



# Improving Mobile Connectivity: A Rural Community Study

July 2023



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# Key Takeouts

This report was produced to look at the impact that the Scotland 4G Infill Programme (S4GI) has had on the specific community of Coigach in Scotland which has benefitted from a new mobile mast site. The purpose is to better understand the impact of a programme designed to improve 4G connectivity, and to establish the viability of 4G as a means of reducing an access based digital divide. It was also developed to understand both the return on capital investment and the return on the emissions investment needed to bring infrastructure to rural communities.

## 1. S4GI PROGRAMME

A c.£30 million programme, designed to ensure that 4G mobile phone coverage is available to poorly served rural areas across Scotland from the Shetland Islands to the Borders.

## 2. THE COMMUNITY

The new mobile site at Polbain on the Coigach peninsula on the north west coast of Scotland provides 4G coverage to the neighbouring communities around Polbain and Achiltibuie and coverage improvements on the primary single track road into the area.

## 3. APPROACH

To understand the impact pre and post build, FarrPoint undertook a local survey to gain an understanding of the impact of poor connectivity across the communities, and then to understand the impact once the service was delivered from the new Polbain mast

## 4. PRE BUILD SURVEY RESULTS

The survey revealed a comprehensive lack of confidence in mobile service across the community with **77%** of respondents classifying mobile phone service as poor or very poor, a further 15% suggested service was fair, but commented on the lengths they needed to go to get a stable signal – examples included walking to specific parts of the garden or driving to a layby.

## 5. POST BUILD SURVEY RESULTS

The post build metrics changed considerably, with now only **35%** of respondents classifying mobile phone service as poor or very poor, matched by **35%** of respondents classifying mobile phone service as good or very good.

## 6. RETURN ON INVESTMENT

The S4GI programme represents a significant capital investment from the Scottish Government. As a result, and whilst it may not be seen as a driver of the project, FarrPoint thought it would be useful to look at the return on the investment (ROI) of financial capital, and the corresponding investment in greenhouse gas emissions.

Here the project also **performs** favourably with a financial breakeven point of circa 15 years, and a modelled emissions breakeven point of only circa 6 years.



# Introduction

# Introduction

## Purpose of the report

Ofcom's Connected Nations report<sup>1</sup> suggests that all premises, and therefore all/most residents of the UK, have access to 4G mobile services from at least one provider. This number falls to c.95% when considering the geographic UK as a whole - that is including areas of the UK with no habitation. For Scotland, the numbers are similar, with all premises able to access a 4G services from at least one provider, but geographic coverage falls to 83%. Detail on the quality of service delivered to end users is also limited. The following should also be noted:

- the data used in the Connected Nations report is supplied by the mobile providers themselves, and
- in urban environments for example, FarrPoint has noted variances in reported and available services levels.

This report was produced to look at the impact that the Scotland 4G Infill Programme<sup>2</sup> has had on the specific communities around Polbain in Scotland which have benefitted from a new mobile mast site. The purpose is to better understand the impact of a programme designed to improve 4G connectivity, and to establish the viability of 4G as a means of reducing an access based digital divide.

## About FarrPoint

FarrPoint is an independent technology consultancy which specialises in digital connectivity. We understand the importance of connectivity as the underlying mechanism for driving economic and social benefits and we have deep personal convictions about the importance and impact of our connectivity work. This works matters to us, and we get professional reward from being part of the change

that improved connectivity can bring to societies and communities.

To achieve this, we provide independent advice on the commercial and technical considerations of connectivity strategies, technical planning and modelling, procurement support and implementation assurance. Our work ranges from connectivity infrastructure programmes through to use cases covering public service delivery, health and social care and environmental issues.

Our team comprise a mix of consulting technologists, economists and data scientists who work together to provide experience, expertise, and complementary resource to clients in the public and private sectors.

More details on our approach and services are found at [www.farrpoint.com](http://www.farrpoint.com).

