Electricity Transmission

The age of AI: UK's first trials to develop fully automated overhead line inspection

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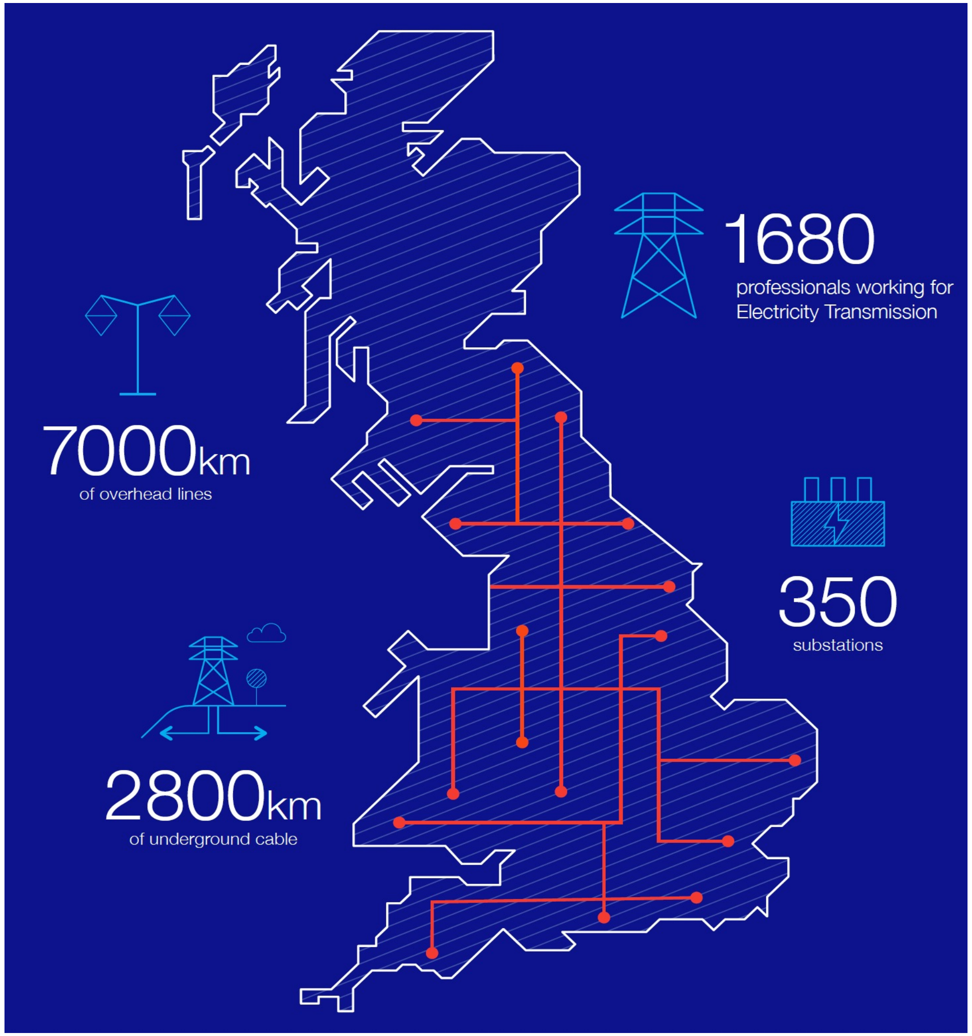
nationalgrid

Who are we and what we do

National Grid Electricity Transmission (NGET) owns and maintains the high-voltage electricity transmission network in England and Wales. Every time a phone is plugged in, or a switch is turned on, we've played a part, connecting you to the electricity you need.

We take electricity generated across England and Wales, including from windfarms and nuclear power stations, and transport it through our network, consisting of more than 7000 kilometres of overhead line, 2800 kilometres of underground cable and 350 substations, on to the distribution system, so it reaches homes and businesses.

