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Open data to underpin the electric mobility revolution.

Deploying Journey EV chargers in Rural Scotland

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Governments across the world are exploring options to transition their population away from internal combustion vehicles towards alternative low and zero-carbon technologies. For small 'light-duty' personal and commercial vehicles, the transition towards battery-powered electric vehicles appears to be the candidate solution. In Scotland since 2013, more than £50 million (~63 million USD) has been invested into a nationwide electric vehicle (EV) charging network consisting of more than 2,400 charging points. Statistics for the year 2022 indicate that more than 2 million vehicle charging sessions took place on the public charging network in Scotland (not including third-party operators nor private charging points) and delivered approximately 43 GWh of energy to vehicles. As of January 2023, there were 69 public charging points per 100,000 population with 17.3 public rapid charging points per 100,000 population. A rapid charger is a device capable of charging an EV at ≥25-kW. Generally, rapid charging points are rated at 50-kW DC and above. Increasingly the classification 'rapid' is being replaced by the term 'journey' charging.

As sales of EVs continue to grow in Scotland, current and future charging infrastructure must provide adequate geographic coverage across the country while also being sized appropriately to service user demand. To facilitate a smooth transition towards a net-zero transport sector, it is necessary for there to be sufficient levels of both public and private charging infrastructure to service the population. While it is important to make sure that there is adequate provision to support demand, it is also necessary that there is a fully country-wide charging network to create user confidence in nationwide travel. Ensuring provision in rural and islanded communities is an important factor when deploying this national charging network.

To deliver future EV-charging infrastructure, stakeholders must work together to accelerate the roll-out of infrastructure in an efficient and cost-effective manner given the climate emergency declared in Scotland and in other countries around the world. The role of open data published by relevant net-zero enabling stakeholders (e.g., distribution network companies, governmental transport departments, etc.) is required to de-risk infrastructure deployment at an early stage of a project's life cycle. Sharing of data will ultimately accelerate the deployment of new low-carbon technologies and avoid unnecessary wasted effort and resources. Additionally, coordinated planning will provide evidence to support ahead-of-need investment cases for power distribution companies to ensure that grid constraints are not seen as a barrier to society's progress towards net-zero.

This article presents the methodology developed to deploy twenty-four ≥50-kW journey charging points across western Scotland as part of the FASTER (Facilitating A Sustainable Transition to EVs in the Region) project. A key philosophy of developing this approach was that data underpinning the analysis was **open**

and publicly accessible to allow similar studies to be carried out in the future, while also making the process transparent to the public sector decision-makers and the wider population.

The role and need for open data in the net-zero transition

As road transportation increasingly decarbonizes via electrification, there will be an increasing requirement for charging stations capable of delivering enough energy to meet societal needs. Distribution companies who manage the 'poles and wires,' known in the United Kingdom as Distribution Network Operators (DNOs), are well positioned to help inform low-carbon technology providers as to optimal network connection locations. However, the volume of applications that their connection teams are tasked with evaluating is considerable, and they often struggle to support an "optioneering" process with customers. To help reduce the lead time for connections, it will become increasingly important for connecting customers to try and mitigate against poor sites through analysis before engaging with the distribution company, but the data required to do this is often characterized by the following:

- Not published at all
- Has large sections of unknown data – particularly for older network sections where paper records may not have been fully digitized
- Published in a non-user-friendly format requiring several documents to be referenced in parallel
- Not published in sufficient detail – particularly for low-voltage networks

With a first-generation electric vehicle charging network already developed across Scotland, the challenge associated with expanding the network with new infrastructure becomes complex. The location of the new journey charging infrastructure needs to ensure the following conditions:

- ✓ Promote fair and equitable access
- ✓ Service local user-demand while considering seasonal variations
- ✓ Enhance existing infrastructure
- ✓ Realize existing infrastructure may not be optimally located
- ✓ Ensure that charging technology and power rating complements the installation location

The transition towards net-zero will require public and private sector investment and project delivery. However, a collaborative approach to new infrastructure must be taken to avoid duplication of effort. Open data supports electricity network operators and EV-enabling stakeholders to identify candidate locations for future electrified transport infrastructure. The role of open data and decision-making will therefore promote the following requirements:

- ✓ A 'dig-once' philosophy
- ✓ Ahead-of-need network investment
- ✓ Network development of 'least-regret'
- ✓ Time and cost efficiency
- ✓ An accelerated path toward a lower-carbon transport system

Scottish EV-Charging Network

The public EV-charging point roll-out in Scotland, for the most part, has been managed by the 32 local authorities and made possible through centralized Scottish Government funding distributed by the national transport agency: Transport Scotland. Charging points deployed through this route are all managed by a single-charge point operator (CPO) called ChargePlace Scotland (CPS). While this may not be the common model to follow, with many countries opting for private-sector rollout, this centralized approach allows users to experience one charging network throughout the country. Charging points can all be accessed via a single RFID (Radio Frequency Identification) card thus simplifying the experience for EV drivers. A secondary benefit of the approach is the centralized view of infrastructure performance and zero-emission vehicle uptake across the country. Figure 1 highlights all the locations of the publicly owned journey charging infrastructure in Scotland.

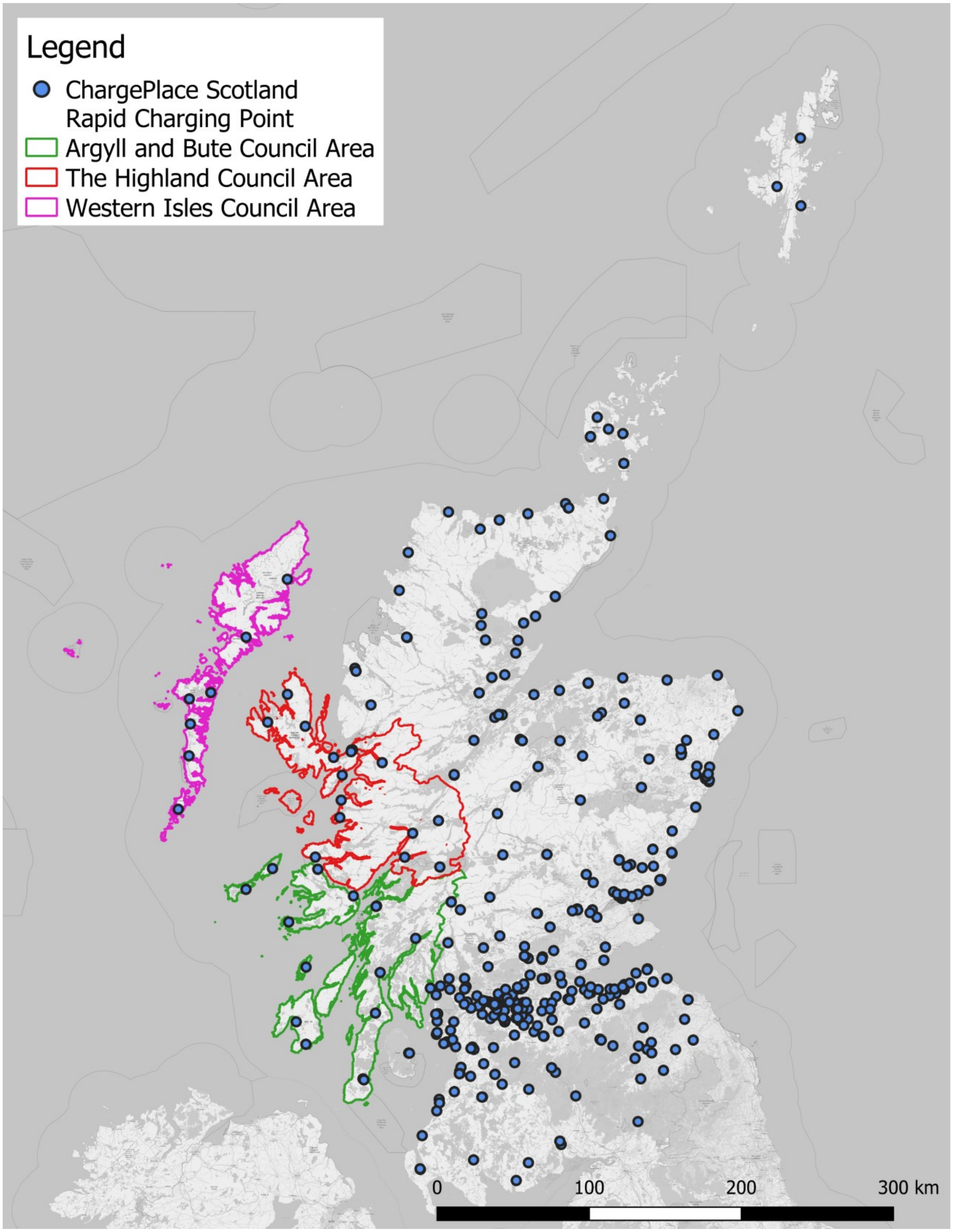

Figure 1 - FASTER local authority regions - Scotland

To support the everyday operation of the network, the publicly owned CPO, ChargePlace Scotland, acts as the interface between end-users and equipment owners, which in most cases are local authorities.