## The challenge of delivering connectivity to rural communities

There are no technical issues when it comes to delivering digital infrastructure to meet the needs of rural communities – the issue is almost always the cost of delivering the infrastructure, and more importantly delivering perceived value, or an economic return for this investment. That said there are limitations to what certain types of infrastructure can deliver. By far the easiest to understand is a wired connection to a premise, in that it is a tangible 'line' into a premise across which signals can be relayed and connectivity achieved. Mobile and other wireless forms of connectivity are less tangible and moreover are affected directly by topology in a manner that fixed connectivity is not. However, a single deployment of mobile technology, i.e. a mast, can deliver service to multiple end users/devices, whereas at the access layer a single wired connection must be delivered to each and every premise,

<sup>1</sup> Connected Nations

<sup>2</sup> Scottish 4G infill programme

with single lines aggregated and delivered back to a point where a connection can be made back to a core network. This 'backhaul' arrangement has similarities across both fixed and wireless connectivity and is not considered as part of this report.

## The S4GI Programme

The Scottish 4G Infill Programme is a c.£30 million programme which was designed to ensure that 4G mobile phone coverage could be developed in a number of rural areas across Scotland, from the Shetland Islands to the Borders delivering new 4G mast sites in c.55 locations. The mast sites are capable of delivering end user services from any of the major mobile phone companies, with EE being the first to establish infrastructure on the majority of sites in operation. S4GI is delivered in partnership with WHP Telecoms Ltd<sup>3</sup> and the Scottish Futures Trust<sup>4</sup> on behalf of the Scottish Government.

Former Economy Secretary, Kate Forbes MSP, said:

“

**“The Scottish Government is helping more residents and workers get online and tackling some of Scotland’s longest standing mobile phone signal black spots.**

**The availability of 4G services has proven transformational for members of these communities, who have taken advantage of new connectivity to enhance how they work, communicate with friends and family, access public services, purchase products and services and consume entertainment.**

**The Scottish Government wants to build on that, through our National Strategy for Economic Transformation, to capitalise on the ability of enhanced digital connectivity to encourage innovation and growth. We will all need to work together to create a more prosperous, fairer, and more sustainable nation.”**

”

This paper is interested in the level to which the Polbain mast has delivered against the key Government ambition, and whether the output of this small study represents a bellwether for other communities that are now served by a S4GI site. Similarly, it could act as an early indicator of what can be expected from the UK Government Shared Rural<sup>5</sup> Network (SRN) programme.

## Methodology

FarrPoint has many years of experience and understanding of working with rural communities and the challenges they face with connectivity. We used this knowledge combined with our expertise in mobile technology and economic project assessments in our approach as follows:

### Survey

A survey and interview stage was conducted in October of 2021, in advance of the Polbain mast delivering service. FarrPoint conducted a small interview with members of the communities likely to benefit from the new mast site at Polbain. This was then followed up by a more in-depth interview to discuss some of the comments made by the respondents and to discuss other issues in more detail. A second survey was carried out in April 2023 approximately 12 months after the site had gone live and included respondents from the previous survey.

### Costs and Benefits

We also wanted to understand how the S4GI programme could deliver value aligned to public funding principles and so, whilst accepting that this is not a priority for the programme, we were interested in how the costs of the build would be balanced by the potential for benefits delivered to the community. In line with current UK Treasury Green Book principles, we have also included some commentary on the carbon cost of delivering service from the new Polbain mast. Economic and Carbon costs are based on assumptions and FarrPoint modelling.