We're investing in the network, connecting more and more low-carbon electricity – it's a crucial role and pivotal in turning the UK's net zero ambitions into reality.



Our overhead line (OHL) network

Power carried at high voltages of 275kV and 400kV through:

- **7,000km of overhead lines**
- **Approx. 22,000 towers (also called pylons):**
  - Lattice structures made of galvanized steel
  - Operating conditions include:
    - Loading: Electrical and mechanical forces
    - Weather: Extreme weather, high pollutant concentrations, wet and coastal conditions

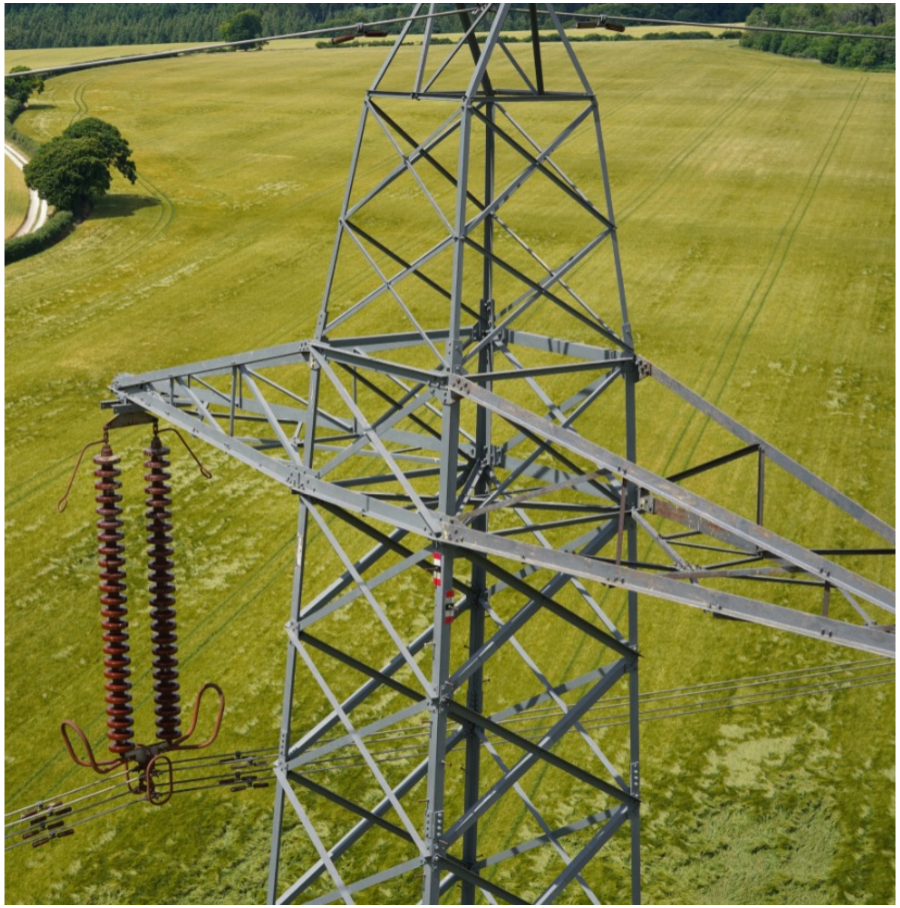
Overhead line towers – asset health

Transmission tower steelwork:

- Manufactured from hot-tip galvanized mid to high tensile steel
- Protective zinc and paint coating on steelwork surface

Anticipated operational life of OHL towers: approx. 100 years

- Depends on structural integrity of towers
  - Influenced by weather-induced corrosion
  - Periodic interventions required to maintain health, safety, reliability and performance of our assets



