Scotland Zero Emission Bus (ScotZEB) Market Transition Scheme 2022/23

STREAM 1 Report
Telford's Coaches

Revision Final

14 MAR 2023

Contents

1. Project Scope

The focus of this report is **Telford's Coaches,** very much a family business founded in 1964 by William 'Sholto' Telford who purchased their first coach and began operating from Newcastleton in the Scottish Borders. Over the years the fleet has progressively grown and now stands at over 25 diesel vehicles employed on a wide mixture of local, regional, national and European coach hire work. Still based in the Scottish Borders and continuing to be family run by the present Managing Director, Alistair Telford. Alistair wishes to explore the business options to decarbonised and electrify their vehicle fleet, in alignment with Transport Scotland objectives.

The project scope covers operations including scheduled municipal buses and school services with routes centred around Newcastleton. It is noted that service routes are due for tender in April 2023.

Telford's buses operate multiple service routes each within a daily duty. The routes in focus are as follows:

- 5 service routes: 128,127,127A,124, 680
- School runs are completed both separately and combined with service routes above.

All vehicles are Telford's own fleet, there are no leased vehicles provided by the council.

Project outcomes achieved in 3 phases: Concept trial, Phase 1 and Phase 2 of the full deployment.

1.1 Project Participants and Contributors

This project report was put together in collaboration with the following businesses, who contributed with product information, market statistics, their professional expertise and data analytics tools.

KLEANBUS

An organisation seeking to rapidly eliminate diesel emissions from our streets. Diesel bus emissions seriously threaten the health of urban residents, particularly children. Kleanbus provides a fast, innovative, and cost-effective solution to remove diesel engines from our bus transport network by repowering diesel vehicles to electric.

INDUCTEV

A technology specialist provider of automatic high-power inductive charging for commercial vehicles. InductEV permits commercial vehicles to carry smaller onboard battery capacities by providing duty cycle range from opportunity pick-up of energy on the go.

GridBeyond

An energy asset management business, involved with renewable micro-grid generation and an award-winning platform which connects, controls and automates energy demand using machine learning technology. Also a Charge Point Operator offering modular electric vehicle charging solutions for both depot and opportunity charging, providing end-to-end services to fleets of all sizes.

Ryse Energy

A global provider of decentralized renewable energy, providing world class technologies and full on/off - grid energy generation system solutions to some of the most challenging urban and rural environments.

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Please note that all the calculations provided in the report are indicative and based on preliminary estimates and prices valid on the day the report is issued.

2. Current Operations Overview

2.1. Fleet Overview

- 100% diesel fleet
- Scheduled service annual mileage= 645,278km with fuel consumption of 110,181 litres.
  - Qualifies for the Network Support Grant (NSG)
- Current cost of fuel £1.60 per litre, incl. VAT
- 25 vehicles in total (see Appendix B for the details):
  - 5 Mercedes deployed into bus service, and perform some school bus activities
  - 5 Fords are dedicated school buses
  - 14 coaches designated for private hire
  - 1 taxi Ford Transit 8-seater

2.2. Overnight Parking / Depot Facility

- Primary depot is situated at Newcastleton (see Appendix A).
- 15-20 buses return to this depot overnight. Remaining coaches are dispatched on away private hire and holiday coach service, or occasionally may be parked elsewhere overnight.
- Single phase 100A fuse box providing energy supply for the depot. No chargers installed.
- Supporting transformer at North end of the site.
- Current electricity costs: energy cost rate day-time and night-time £0.164 per kWh.
- There are currently no EV chargers installed at the depot.

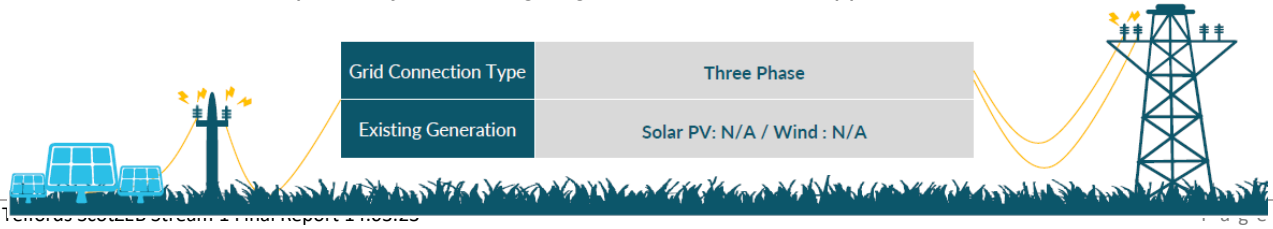
2.3. District Network Operator (DNO) Status and New Connection Feasibility

According to the map of the distribution network operators in the UK, in the national Grid Connections and DNO guide, electricity in the Newcastleton area is supplied by Scottish Power (SP) Energy Networks. Closer investigation confirmed that the local substation is operating at capacity. There are no upgrades planned until 2024 or later. Please refer to Appendix C for detailed illustrations.