<sup>3</sup> WHP Telecommunication Services

<sup>4</sup> Scottish Futures Trust

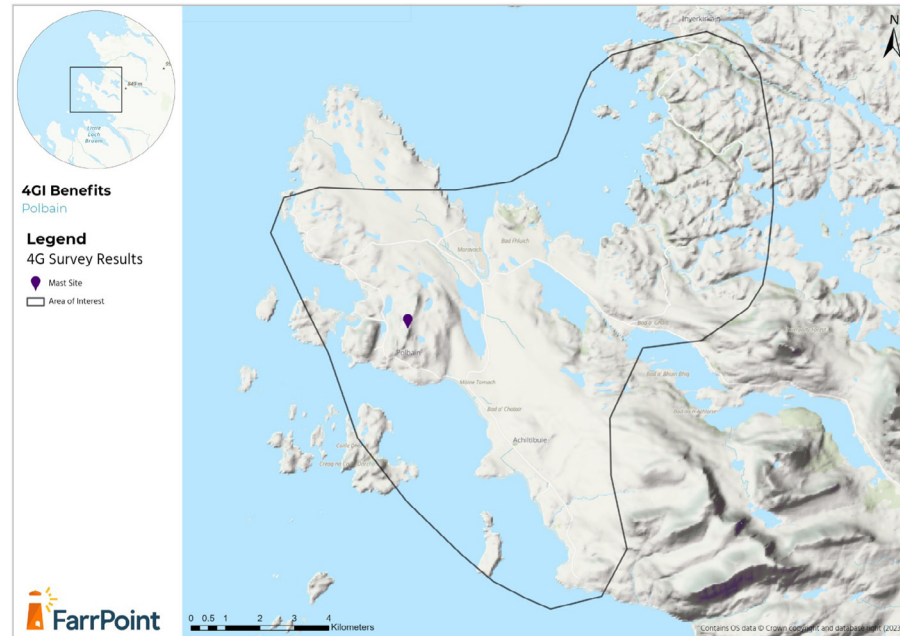
<sup>5</sup> Shared Rural Network



# Results

# Results

## The Polbain site and surrounding communities



**Figure 1 – Polbain mast site and surrounding area.**

The mast at Polbain should provide an improved 4G service to the settlements of Altandhu in the Northwest, Achnahaird in the North, Southeast through Achiltibuie, Polglass and potentially as far as Achduart and Culnacraig, and east on the road out to Ullapool. In practice there will be significant impact from the local topology interfering with the quality of 4G signal as demonstrated in **Figure 2**.

## Connectivity options

While this paper is concerned with the impact of the Polbain mast, and the 4G service it can deliver, it is also important to understand 4G within the context of connectivity options more generally.

In early 2019, before the initial survey, Ofcom statistics<sup>6</sup> show that most premises in the area with access to fixed broadband had speeds of less than 10Mbps making them eligible for improvements under the broadband universal service obligation (USO)<sup>7</sup>. By April 2023 significant improvements have been made to the availability of higher bandwidth connections to premises, although still well below the UK and Scottish averages with little to no broadband available at ultrafast+ speeds and the majority receiving speeds under 30Mbps. Broadband is delivered to premises in the communities by fixed (wired) broadband connections from BT and fixed wireless access from Highland Community Broadband<sup>8</sup> who deliver in-home/business broadband services to premises in the communities served by the Polbain mast as well as the surrounding area.

The provision of good mobile broadband access is therefore more significant to this type of community compared to one already well served by other connectivity options.

<sup>6</sup> Source: Connected Nations and infrastructure reports - Ofcom

<sup>7</sup> More details: Your right to request a decent broadband service: Ofcom

<sup>8</sup> More details: Highland Community Broadband



## Impact of the Polbain mast

The S4GI programme identified that the mast at the Polbain site would improve 4G services to the communities in, and visitors to, the region. The mast became operational in November 2021.