The CPO is responsible for the following activities:

- ✓ Customer billing
- ✓ 24/7/365 customer support
- ✓ Providing information on charger location, type, availability, and status to end-users
- ✓ Basic remote fault restoration (if possible)
- ✓ Equipment failure reporting to charge point owners
- ✓ Tariff implementation – however, tariffs are set by equipment hosts (e.g., local authorities) and are designed to cover operational costs, maintenance. and end-of-life replacement.
- ✓ Reporting of key performance metrics.
- ✓ Maintenance of back-office infrastructure

The FASTER Project

The FASTER project deployed 73 publicly accessible journey charge points throughout Western Scotland and the border region between the Republic of Ireland and Northern Ireland. The project is a €6.4 million (~7 million USD) Interreg VA project led by East Border Region Ltd in partnership with the University of Strathclyde and HITRANS (Highlands and Islands Transport Partnership). Interreg Europe is an interregional cooperation program, co-funded by the European Union. HITRANS is one of seven Regional Transport Partnerships in Scotland. which were established through the 2005 Transport (Scotland) Act. East Border Region is a local authority-led cross-border organization severing six local authorities along the east coast of Ireland and Northern Ireland. The FASTER project worked with several rural local authorities across Western Scotland, as outlined previously in Figure 1, to identify suitable locations for 24 journey charge points, which were installed throughout 2023. More information on FASTER is presented in Table 1.

Table 1: FASTER Project Factsheet

✓ Project website: https://www.fasterevcharge.com/
✓ Total cost: €6.4 million
✓ Infrastructure budget – Scotland: c. €1.3 million (~£1.1 million)
✓ Project Funder: INTERREG VA Programme
✓ Project Output: 73 EV charge points
✓ Project Regions:
• Western Scotland • Northern Ireland • Republic of Ireland
✓ Project Partners
• Lead partner: East Border Region Ltd
• Dundalk Institute of Technology
• HITRANS (Highlands and Islands Transport Partnership)
• Louth County Council
• South West College
• Ulster University
• University of Strathclyde | PNDC

Site Identification Process

Determining the location for new EV infrastructure is a challenging undertaking for EV-enabling stakeholders and is especially true for public sector bodies who need to demonstrate that infrastructure is being deployed in a fair, efficient, and just manner. The site identification process developed for the FASTER project uses open and public EV data to underpin the analysis, thus helping support a transparent approach to infrastructure development. A summary of the site identification process is outlined in Figure 2 and is described in more detail in the subsequent sections. Where possible, infrastructure for the project was to be sited on land owned by local authorities or other public sector organizations to reduce the number of legal stakeholders and land-sharing agreements required to deliver the portfolio.

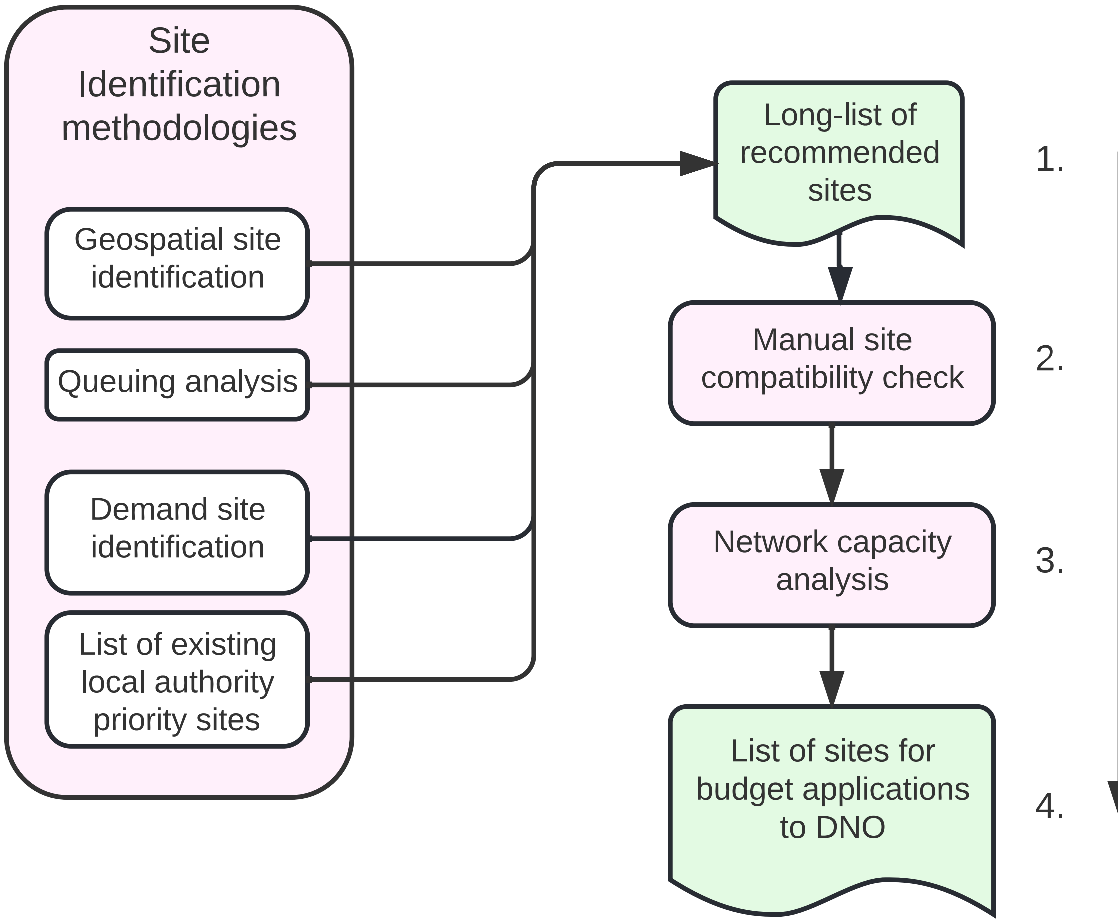

Figure 2: Process Summary

Geospatial coverage

Geospatial coverage analysis is used to determine areas of the road network that are furthest away from the existing journey charging network. Geospatial coverage analysis allows regions that could be considered remote from the charging network to be identified and numerically characterized. This analysis aimed to find the "most remote" charging points in the current network across the study region. Several open and publicly accessible data sources were used to underpin this work including the following:

- ✓ Location of existing publicly accessible journey charge points
- ✓ Local authority land
- ✓ Map of major roads

For the region, it was determined that a 30-minute driving time represented a good starting point for the analysis. This 30-minute coverage was selected: a) as it was deemed to be an acceptable journey time to reach a charging point given the current infrastructure provision in the area and b) to allow a suitable quantity of gaps in the network coverage to be identified. Note, that for more densely populated regions, or areas with greater existing infrastructure provision, a reduced driving time may be sought to increase user-convenience. To represent driving time on maps, isochrones (iso = equal, chrone = time) were calculated from each existing journey charging point to determine how far a selected vehicle type (in this case a passenger car) may travel in 30 minutes using the road network. It is worth noting that for this study, driving time was used for the isochrone calculation (commonly referred to as the feature metric). Several valid arguments could be made for using alternative feature metrics such as distance, however, for a rural environment where roads are often-single track and slow to traverse, it was deemed that a time-based metric would be more appropriate. This approach was taken primarily due to the inconvenience factor associated with needing to travel further to charge.

A summary of the developed geospatial process is presented in Figure 3. Note that the study region was expanded by a project-defined time of 15 minutes to capture the demand served by infrastructure slightly outside of the study region.