Overhead line towers – steelwork condition

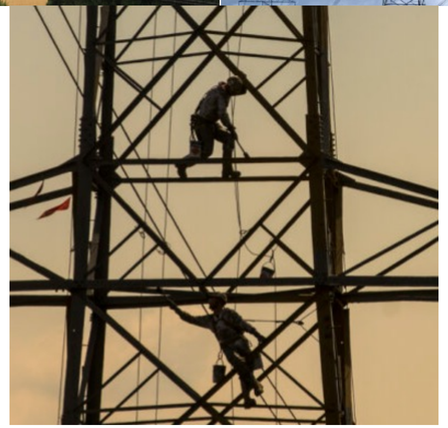
Steelwork condition:

- graded based on the level of corrosion
- Improved through regular maintenance regime: repainting, partial or full replacement of steel sections

Grade	1	2	3	4	5	6
Grade description	Fully painted – overcoat and undercoat intact Fully galvanised – coating intact 	Paint coating on all surface, but some overcoat may not be intact. Galvanising intact except for small areas of corrosion 	Very light surface corrosion, majority of coating intact 	Light pitting, with loss of coating and zinc layers. Bar thickness is still equal to its specification 	Significant pitting - loss of section clearly visible Bar thickness is smaller than its specification 	Perforated element with severe physical damage 
Intervention	No action required	No action required. Part of the long-term painting plan (10-15 years)	Optimal time to paint. Plan painting within 5 years – steelwork then reclassified as Grade 1	Recover steelwork via enhanced treatment – steelwork then reclassified as Grade 1	Steelwork measured to identify thickness loss and structurally assessed, then treated to prevent further degradation if required. Replacement of critical steelwork members.	Replacement of steelwork required

Steelwork condition assessment – data collection

Data collection method	Benefits	Limitations
Helicopter surveys	Cover larger inspection area	Do not allow close quarter imagery, expensive, carbon and noise intensive
Drone surveys	Allow close quarter inspection	Currently cover smaller inspection area and resource intensive due to existing regulation requiring drone pilots on site
Climbing inspection	Precise measurement of remaining steelwork	Not scalable, involves risk



Process improvement: Reduce helicopter usage, resource intensiveness of drones to cover larger inspection area to cover future inspection volumes

Current annual inspection volume: 3650 towers

Steelwork condition assessment – data analysis

Data processing of collected imagery:

- Analyzed by a pool of experienced inspectors – roughly 8 towers per hour
- Where grading is marginal, there could be risk of inconsistent assessments – triggering unnecessary additional work/missing necessary ones
- Assessment rate becoming increasingly limited as inspection volumes are projected to scale up

Process improvement: Automate data analysis to be able to cover larger inspection volumes and remove subjectivity

Technical challenges to solve

Segmentation: Accurately separate sections of steel in the image from background imagery

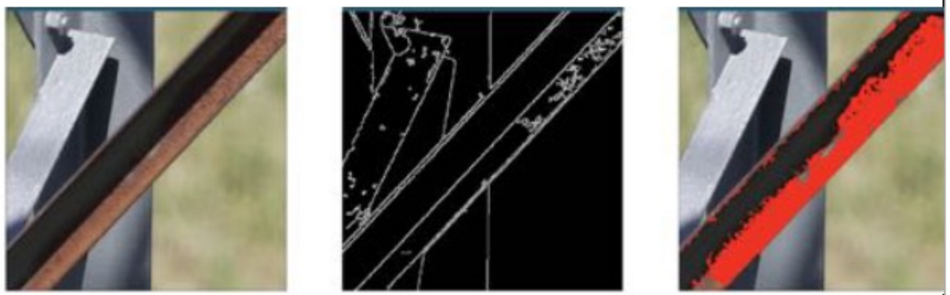
Solution: Switch from signal processing methods to AI powered image processing

Localization: To accurately assign captured images to correct section within the tower and to geographic location of the tower.