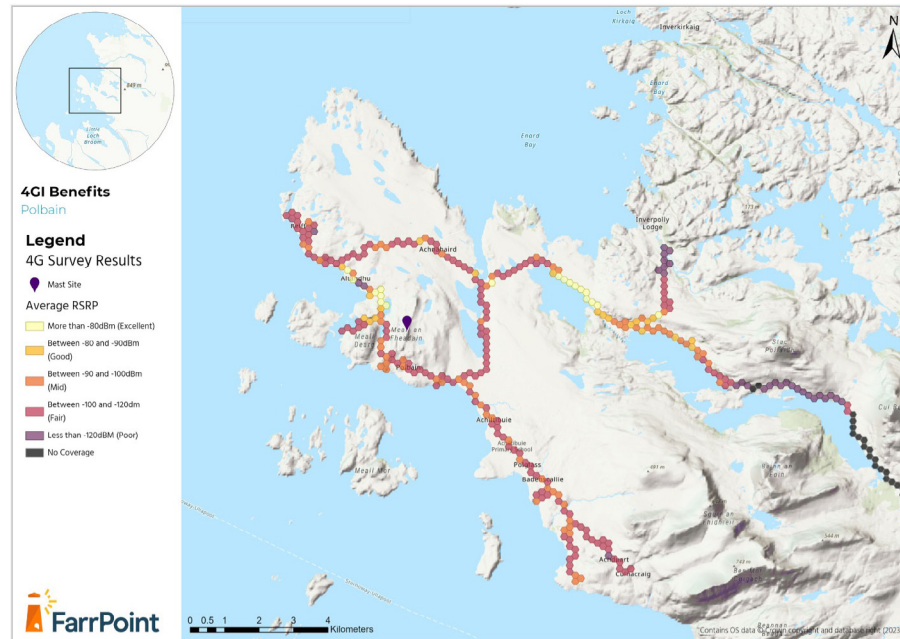


Figure 2 - Signal quality and strength. Source: FarrPoint survey

A technical survey conducted by FarrPoint, illustrated in **Figure 2**, shows the signal strength and availability of 4G resulting from the Polbain mast site. It is clear from the results that, as expected, the local topology has a significant impact on the availability of a good quality signal. Whilst the result of this technical survey creates a clear picture of where signal quality is good, it does not record the direct impact on the residents and businesses in the area.

## Results before the new mast

From the community survey results conducted **before** the Polbain mast went live:

**77%** of respondents classified their mobile connectivity as poor or very poor.

**8%** of respondents classified their mobile connectivity as good or very good.

**15%** were broadly satisfied with service but noted limitations and the need to be adaptable (moving to spaces in the garden with a better signal etc).

The split between the mobile network subscribers was as follows

EE	30%
O2	37%
Vodafone	30%
Three	0%

\*4% of respondents did not have a mobile phone.

## Results after the new mast installation

From the community survey results, conducted **after** the Polbain mast went live:

**35%** of respondents classified their mobile connectivity as poor or very poor.

**35%** of respondents classified their mobile connectivity as good or very good.

**30%** were broadly satisfied with their 4G service

The split between the mobile networks, as may have been expected, changed as follows:

EE	60%
O2	15%
Vodafone	20%
Three	5%

There was also a small subgroup who responded to both survey requests. For this group the results are equally interesting:

**22%** changed provider, although not all to EE, the only current provider on the Polbain mast.

**33%** said service had improved from one survey to the next,

**45%** felt the service was broadly similar, and

**22%** felt service had got worse. Curiously for this group of respondents the change in service quality is also aligned to a change in mobile service provider.



<sup>3</sup> WHP Telecommunication Services

<sup>4</sup> Scottish Futures Trust

## Comments and reaction of local communities

One of the main themes that came out of the first survey was a lack of confidence in the 4G service. Whilst most of us take for granted that a mobile phone in our pockets represents access to calls and data, this is not the case for all. Communication had become something that needed to be planned, with members of the community needing to consider where they will be and how their location will impact their ability to communicate. 'Waiting in the home' for a call was still common, whereas that concept is mostly outdated for the majority of the UK.

Similarly, security when purchasing goods or accessing bank accounts can often require a second form of communication. Two-factor authentication, where synchronous contact is required to validate a transaction, either via a text message, a call on a mobile, or to send some form of contact over broadband has become a means of limiting fraudulent use of banks and personal details. During the original survey this came out as an issue for residents who cannot receive text messages in the home while using domestic broadband services to access banks or consumer websites. Again, this is something that is taken for granted for the majority of residents across the UK and is assumed to be available by banks and retail channels who use this as part of their validation and checking services.

A common theme was also one of the surprise visitors have when they move into and around the region. Given how normal it has become to have at least a reasonable 4G service, tourists and other visitors to the region were often said to be surprised by the lack of 4G coverage. This was most acute in public sites for example car parks and camp sites.



