IB1 Icebreaker One

Project NIMBUS
Network Innovation and Meteorology to BUild for Sustainability

Alpha Phase
Data accessibility and interoperability report

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Executive summary

NIMBUS (Network Innovation and Meteorology to BUild for Sustainability), a partnership between [SSEN Transmission](#), [Palantir](#), [Icebreaker One](#) and [IBM](#), is an ambitious project seeking to prolong the life of energy assets by using granular meteorological (weather) data to enable improvements to network asset design, investment and operations.

NIMBUS demonstrates how the use of meteorological data can facilitate the development and adoption of a more precise and reliable risk-based methodology for evaluating asset conditions, offering significant improvements over existing approaches. Enhanced forecasting of asset and component degradation produces tailored insights into the condition of energy assets. This enables asset inspection cycles to be planned around the specific risks associated with each asset, accounting for its characteristics, geography and exposure to weather patterns.

NIMBUS contributes to accelerating the Net Zero transition by optimising the lifespan of the existing energy asset base, reducing carbon emissions from asset manufacturing, installation and repair and freeing up capital for investment in the green transition. By reducing costs and improving operational efficiency, it also benefits asset owners. NIMBUS further enables more granular assessment of probability of failure, enabling predictive component and asset replacement and improving resilience which benefits stakeholders, customers, consumers and users of the transmission network.

During the Alpha Phase of NIMBUS (October 2023 - March 2024), NIMBUS partners addressed two core goals:

1. To build a Proof of Concept (PoC) integrating granular weather data into asset risk assessment methodologies.
2. To demonstrate the business value that the adjusted methodology could bring to the energy sector.

This report details the contributions made specifically by Icebreaker One during the Alpha Phase, focusing on data sharing, accessibility and interoperability. Icebreaker One explored three core areas of research: 1) reviewing the data landscape supporting NIMBUS, 2) evaluating dataset applicability to NIMBUS, and 3) convening expert input to guide the project and ensure transferability of learning to the wider energy sector and other infrastructure sectors. Research findings from Work Packages (WPs) led by Icebreaker One highlight a paucity of Open weather data in the current ecosystem, noting that this is complex to address and requires parallel improvement of transparency about data transformation processes. Findings also assess notable

barriers to publishing and discovering energy asset data in both Open and Shared forms and evidence the value of a collaborative, multi-stakeholder approach to addressing different aspects of improving data accessibility going forward. Finally, research findings emphasised the need for the development of common mechanisms to exchange Shared Data between trusted parties.

Based on the research and analysis carried out during this phase, Icebreaker One makes **five recommendations** for improving asset data sharing and data interoperability for the energy sector.

Recommendations

Recommendation 1: Align industry-wide definitions
The Energy System Operator (ESO) **must** take the lead on urgently aligning industry-wide definitions of the key concepts for climate and weather-related asset risk to ensure policy, investment and operation are aligned.

Recommendation 2: Align existing data triage processes
Ofgem, in collaboration with the energy sector, **must** continue to align existing data triage processes to a shared framework like IB1's data sensitivity classes. This will allow the sector to standardise data sensitivity classification and facilitate interoperability. This also lays the groundwork for broader data governance as part of a Trust Framework.

Recommendation 3: Co-create standards for energy asset data
The Energy Networks Association (ENA) **must** facilitate the co-design and co-creation of standards for energy asset data to unlock further innovation and reduce bottlenecks across the energy sector.

Recommendation 4: Establish cross-sector engagement for risk and resilience
The government, potentially via the National Infrastructure Commission (NIC), **should** establish and appropriately resource processes to facilitate continued cross-sector engagement on matters of asset management, specifically risk and resilience metrics, for national infrastructure.

Recommendation 5: Directly engage with end users of data
TSOs (Transmission System Operators), Transmission Owners (TOs) and DNOs (Distribution Network Operators) **should** regularly invest in engagements directly with

the end users of data and gather their feedback and suggestions for improved data sharing.

Introduction

Icebreaker One, in partnership with SSEN Transmission, IBM and Palantir, has been working on the NIMBUS (Network Innovation and Meteorology to BUild for Sustainability) project. The NIMBUS project is funded through the Strategic Innovation Fund (SIF), a programme from the UK's independent energy regulator Ofgem, managed in partnership with Innovate UK. The key aim of NIMBUS is to demonstrate how incorporating granular weather data into asset risk modelling methodologies has the potential to prolong the life of energy assets and accelerate the transition to Net Zero. Throughout this report, Icebreaker One uses the terms Open, Shared and Closed Data as defined by Icebreaker One here[1] and reproduced below.

- **Open Data** can be used by anyone for anything for free [any-to-any]
  (e.g., Creative Commons, Open Government Licence).
- **Shared Data** is data with a preemptive licence [many-to-many]
  (e.g., 'data as a service' that can be used with certain restrictions. 'Smart Data', for example, includes confidential information that can be shared with clear permission to authorised parties).
- **Closed Data** requires, if shared, a user-specific custom licence or contract for use [some-to-some or none](e.g., 'bilateral contract' for a specific project or not shared at all).

After completing Discovery in 2021, the Alpha Phase of NIMBUS was conducted from 1 October 2023 to 31 March 2024. The primary use case shaped during the Discovery Phase of NIMBUS was centred around modelling the effects of weather-related degradation to energy assets. This use case served as the foundation for a Proof of Concept (PoC) built during the Alpha Phase to demonstrate the value this would bring to organisations in the sector. Additionally, engagements with an Advisory Group composed of domain experts and project partners helped to guide further development of the use case, ensuring its relevance both to the wider energy sector and other infrastructure sectors.

