Ofcom Consultation

Review of the use of Fixed Wireless Links and Spectrum Implications

1.0 Executive Summary

The UK Energy Network Operators make significant use of fixed links for a range of mission critical operational telecommunications services to ensure the operational integrity of critical national infrastructure sector. The ENA-STG and JRC welcome the opportunity to contribute this joint response on behalf of the UK Energy Network Operators setting out current and future expectations for continued and expanding use of microwave fixed links to facilitate enhanced real time connectivity and control of the Energy Networks which in turn will facilitate 'Net Zero' transition. Terrestrial Fixed links have a unique role in the toolbox of connectivity options available to the Energy Network Operators - the properties of such links have both technical and financial characteristics which make them extremely useful for hard to reach locations – where the provision of highly available low latency communication by other means would be uneconomic and would require extremely protracted implementation timescales.

2.0 Background

The Energy Networks Association (ENA, www.energynetworks.org)

Energy Networks Association (ENA) represents the 'wires and pipes' transmission and distribution network operators for gas and electricity in the UK and Ireland. Our members control and maintain the critical national infrastructure that delivers these vital services into our homes and businesses.

ENA's overriding goals are to promote the UK and Ireland energy networks ensuring our networks are the safest, most reliable, most efficient, and sustainable in the world. We influence decision-makers on issues that are important to our members. These include:

- Regulation and the wider representation in UK, Ireland and the rest of Europe.
- Cost-efficient engineering services and related businesses for the benefit of members.
- Safety, health and environment across the gas and electricity industries.
- The development and deployment of smart technology.

As the voice of the energy networks sector ENA acts as a strategic focus and channel of communication for the industry. We promote the interests and good standing of the industry and provide a forum of discussion among company members.

The ENA-STG (Strategic Telecommunications Group) provides opportunities to exchange information and best practice in the key elements of telecommunications[1] in electricity and gas distribution networks.

The Joint Radio Company (JRC, www.jrc.co.uk)

Joint Radio Company Ltd is a wholly owned joint venture between the UK electricity and gas industries specifically created to manage the radio spectrum allocations for these industries used to support operational, safety and emergency communications.

JRC manages blocks of VHF and UHF spectrum for Private Business Radio applications, telemetry & telecontrol services and network operations. JRC created and manages a national cellular plan for co-ordinating frequency assignments for several large radio networks in the UK.

The VHF and UHF frequency allocations managed by JRC support telecommunications networks to keep the electricity and gas industries in touch with their field engineers and remote assets. These networks provide comprehensive geographical coverage to support installation, maintenance, operation and repair of plant in all weather conditions on 24 hour/365 days per year basis.

[1] Operational telecommunications – Energy Networks Association (ENA)

JRC's Scanning Telemetry Service is used by radio based Supervisory Control And Data Acquisition (SCADA) networks which control and monitor safety critical gas and electricity industry plant and equipment throughout the country. These networks provide resilient and reliable communications at all times to unmanned sites and plant in remote locations to maintain the integrity of the UK's energy generation, transmission and distribution.

JRC also manages microwave fixed link and satellite licences on behalf of the utility sector.

JRC supports the European Utility Telecommunications Council's Radio Spectrum Group, and participates in other global utility telecom organisations. JRC participates in European Telecommunications Standards Institute (ETSI) working groups developing new radio standards, and European telecommunications regulatory groups and workshops.

JRC works with the Energy Networks Association's Future Energy Networks Groups assessing ICT implications of Smart Networks, Smart Grids & Smart Meters, is an active member of the Energy Networks Association Strategic Telecoms Group and is an acknowledged knowledge source for cyber-security in respect of radio networks.

3.0 Fixed Links in an Energy Network Operator Context

Fixed (Microwave) links have been utilised for many decades in order to provide backbone transmission capability to support existing, application specific networks such as SCADA, Scanning Telemetry and push to talk voice. Increasingly, as these multiple applications convene in the IP domain, increases in backhaul bandwidth requirements are essential. So too is the number of links required, as connectivity is required to push further and further towards the periphery of the energy networks. As noted in other dialogue with Ofcom, JRC & ENA-STG are striving to gain access to additional dedicated radio spectrum to allow the deployment of an LTE based smart grid connectivity FAN (Field Area Network)[2]. The eventual deployment of such a network will require the introduction of more fixed links in order to provide backhaul from the RAN back to the core.