**"Before the mast went live, I used to have various problems with dropping mobile connection when out and about but since the mast has been turned on connectivity is vastly improved and I am pretty much assured of being able to keep up with business communications when away from the house. Life is easier!"**



**ALISON SINCLAIR  
LOCAL RESIDENT**



“Now that just about all of us have mobile phones - we want to be able to use them! For many years lack of signal and difficulties with connectivity has been really inconvenient and in some cases a safety issue. Between us and Ullapool is 15 miles of single track road through remote and mountainous terrain and until recently a mobile black spot. If you had an accident or problem there you couldn't call help - I have rescued several tourists over the years, marooned by a puncture and faced with the prospect of walking miles to find a signal.

Even at home the phone signal was poor - I have missed various important calls from the GP and the bank to name but two, only to receive a voice message that took over 24 hours to get here!

I'm pleased to say the new mast has made a massive difference - I can call people and they can call me! And while the actual surface of the single track road hasn't improved much itself, the vastly improved signal means we can all summon help with the inevitable punctures. Living in a remote area it's vital that we can reach the rest of the world via our phones. I'm using mine a lot more now - staying in touch and not feeling as isolated as I did before.”

**JULIA CAMPBELL**  
LOCAL RESIDENT



## Financial build costs

As this is an independent study, and all financial reporting is yet to conclude for the programme as a whole, there is limited public data available. As a result, from a cost perspective, the cost of the programme has been divided by the number of assets (mobile masts) to create an average cost per site.

Total programme cost<sup>9</sup> is **£28.75m** shared across 55 planned sites.

Average cost per site: **£522,727**

## Environmental build costs

From previous work undertaken for the Scottish Government, FarrPoint worked alongside SFT to better understand the greenhouse gas emissions (GHGe) of digital infrastructure programmes such as the S4GI programme. Using this same methodology, the assumed GHGe cost of the Polbain mast site has been estimated as **9 tonnes of CO2e**<sup>10</sup>. This value is derived from:

- Civils
- Production of concrete bases
- Cost of towers and equipment
- Costs for backhaul
- Contribution for the transfer of workers and equipment to site
- A contribution to ongoing operation and maintenance

## Summary of costs

Polbain site cost: **£522,727**

Polbain GHGe cost: **9 tCO2e**

<sup>10</sup> Value based on FarrPoint modelling and discussion with the S4GI programme.

<sup>11</sup> RBD0025 - Evidence on Rural broadband and digital only services (parliament.uk)

<sup>12</sup> Source: Superfast Broadband Programme – State aid Evaluation Report 2020 (January 2021), DCMS

## Benefits

### Socio-Economic

As part of the business case justification for the S4GI programme, a number of reports and studies were used to demonstrate the value and impact of digital services for rural communities. Whilst some of the data is outdated, to retain a degree of consistency a decision was made to use them as part of the benefits profile for this paper.

The benefit of good quality digital communication infrastructure to the rural economy is estimated to be<sup>11</sup> c.£4.6 billion. Some 22% of premises are based in rural communities which accounts to just over 5.7 million premises. As a result on a per premise basis the value of good quality digital communication infrastructure can be assumed to be £804 per premise per annum of which over £422 per premise could be attributed to wellbeing impacts<sup>12</sup> taken from alongside the UK Governments own wellbeing metrics of c.£222 per person per annum.

This is based on a subjective wellbeing analysis undertaken as part of the evaluation of the Superfast Broadband programme. Whilst the analysis focuses on the impact of superfast connectivity, it can be used as a proxy for enabling an uplift in residents' wellbeing due to improved digital connectivity. The use of subjective wellbeing (SWB) to measure and value impact in the telecommunications industry reflects the increasing importance of this approach in policy making and is not limited to simply attempting to create a model that has a simple return on investment (ROI) profile. This econometric analysis indicates that access to superfast broadband is associated with an increase in wellbeing, measured as life satisfaction, even when controlling for other key determinants of wellbeing (including but not limited to earnings, age, education, ethnicity, employment, population density).

To further establish a view of benefits, it was also considered that there would be some limitation in service take up and incremental benefit based on albeit lower speed fixed broadband availability

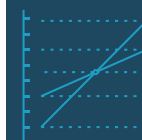
to the communities served from the new mast at Polbain and the change in quality perceived by the survey respondents. For the purpose of this paper, and using the direct response from the resident surveys, a factor of 43%, a figure that represents the proportion of respondents who have benefited from the new mast, has been used to determine the proportion of direct beneficiaries of the Polbain mast. This adjusts the benefit profile in line with responses received.