Application for new connection is only feasible if there is proposed onsite solar and /or wind microgrid generation. PV systems rated up to 3.68 kW on single phase (up to and including 16 A per phase) can be connected under G98 with only post notification being required by the DNO. An application will need to be made to the DNO to determine the costs associated with connecting a solar PV array at the property as well as wind turbine. Three Phase supply connection is recommended.

The cost of the microgrid generation farm would require grant funding. The reason Telford's represent such an energy challenge is it's isolated rural location, however, the depot building itself and adjoining land have the capability to produce surplus energy above the needs of the electric fleet which would benefit the local area.

Three phase connection application, planning application for wind turbine and civil works for all installations shall be completed by the microgrid generation solution supplier.



2.4 Financial Assessment of Current Operations

Total Current Diesel Fleet: 9 minibuses and 14 coaches (excluding the 8-seater taxi vehicle). Applying Telford's £1.60/litre diesel rate.

This report uses a detailed fleet modelling tool, which requires the fleet operator to enter values and constants. What is displayed is an output based on the selected input values.

Fleet Details	# of vehicle type	mpg by type	Fuel cost per mile (£) by vehicle type	Average daily mileage by vehicle type	Annual mileage per vehicle by vehicle type	Total sub-fleet annual mileage by type	Total sub-fleet fuel cost by type (£)
# of minibus	9	18	£0.40	131	44,540	400,860	161,983
		e.g. Mercedes Sprinter					
# of full size single deck	14	8	£0.91	50	17,000	238,000	216,390
		e.g. Optare Solo					

Figure 2.4.1 Current Telford's diesel fleet fuel costs

Total operational cost, including diesel fuel and Maintenance, Service and Repair (MS&R) for these diesel vehicles is captured within the modelling tool, with operator input to define average annual costs, typically increasing as the vehicles age and worn components require replacement.

Maintenance, Service & Repair (MS&R) (parts & Labour)							
Years 1 - 3		*Years 4 - 6*		*Years 7 - 15*		*Years 15 - 24*	
Annual MS&R	Total sub-fleet MS&R by type	Annual MS&R	Total sub-fleet MS&R by type	Annual MS&R	Total sub-fleet MS&R by type	Annual MS&R	Total sub-fleet MS&R by type
£7,000	£35,000	£10,000	£50,000	£12,000	£60,000	£15,000	£75,000

Figure 2.4.2 Current Telford's diesel fleet operational costs

Excluding the current Network Support Grant (NSG) payment, of £0.144 per kilometre on scheduled service duties (because the private hire proportion of the fleet does not qualify), the cost of running this diesel fleet will be in the region of £1.00 per mile, or £0.63 per km, increasing to £0.73 as vehicles age.

3. Approach

There are three elements to the recommended approach:

(1). **Vehicles**: repowered diesel to electric vehicles, from within the existing Telford's fleet, working with specialist repowering partner Kleanbus.

(2). **Charging**: a strategy of engaging three different charging approaches in combination to address the challenge of achieving the duty cycle each day, as follows; (i) high-power opportunity charging in bus stop / stand locations common with other services, routes and fleet operators (ii) medium power charging in natural schedule daily break points, in convenient locations, where the driver typically rest for lunch breaks (iii). Low-power overnight depot charging.

(3). **Energy**: The deployment of micro-grid generation technologies to lower the cost of electricity power needed, and to provide long-term financial certainty of this supply.

3.1 Fleet

- x7 private hire coaches have been identified as suitable for Kleanbus repower (approx. price of the repower £180,000, incl. battery).
  x5 Mercedes Sprinters used for service routes mostly have been identified as suitable for Kleanbus repower (approx. price of the repower £115,000, incl. battery).
- x6 Ford Transit buses mostly too small and old to repower and should be phased out with new electric buses. Proposed suitable replacement is EVM Cityline (approx. price of new vehicle £230,000).
- Remaining x7 coaches used for private hire are also too old for repower and should be phased out with new electric buses. Proposed suitable replacement is Yutong E-bus and E-coach (approx. price of new vehicle £375,000).
- It is proposed that existing diesel vehicles which are unsuitable for repowering (due to age, condition, odometer etc), could be disposed of, and then appropriate pre-owned, Kleanbus repowered vehicles can be supplemented back into the fleet. This is an effective method of transitioning to electric fleet whilst avoiding the high cost of new OEM electric vehicles.

