferred mode of network sharing. Network components assessed in the model include CAPEX elements – fibre backhaul, trenching, gateways, site buildout and installation costs, small cell equipment, and power equipment – and OPEX elements – power consumption, site lease, and maintenance.

Please note that while there are other modes of backhaul available, fibre backhaul is modelled to support the high capacity and low latency required of 5G networks. Additionally, spectrum costs can differ significantly in each scenario – this can be due to payment for Spectrum Access System (SAS) services in a CBRS setting or via commercial agreements with spectrum licensees in Italy – and are not accounted for in this model.

Figure 1: Network Model Architecture



Source: ABI Research

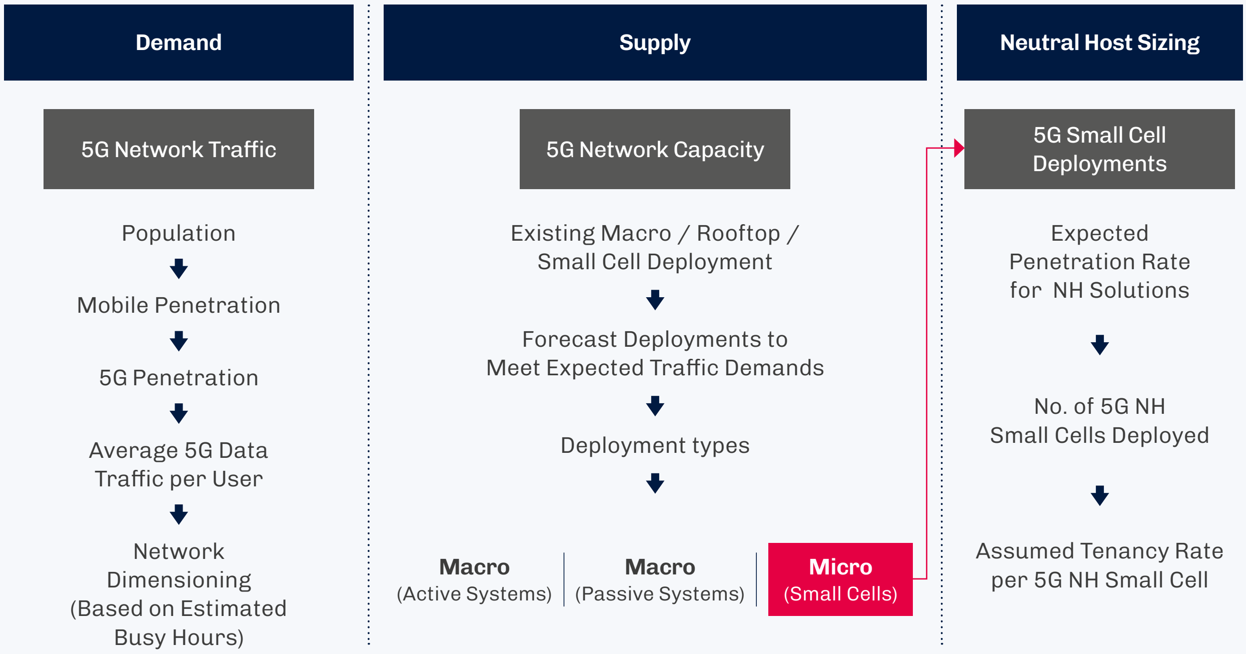
3.1.3. Network dimensioning

To estimate 5G small cell deployments, a network traffic dimensioning model is used to assess the demand and growth of 5G traffic in the different cities. This is calculated by considering the city's population, 5G mobile penetration rate, average 5G data traffic per user, and estimated busy hours.

Thereafter, a model is developed to estimate the number of cell sites and infrastructure needed to support 5G traffic demand. This is done by examining existing deployments in the city (macro and micro sites), and the number of new deployments needed to support 5G traffic demand forecasts.

Lastly, based on the forecast number of 5G small cell deployments, the model assumes a 5G NHN small cell deployment/penetration rate based on 1) existing and/or intended deployments based on announced public/private NHN projects; and 2) analysing existing fibre network coverage in the respective cities, where a higher adoption rate is assumed in areas with lower fibre reach.

Figure 2: Network Traffic Dimensioning



Source: ABI Research

3.1.4. Accounting for Greenfield versus Brownfield sites

To consider a realistic simulation of real-world circumstances, appropriate consideration is also afforded to greenfield and brownfield sites. The definitions used in the model are as follows:

- **Greenfield:** A completely new site with no existing site infrastructure, fibre backhaul, or power.
- **Brownfield:** An existing 4G site with site infrastructure, fibre backhaul, and power. However, installation works will be required to install new 5G small cell radios and upgrade infrastructure to support the deployment, where required.