Solution: Combine GPS, LiDAR and high quality imagery for this activity

Automated assessments and visualisations: To automate corrosion grading, recommendation for interventions and reporting

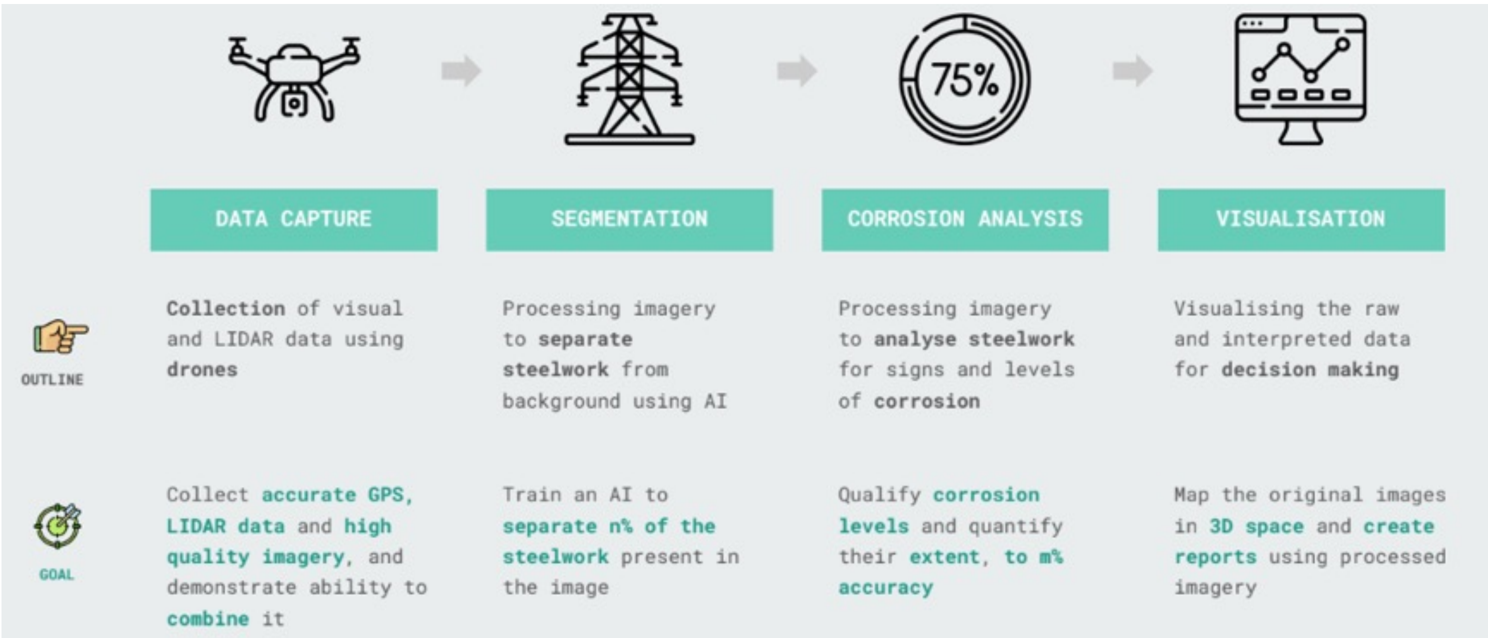
A corroded section of a tower. Background and foreground colours are very similar



Section of tower, segmented then regions of corrosion identified

NIA funded innovation project: VICAP

- Collaborating with deep tech startups sees.ai (BVLOS drone services) and KeenAI (AI data processing platform), develop solutions for technical challenges identified
- Apply for BVLOS permissions for this use case and help lobby CAA for BVLOS policy development