3.2 Overnight / Depot Charging

Provisionally, to migrate the whole fleet to electric the following charging infrastructure shall be required:

- x6 cable chargers, min spec 50kW DC double-gun (25kW per gun for dual use), shall be required for overnight charging at the Newcastleton depot.
  NOTE: the strategy of using opportunity charging in public locations significantly reduced the need for overnight charging of the vehicle. It is designed for 80 - 90% of the bus charge to be obtained from opportunity charging.
- x2 cable chargers, min spec 100kW DC double-gun (50kW per gun for dual use), shall be required at for top-up charging buses during dwell time and breaks at the identified public locations (see later).

3.3 Microgrid generation to Support Charging Facilities

- Telford's own a piece of land at the back of the property with a natural 30^{o} slope ~50m x 6m, 300 m2 area, currently unused scrubland. A solar photovoltaic (PV) micro-gird electricity generation farm could supply to an onside energy storage facility, with built-in charger.
- South facing, 30^{o} sloping roof on the main building ~20m x 4m could potentially support roof-mounted solar panels / solar film sheet.
- Microgrid energy generation options shall be evaluated, including solar and wind as well as battery storage to support electric chargers.

3.4 Opportunity Charging

Opportunity charging locations shall be initially evaluated via a desktop model for current service routes and once approved and installed, will remain available to use to whatever operator takes over those routes and associated vehicles.

Opportunity charging solutions to be evaluated: high power wireless charging technology and inverted pantographs for quick top-ups at bus stops as well as rapid cable chargers 100kW+ at dwell points.

Opportunity chargers shall be shared with other operators and other routes and become a part of the local infrastructure to benefit other businesses and community as a whole.

4. Baseline

4.1 Fleet

Focusing on the x5 Mercedes Sprinter minibus vehicles, assuming they covered each around 70 miles per "operational day" of service per year, using 340 operational days per year. At £1.60 per litre, the 120,000 miles would have cost just under £50,000 per year.

Fleet Details	# of vehicle type	mpg by type		Fuel cost per mile (£) by vehicle type	Average daily mileage by vehicle type	Annual mileage per vehicle by vehicle type	Total sub-fleet annual mileage by type	Total sub-fleet fuel cost by type (£)
# of minibus	5	Fleet Details	# of vehicle type	mpg by type	Fuel cost per mile (£) by vehicle type	Average daily mileage by vehicle type	Annual mileage per vehicle by vehicle type	Total sub-fleet annual mileage by type	Total sub-fleet fuel cost by type (£)
		# of minibus	5	18	£0.40	70	23,800	119,000	48,087

Figure 4.1 Current Telford's operational costs for service vehicles proposed for repower

The operational cost of this sub-fleet of minibuses will be £0.21 per km, including the NSG payment (£0.35 per km without). This is the figure we establish as baseline cost of existing operations to compare future proposals against.

4.2 Depot Charging

A perfect technical solution for Telford's bus depot for energy would be a solar and wind energy farm feeding either into a static on-site energy store or directly into the grid.

Preliminary evaluations suggest that approx. 500 kWh of energy could be harvested each day, which would be sufficient to charge x5 vehicles at night. Total annual requirement for supporting these vehicles is estimated at 175,000 kWh (excluding service days and holidays). This requirement must be fulfilled by a combination of opportunity and depot charging, with opportunity charging providing at least 20% of the annual estimate.

There are two options for depot microgrid generation, as per SP Energy Networks guide for Connecting your EV fleet:

- OPTION 1 - Microgrid generation is fully supported by the battery storage unit which EV chargers onsite are connected to, without the need for a new or upgraded grid connection. The new three phase connection will only be required to feed surplus energy to the grid.
- OPTION 2 - All of the microgrid generated energy is supplied directly into the grid, without using a battery storage, and EV chargers are connected to the grid. Annual capacity of the microgrid generation farm must be equal or exceed the maximum annual amount of energy EV chargers are expected to consume. Three phase connection to the grid is required.