Icebreaker One explored three core areas of research during Alpha Phase. Firstly, a review of the data landscape was conducted, identifying eight datasets with the potential to support the NIMBUS priority use case. Secondly, each dataset was evaluated to validate its relevance to the project. Openly published datasets were prioritised and indexed on the Open Net Zero search engine, adding value by improving dataset discoverability and accessibility for NIMBUS and beyond. Thirdly, Icebreaker

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[1] Icebreaker One, 2021.

One convened a series of Advisory Group sessions that used collaborative expert input to shape the development of NIMBUS and more deeply understand the transferability of project learning to the wider energy sector and other infrastructure sectors.

Research findings from Work Packages (WPs) led by Icebreaker One highlight a paucity of Open weather data in the current ecosystem, noting that this is complex to address and requires parallel improvement of transparency about data transformation processes. Findings also assess notable barriers to publishing and discovering energy asset data in both Open and Shared forms and evidence the value of a collaborative, multi-stakeholder approach to addressing different aspects of improving data accessibility going forward. Finally, research findings emphasise the need for the development of common mechanisms to exchange Shared Data between trusted parties.

Based on the research and analysis carried out during the Alpha Phase, Icebreaker One makes **five recommendations** for asset data sharing and data interoperability for the energy sector listed in the [Recommendations](#) section of the report.

This report is structured as follows:

- **NIMBUS primary use case** provides an overview of the primary use case developed during the Alpha Phase of NIMBUS and explains the reasons behind its selection.

- **NIMBUS Alpha Phase** provides an overview of NIMBUS Alpha Phase and a summary of the Work Packages allocated to Icebreaker One.

- **Data accessibility** provides an overview of the methods used and the findings uncovered as part of the data accessibility work carried out during the Alpha Phase.

- **Standards for data interoperability** provides an overview of the methods used and the findings uncovered as part of the data standards and interoperability work carried out during the Alpha Phase. A set of recommendations for asset data sharing and interoperability for the energy sector is also included in this section.

- **Reflection on benefits, challenges and lessons learned** provides a reflection on the key benefits, challenges and lessons learned during the Alpha Phase of the NIMBUS project.

- **Conclusion** provides a summary and final assessment of the key findings, outcomes and recommendations presented in the report.

NIMBUS primary use case

During the three-month Discovery Phase of NIMBUS in 2021, a **primary use case** was identified as follows: "Modelling weather-related degradation to Probability of Failure (PoF) for assets connecting large volumes of generation to the grid." This use case was selected because the current approaches to asset risk modelling only make use of basic weather data, which does not significantly contribute to risk assessment. To account for the effects of weather on energy assets, the use case of NIMBUS focused on proving the business value of utilising granular weather data to demonstrate its impact on asset degradation. For greater detail on the use case definition and selection processes refer to Icebreaker One's [Discovery Phase Final Report](#) (section: *Priority use case selection context and rationale*).

Asset degradation is currently modelled linearly. This is based on asset age, materials used and asset location, as well as a range of other parameters throughout their lifecycle[2]. Integrating the effects of weather into these models, however, can enhance asset longevity and provide a better basis for investment decisions concerning asset replacement and maintenance. By effectively managing risks associated with asset degradation, Transmission System Operators (TSOs), Transmission Owners (TOs) and Distribution Network Operators (DNOs) can proactively extend and maintain the lifespan of their assets, while improving their risk/return profiles and overall network resilience.

NIMBUS Alpha Phase

The Discovery, Alpha and Beta Phase approaches to project development are part of SIF's three-phase approach to supporting innovative projects:

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[2] [Icebreaker One, 2021.](#)

Figure 1: SIF three phase approach
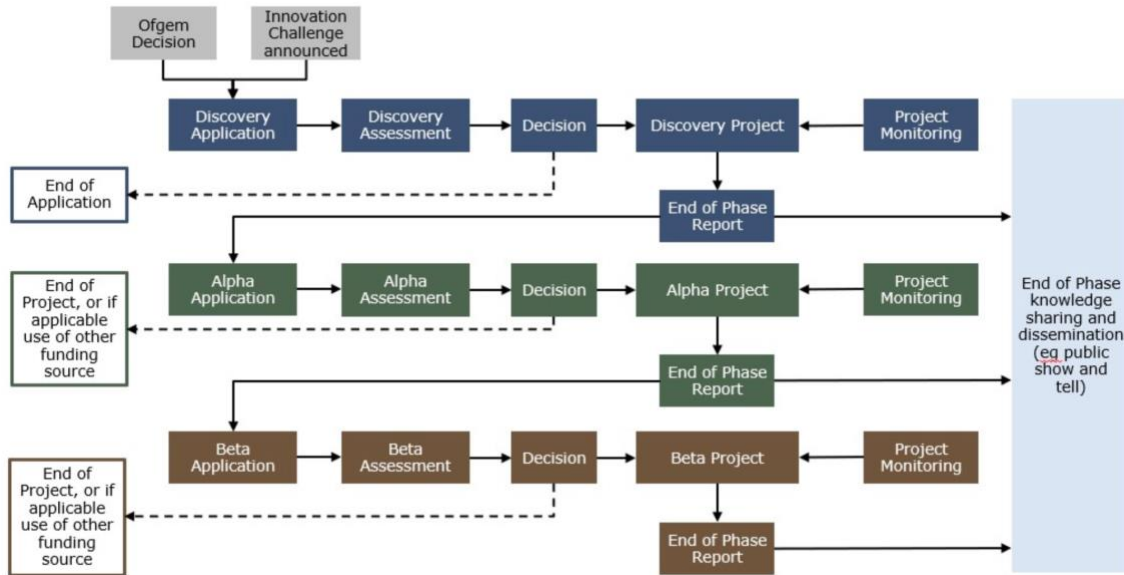
As outlined in the previous section, a primary use case was identified during the three-month Discovery Phase of NIMBUS in 2021. This use case became the foundation of further research and development of a PoC for the Alpha Phase of the project.