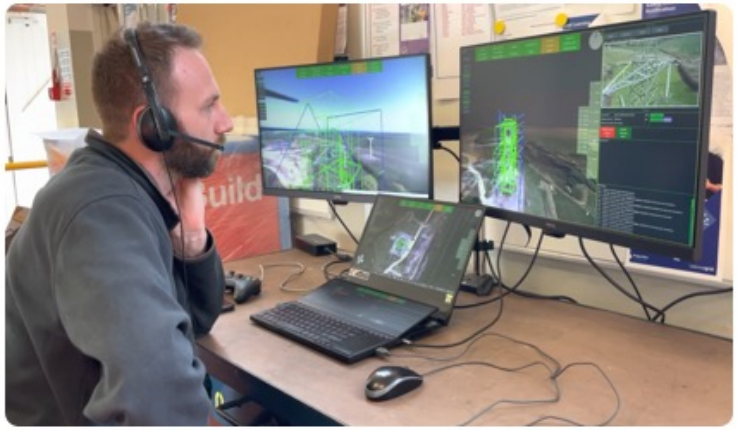


NIA: Ofgem’s Network Innovation Allowance funding mechanism

VICAP outcomes: data capture

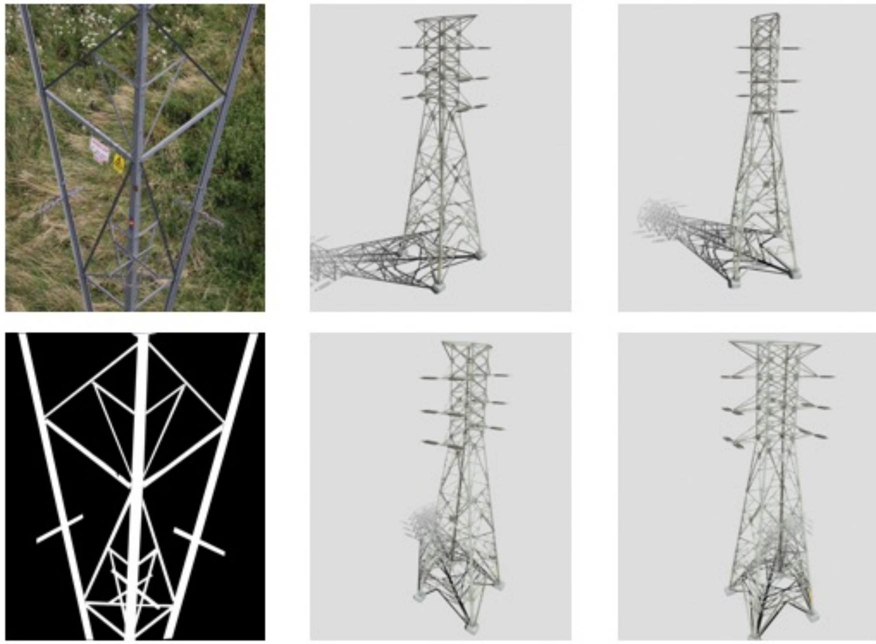
sees.ai's drone systems

- Adapted to carry out semi-autonomous inspection of transmission towers BVLOS
- Imagery, GPS and LiDAR collected
- Reliable and repeatable results tower-to-tower and flight-to-flight
- Apply for BVLOS permissions for this use case and help lobby CAA for BVLOS policy development