5. Concept Trial with Opportunity Charging

5.1 Service Routes

Suggested service routes for the concept trial: Service 128 (dwell at Hawick), Service 124 (dwell at Langholm), Service 127A (dwell at Newcastleton depot)

5.2 Fleet

- 5 service Mercedes Sprinters are recommended to be repowered by Kleanbus. Recommended battery capacity of 115 kWh will provide 190 miles range for the bus of this size.

- Kleanbus price of the repower £90,000 + £25,000 for the battery or £5,600 annual battery as a service lease.

5.3 Opportunity Charging

- x1 rapid cable charger 100kW+ is recommended for each of the dwell points:
    - Car park at Hawick TD9 7NP (22kW AC chargers already installed onsite, but only suitable for passenger vehicles)
    - Kilngreen at Langholm (22kW AC chargers and 50kW DC chargers already installed onsite, but only suitable for passenger vehicles and vans)

Charger Type	Total Qty	Price per Unit	Total Equipment Price
100kW DC charger	2	£20,000	£40,000

*GridBeyond price includes equipment only, installation cost is subject to site survey, excl.VAT

5.4 Overnight Charging

- Initially x2 overnight chargers, 50kW DC double-gun (25kW per gun for dual use), are recommended Newcastleton Depot and x1 rapid charger 100kW DC double-gun (50kW per gun for dual use) to top-up buses during dwell time on route 127A.

Charger Type	Total Qty	Price per Unit*	Total Price
50kW DC charger	2	£19,000	£38,000
100kW DC charger	1	£38,680	£38,680

* GridBeyond price includes installation estimate, subject to site survey and verification, excl.VAT

5.5 Microgrid Generation

- OPTION 1 – GridBeyond® solution with battery storage:

Item	Description	GridBeyond Price
Solar 110kW system for both roof and land. 105,600 kWh/year	Price includes site survey, installation and connection to the battery storage.	£132,000
100kW/500kWh battery storage	Price includes installation and connection to EV chargers.	£420,000
15kW wind turbine, generates 43,800kWh/year	Price includes site survey, planning permission, installation and connection to the battery storage.	£115,000
TOTAL: 149,400kWh/year	excludes 20% VAT	£667,000

- OPTION 2 – RyseEnergy® Solution without battery storage supplying direct to the grid:

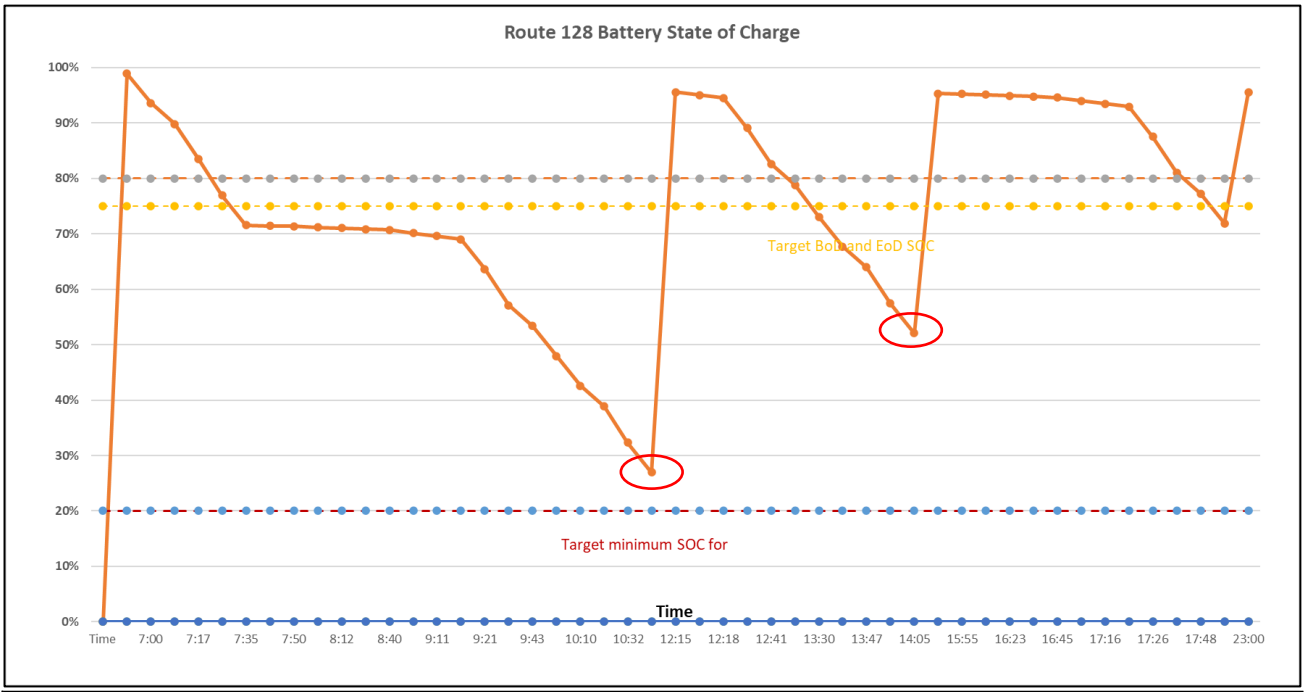
Item	Description	RyseEnergy Price
Solar 15.2 kWp system on the roof. 13,406kWh /year.	Price includes equipment and installation.	£18,000
Solar 19.8 kWp system on the adjacent land. 17,463kWh /year.	Price includes equipment, installation and commissioning.	£23,000
E- 60 Wind Turbine, 62.5kWp, 24m lattice tower. 113,851 kWh /year.	Price includes equipment, installation and commissioning.	£ 300,000
TOTAL: 144,720 kWh/year	excludes 20% VAT	£341,000