NIMBUS Alpha Phase was conducted from 1 October 2023 to 31 March 2024. The phase had two core aims:

1. To deepen exploration of the primary use case.
2. To establish a PoC.

Alpha Phase was structured through 10 Work Packages (WPs) outlined in the table below. Icebreaker One's role is highlighted in bold.

Work Package number	Description	Organisation responsible for delivery
WP0	Project Management	SSEN Transmission
WP1	Business objective and value	Palantir
WP2	Statement of Requirements & Architecture	Palantir
WP3	Data Assessment (Content & Availability)	SSEN Transmission

WP4	Proof of concept development (PoC)	Palantir
WP5	Lessons Learned from PoC	SSEN Transmission
WP6	**Data accessibility**	**Icebreaker One**
WP7	**Standards for interoperability**	**Icebreaker One**
WP8	Understanding benefits to consumer/customer	SSEN Transmission
WP9	High-level plan for Beta	SSEN Transmission

Table 1: NIMBUS Work Packages

The primary focus of this report is the two Work Packages led by Icebreaker One, which are examined in depth in the following sections.

Data accessibility

This Work Package (WP6) aimed to identify additional datasets holding the potential to support the NIMBUS use case and, wherever possible, increase discoverability of relevant data by indexing datasets to Open Net Zero.

Open Net Zero is a data catalogue that improves dataset discoverability by indexing them. This enables a wider community of innovators to identify and bring datasets together, for example to model complex risk or create solutions that mitigate risk. This catalogue contains over 50,000 global datasets from 400+ organisations. It provides an open-standards CKAN/DCAT data catalogue that can be easily integrated with open-standards geographical visualisation tools, such as QGIS[3].

Methods and process

Work Package 6 used desk research, stakeholder interviews and Advisory Group sessions to review the data landscape surrounding the NIMBUS priority use case. Project partners Palantir, who led the PoC build for NIMBUS Alpha phase, initially proposed to use three datasets provided by SSEN Transmission and IBM to build the PoC. Icebreaker One was tasked with supporting this build by identifying any additional datasets that could be used to advance the use case.

The datasets, proposed by Palantir, identified for the PoC build were as follows:

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[3] e.g., https://extensions.ckan.org/extension/qgis-ckan-browser/

Dataset owner	Dataset description	Open/Shared/Closed[4]
SSEN Transmission	Energy asset data containing key information about the assets and their components	Closed
SSEN Transmission	Inspection scores for each tower component	Closed
IBM	Weather data containing 34 variables that characterise the weather conditions on a 4 km x 4 km grid	Closed

Table 2: Proposed datasets for Alpha project

Building from this foundation, Icebreaker One identified eight additional datasets with the potential to support the NIMBUS use case (Table 3). Each dataset was then evaluated for suitability, relevance and openness, prioritising the identification of openly published datasets. This work prioritised the evaluation of other sources of granular weather data, preferably published with an open licence, which could be used to replicate the work done on the use case. This assessment was deemed crucial to avoid vendor lock-in and to demonstrate this work could be replicated by other organisations across the industry with similar inputs. Icebreaker One's review of the data landscape identified eight weather datasets that could support use case delivery. These are discussed in more depth in the following section - Finding 1.

In parallel to identifying suitable datasets, Icebreaker One critically analysed the process of reviewing the data landscape and key challenges in this space. The outcomes of this research are discussed across Findings 2-4 in the following section.

Findings

Finding 1: There is a lack of openly published weather datasets that are suitable for supporting the NIMBUS priority use case

Icebreaker One's research and stakeholder engagement confirmed that there is a noticeable lack of Open weather datasets available to support the NIMBUS use case.

There are two main sources of weather datasets:

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[4] [Icebreaker One, 2021.](#)

1. Dataset of standard observations - such as wind speed and direction, temperature, humidity and precipitation - published by private or public bodies (e.g., Met Office).
2. Derived data sourced from third-party vendors (e.g., IBM).

Many of the datasets available are provided by third-party vendors, who source weather data from original providers and then transform the data into formats that are useful for further analysis. These data transformation mechanisms and processes are proprietary and, therefore, cannot be easily replicated, which is an important data assurance and transparency barrier. This presents a challenge in the context of NIMBUS and other use cases. This is because the inability to understand what transformation processes the data has been through hinders transferability and makes it challenging for this work to be replicated by other organisations in the sector. Further research in this space would be highly beneficial in improving the transparency of the current weather data landscape.

Reflecting the comparative lack of Open Data, both open and proprietary weather datasets deemed relevant for the use case have been included in the summary table below. To facilitate dataset discoverability and accessibility, open datasets from this table have been added to Open Net Zero.

Dataset	Owner	Description
HadUK-Grid	Met Office	HadUK-Grid is a collection of gridded climate variables derived from the network of UK land surface observations. The data has been interpolated from meteorological station data onto a uniform grid to provide complete and consistent coverage across the UK.
MIDAS Open	Met Office	Midas-open is a subset of the fuller Met Office Integrated Data Archive System (MIDAS) Land and Marine Surface Stations Data (1853-current), containing only UK mainland land surface observations owned or operated by Met Office. Currently, this represents approximately 95% of available daily temperature and weather observations, 83% of hourly weather data and 13% of daily rainfall within the full MIDAS collection.