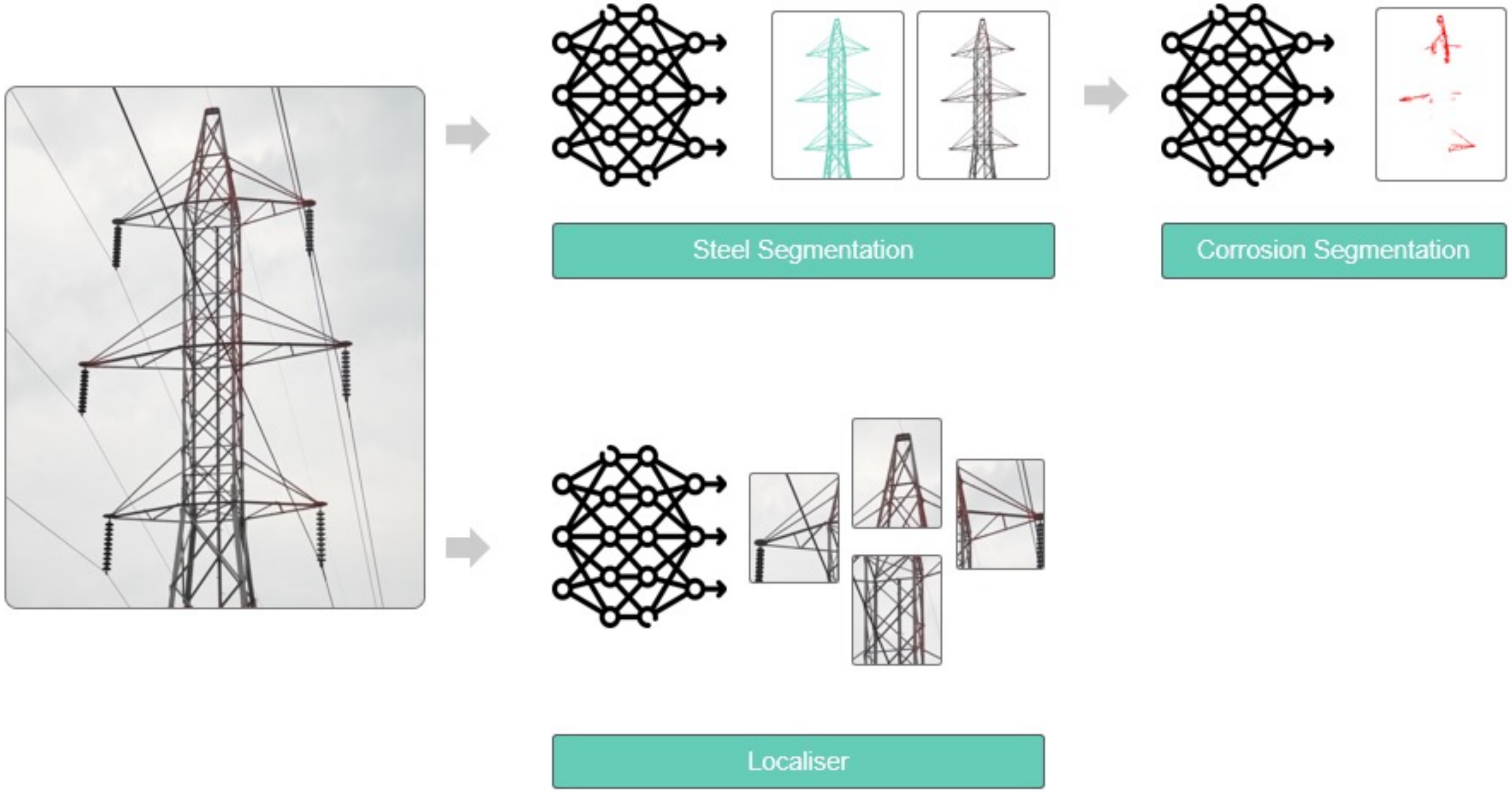
VICAP outcomes: AI training

- AI models trained using real and synthetic data
- Real tower data collected and AI model refined through three iterations of semi-autonomous drone flights on a stretch of 10 towers in Charlton, Hampshire.
- Enabled the automated process to recognize tower sections in different configurations and locations with varying ambient conditions