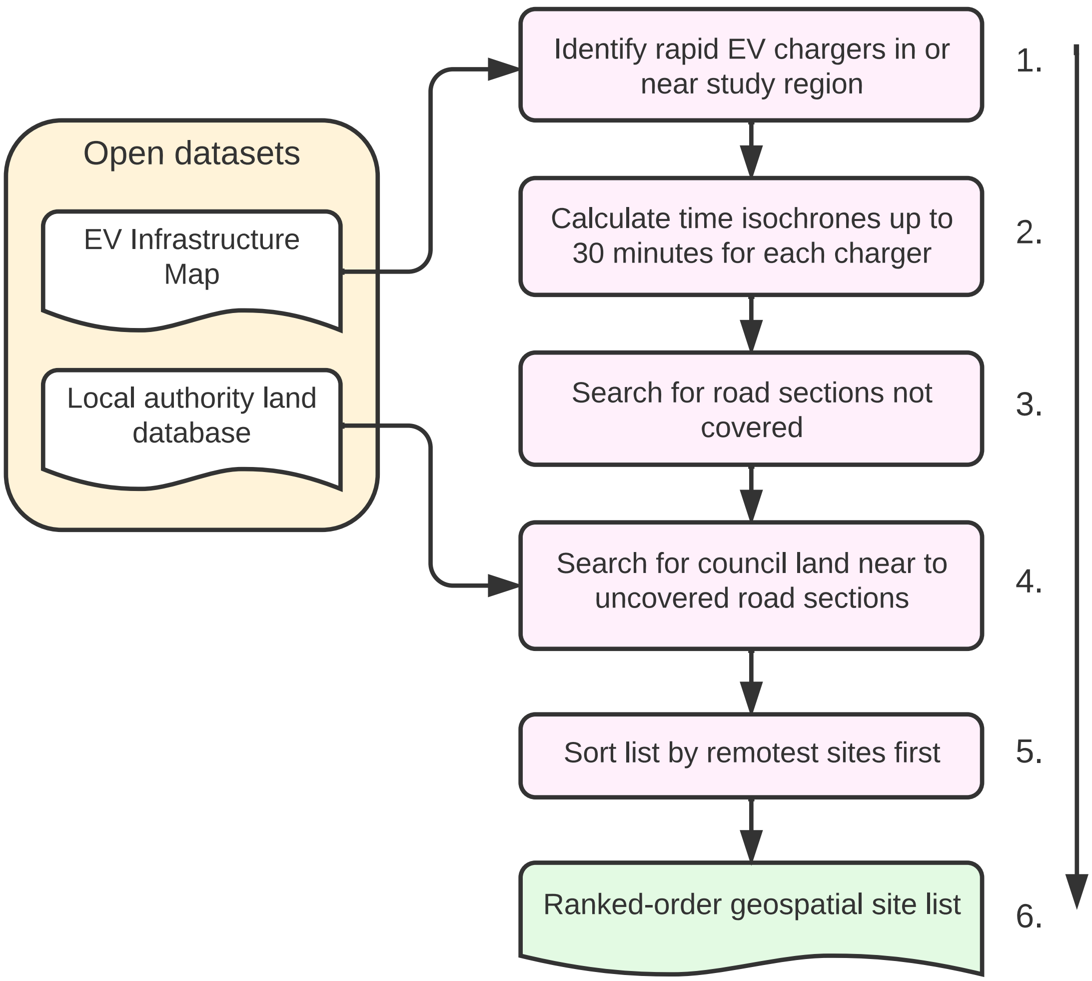

Figure 3: Geospatial coverage process

Figure 4 presents an example of the resulting isochrones for several charge points in an area of the FASTER region. The analysis shows several local authority land assets not covered by the 30-minute time isochrone as indicated inside of the dashed circle.

Figure 4

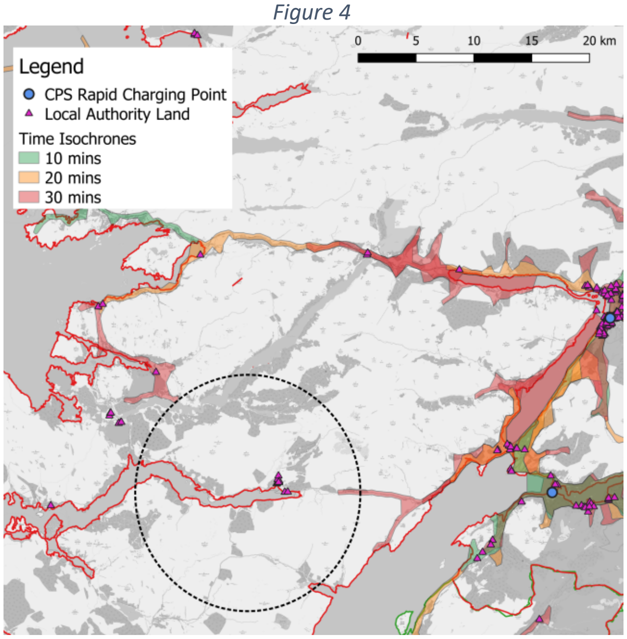

Figure 4. Time isochrones for the existing network with an area of poor coverage outlined via the dashed circle.

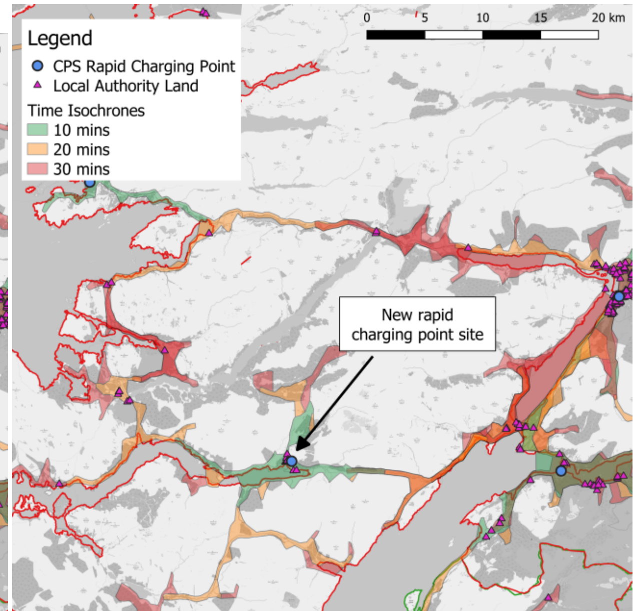

Figure 5. Recalculated time isochrones based on the introduction of a single journey charge point on local authority land.

The local authority asset furthest away from the isochrones was identified as the first candidate site for the installation of an EV charger. Recalculating the time isochrones with this new asset installed at this location is outlined in Figure 5 where improved coverage is observed for the region.

Demand forecasts

While geospatial coverage could be considered a quantitative problem, the challenge associated with forecasting user demand and behavior, as with any wide-scale population trending, is that analysis is reliant upon many more input assumptions. The concept of demand forecasting was to initially determine the expected energy required to service existing electric vehicles in the area and was based on vehicle registration data, population, and vehicle trends. Based on existing uptake, forecasts of future demand were estimated using EV growth estimates for scenarios published by the electricity system operator. The Electricity System Operator (ESO) is responsible for second-by-second balancing of electricity supply and demand and advising on network investments. In the UK the ESO is independent from transmission and distribution network companies.Several publicly available datasets published by various organizations underpin the analysis outlined in Figure 6. The analysis was calculated based on census areas; however, higher- or lower-level analyses (e.g., at a regional level or at a city level) could be considered depending on data availability.