The obligations placed upon energy utilities by Ofgem require extremely high availability of services to end users (average power outage direction for 2023 in the UK is 32 minutes – 99.994 % availability). Similar high availability levels are a key design criterion for the communications networks and operational telecommunications systems which are used to monitor and control the assets making up the UK's energy networks.

Such high system availability is generally achieved by using a combination of multiple microwave links (n +1) or hybrid microwave and fibre delivery with automated 'hot-standby' configurations to allow seamless switching between two paths. Individual microwave links are protected from power outages by a combination of generators and battery backup systems for a minimum period of 96 hours. Individual microwave links will typically be designed with a path availability of 99.999%. This means that when considering appropriate frequency bands to be used in such a network, bands below 18 GHz are the most likely to satisfy the propagation availability (influenced by rain, sleet, snow, gaseous absorption and atmospheric effects) as defined in ITU R P 530. High operational availability is also considered when deploying the fixed links through the provision of power autonomy to the equipment of up to 96 hours to address the regulatory obligations imposed on the Energy Network Operators by Ofgem. To this end it is imperative that the Energy Network Operators have appropriate spectrum access to allow this capability to be deployed recent evidence from Ofcom[3] demonstrates that Public / Commercial networks are not capable of offering this level of power autonomy.

Typical path lengths for Energy Network fixed links range from 4km to 50 km. As can be observed in the specific attenuation charts on the next page, once above approximately 20 GHz, the attenuation figures are so high that it is not possible to achieve an acceptable availability at the typical path lengths which are deployed.

[2] Call for Input: Potential spectrum bands to support utilities sector transformation https://www.ofcom.org.uk/consultations-and-statements/category-1/potential-spectrum-bands-to-support-utilities

[3] Consultation: Resilience guidance, https://www.ofcom.org.uk/consultations-and-statements/category-1/resilience-guidance

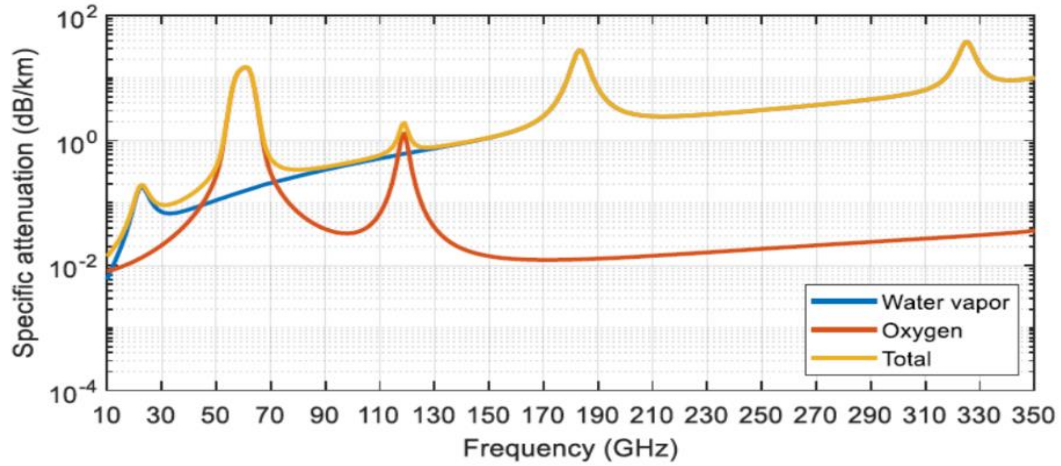

Figure 1: Increasing water & gaseous attenuation vs frequency affecting millimetre wave fixed links