A percentage split between greenfield and brownfield sites is assumed in all scenarios modelled.

Greenfield versus Brownfield sites

	Deployment Modes			
Architectures	5G Neutral Host (MOCN)		Standalone Small Cell Deployments	
	Greenfield	Brownfield (existing infrastructure)	Greenfield	Brownfield (existing site upgrades)
5G Small Cells	Shared	Shared	Not shared	Not shared
Fibre Backhaul	Shared	No	Not shared	No
MOCN Gateway	Shared	No	No	No
Power Equipment / Cabinets / Trenching	Shared	No	Not shared	No
5G Small Cell Installation	Shared	Shared	Not shared	Not shared
5G Site Buildout	Shared	No	Not shared	No
Network Planning	Shared	No	Not shared	No
Site Lease / Rental	Shared	Shared	Not shared	Not shared
Site Maintenance	Shared	Shared	Not shared	Not shared
Power Consumption	Shared	Shared	Not shared	Not shared

Source: ABI Research

3.2. Key results & discussion

Table 3: Key Model Results Forecast: 2024 to 2028

Cities	Manhattan	Brooklyn	Bronx	Rome Capitale (Municipio I,II,IV,V,VII)	Rome Capitale (Municipio III,VI,VIII–XV)
Individual Standalone 5G Small Cell Deployments	1209	471	313	726	923
Equivalent 5G Small Cell Deployments with NHNs	726	252	168	388	493
Accumulated Cost Savings as of the End of 2028 (US$)	16,800,000	10,400,000	9,100,000	9,050,000	20,300,000
Net Energy Savings	20%	27%	35%	33%	38%
Cost Savings	40%	47%	47%	47%	47%

Source: ABI Research

The model outputs show that the NHN architecture brings about both cost and energy saving benefits as a whole. The city itself benefits from the energy savings that NHNs enabled, while cost savings can, in turn, be passed back to sharing parties.

3.2.1. Deployment cost savings

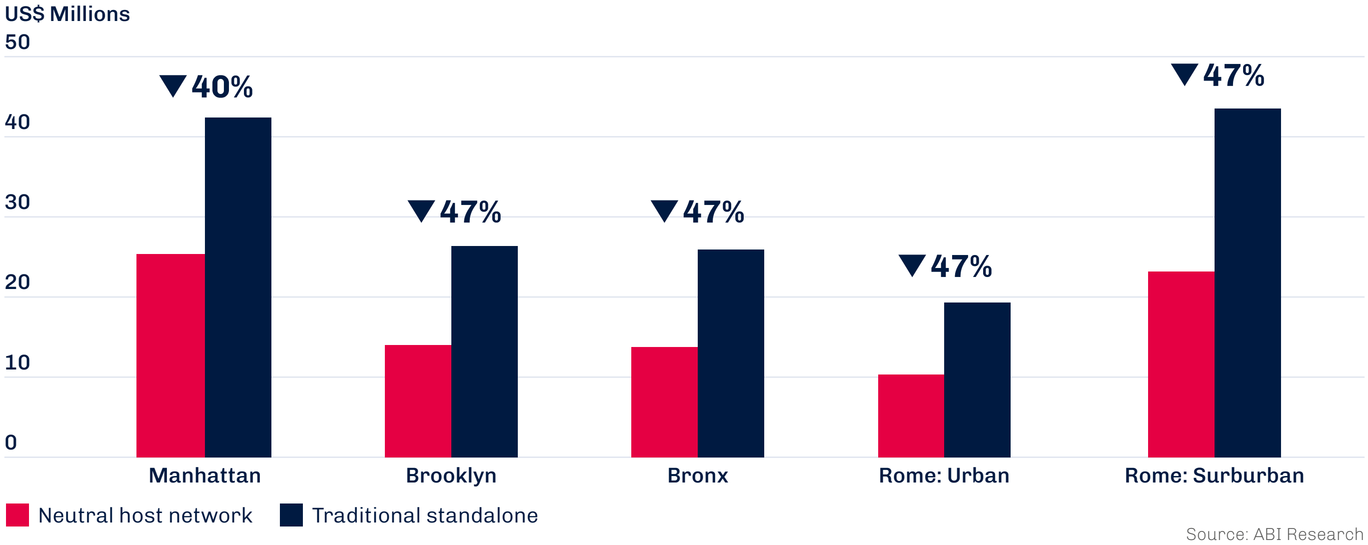
In determining cost savings, the following factors were examined:

- **CAPEX:** Fibre backhaul deployment/trenching, MOCN gateway, small cell equipment, power cable deployments & cabinets, equipment installation, and site buildout.
- **OPEX:** Power consumption, site lease or rental, maintenance costs.