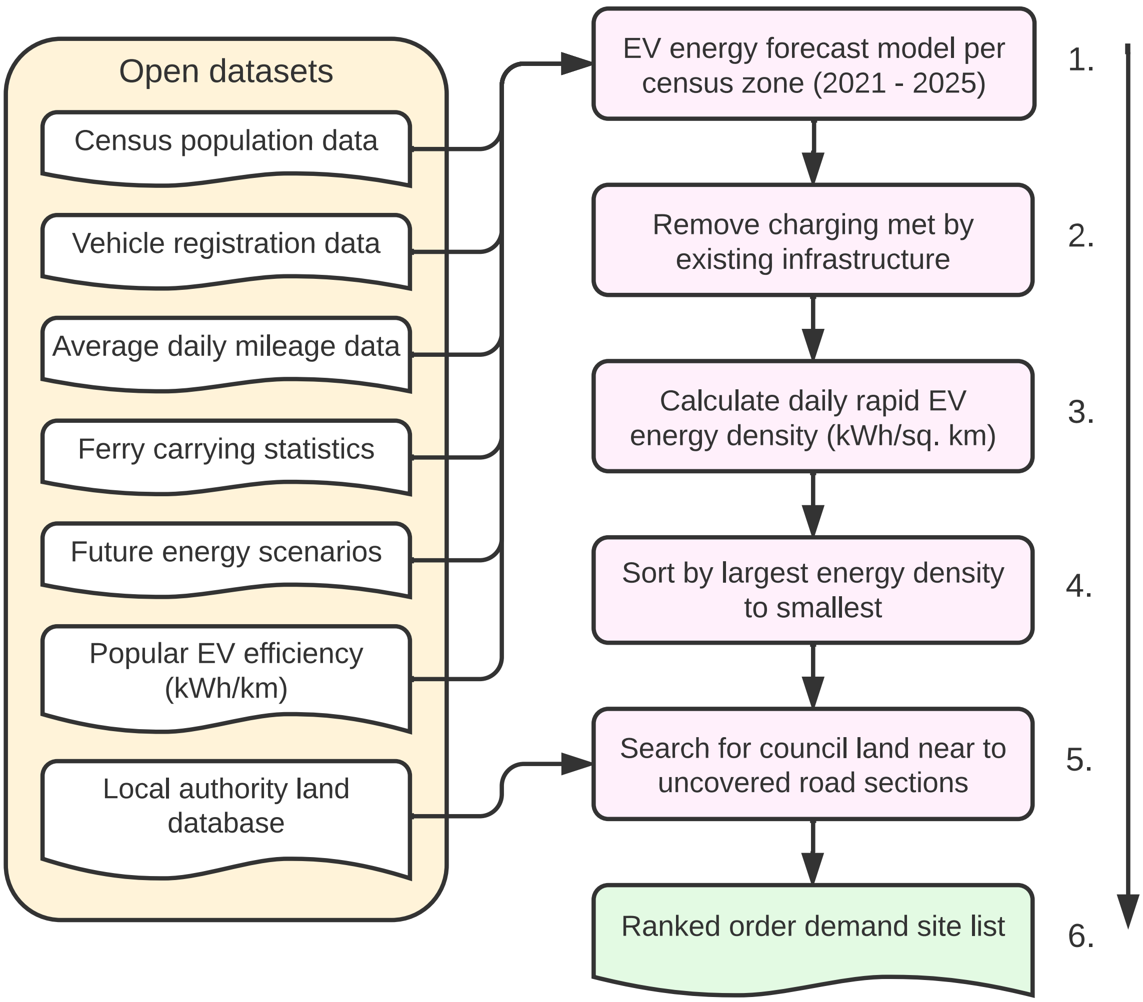

Figure 6: Demand calculation methodology

The output of this process was a ranked-ordered list of average daily energy density per square kilometer (kWh/km^2). The density element of this analysis is important as it captures those living in housing where charging at home is less likely and a greater reliance on public infrastructure is required. Once the daily energy density for each census zone was calculated, the energy served by existing charging infrastructure was subtracted from the calculated value to determine how much additional infrastructure is required to meet demand.

Figure 7 presents the demand analysis results in the form of a heat map for the three local authorities with Figure 8 highlighting the energy densities calculated for the urban area outlined in the dashed area in Figure 7.

The demand analysis helps identify areas where high levels of charging events on public infrastructure are to be expected In reality, the use of EV hubs in these areas may prove the most cost-effective solution going forward.

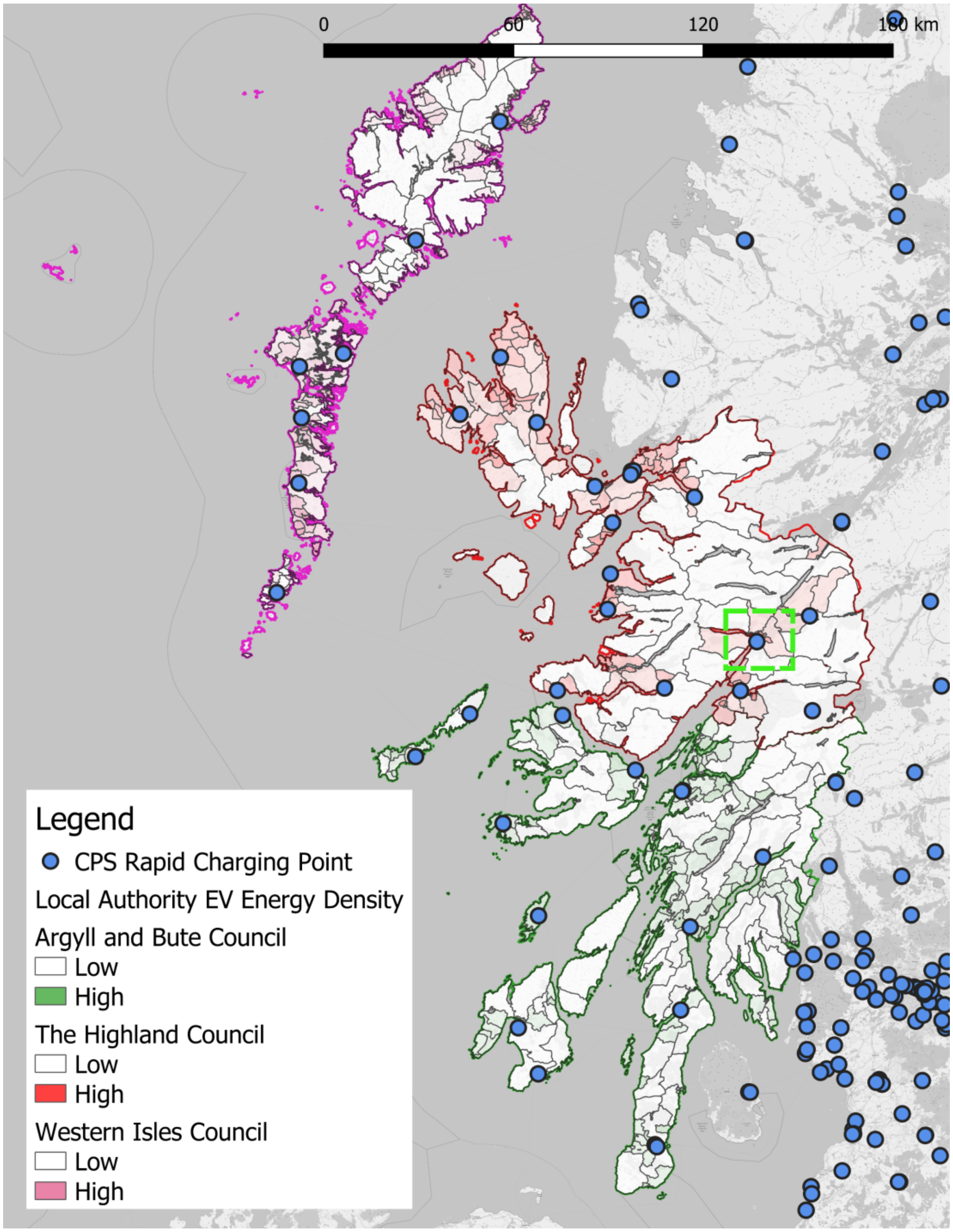

Figure 7. Overview of EV demand density for study region with an area of high density outlined by the dashed area – see Figure 8.