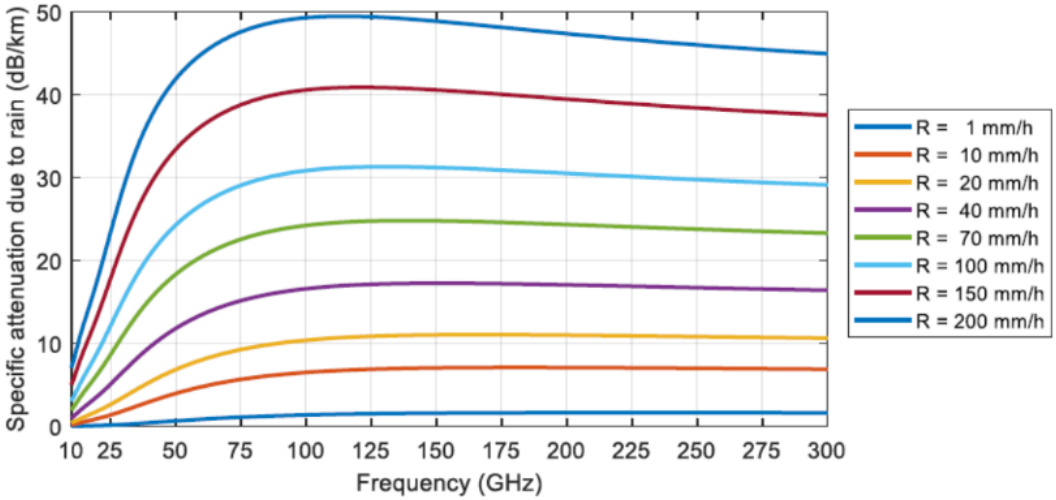

Figure 2: Specific attenuation due to rain according to Recommendation ITU-R P.838-3

4.0 Detailed Responses to Questions

Q 1. Please provide a description of your current use of fixed links (or indicate which of the use types in Table 3.1 best describe your user type)

Q 1. Response

Confidential? No.

The Energy Network Operators primarily utilise fixed links as backhaul from hilltop and rooftop locations to transport SCADA and mission critical voice services from a range of distributed energy infrastructure back to regional control centres in order to facilitate the real time monitoring and control of the UK's energy infrastructure (i.e. mission critical operational Telecoms of Critical National Infrastructure). There are also instances of fixed links being used to connect directly to some large primary substation for the purposed of diversity and / or teleprotection services (an extremely low latency application without which electricity networks cannot operate safely)

IEC 61850 international standard for latency requirements in Operational Telecommunications (OT) networks supporting electricity distribution[4]

TABLE 1: MESSAGE TYPE AND PERFORMANCE CLASS FROM IEC 61850 [5]

Performance class	Requirement description	Transfer time		Application
		Class	ms	
P1	The total transmission time shall be below the order of a quarter of a cycle (5ms for 50Hz, 4ms for 60Hz).	TT6	≤ 3	Trips, blockings
P2	The total transmission time shall be in the order of half a cycle (10ms for 50Hz, 8ms for 60Hz).	TT5	≤ 10	Releases, status changes
P3	The total transmission time shall be of the order of one cycle (20ms for 50Hz, 17ms for 60Hz).	TT4	≤ 20	Fast automatic interactions
P4	The transfer time for automation functions is less demanding than protection type messages (trip, block, release, critical status change) but more demanding than operator actions	TT3	≤ 100	Slow automatic interactions
P5	The total transmission time shall be half the operator response time of ≥ 1s regarding event and response (bidirectional)	TT2	≤ 500	Operator commands
P6	The total transmission time shall be in line with the operator response time of ≥ 1s regarding unidirectional events	TT1	≤ 1000	Events, alarms

[4] https://webstore.iec.ch/publication/75090

Q 2. What are the factors driving your choice of fixed links over alternative connectivity solutions, and which factors have the biggest impact on your decisions? Is this likely to change in the next 5 years? If so, what do you expect will change?

Q 2. Response

Confidential? No.

There are four prime factors driving the use of fixed links versus other connection solutions –

- *High availability of services (99.999x %) which cannot be provided by commercially available fixed or mobile operators*
- *Diversity as part of a two-legged connection architecture in parallel with either another fixed link or fibre optic connections*
- *Speed to deploy compared with fibre optic deployments over long distances especially in rural areas*
- *Cost (total cost of ownership) i.e. Capex vs Opex and the impact on the bills paid by energy customers.*

The criteria (weighting) of each of the four items above varies depending upon the site to be connected and the importance / criticality of the operational control of the energy network assets being connected to the overall performance / integrity of the energy network.