In dense urban environments, such as Manhattan, cost savings are expected to be lower than less dense environments due to a higher concentration of mobile users and demand for data throughput. The model assumes that one 5G small cell has an average range of 1.4 kilometers (km) and supports up to 200 simultaneous users. Given the forecast traffic profile of the dense urban city of Manhattan, a single 5G NHN small cell is unable to support the capacity needs of all sharing operators (assumed to be an average tenancy rate of 2.4 through 2028). This requires denser deployment, which, in turn, reduces the percentage of cost savings.

Nonetheless, NHNs are expected to be more widely deployed in dense urban and urban areas, given its ability to address other concerns, such as site deployment time and city aesthetics. With a higher adoption rate, ABI Research expects significantly more accumulated cost savings in dense urban and urban environments between 2024 and 2028.

Accumulated deployment cost per scenario forecast: 2024 to 2028



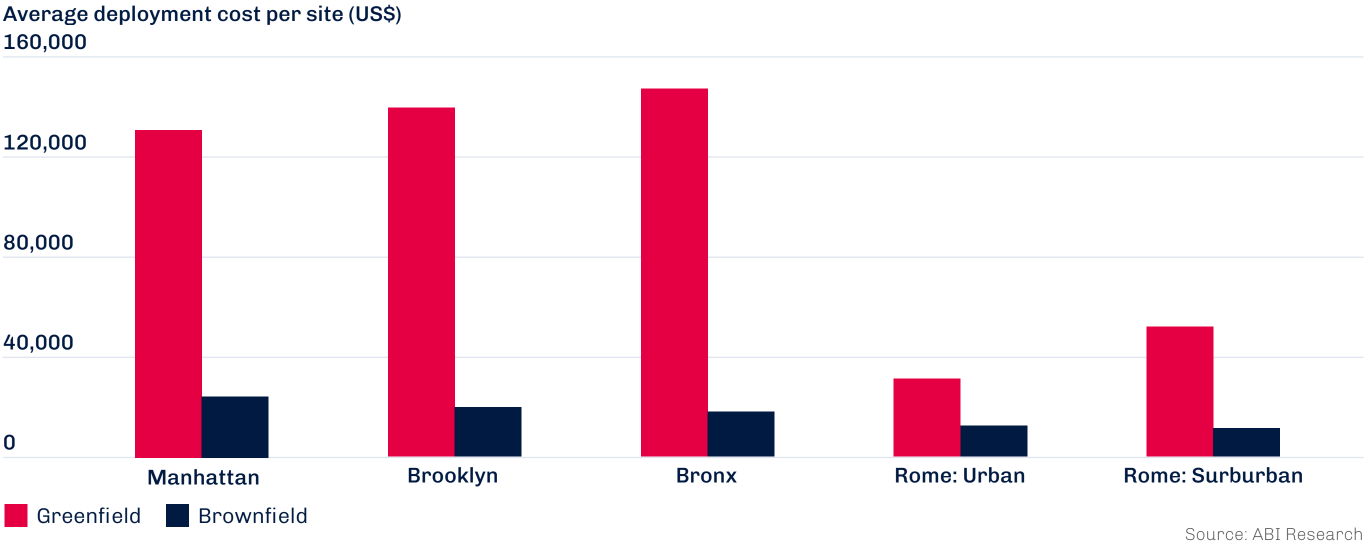
Source: ABI Research

3.2.2. Deployment cost breakdown

The model outputs show a significant difference in deployment costs per site for greenfield and brownfield scenarios. The reason for this difference is the large CAPEX costs incurred for greenfield sites due to fibre and power cable trenching and deployments.

Additionally, it was also observed that the deployment costs per greenfield site trended upward as the deployment moved away from dense urban areas. This is attributed to the less dense existing fibre infrastructure in urban and suburban areas, which necessitate longer fibre runs and trenching from each small cell site to the nearest fibre backbone.