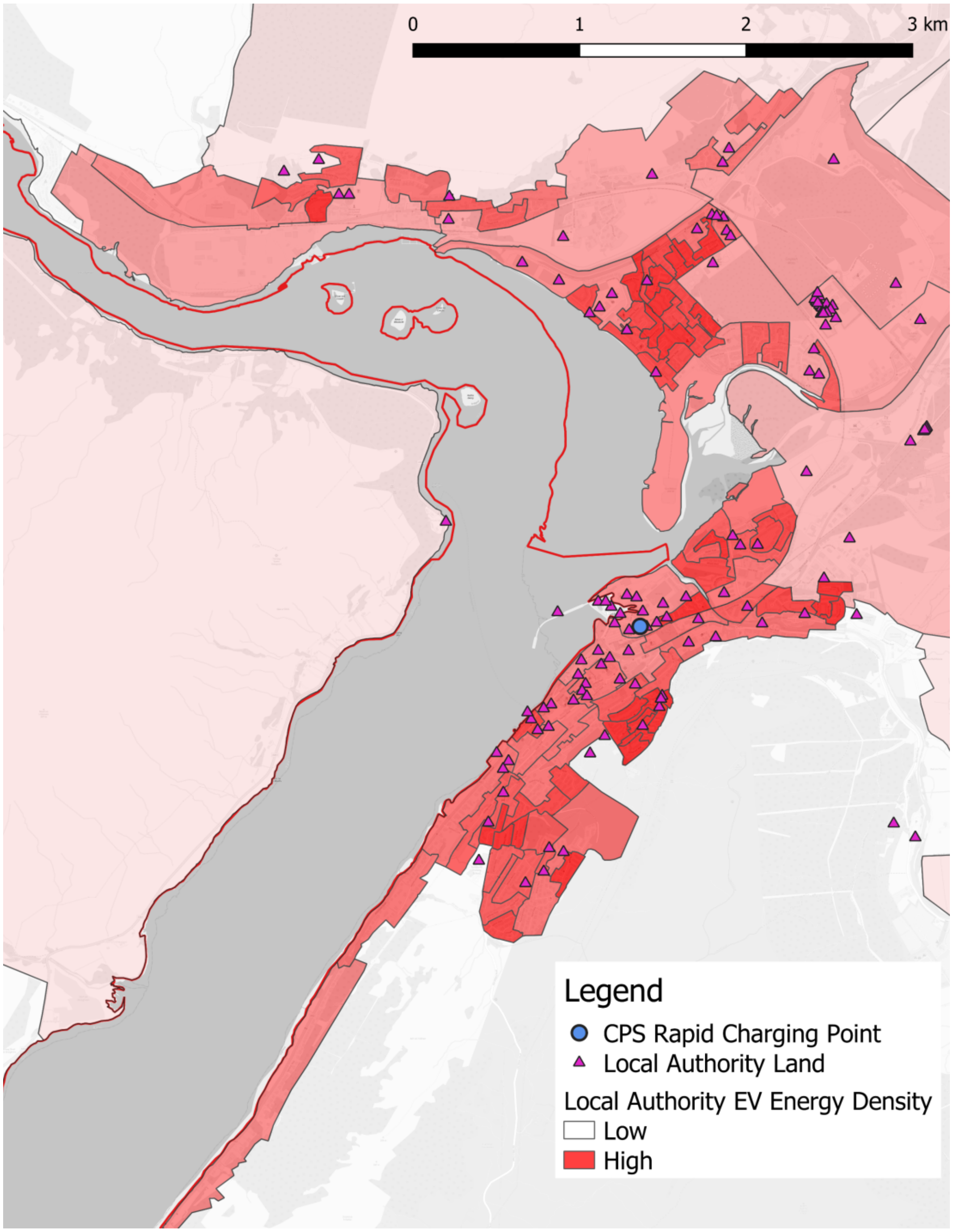

Figure 8. Detailed view of the highlighted area in Figure 7 displaying EV demand density in an urban population center.

Queuing Analysis

While the previous two methodologies aim to determine new sites suited for charging infrastructure, it is important to assess the performance and capacity factors of existing sites to determine where supplementary infrastructure is required to minimize the likelihood of users having to queue at charging points. The data made available by the CPO allowed for the analysis of charging point capacity factors, as well as for determining the time between sessions. The time between sessions was categorized into four data bins and analyzed for different times of the day as well as between months of the year to capture seasonal demands. The data points were classified using the following criteria:

- ✓ <1 minute: Suggests an issue with the charge point or user billing system e.g., payment issue, communication fault with the back-office, error in establishing a charging session with the EV
- ✓ >1 to <5 minutes: Suggests immediate queueing issue at a site
- ✓ >5 to <30 minutes: Suggests popular charging point where queueing is likely to become an issue in the short- to mid-term
- ✓ >30 minutes: reduce risk of queuing.

These classification times were tuned to the area covered by the FASTER project. If looking to replicate this approach, engineers may need to tune the time intervals accordingly. The probability distribution of the dataset helps to provide evidence as to popular charging point locations where the likelihood of needing to wait for a previous user to complete a charging session is high. A high probability of users waiting to charge suggests that additional infrastructure may be required to support EV growth in the area.

An interesting observation from queuing analysis was the impact that local ferry arrival and departure times had on the likelihood of back-to-back charging events taking place. This observation was apparent across much of the FASTER region where ferry services that carry vehicles represent life-line connections from the islands and remote communities to the mainland. Considering ferry operation when planning EV infrastructure leads to interesting engineering tradeoffs for these sites, for example, between the following criteria:

- ✓ Charging point power rating
- ✓ Number of charging points
- ✓ New grid connection capacity
- ✓ Possibility for on-site storage to minimize grid connection requirements
- ✓ Operational expenditure versus capital investment trade-offs for site owners/operators

It is worth highlighting that due to the ownership and operating model adopted at present in Scotland, applying this queueing analysis to a portfolio of charging points operated by a single CPO is much simpler than compared to a region where several CPOs operate. It is appreciated that this approach may be more challenging to implement when considering several commercial operators.

Local Authority Inputs

Engineering methodologies underpinned by open data provide a scientifically rigorous and repeatable approach to deploying EV infrastructure to meet an objective or series of objectives. These approaches can guide enabling stakeholders as to the approximate location for infrastructure to service a customer base; however, the final location of infrastructure is often influenced by the following non-technical factors:

- ✓ Immediate local amenities
- ✓ Land ownership
- ✓ Infrastructure and access wayleaves
- ✓ Land use
- ✓ Wider area redevelopment plans
- ✓ Security and safety factors
- ✓ "Not in my back garden(/yard)" culture

Before conducting power capacity studies, it was deemed important that appropriate officers in local authorities and wider-area transport partnerships were able to discuss the candidate sites identified through the processes outlined. Local insight allowed knowledge relating to the site and its surroundings to be considered while also offering the opportunity to introduce nearby alternatives that were still supported by the geospatial, demand, and queuing analysis.

This process produced a list of candidate sites to be advanced to the detailed power capacity analysis phase of the process.

Power capacity analysis

The "shortlist" of candidate locations was assessed from a power capacity perspective to determine whether sites were capable of hosting a three-phase connection suitable for 50-kW charging equipment. Note that 50-kW chargers were selected due to project funding requirements. Where there was a suitable evidence-based justification, the installation of multiple chargers at sites was considered. Power capacity analysis was carried out by cross-referencing several of the following publicly available documents produced by the distribution company:

- ✓ Graphical information system (GIS) shapefile for the region consisting of:
    - Overhead, underground, and sub-sea conductor routes for EHV (33 kV), HV (11 kV), and LV (400 V) networks
    - Substation, switchgear, and transformer locations
    - Customer connection points
- ✓ Transformer loading database for 11 kV and LV networks
- ✓ 11 kV schematic
- ✓ Generation and demand heatmaps

An example extract of the GIS shapefile is presented in Figure 9. Power capacity was assessed for each of the candidate sites using the process summarized in Figure 10.