Q 3. **Question 3:** Is the current spectrum available for fixed links in the UK suitable and sufficient for your needs? If not, what would you change and why? If you believe changes are required, please give specific examples and reasons along with supporting evidence if available.

Q 3. Response

Confidential? No.

Fixed links spectrum at the moment is only just sufficient for current needs of the energy utilities sector. At a time when the communications requirements of the utilities sector are significantly increasing, it is challenging to have had the 26 GHz band removed / excluded, as well as 1.4 GHz and now also a question mark over the future of 6 GHz. As indicated in previous JRC responses concerning 6 GHz & 26 GHz, there is the potential scenario of Ofcom displacing incumbent users from these bands without certainty that widespread use of an alternate application will transpire – leading to a regulatory failure.

The energy network operators are unable to commit investment to fixed links in frequency bands which may be considered for other applications, i.e. IMT at relatively short notice (the Energy Network Operators will typically operate a fixed link for 10 – 20 years). Whilst the Energy Network Operators have recently secured access to the 10.5 GHz band to ensure security of access and flexibility of deployment, some additional spectrum in this band (possibly via MOD) would be extremely useful to make the band more usable (the current 2 x 20 MHz allocation does not fit with industry standard ETSI channel raster of n 7MHz) this could be enabled through the Public Sector Spectrum Release programme which has stalled.

Q 4. **Question 4:** Is there anything about Ofcom's current framework for authorising fixed links which you consider could be improved?

Q 4. Response

Confidential? No.

The day to day framework for authorising fixed links is adequate – although there are some instances of unexplained delays to applications being processed and technical details being incorrect. The principal challenge now being encountered is associated with the lack of available channels in the reduced number of suitable frequency bands to address the exacting needs of the Energy Network operators. As noted elsewhere, comparatively high TX powers are required by the Energy Network Operators to achieve 99.999x% availability – there are increasingly fewer channels of suitable bandwidth (28 or 56 MHz) in the remaining millimetre bands to accommodate such links. In addition, we encourage Ofcom to maintain proactive involvement in any new propagation modelling activity to address the impact of climate change on precipitation models.

Q 5. How has your use of fixed links changed between 2016 and now? Please provide information on:

- Reason for increase or decrease in the number of your links since 2016;
- Changes in the capacity of your links since 2016; including how you have ; delivered this capacity change, e.g., different channel bandwidths, different link technology (please specify), etc.

Q 5. Response

Confidential? No.

There has been an increase in the number of fixed links used by the Energy Network Operators since 2016. This is primarily due to the implementation of enhanced digital connectivity required to facilitate the UK's net zero targets. This requires greater visibility of devices connected at the periphery of the network – which are most cost effectively supported by fixed links. In addition to the general trend of more fixed links driven by a requirement for greater connectivity, other drivers include

- *Higher bandwidth links required as part of the continued migration from legacy PDH / SDH technology to all IP / Ethernet services (a typical increase in throughput from 4 x MB/s to n x 100 Mb/s accompanied by a 7MHz to 28 MHz RF channel bandwidth requirement);*
- *Requirement for additional resilience at some sites greater than that possible by using a single fibre or microwave link;*

Q 6. How do you expect your usage to change over the next 5 – 10 years? Please provide information on:

- any increase / decrease in the number of links (by band) and bandwidth expected;
- likely changes in geographic distribution of links;
- likely changes in distribution of links by frequency band;
- likely changes in capacity of links and how you expect to deliver this capacity;
- other changes not covered above.

Q 6. Response

Confidential? No.