As a result, the year one benefit of the Polbain mast is modelled to be £86,000 (based on the number of premises benefiting from the mast - 43% of total - multiplied by the benefit value per premise) against a cost of £522,727. In order to establish a break even point, discounting and persistence factors consistent with UK treasury modelling have been used. When applied to the year one benefit, the break-even point, that is when the value of benefits are equal to or greater than the cost of the Polbain mast, occurs in year 15. A 15-year return is wholly consistent with major UK Government digital infrastructure investment and on these terms alone the investment would be seen to be economically viable and a positive use of public funds.

**£86,000**  
ANNUAL SOCIO-  
ECONOMIC BENEFIT  
OF POLBAIN MAST



POLBAIN MAST  
HAS A SOCIO-  
ECONOMIC BREAK  
EVEN POINT OF  
**15 YEARS**



**£804** PER PREMISE  
IN BENEFIT FROM GOOD  
QUALITY DIGITAL  
INFRASTRUCTURE



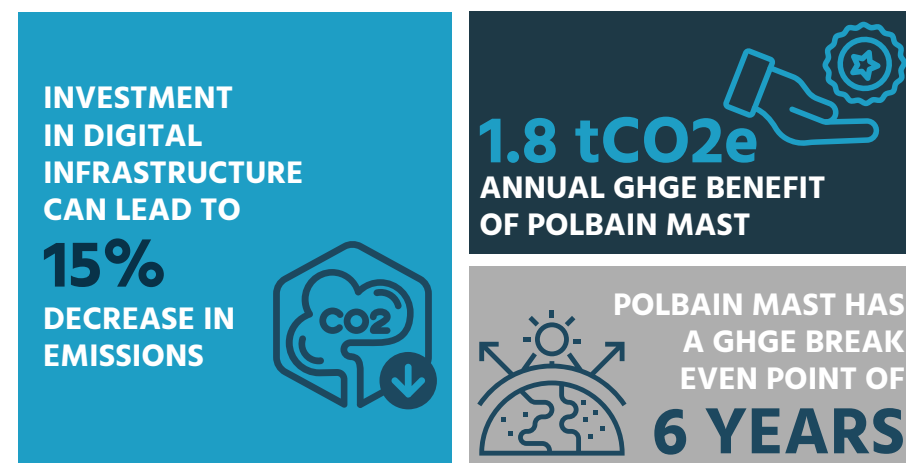
## Environmental

From follow up interviews it was clear that there were a number of opportunities to reduce GHGe with better connectivity. Most of the examples given were concerned with journeys – including journeys simply to be in an area with available mobile signals. Such examples included crofters in need of veterinary services having to drive a number of miles simply to make a call. There are also the more standard social and consumer-based impacts that communications infrastructure can bring to individuals and communities and the efficiencies they can drive in logistics etc. Modelling emissions costs and benefits does not have the historic rigour of pure economic modelling and a number of approaches could be taken, all of which will have some validity and some issues. For the purpose of this paper, benchmarking statistics have been taken from Scottish Government statistics<sup>13</sup>, and all modelling is taken from FarrPoint's own in-house GHGe modelling.

To create a simple cost benefit analysis for GHGe, a number of assumptions have been made:

- Of the large sectoral emissions, only Domestic Transport and Residential emissions have been included as areas where benefit could be derived from digital infrastructure.
- Of the reports that claim GHGe reductions as a result of digital infrastructure, this paper makes use of the lower metric of 15% in line with the World Economic Forum<sup>14</sup> rather than the 20% claimed by the Global e-Sustainability Initiative (GeSI)<sup>15</sup>
- Finally, to ensure that the benefit is derived from the use of the 4G service, rather than from the use of 'digital' overall, a factor of 1.25% has been used to reflect the proportion of data over 4G versus fixed and other broadband solutions<sup>16</sup>.