5.6 Energy Models

Kleanbus repowered vehicle characteristics were used for building energy models below to verify vehicles will be able to complete daily service routes without disruption.

Route 128

- Start time 07.00 - Finish at 18:00
- Daily mileage = 130.6 miles
- Opportunity charging in all weather (winter -6ºC depicted on the graph below):
  - **90 min** charging during dwell times at **Hawick car park** with a **100kW** charger.
- Sufficient 'buffer' time available in the schedule to increase charging time if required.
- **1.5 hrs** night-time charging with **25kW** plug-in charger shall be sufficient.



Stops/Potential Sites	Select Charger	Level-kW	Dwell Time	Max	Schedule
Hawick, Mart Street- dwell1	Plug100	88.0	-	0:25:00	8:45-9:10
Hawick, Mart Street- dwell2	Plug100	88.0	55.0	1:32:00	10:43-12:15
Hawick, Mart Street- dwell3	Plug100	88.0	35.0	1:37:00	14:13-15:50
Telfords Depot -OVERNIGHT	Plug25	22.0	90.0	11:00:00	18:00-6:00

Figure 5.6.1 Energy Model Route 128

Google Maps Image 1 Car park at Hawick TD9 7NP, next to the bus stop
Infrastructure already available onsite for EV charging

Selection of Opportunity charging locations: Example

The critical factor here is distributed, shared, community high-power charging infrastructure, for public transport, and potentially to be available for other commercial vehicles, including emergency services.

Therefore, the evaluation of these target locations for dwell point charging is important. One major consideration would be the popularity of the selected location, which would then determine the interest of commercial businesses in whether private investment in the infrastructure was feasible or not. Charging asset utilisation is a key factor, the higher the utilisation, the higher the potential commercial revenue from the infrastructure.

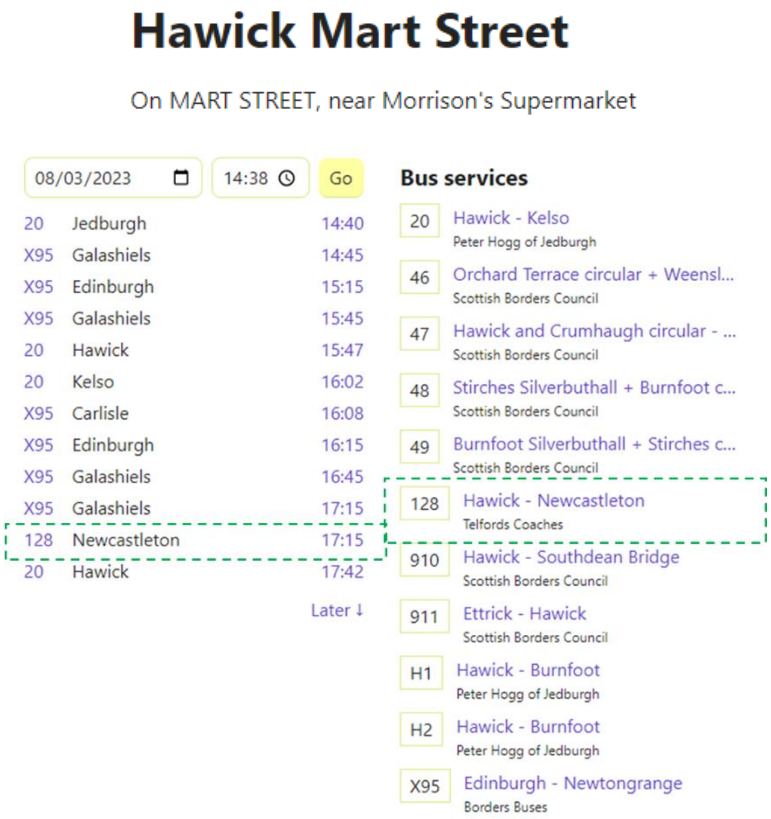
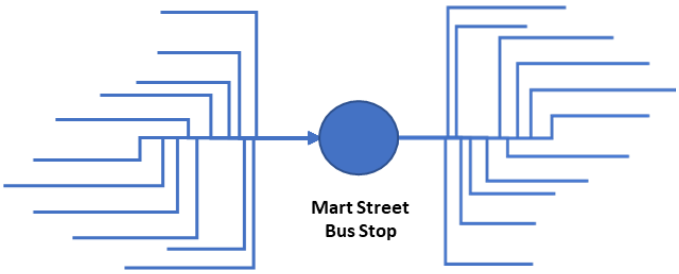