Climatic Research Unit (CRU) Time-Series (TS)	CRU	The gridded Climatic Research Unit (CRU) Time-series (TS) data version 4.07 data are month-by-month variations in climate over the period 1901-2022, provided on high-resolution (0.5x0.5 degree) grids.
ERA5	European Centre for Medium-Range Weather Forecasts (ECMWF)	ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate covering the period from January 1940 to the present.
UERRA	European Centre for Medium-Range Weather Forecasts (ECMWF)	The objective of UERRA is to produce ensembles of European regional meteorological reanalyses of Essential Climate Variables (ECVs) for several decades and to estimate the associated uncertainties in the data sets.
Weather API, Weather map tool, Data shop	Meteomatics	Observational data from weather stations, satellites, rainfall radar and lightning information and access to the most accurate and up-to-date weather data through 'on the fly' calculations.
E-OBS	Copernicus	Gridded observational dataset for precipitation, temperature, sea level pressure, global radiation and wind speed in Europe, including the UK.
Historical Weather API	Open-Meteo	Open-Meteo is an open-source weather API offering free access for non-commercial use. It combines reanalysis weather data from ERA5 and ERA5-Land. Both reanalyses employ weather station, aircraft, buoy, radar and satellite observations, combined with numerical weather models, to create global datasets of past weather conditions. The ERA5 reanalysis has closely integrated with the ECMWF IFS weather model for consistency over the years.

Table 3: Summary of weather datasets relevant to NIMBUS primary use case

None of the above datasets could be used in isolation to replicate the work carried out using IBM's weather data for the NIMBUS PoC. However, in publishing our findings Icebreaker One seeks to improve weather data discoverability which could support other organisations looking to integrate granular weather data into their asset risk modelling processes (e.g. by combining and further transforming these datasets in relation to other use cases).

Since the data transformation processes done by IBM on the weather data supplied for the PoC are proprietary, it was not possible to define the exact steps that should be taken to transform the data into a shape suitable for integration into an asset risk model. Going forward, however, this could be an opportunity for further research and exploration.

Finding 2: Challenges to openly publishing energy asset data suggest that the sector would benefit from developing a consistent approach to Shared Data exchange

All British (GB) energy networks currently assess whether asset data can be published openly, in accordance with Ofgem's [Data Best Practice Guidance](#)[5]. Ofgem's guidance provides processes ('open data triage') that data custodians are required to follow to assess the sensitivity of datasets before publishing them as Open Data. Practically, processes of data triage currently vary from network to network and not all networks publish their triage process and decisions as easily discoverable Open Data. Nevertheless, the open publication of the data triage processes and results (e.g., [SSEN Transmission Open Data Portal Data Triage Dataset](#)) represents progress towards increased transparency around how data publication decisions are reached. As the energy data landscape grows in future, such transparency will only increase in importance.

Within NIMBUS, many stakeholders across the energy sector, such as asset managers and operations teams, emphasised that there are challenges to publishing energy asset data as Open Data. Two particular barriers identified by data triage processes are:
1. Accounting for commercial sensitivity of asset datasets.
2. Maintaining cyber and physical security of critical infrastructure.

Accordingly, a significant portion of energy asset data can only be shared with restrictive access controls and licensing to ensure that it is shared with appropriate audiences, for permitted purposes.

While certain barriers to Open Data publishing in this sphere could potentially be challenged in light of the imperative to meet Net Zero goals, others are unlikely to change. For instance, ensuring adequate security of critical assets in response to a changing cybersecurity landscape is a key concern for the sector as digitalisation progresses and the energy data and data-sharing landscape must support this.

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[5] [Ofgem, 2023.](#)

While such rationales to restrict data access present challenges to collaborative innovation and sharing of learnings in the asset management space, there is potential to constructively address these challenges in a manner that does not require all data to be made fully Open. Icebreaker One's analysis suggests that the development of a consistent approach to exchanging Shared Data between appropriate parties in a trusted, assurable manner, accompanied by appropriate governance mechanisms to address change management and handle disputes, would hold benefits for the sector accordingly.

This suggestion aligns with ongoing work by Ofgem and other sector bodies to advance the design and implementation of a sector Data Sharing Infrastructure by 2028[6]. It also aligns with findings from the academic literature[7]. Further research is required to determine the exact form and rules of Shared Data exchange in the NIMBUS context, however we suggest should be built around three principles: 1) collaborative and open co-design between stakeholders, 2) technology build directed by sector and user needs, 3) integrated development of governance and technical components. One such approach that could be explored is the adoption of a [Trust Framework][8] and the creation of a dedicated [scheme][9], or schemes, within this.

Where appropriate, there may also be benefit in aligning approaches to Shared Data exchange across sectors (e.g. transport, water, energy, finance) as advocated by the [Smart Data Council]. An approach to Shared Data exchange offering improved consistency in cross-sectoral spaces could potentially hold particular benefit for projects such as NIMBUS, where there may be benefits to building economies of scale across sectors facing common challenges (e.g. asset management under conditions of climate change).

Finding 3: Data discovery is a necessary precursor to data use, however, it remains challenging in the absence of openly published metadata

Advisory Group members and project partners strongly identified that being able to easily discover data relevant to one's user needs is a necessary precursor to accessing and practically using the data. Data discovery is important for energy asset owners because it represents the first step in empowering organisations to learn from the data available across the sector, innovate in the digital realm and collaboratively solve

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[6] [Hayes, 2023.]
[7] E.g. [Judson, 2023.]
[8] [Icebreaker One, 2024.]
[9] [Icebreaker One, 2024.]

challenges. As outlined in the report introduction, the ability to do this effectively in areas including, but not limited to, the optimisation of asset management and investment cycles also has positive implications for accelerating the transition to Net Zero and avoiding unnecessary emissions production along the journey.

Our analysis, which is aligned with Ofgem Data Best Practice, suggests that the open publication of metadata plays a crucial role in facilitating the data end users' ability to discover and review datasets that are relevant to their needs. Accordingly, our research concludes that it is vital for data publishers to produce clear metadata that is published openly, even if the dataset itself is subject to restrictions surrounding its access and use.