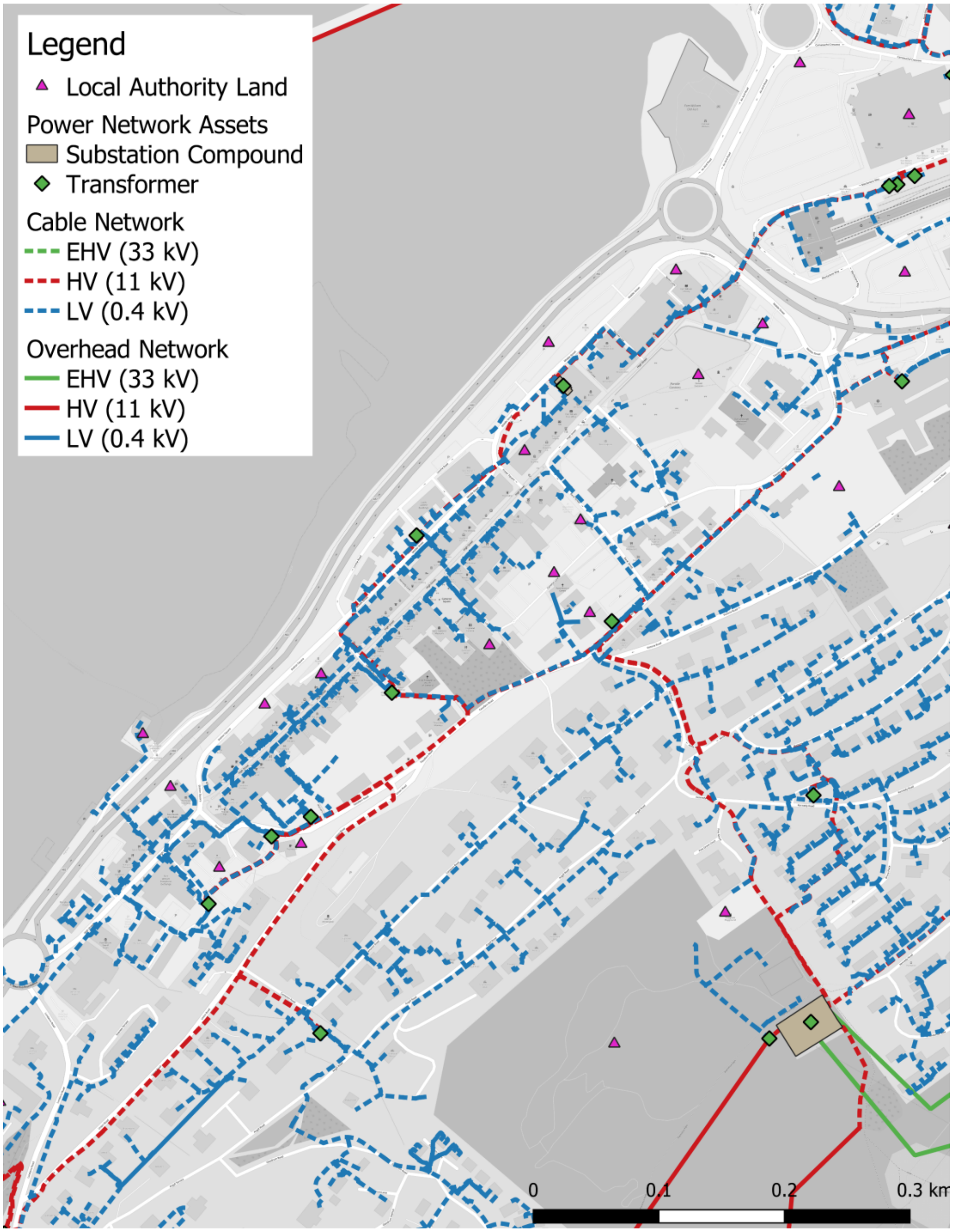

Figure 9. Example extract from the distribution company GIS network map.

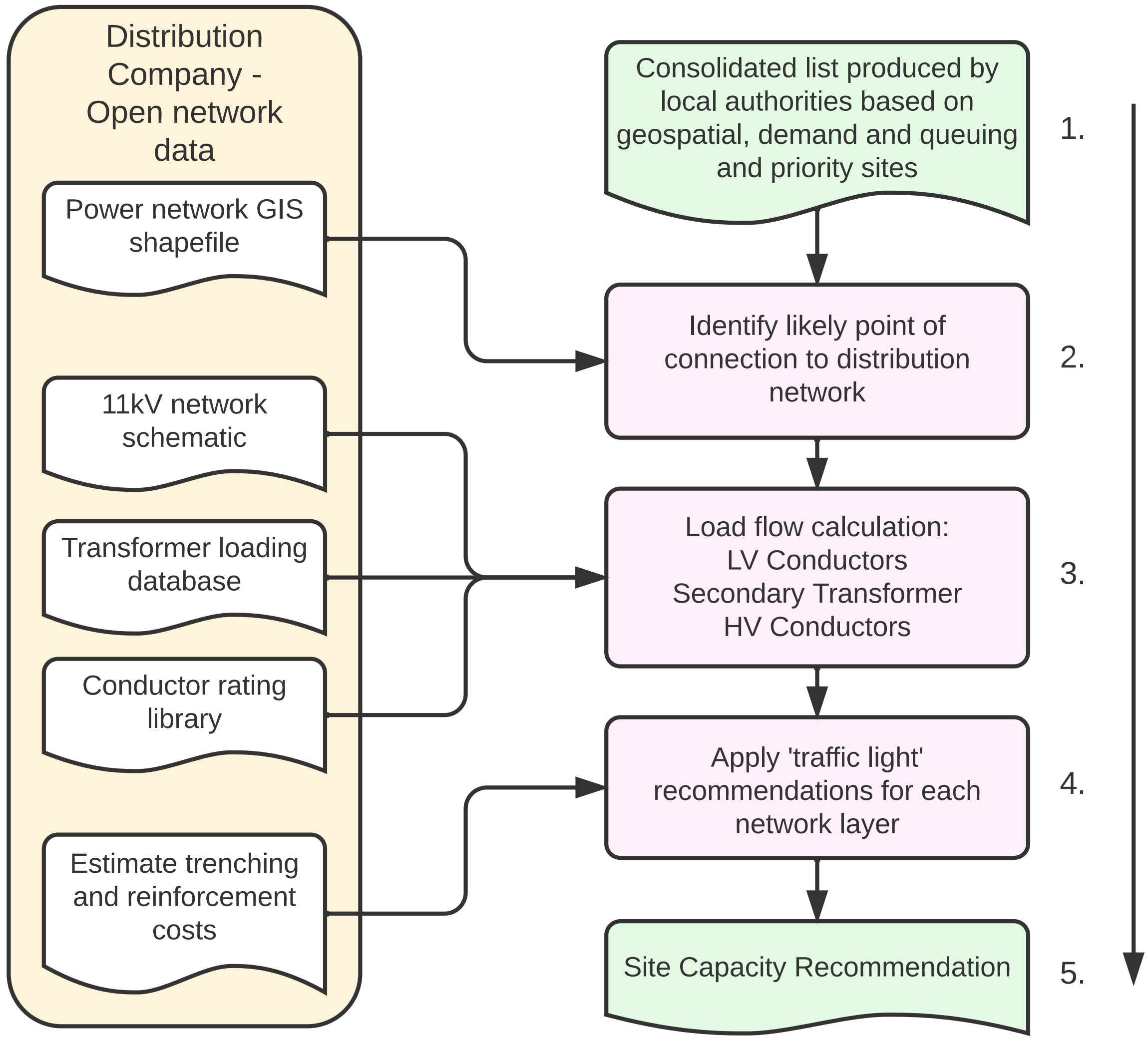

Figure 10: Power capacity assessment process

Combining GIS shapefiles for the network area with a publicly available asset rating and loading library allowed load flow and voltage drop calculations to be carried out using an open-source power system simulation platform, OpenDSS. Note that in most cases, the information held in the datasets outlined in Figure 10 was sufficient to build models suitable for balanced three-phase power flows to be conducted. For areas with insufficient information, engineering judgment was applied. Capacity analysis was conducted for the following network components for each of the sites in the shortlist:

- ✓ LV conductors
- ✓ Secondary transformers
- ✓ HV conductors

To help disseminate the findings from the power capacity studies, a 'traffic-light' notation was used with colors scaled against the project site budget. Based on the allocated funding for the project, an average budget of ~£46k had to be achieved per site for the portfolio of 24 journey chargers. The following classifications were applied to each 'traffic-light' category:

- ✓ Red – major reinforcements anticipated – Costs expected to be greater than the total site budget allowance,
- ✓ Yellow – minor reinforcements anticipated – Costs expected to be greater than the site distribution connection budget but less than the site budget
- ✓ Green – no constraining factors identified – Costs expected to be within the site distribution connection budget
- ✓ Blank – insufficient information to conduct analysis

These categories were predominantly based on the anticipated reinforcement costs required to upgrade the distribution network in the area. Using cost data published by the distribution company, it was possible to determine ahead of time the extent of the reinforcement required. Note that due to the rural nature of much of the project, upgrading transformer capacity was required for several sites.

During the power capacity assessment process, a notable limitation to the placement of high-powered EV-charging infrastructure was determined and related to the lack of three-phase electrical systems in many rural communities as the historic preference of the distribution company was to service these customers with a single-phase system. **The lack of three-phase electricity distribution is a considerable barrier to net-zero for many rural communities in Scotland**. While single-phase to three-phase conversion systems do exist, they introduce additional complexity and costs to remote EV-charging sites and will introduce additional points of failure in the system. Ultimately, in the context of the FASTER project, it was determined that these systems did not represent a cost-effective solution while considering the wider project budget. Regulatory changes that govern the cost of new connections to the distribution network were introduced in Great Britain in April 2023. The aim of these changes is to help socialize grid reinforcement costs and should promote more cost-effective connections for net-zero enabling infrastructure going forward. Unfortunately, the impact of these changes was not felt by the FASTER project as the project had already committed to sites before the April 2023 implementation.