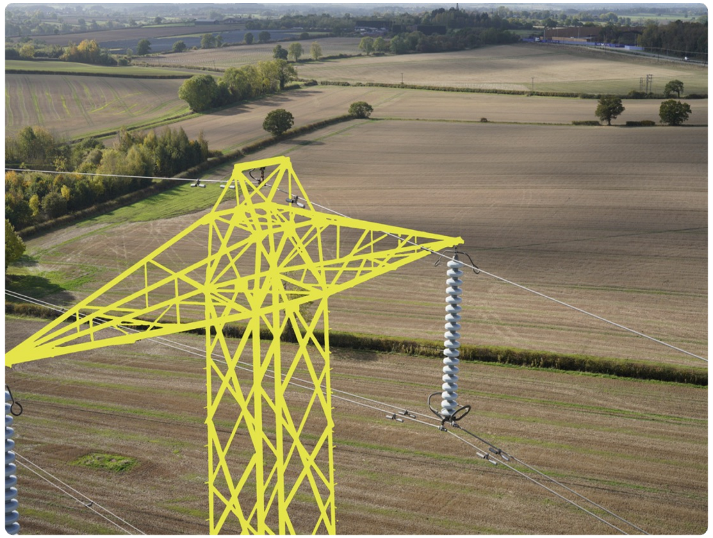


VICAP outcomes: AI pipeline

KeenAI's DeepSteel platform updated with a series of algorithms – automated pipeline for corrosion assessment of steelwork on OHL towers



VICAP outcomes: steelwork and corrosion segmentation



Steelwork segmentation

- AI model capable of carrying out segmentation automatically
- Can zoom into the steelwork accurately – ignoring background, other fittings, etc.

Corrosion segmentation

- AI model automatically detects corrosion using raw or pre-segmented image
- Learns texture and colour
- Tower condition is calculated and broken down by segments

VICAP outcomes: visualization

KeenAI's DeepSteel Platform

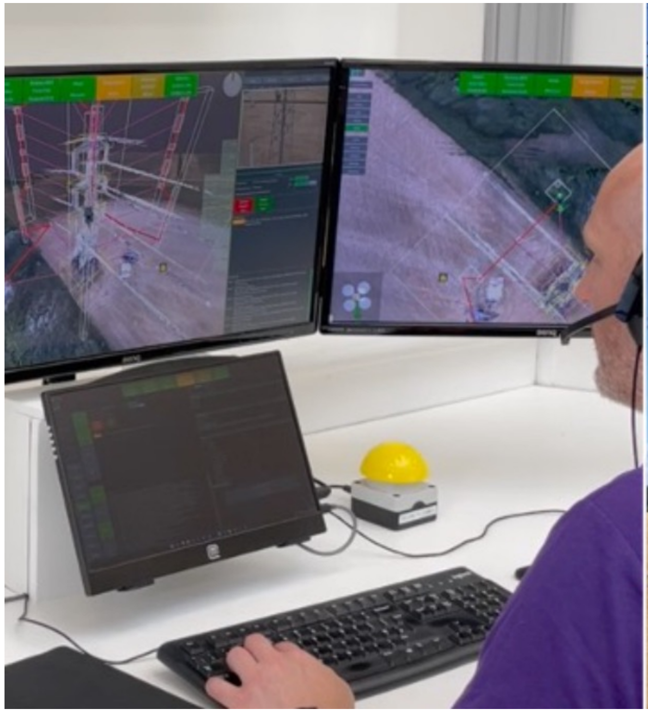
- Accurate 3D reconstruction of real environment
- Captured images mapped to real-world position on tower
- Viewable corrosion analysis

https://deepsteel.keenai.co.uk/

VICAP outcomes: BVLOS permission for OHL inspection

sees.ai secures UK's first routine BVLOS permission to inspect live OHL assets

- Can now fly drones routinely semi-autonomously along 2 specific stretches of our OHL network
- Drones flown and controlled from a remote ground control station – improving the resource intensiveness of our current practice



VICAP: benefits and next steps

Benefits

- **Operational**: Data collection enhanced with BVLOS drone flights, improved imagery, reduced time for processing and subjectivity
- **Environmental**: Enables phasing out of carbon and noise intensive helicopter surveys
- **Financial**: Increased efficiency = lower annual inspection costs = benefits passed on to UK consumer

Next steps

Further innovation through 2 NIA projects:

- **Aerial inspections of OHLs from Beyond Visual Line of Sight (BVLOS)**: Expand data collection method to other OHL sub systems such as fittings, insulators + expand BVLOS permission to broader network
- **Visual Inspection and Condition Assessment Platform for OHL Steelwork 2**: Enrich AI model capabilities using existing asset health data + dynamic models to predict future state of the towers

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