Finding 4: Increasing data accessibility is complex and requires multi-stakeholder involvement across technical, regulatory and organisational domains

The complexity associated with publishing energy asset datasets as Open Data arises from the need to address diverse technical, regulatory and organisational considerations. It is a fine balance between the need for internal data triage processes required to assess datasets' suitability for publication, the dynamic nature of the data end-user needs and legislation and incentives aimed at enhancing data accessibility across the sector.

The technical complexity arises from the fact that for some TSOs, TOs and DNOs historical data beyond a certain time point is frequently stored in legacy systems, archives or paper form, which makes it difficult to make this data accessible digitally as Open Data. Regulatory considerations are enforced through legislation, which TSOs, TOs and DNOs have to comply with as part of their licence conditions. This, in turn, has to be balanced against the need to protect and secure data deemed sensitive by these organisations.

Collectively, these considerations all play a part in steering the decision-making process regarding publishing datasets as Open Data, which, as described above, is a multifaceted process. Looking to the future, further incentives to increase data accessibility and usability would benefit from assessing the stakeholder landscape prior to commencing and devising an appropriate plan for ongoing, representative engagement.

Standards for data interoperability

This Work Package (WP7) convened an Advisory Group addressing two core aims:

1. To support the energy industry to apply NIMBUS by better understanding and meeting user needs across distribution and transmission networks.
2. To generate a set of recommendations to improve data accessibility and interoperability related to the NIMBUS use case.

Methods and process

To capture a wide range of expertise and views that reflect the data sharing landscape relevant to the NIMBUS use case, recruitment for the Advisory Group focused on gathering a mixture of cross-sector stakeholders and deep domain experts. The Advisory Group had a number of objectives that centred around steering the development of the NIMBUS use case and meeting user needs across distribution network and transmission organisations. A detailed list of objectives for the group is available [here](#).[10] Meeting summaries from our Advisory Groups are published openly for transparency. Summaries from our December[11], January[12], and March[13] Advisory Groups can be found on the Icebreaker One website.

There were 18 active members of the NIMBUS Alpha Phase Advisory Group, with participation from organisations such as TYPSA, UK Power Networks, SSE, Academics from the University of Manchester and University of Birmingham, and more. Our Advisory Group members played a crucial role in shaping the development of NIMBUS by providing guidance on how any key learnings could be effectively applied within their respective organisations. They also contributed to shaping a set of sector readiness recommendations for energy asset data, which are detailed in the [following section](#) of this report.

Recruitment challenges and learning

The task of securing participation in our Advisory Group presented some difficulties. We reached out to a broad range of stakeholders spanning the fields of energy networks (DNOs, TOs and TSOs), as well as rail and telecommunications asset managers. However, despite reaching out to 50+ potential stakeholders directly – as well as outreach using our [NIMBUS landing page](#), communications channels and existing

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[10] [Icebreaker One, 2023.](#)
[11] [Icebreaker One, 2024.](#)
[12] [Icebreaker One, 2024.](#)
[13] [Icebreaker One, 2024.](#)

networks – we were unable to achieve the full diversity of participation aligning with our original aim. Participation from the rail sector in particular was limited. While our research programme aimed to address the gap through consideration of wider literature and secondary information sources, it remains an acknowledged limitation of this research report. Future research would benefit from establishing a deeper knowledge of the infrastructure sectors (e.g. rail, water, telecommunications) and how data is managed within these companies (e.g., whether mainly handled by particular departments or job roles) in advance of any recruitment period for research or Advisory Group participation.

While time constraints were the most frequently cited barrier to Advisory Group participation, informal scoping conversations also identified that incentives to participate could be hampered by concerns about:
- Unintentionally sharing information with negative security implications.
- The potential for collaborative work to bring about unforeseen negative impacts on business competitiveness, although our antitrust guidelines were created to mitigate these concerns, ensuring that participants do not discuss competitively sensitive information in our meetings.
- A lack of understanding about the relevance of project NIMBUS and its potential benefits to business across the target sectors.

While Icebreaker One did not formally collect data on this topic and, therefore, cannot present a deep analysis, we suggest that future work would benefit from identifying and proactively addressing such perceptions at an early stage to hone communication about the project and remove barriers to collaboration where possible.

With a view to gathering a wider range of responses and to complement the guidance emerging from the Advisory Group, Icebreaker One additionally published an [Open Consultation](#) seeking feedback from TOs, TSOs and DNOs, as well as the wider infrastructure sector, specifically pertaining to practices of asset data sharing. Despite the active promotion of the Open Consultation across a range of communications channels, owned both by Icebreaker One and project partners, the consultation received no formal responses. This research limitation is explored and discussed in more detail in the [Challenges](#) section of the report.

The following section presents four key findings generated through methods used under WP7. These findings demonstrate some crossover with findings in WP6, further strengthening the evidence base supporting a collaborative, multi-stakeholder approach to data use for asset management and articulating the need for developing a consistent approach to Shared Data exchange.

Findings

Finding 1: Improving the use of data for asset management can only be facilitated through a collaborative approach to all phases of method design and use

Despite the limitations acknowledged above, Icebreaker One's analysis of the Advisory Group process and relevant literature strongly suggests that a collaborative approach is necessary to improve the use of data for asset management across all infrastructure sectors.

In WP7, this collaborative approach was found to have two main dimensions:

1. Cross-sector collaboration
2. Collaboration with data end users.

These findings also build on the discovery outlined in WP6 Finding 4, which emphasises the need for multi-stakeholder collaboration across technical, regulatory and organisational domains.

Whilst the limitations in this project are acknowledged above, NIMBUS Alpha Phase research emphasised that the importance of engaging a wide range of stakeholders, not just from the energy sector but also from other sectors, such as rail, water and telecommunications, cannot be overestimated. Asset managers and operations teams from these sectors face similar challenges affecting asset risk management, such as asset degradation caused by weather. It is, therefore, important to capture their insights and identify where new approaches can make the best use of economies of scale to maximise benefits for businesses and the Net Zero transition. Incorporating their feedback into how asset risk modelling can be further improved and standardised will ultimately benefit the energy sector and the infrastructure sector as a whole.