Deployment cost breakdown per site forecast: 2024 to 2028



Source: ABI Research

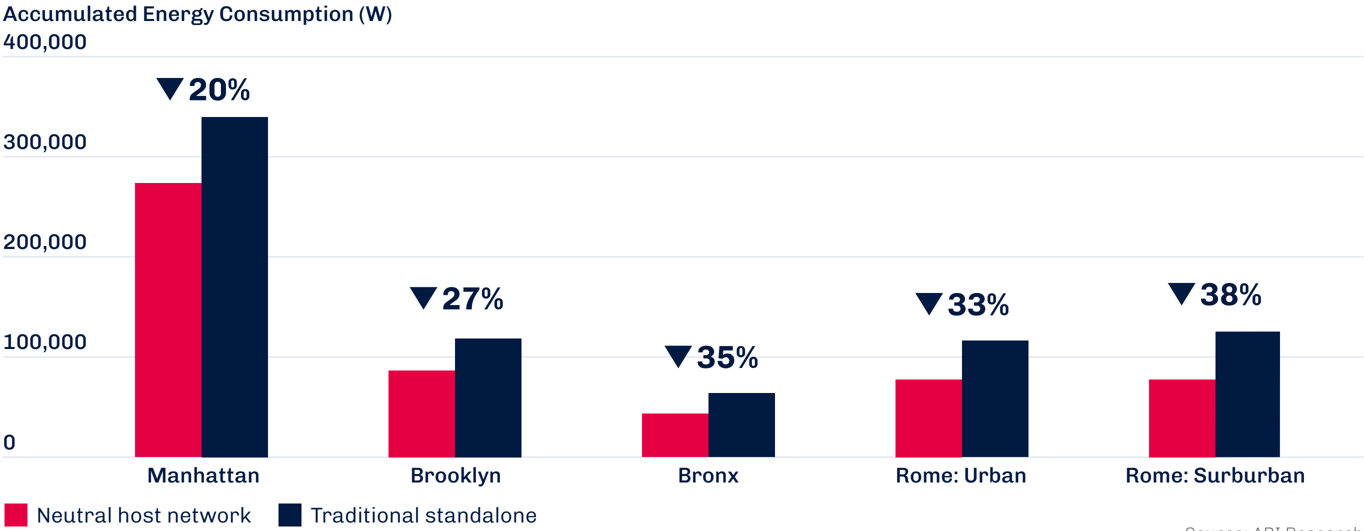
3.2.3. Energy savings

In determining cost savings, the following factors were examined: small cell equipment, MOCN gateway, and fibre backhaul.

Energy consumption is generally dependent on its overall utilisation level. For example, a small cell or gateway switch processing a higher amount of network traffic will consume more energy compared to similar equipment with a lower network load. Hence, the model compares the overall energy savings from using a smaller number of 5G small cells, but with higher average utilisation (NHN model) against a larger number of 5G small cell deployments with lower average utilisation (standalone operator deployments). The results indicate that the NHN deployment mode will still bring about energy savings when compared to traditional network deployments.

Using this same reasoning, less dense environments are expected to experience more energy savings compared to denser scenarios due to an overall lower average utilisation rate across the small cell network.

Accumulated energy consumption per scenario forecast: 2024 to 2028



Source: ABI Research

4

Key take-aways & recommen-dations

As per the initial assumptions, ABI Research's network model demonstrates that Neutral Host Networks (NHNs) can provide cost – and energy-saving benefits to Communication Service Providers (CSPs). Below, ABI Research has distilled these key learning points for the different stakeholders in the telecommunications ecosystem.

4.1. Communication service providers

- NHNs are expected to be best suited for dense urban and urban environments due to their ability to address multiple issues, including but not limited to deployment costs, power consumption, maintaining city aesthetics, and deployment duration. CSPs need to consider how they can best utilise NHNs to augment their mobile networks, particularly in these dense urban and urban areas.
- CAPEX is a significant cost component for greenfield builds. This is especially evident for suburban areas, where less dense existing fibre infrastructure necessitates longer fibre runs and trenching from each small cell site to the nearest fibre backbone. CSPs need to consider how NHNs can be leveraged to drive down CAPEX costs in order to support more extensive network rollouts.

4.2. Regulators and city councils

- Energy consumption savings are observed across all NHN sharing scenarios compared to traditional standalone deployments, with the extent of energy consumption savings being inversely proportional to the densification/utilisation rate of the small cell network (i.e., higher densification/utilisation of 5G small cell networks in dense urban areas lead to lower energy savings). City councils should consider how they can encourage the rollout of NHNs within their cities to support network coverage and smart city applications, while also minimising the energy consumption of these networks.
- The current model assumes a conservative average tenancy rate of 2.4 through 2028. A higher tenancy rate will further improve costs and energy savings. Encouraging greater sharing and deployment of NHNs should be a key consideration for city councils and management.

About ABI Research

ABI Research is a global technology intelligence firm uniquely positioned at the intersection of technology solution providers and end-market companies. We serve as the bridge that seamlessly connects these two segments by providing exclusive research and expert guidance to drive successful technology implementations and deliver strategies proven to attract and retain customers.

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