Additional site considerations & surveys

The following non-electrical, additional site checks were carried out before final site approval:

- ✓ Flood risk analysis
- ✓ Cellular (mobile) data coverage
- ✓ Physical site survey.

While flood risk and cellular coverage could be checked via online services, additional confirmatory checks were conducted during site visits.

Flood risks

Due to the geographical coastal and rural regions covered by the FASTER project in Scotland, sites needed to be assessed for flood risks to ensure that charge point warranties would not be voided because of locating equipment in an area with the likelihood of flooding. Online flood risk maps were available to access through the environment agency and could be integrated into the GIS modeling system used in the methodologies outlined previously. Visual checks were carried out during the physical site survey to ensure there was no evidence of localized water pooling.

Cellular data coverage

To communicate with the CPO's back-office software, it is key that reliable communication systems are in place and readily accessed when installing EV-charging equipment. Reliable communications to the CPO allow for charging point telemetry and billing to be processed and include the ability for the CPO to mark charging units as being defective on EV-charging point maps. Reliable communication between charging points and the CPO is particularly important in rural environments since the probability of EV drivers not having a sufficient range to reach the next available charging point in the event of equipment failure is increased as assets are more geographically dispersed. A secondary benefit of reliable communications to remote charging sites allows charging equipment to be interrogated remotely to preemptively react and respond to equipment failures. Increasing reliability, or lack thereof, of charging infrastructure is gaining press and political attention. The telecommunications regulator for the UK, Ofcom, publishes an open coverage map and associated application programming interface (API) on its website detailing the coverage for the major mobile telecommunication providers in the country.

Site Survey

While online mapping and street-level imagery tools allow a portfolio of sites to be evaluated quickly from a desktop, site visits are still an essential component of the site selection process. Online imagery is usually timestamped to determine the date of capture. Due to the remote nature of many of the sites selected in the FASTER project, some imagery was more than 13 years old thus increasing the likelihood of unknown changes for an area. During desktop studies, it is also recommended that online satellite and street-level imagery be compared across several data providers as there are often quality and detail differences between services.

When onsite, the following measurements and information were collected:

- ✓ GPS coordinates of prospective charge point location
- ✓ Ground type and terrain condition between the charging point and the distribution company point of connection
- ✓ Photos of the site including a 360-degree "photo-sphere" to allow for post-survey site checks
- ✓ Understand and identify the safe route between the charging location and local amenities
- ✓ Existing onward travel options at the site? e.g., train, bus, ferry, personal e-mobility, walking and cycling infrastructure (travel by foot, cycling/wheeling, and by other physical ways is often referred to as "active travel")

- ✓ Check for site access restrictions if considering charging points for larger vehicles – height, width, weight, etc.
- ✓ Ensure suitable drainage is in place and look for evidence of water pooling nearby the proposed charging point location
- ✓ Time restriction i.e., does the site close overnight or for any prolonged period
- ✓ Identify the adequacy of street lighting and additional security measures at the site (e.g., CCTV)
- ✓ Confirm cellular data coverage for an appropriate number of providers
- ✓ Confirm the site can spatially accommodate a charging point, physical protective devices, and the vehicle(s)
- ✓ Confirm if other accessibility and comfort features could be installed – canopies, wider and longer bays, cable management systems, wind shelters, etc.
- ✓ Identify if there are better locations for the infrastructure in the identified car park
- ✓ Attempt to park a vehicle in the allocated space to ensure easy maneuverability

These elements should be recorded in a site survey report. Within the site report, a layout diagram for the proposed infrastructure was also included. An example of a site layout diagram is outlined in Figure 11 for a site with two 50-kW charging points. These bays were designed to accommodate long-wheelbase commercial vehicles while providing step-free access for users with mobility challenges.

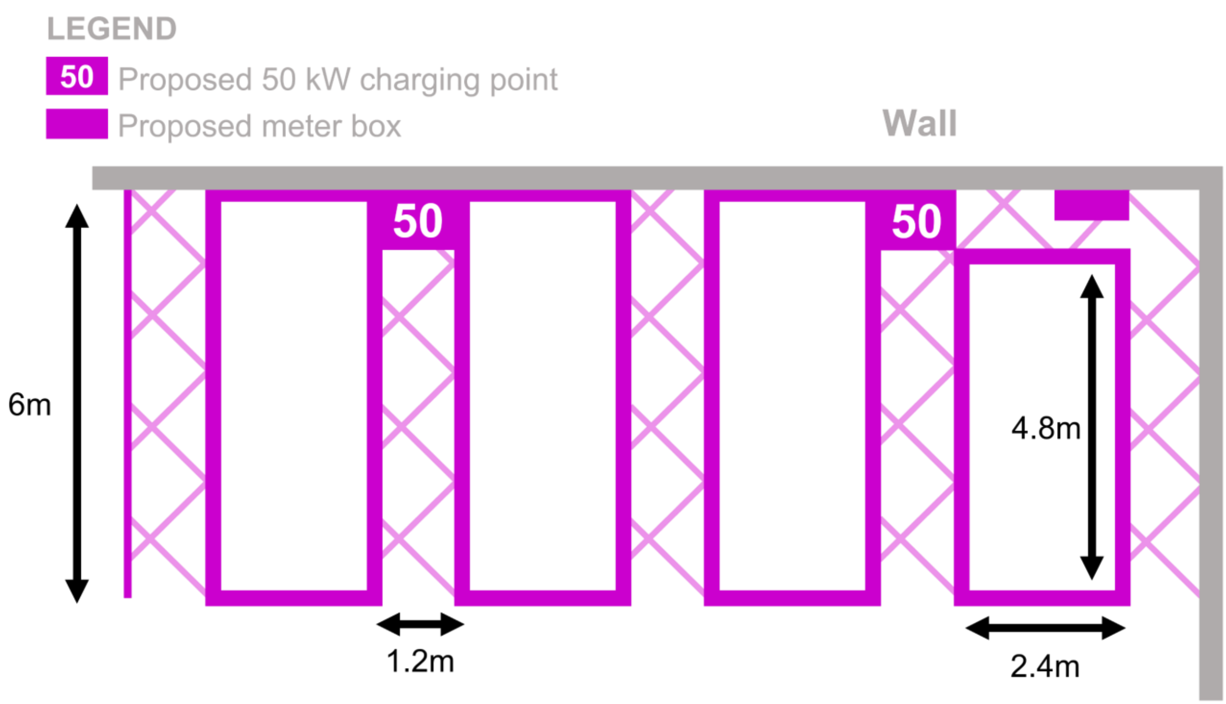

Figure 11: Example site layout for twin 50-kW charging site incorporating long bays for van charging

Key Lessons Learned and Findings

The process of developing a large portfolio of sites through one funding mechanism allowed and justified the development of the processes outlined in the previous sections to help promote a data-first approach to site selection. Key learnings and findings discovered through the project are summarized in the following sections, focusing on site design, minor site relocation, regulatory frameworks, 'hidden' charges, and the provision and type of data.

Site Design

Since project conception, thinking related to accessibility and the built environment adjacent to EV-charging points has progressed significantly. Best-practice guidance for developing accessible EV infrastructure may include consideration of the following factors:

- ✓ Charging point screen height and charge ergonomics
- ✓ On-screen user interfaces (options for alternative languages)
- ✓ Payment methods
- ✓ Accessible bays and access to charging equipment for users with increased mobility requirements
- ✓ Cable retention systems to reduce the perceived cable weight for users
- ✓ Avoid infrastructure immediately at car park entrances to reduce the likelihood of a higher speed collision
- ✓ Is there sufficient space to safely maneuver vehicles in and out of charging bays?
- ✓ Adequate street lighting and CCTV coverage appropriate for the area
- ✓ Charging infrastructure vehicle protection equipment (e.g., bollards) while not hindering access and increasing trip hazards
- ✓ Does the site need to accommodate larger vehicles (e.g., campervans and commercial vehicles)?

Minor adjustments

Communicating power network opportunities and constraints to non-technical stakeholders is important to help demonstrate why grid connections costs between locations can be highly variable. In many cases, the biggest variable between the delivery costs of charging infrastructure between sites is the underlying connection to the power network. To help communicate these challenges to stakeholders, GIS extracts were provided alongside 'traffic-light' power capacity assessments for different network elements to help demonstrate where reinforcements may be required and where candidate alternative sites existed.