Going forward, WP7 research analysed how cross-sector collaboration might best be driven forward and which organisations could facilitate this. Due to the potential diversity of inputs required and the need for deep knowledge of different sector structures as a precondition for effective engagement, our research suggested that the National Infrastructure Commission (NIC) could be uniquely positioned to facilitate this kind of collaborative work. In addition, as NIC is a cross-sector infrastructure body that is independent from the commercial landscape, it has the potential to steer future

collaboration across the sector in an impartial and inclusive way avoiding any conflict of interest. Further exploration of this topic is required to concretise this recommendation as the NIC was not involved in NIMBUS and Icebreaker One did not have capacity to seek its input during the NIMBUS Alpha Phase.

Additionally, Icebreaker One's research identified that - at present - opportunities to proactively collaborate with data end users tend to be overlooked. This is particularly pertinent for Open Data publication, in which data end users tend not to be widely engaged in providing feedback and suggestions. This can result in missed opportunities for data publishers to create resources with higher utility value by better understanding user needs. Going forward, workshop sessions with data users could present a meaningful opportunity to allow - where possible - for any issues or limitations in Open Data to be surfaced and addressed, resulting in iterative improvements in the data publication processes. Asynchronous mechanisms for end-user input could also be used to allow for dialogue to evolve over time as Open Data resources develop and their user bases widen. Such activities represent part of a wider imperative to iteratively improve the landscape of open resources in the energy sector, which can be used to accelerate the Net Zero transition.

The principle of proactively seeking data end-user feedback in the data publication process also stands with regard to Shared Data. While not explored in depth in the NIMBUS project, Icebreaker One's wider research base demonstrates the value of understanding user needs for all types of data publication (i.e., SSEN Transmission SIF Alpha project REACT, Office for Zero Emission Vehicles – EV On-Street Charge Points Use Case[14]). In the case of NIMBUS, and the broader asset data landscape, further exploration of Open and Shared Data user needs represents a valuable avenue for further research.

Finding 2: The absence of a consistent approach to exchanging Shared Data creates bottlenecks and hinders interoperability

Whilst the energy sector is undergoing a transformation with data sharing and publication becoming a more widely accepted practice, there is still a noticeable lack of agreed data standards, methodologies, tools and governance processes to facilitate the external sharing of asset data in a consistent and accessible manner.

Through a series of Advisory Group sessions, Icebreaker One identified particular feedback from energy transmission networks that a lack of shared data standards and methodologies represents one of the key challenges for future innovation in asset

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[14] [Icebreaker One, 2022.](link)

management optimisation. These challenges are important to acknowledge, as resolving them would allow for organisations in the energy sector to share data in a consistent way, allowing for any potential tools or products using this data to be developed more easily and with less friction. In addition, the development of Shared Data standards as part of NIMBUS could serve to provide guidance on how these standards could be adopted to facilitate data sharing across other sectors.

Stakeholders in the Advisory Group discussed which organisation should take leadership of future work to establish energy sector data standards pertinent to the NIMBUS use case. The Advisory Group concluded that the Energy Networks Association (ENA) is best placed to lead, as its representative role across the different types of energy networks positions the organisation to thoroughly understand the needs and challenges faced by networks.

Building from Finding 1, Icebreaker One encourages the ENA to take a multi-stakeholder collaborative approach to any such workstream and emphasises the importance of inviting a variety of stakeholders into the process. This could include policy and regulatory stakeholders, to align with current sector developments, such as the Shared Data Infrastructure[15], as well as a variety of data end users.

As outlined in WP6 Finding 2, beyond the establishment of specific data standards, the development of a consistent approach to exchanging Shared (i.e. restricted) Data between appropriate parties in a trusted manner, would hold benefits for NIMBUS use-case stakeholders, the wider energy sector and, potentially, other infrastructure sectors. The adoption of a Trust Framework approach would enable relevant stakeholders to meet these challenges effectively.

Trust Frameworks are specifically designed to minimise friction at every stage of the value chain. They have a proven track record of doing this in the financial sector through Open Banking[16]. They are a core component of a Data Sharing Infrastructure[17] that enables data to flow at local, national and international scales.

Trust Frameworks achieve this by implementing and automating the adoption of rules for data providers, aggregators and users. They enable assurable data to flow between organisations at a peer-to-peer level by verifying that organisations and their data sharing are compliant with the rules.

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[15] Hayes, 2023.

[16] e.g., NatWest Group, 2024.

[17] See "Designing our Data Sharing Infrastructure" in Icebreaker One, 2024.

Key elements of a Trust Framework are:

- **Frictionless discovery of Open and Shared Data:** All data is described by standard metadata and indexed in the open.
- **Access control for sharing data between organisations:** Access conditions are published openly and access controls use proven technology widely used in Open Banking.
- **Agreed definitions and rules:** The Trust Framework agrees definitions and rules for licensing terms, data access and data sensitivity.
- **Assurance-backed trust:** Trust is guaranteed through independently verified assurance levels that apply to data and organisations
- **Effective governance:** A key element of any Trust Framework is the establishment of effective governance processes that support policy and regulatory oversight. This typically works through the establishment of an overall steering group and more specific Advisory Groups focused on legal, technical and other aspects.

A Trust Framework provides a set of unifying standards, policies and mechanisms for Shared Data interchange between all the organisations in the Framework. A known, agreed Framework speeds innovation, reduces costs and de-risks investment. A Trust Framework represents a proven process for achieving market-scale accessibility and interoperability of data and a robust and secure way of dealing with non-Open, Shared Data. It should, therefore, be embraced in future iterations of the NIMBUS project to ensure the project achieves its full potential.