The GHGe cost of the Polbain mast was modelled to be **9 tCO<sub>2</sub>e**. Analysis from FarrPoint has determined that the annual GHGe benefit derived from access to the 4G service delivered by the Polbain mast has the potential to save up to **1.8 tCO<sub>2</sub>e per annum** ensuring that a GHGe benefit will be accrued from the end of year 6.



<sup>13</sup> Scottish Greenhouse Gas Statistics 2020 ([www.gov.scot](http://www.gov.scot))

<sup>14</sup> Digital technology can cut global emissions by 15%. Here's how | World Economic Forum

<sup>15</sup> GeSI

<sup>16</sup> Source: The Communications Market 2022 - Ofcom



# Conclusion

## Conclusion

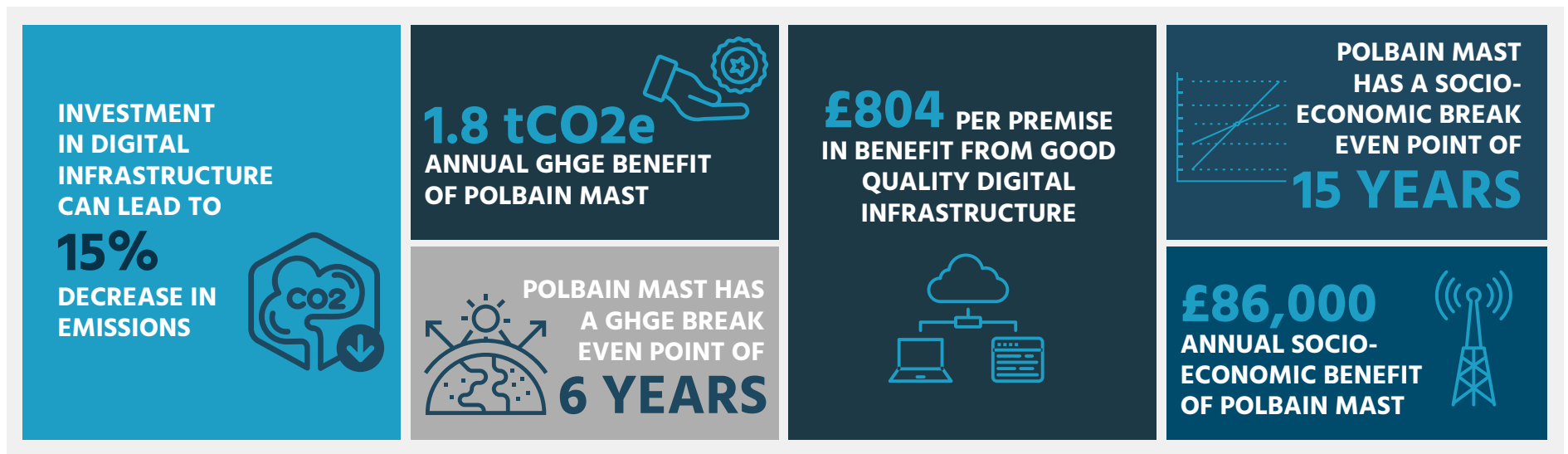
The Polbain mast has delivered a mix of results from the survey response collected by FarrPoint for this paper, but in the main the response is positive.

Satisfaction with the availability of 4G mobile services within the communities benefiting from the Polbain mast has improved significantly- **from just 8% to 35%**. The proportion who are dissatisfied with mobile services decreased by over a half - from 77% to only 35%.

However, as this paper sets out, the satisfaction of the communities is only part of the story, it is how the service is used and the wider benefits it could deliver that should also be considered – more so as this improvement in connectivity has been delivered using public funds.

Here the story is also positive. Economic benefits of the Polbain mast are sufficient to meet the required ROI of a public investment with a payback period of around 15 years, and incremental climate benefits enabling a range of actions from residents and businesses to take advantage of CO2 reduction activities that might otherwise have remained unavailable to them.

Ultimately in our rural communities, better connectivity, and connectivity at a level that should at least match the national average, should not be determined by economic and other benefits alike, but rather as it is simply the right thing to do. That the mast in Polbain has also made sound economic and ecological sense too is simply a bonus.





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