Figure 12 provides an example where the local authority was considering hosting a charging point at 'Site A' due to the proximity to a ferry service. The analysis identified that the following significant reinforcements were required to support this connection:

- ✓ LV cable and overhead network conversion to three phase
- ✓ Single-phase 50 kVA transformer required upgrading to a three-phase 100 kVA unit

✓ Overhead single-phase HV network required conversion to three-phase

'Site B' was proposed as an alternative as less extensive network upgrades were anticipated. Note that 'Site B' is in close driving range (<2 minutes) to 'Site A'. Budget quotations received from the distribution network operator indicated that this recommendation would save approximately £35k (~44k USD) – noting that the average site budget, including the purchase of the journey EV charger (~£25k), was approximately £46k.

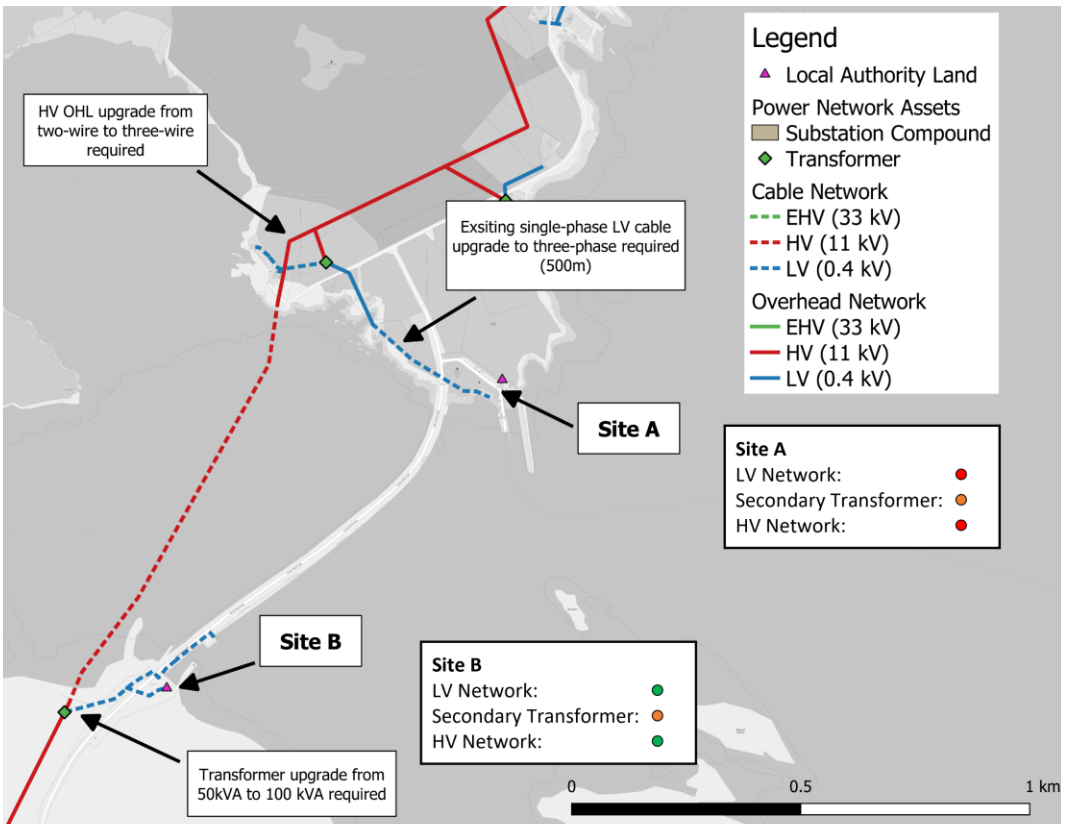

Figure 12. Example power capacity recommendation provided to local authority using 'traffic-light' notation to show challenges for potential charger locations.

Second-Comer Charges and Regulatory Framework Changes

With the distribution company for the Scotland FASTER region requiring up to 65 working days to process formal quotations, it was important to de-risk connections as far as possible before making a formal connection application. This approach worked well for most sites; however, some network connection charges only became visible to the team after receiving the returned quotation for the works – notably, second-comer charges.

'Second-comer' charges were designed to try to ensure the cost of connecting to the electricity distribution network is shared more fairly between different parties. In Great Britain, any connectee who subsequently connects (i.e., the second-comer) to and benefits from infrastructure paid for by an earlier connectee is liable to pay for their share of incurred costs under the electricity connection charging regulations.

In one example, a second-comer charge of approximately £75k was returned through the formal application connection process. With an average site budget of ~£46k (including the charge point), these unexpected network charges can be a considerable barrier to deploying infrastructure.

Second-comer charges were introduced to the market in 2002; however, in the context of the climate emergency and the transition to net-zero, the energy regulator in Great Britain conducted a "significant code review" into distribution network connections. This code review recommended that network upgrades are socialized with a "high-cost cap" to protect consumers from connections that will be too costly to deliver. Unfortunately, the implementation date for the code review did not align with the timescales associated with the FASTER project, however, sites identified that would benefit from these regulatory changes were listed and passed on to local authorities for consideration at a future date.

Provision of Data

Charging infrastructure provision across a country is a constantly changing environment. New charging point installations may be commissioned, while other sites may be out-of-service or removed from service. Methodologies assessing the demand for charging infrastructure need to be dynamic to allow the ever-changing charging network to be considered in site-identification processes. Also, a risk exists that several public and/or private entities could unknowingly be competing to secure electrical capacities for EV-charging infrastructure in parallel. Distribution companies are well positioned to understand the network activity in different regions of their operation areas. However, there are challenges with sharing this activity meaningfully with third-party stakeholders. Innovation is likely required here to help pinpoint areas of high connection interest.

Open data and transparent engineering processes underpinning the FASTER methodology have allowed the creation of a process that helps local authorities, transport partnerships, and other EV-enabling stakeholders to understand the steps involved to deliver the infrastructure associated with the project. The availability of power network shapefiles combined with schematics and demand information allows sites to be de-risked before formal connection applications, saving time for both the project stakeholders as well as reducing the burden on connection teams working for distribution companies.

It should be noted that the regulatory arrangements of different countries and regions around the world may expose or restrict different datasets for a variety of reasons (e.g., market structure, security concerns, etc.).

Conclusions

The FASTER process has successfully identified candidate sites for 24 journey EV-charging points that are deliverable both within the project budget and timescale. The process designed used open and/or public datasets ranging from tourism statistics to vehicle registration data to underpin the analysis. Summary engineering process diagrams have been presented throughout this article to demonstrate the data transformations designed to estimate the requirement for EV-charging points in an area.

To facilitate the transition towards net-zero, the role and requirements of open energy data will likely be increased. Collaboration between stakeholders and sharing of data helps to avoid duplication of effort and, therefore, will accelerate the transition towards net-zero. With the increasing number of low-carbon technologies looking to connect to distribution networks, automated ‘self-serve’ connection tools informing potential customers as to the cost of connecting at a location are becoming increasingly common. Self-serve tools provide an immediate estimate of the cost to connect to the network while also helping to manage the workload of connection teams within distribution companies given the increase in activity expected as the transition towards net-zero accelerates. Self-serve tools are only valuable if the under-pinning data is accurate and updated regularly. The use of confidence intervals could be a useful addition to the output of tools and may help manage the expectations of customers at locations where multiple projects are competing for grid access. Until a formal time-bound quotation is received by infrastructure installers, self-serve budgets should only be considered for initial site validation.

While second-comer charges prevented a small number of sites from moving forward to construction, the remaining sites identified through the process returned costs that were within the project budget allocation.

As the world transitions towards net-zero and in the context of the climate emergency, the role of open data and transparent engineering processes will help support engineers as they develop an EV-charging network that is fit for the future. While much of the existing charging network has been established in an ad-hoc manner, the challenge associated with further decarbonization of road transport will likely require an increased focus from all stakeholders to ensure the delivery of a charging network that has the following characteristics:

- ✓ Equitable
- ✓ Innovative
- ✓ Centered around active and onward travel choices (e.g., charging infrastructure deployed at “park and ride” facilities to encourage the use of public transport into city centers)
- ✓ Affordable
- ✓ Stimulating for local economies and communities

Open and transparent data and processes are one means to help facilitate the transition.

For Further Reading

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