A Trust Framework methodology is now being adopted within the 'Virtual Energy System' programme whose goal is to "enable the creation of an ecosystem of connected digital twins of the entire energy system of Great Britain" (Virtual Energy System, 2023, p3).

Finding 3: Lack of alignment in data sensitivity classification methodologies utilised by the sector

TOs, TSOs and DNOs currently use a range of frameworks and methodologies to assist with data triage processes and assess their data sensitivity levels. For the NIMBUS use case, the SSEN Transmission Open Data Portal makes use of a data triage process that is applied to all SSEN Transmission datasets prior to publication, with the results of the triage processes being published on the Open Data portal here. This data sensitivity classification framework appears to be closely aligned with Icebreaker One's data sensitivity classes, whilst the differences could be accounted for by the need to adopt

the classes to fit the needs of the business in line with Ofgem [Data Best Practice Guidance](#)[18] (Guiding principle 11) . Further standardisation and alignment of the various data triage frameworks would enable better interoperability and transferability of these frameworks within the energy sector, as well as the wider infrastructure sector.

In addition, to encourage best practice around data sensitivity classification, members of the Advisory Group and project partners were introduced to Icebreaker One's data sensitivity classification in order to deepen their understanding of how this framework could function as a model for harmonising data triage processes within the energy sector.

Stakeholders in the Advisory Group noted that Ofgem would be best placed on aligning the data triage processes to a shared framework like IB1's data sensitivity classes, which will allow the sector to standardise data sensitivity classification and facilitate further interoperability.

Finding 4: A number of organisations from the energy sector acknowledge the importance of reaching agreement on key terms and definitions related to NIMBUS

Through ongoing collaboration between NIMBUS and a range of Ofgem Strategic Innovation Fund (SIF) projects, such as [CREDO+](#)[19] and [WELLNESS](#)[20] stakeholders from across the energy sector highlighted the importance of reaching agreement on key term definitions, such as 'resilience' or 'extreme weather event'. It was further suggested that priority should be allocated to terms that may affect the alignment of NIMBUS with other related in-development methodologies, such as those modelling the risk of asset failure under extreme weather conditions[21] or modelling the use of flexibility to tackle grid strain from extreme weather events[22], such as storms or heatwaves.

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[18] [Ofgem, 2023.](#)

[19] CReDo+ (Climate Resilience Demonstrator - extension to new climate risks) is a development on the original CReDo decision support tool aiming to incorporate newly developed models of Distribution Network Operator asset failure risk under extreme weather conditions.

[20] WELLNESS is designed to be a consistent approach to develop resilience standards that inform whole energy decision making, which capture multi-energy flexibility, to create a cost-effective and consistent UK resilience strategy.

[21] [UK Power Networks, 2024.](#)

[22] [Energy Networks Association, 2023.](#)

While it was outside the scope of NIMBUS to facilitate this level of sectoral agreement, this finding demonstrates a significant need for further research and sector-convening activity. Without this work, there is a risk that a portfolio of valuable research and development work, supporting the Net Zero transition and climate change adaptation - backed by significant public and industry investment - will not be adequately interoperable, reducing its real world impact and value for money.

Stakeholders in the Advisory Group discussed which energy sector bodies would be well positioned to take on the responsibility of driving forward this programme of research. While several potential stakeholders were raised, the Group determined that the Energy System Operator (ESO) was best placed to implement the work based on their established role in reviewing asset risk reports.

Recommendations for asset data sharing and data interoperability for the energy sector

Through analysis of data collected via the WP7 research programme, Icebreaker One has prepared a set of recommendations to improve asset data sharing and interoperability in the energy sector. These recommendations have been reviewed and positively accepted by the members of the [Advisory Group.](#)

Recommendation 1: Align industry-wide definitions

The Energy System Operator (ESO) must take the lead on urgently aligning industry-wide definitions of the key concepts for climate and weather-related asset risk to ensure policy, investment and operation are aligned.

Recommendation 2: Align existing data triage processes

Ofgem, in collaboration with the energy sector, **must** continue to align existing data triage processes to a shared framework like [IB1's data sensitivity classes](#). This will allow the sector to standardise data sensitivity classification and facilitate interoperability. This also lays the groundwork for broader data governance as part of a [Trust Framework](#).

Recommendation 3: Co-create standards for energy asset data

The Energy Networks Association (ENA) **must** facilitate the co-design and co-creation of standards for energy asset data to unlock further innovation and reduce bottlenecks across the energy sector.

Recommendation 4: Establish cross-sector engagement for risk and resilience

The government, potentially via the National Infrastructure Commission (NIC), **should** establish and appropriately resource processes to facilitate continued cross-sector engagement on matters of asset management, specifically risk and resilience metrics, for national infrastructure.

Recommendation 5: Directly engage with end users of data

TSOs (Transmission System Operators), Transmission Owners (TOs) and DNOs (Distribution Network Operators) **should** regularly invest in engagements directly with the end users of data and gather their feedback and suggestions for improved data sharing.

Reflection on benefits, challenges and lessons learned

This section brings together critical reflections, from the perspective of Icebreaker One, on the benefits and challenges encountered during NIMBUS Alpha Phase. These are presented with the aim to increase transparency and share useful learnings that may inform future programmes of related research. Identification of benefits and challenges draws from a combination of Icebreaker One's research across WPs 6 and 7.

Benefits

- NIMBUS Alpha Phase generated a forum for energy asset specialists from different organisations to collaborate and discuss data interoperability challenges and solutions.

- Development of a PoC demonstrated how using granular weather data enabled asset managers to identify which assets were more affected by weather-based degradation and consequently required earlier inspection.