- *The largest increase in fixed links usage is likely to be in the bands below 20 GHz i.e. 18, 15, 13 10.5 and 7.5 GHz. This is due to the suitability of these frequency bands to support the required path lengths typical of the Energy Network Operators whilst simultaneously providing a high degree of link availability (rain fade / atmospheric fade) with antenna sizes that can be accommodated on existing site infrastructure. The typical increase in data throughput is associated with the migration from legacy PDH (8 or 34 Mb/s) to 100 Mb/s or other fractional Gig E speeds;*
- *The distribution of links is likely to continue to be UK wide with a bias towards rural and deep-rural areas to support existing systems / technologies;*
- *Frequency bands employed in given regions will be partially dictated by suitability to support long path length but also by availability of suitable frequency bands. i.e. the Energy Network Operators typically use the highest frequency band which is technically suitable for the bandwidth and availability but if there is no channel availability then a lower band may be employed.*
- *Higher capacity links are likely to be achieved by a combination of wider RF channels, more advanced modulation schemes and possibly employment of XPIC technology.*
- *The ongoing migration of links away from 1.4GHz and 26 GHz will also act as a driver towards alternative frequency bands.*
- *Enabling the 'Net Zero' transition; A fundamental change to operational design and architecture of the energy networks, from a centralised model to a distributed model, will be the prime driver for a significant increase in the number of fixed links and hence future fixed links spectrum needs of the Energy Network Operators – largely driven by the anticipated deployment of a Private LTE network for enhanced operational control. Noting Ofcom's recent work to establish spectrum options for such a solution[5].*

Q 7. Which of the developments listed above are expected to have the biggest impact on your use of fixed links? Are there other developments to be aware of that have not been listed? Please explain the reasons for your answer.

Q 7. Response

Confidential? No.

The anticipated allocation of dedicated spectrum for a private LTE network will be the single largest element to the increase in the number of fixed links from a backhaul perspective. Several thousand additional links will be required with a minimum capacity of 100 Mb/s per link (possibly n x 100 MB/s) It is anticipated that the topology / architecture to be deployed in the backhaul layer will comprise rings of microwave links terminating at fibre connected core sites.

Q 7a Are you considering using NGSO satellites to provide backhaul for your network? If so, please provide details of capacity requirements / expectations and the locations where delivery of this type of backhaul would be likely.

Q 7a. Response

Confidential? No.

[5] Call for Input: Potential spectrum bands to support utilities sector transformation https://www.ofcom.org.uk/consultations-and-statements/category-1/potential-spectrum-bands-to-support-utilities

At the present time the energy network operators are not considering NGSO solutions as backhaul. The technology remains immature / unstable[6] and there is no certainty around its suitability for use in critical national infrastructure applications from either a technical, commercial or geo-political perspective.

Q 8 If you already use alternative transport solutions for delivering your services, please :

Provide an indication of the proportion of your services delivered over fixed links vs each alternative that you currently use. Is this proportion likely to change over the next 5 – 10 years? If so please provide details;

Explain how your business rationale for use of fixed links vs alternative connectivity solutions is changing over time ;

If possible, provide examples of your decision-making process for recently deployed connections.

Q 8. Response

Confidential? No.

The Energy Network Operators(ENOs) use a combination of private, self-owned fibre connectivity, 3rd party fibre connectivity and privately operated fixed links. The major requirement for new connectivity is expected to be in areas which are unlikely to be cost effectively served by further private or publicly funded fibre optic connectivity (the exception to this would be the relatively infrequent addition of new overhead or underground power lines – where the incremental cost of installing a new fibre optic cable is very small). As a result, the ENOs would expect a large proportion of the connectivity to embedded / distributed energy network assets to be dependent upon fixed links, either directly or by a private LTE network whose backhaul would be reliant on those fixed links. In the case or a small number of large network sites (primary substations for instance) there would be potential for a dedicated microwave link to serve just that site. In the case of the largest number of distributed assets, these would be connected by an LTE network with the local serving base station being connected to the core network by microwave link. In addition, and as has been noted in section 3.0 the operational integrity of the energy networks is dependent on the deployment of fixed links with power autonomy of up to 96hrs to ensure that the Energy Networks are able to deliver against their regulatory obligations – noting that Ofcom's analysis[7] demonstrates the Public / Commercial networks are not capable of such levels of power autonomy.

Q 9 Which of the listed technologies are you already using or do you plan to use in the future? For each that you are using / plan to use, please explain: - the current extent of your use, whether you expect to expand or shrink your use over the next 5 – 10 years, and how availability of these capabilities might impact your choice to deploy fixed links vs an alternative.

Estimates of numbers or percentage of links deployed with each capability now and in the future would be valuable. We are particularly interest in feedback on future use of BCA.

[6] Tax Payer Loss on OneWeb Satellite Deal hits £200m, Telegraph, 26 December 2023, https://digitaleditions.telegraph.co.uk/data/1566/reader/reader.html?#!preferred/0/package/1566/pub/1566/page/87/article/NaN

[7] Consultation: Resilience guidance, https://www.ofcom.org.uk/consultations-and-statements/category-1/resilience-guidance

Q 9. Response

Confidential? No.

The Energy Network Operators are utilising XPIC and relatively high modulation (128 and 256 QAM). Many of the other solutions such as ACM, ATPC, W, D and E band and BCA do not necessarily fit with the operational requirements of the energy network operators due to specific performance criteria, i.e. extremely high availability, long path lengths and long duration product life cycles.

We recognise that BCA, W & D bands etc may be very useful for consumer grade 'reasonable efforts' connectivity but they are not aligned with the mandatory operational requirements of the energy network operators.

Q 9a If you plan to us BCA would you plan to use this primarily for new links, upgrades to existing links or a mix? What factors affect your decision to deploy (or not deploy) BCA today? Please provide whatever detail you can.

Q 9a. Response

Confidential? No.

As noted above the dynamic nature of BCA and the risk of instability resulting from the failure of different carriers at different times due to changes to propagation conditions would not be compatible with the operational requirements of the energy network operators.

.Q 10 Do you have a need for W and D bands for fixed links use (or alternative uses) ? If so, in what timescales? Please provide further details, including any evidence you have to support your response.

Q 10. Response

Confidential? No.

Due to the short range capability (<2 km) of W & D bands, they do not lend themselves to the typical link distances most frequently required by energy network operators in the UK. The exception being where short, high bandwidth links are deployed locally on an operational site to connect assets.

Q 11 Do you expect to apply for new fixed links in the upper 6GHz band in the future, and if so in which geographical areas? What are the reasons for choosing this band over other available bands or alternative technologies? Is there are technical reason why you would choose the upper 6GHz band?

Q 11. Response

Confidential? No.

The Energy Network Operators have historically tried to avoid use of the 6GHz band due to the relatively small amount of hardware choice available, large antennas and small number of channels available. Typically the Energy Network Operators would only choose to use 6GHz (Lower or Upper) when channel availability in 13 GHz or 7.5 GHz was an issue due to lack of channels or a TX Hi Lo clash. Moreover, the uncertainty over the future of U6 GHz (for IMT or Wifi use) is a further disincentive to Energy Network Operators to deploy in the U 6 GHz,

although it may be necessary as a last resort to deploy a small number of fixed links where no other options are available.

Q 12 Are there other international developments that you are aware of that could affect availability and utility of fixed links in the next 5 – 10 years?

Q 12. Response

Confidential? No.

Specifically, JRC & ENA-STG encourage Ofcom to track global developments around Europe on smart grid evolution and its relevance to achieving the UN's net zero objectives. Enhanced Operational Telecommunications capability and specifically private LTE deployments are a major enabler of the European Energy Network Operator capability particularly in Ireland, Poland, Germany and Spain. The recently published ITU report contains significant additional and relevant information in this context. https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2533-2023-PDF-E.pdf

There are also significant developments connected with future 5G and 6G capabilities for the utility sector which are underway withing 3GPP.

Additionally, JRC & ENA-STG are aware of new agenda items proposed at WRC 23 for inclusion at the next WRC (27) exploring the potential for the introduction of IMT systems in two additional fixed link frequency bands (7.5 and 15GHz bands) which would significantly impact incumbent users. These two bands are used extensively by the Energy Network Operators and would lead to a reduction in the relevant bands available within the context of increased need for fixed link spectrum from the sector to deliver the 'Net Zero' transition.