- The ability to move away from a time-based approach to asset maintenance to a risk-based approach at individual asset level has the potential to enhance network resilience and prevent high-risk or urgent repair operations for TOs, TSOs and DNOs.

- Optimising individual asset maintenance and replacement schedules has the potential to improve cumulative network resilience of the energy sector, aligning with regulatory mandates covered by the RIIO[23] (Revenue = Incentives + Innovation + Outputs) regulation to maintain network functionality and deliver power to end customers.

- Insights gained from assessing the effects of weather-related degradation on energy assets can be adapted and applied to assets in other infrastructure sectors (e.g., rail, telecommunications, water) building economies of scale.

- NIMBUS is designed to prolong the life of energy assets by optimising asset management practices and reducing associated inspection and maintenance costs providing benefits to asset management businesses (e.g., energy networks or generators).

- NIMBUS supports the acceleration of the Net Zero transition by optimising the lifespan of the existing energy asset base, reducing network risk and enhancing resilience, as well as reducing carbon emissions from asset manufacturing, installation and repair and freeing up capital for investment in the green transition.

Challenges

- During the open engagement process we encountered significant barriers when trying to recruit members from the energy, rail and telecommunications sectors. This was particularly true when it came to the rail sector. Hesitancy towards involvement was driven by diverse factors.
  - Some factors are hard for any single organisation or project to influence within a short time period (e.g. in house prioritisation decisions or broader cultural factors shaping data sharing). However, these factors represent important systemic considerations because they hold power to either enable or constrain the deep shift in data sharing culture across infrastructures which is necessary to develop good data governance and use data effectively to support Net Zero goals.
  - Other factors require a sensitive approach to ensure that stakeholders are appropriately protected when collaborating on sensitive topics (e.g.,

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[23] [RIIO-2: 2021-2028](#)

commercially sensitive topics, security sensitive topics). Icebreaker One proactively addressed commercial concerns through the use of antitrust [guidelines](#) to support Advisory Group discussions. Concerns related to security were harder to address due to their multifaceted nature. It should be anticipated that the negotiation between security and openness is an ongoing feature of projects using energy asset data.

- During open engagement processes, stakeholders often appeared to make a quick decision on project involvement. This highlights the need for clear and tailored communication resources supporting project members to succinctly articulate the benefits of the project to different target audiences. In future, it would be useful to deepen knowledge of the dynamics and structure of the sectors and sub-sectors relevant to NIMBUS - and potentially to work with existing cross-infrastructure bodies - to support wider engagement and production of tailored communications content.

- One key technical challenge in developing the PoC for NIMBUS Alpha was a lack of historical weather data at an appropriate resolution to support the use case. The historical weather data on a 4km grid was only available from 2017 onwards, whereas the average asset lifespan spans multiple decades. This presented a limitation in assessing historical weather impacts on asset condition. Weather data from as far back as the 1980s was available, however this was recorded only on a 30 km grid, thus was not considered granular enough for the project's requirements and was not investigated during Alpha Phase. This challenge was echoed by a solutions engineer from IBM who stated: *"Weather data isn't collected at the granularity of asset level, it's always about the down-scaling of the data we do have."*

- Another technical challenge was associated with the limited availability of data on asset inspection scores. This data was only available from a single inspection carried out by SSEN Transmission in 2022. Lack of data availability limited the project's ability to understand asset degradation over time and incorporate these insights into the risk model development.

- In the absence of an industry-wide standard definition, a set of rules were established in the NIMBUS PoC model to define an extreme weather event (e.g., corrosion, ice, etc). Going forward, consistent industry-wide adoption of the same terminology and rules would support improved clarity, relevance and applicability of widely used but divergent terminology.

- There were a number of challenges around data openness and licensing affecting the use of energy asset data during this stage of the project. In particular were the current challenges associated with asset data sensitivity, which prevented it from being openly published due to commercial and security concerns.

- Data discoverability is limited by a lack of openly published, accurate, descriptive metadata. Getting this right is a critical first step to making the data discoverable, which is a necessary precursor to usability.

Conclusion

During the Alpha Phase of NIMBUS, the integration of granular weather data into the PoC demonstrated clear benefits in helping to assess the extent of asset degradation and consequently adjust the frequency of inspection schedules. This has the potential to reduce inspection and maintenance costs, as well as shift the modelling approach from time-based to risk-based thus reducing the inefficiencies in current modelling. As the impacts of climate change are becoming more frequent and extreme, the risk landscape is becoming more deeply affected by weather-related factors, so it is particularly important for energy networks to ensure these variables are well embedded into the risk modelling methodologies. NIMBUS has demonstrated the potential of this new approach to contribute towards the Net Zero transition by optimising the lifespan of the existing energy asset base, reducing carbon emissions from asset manufacturing, installation and repair and freeing up capital for investment in the green transition.

Icebreaker One, along with project partners and Advisory Group members, has explored the key challenges and limitations faced by the energy sector, specifically with regard to data accessibility, interoperability, asset data sharing and publication. Research findings from Work Packages led by Icebreaker One highlight a paucity of Open weather data in the current ecosystem, noting that this is complex to address and requires parallel improvement of transparency about data transformation processes. Findings also assess notable barriers to publishing and discovering energy asset data in both Open and Shared forms and evidence the value of a collaborative, multi-stakeholder approach to addressing different aspects of improving data accessibility going forward. Finally, research findings emphasised the need for the development of common mechanisms to exchange Shared Data between trusted parties.

Looking ahead, Icebreaker One's recommendations on sector readiness for asset data sharing and interoperability serve as the foundation to help steer the energy sector towards improved data governance, accessibility and use. NIMBUS strives to assist TOs,

DNOs and TSOs in understanding the impacts of weather and climate on their assets' health and functionality, offering a way to optimise inspection and incident management practices, as well as boosting network resilience as a whole.

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