Figure 5.6.2 Hawick bus stop timetable

- **Hawick, Mart Street**
- **One bus stop**
- **11 associated routes**
- **Four different fleet operators**

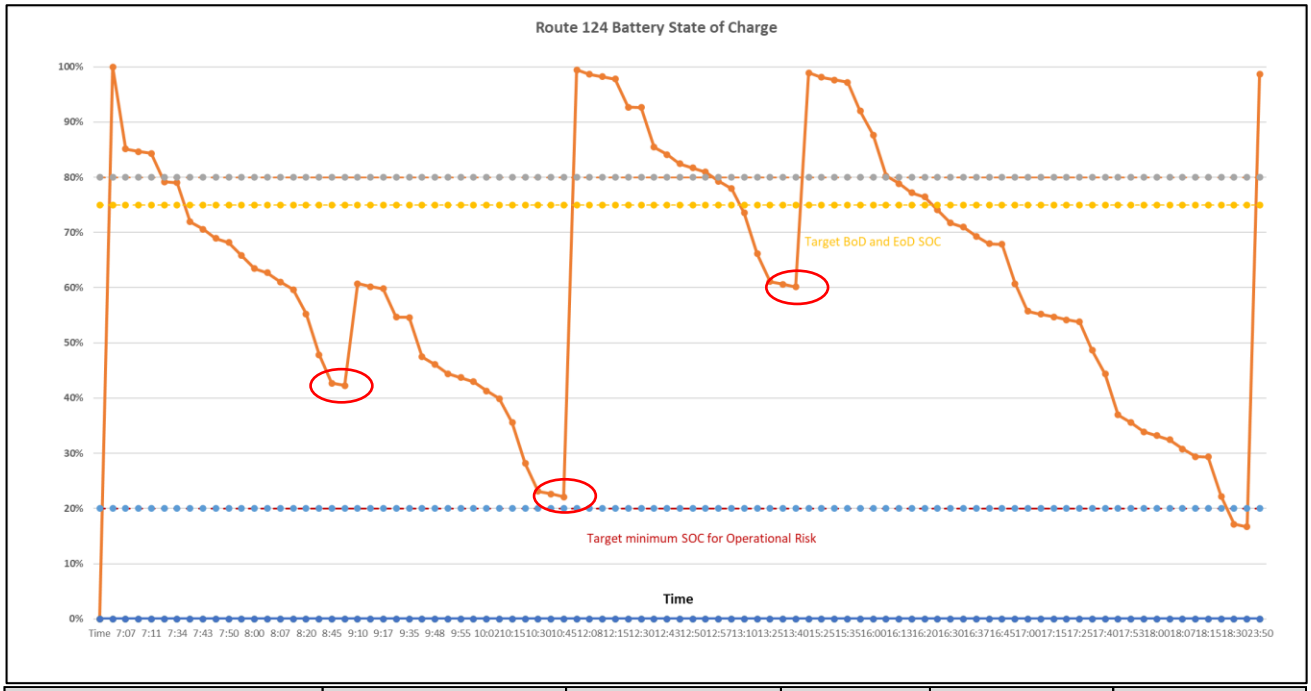


This analysis shows that within a short window of just a few hours (14:20 to 17:42), there are 12 buses coming to use the Mart Street, Hawick bus stop, including the Telford's route 128 service.

This is an example of an ideal location for the investment in charging infrastructure.

Route 124

- Start time 07.00 - Finish at 19:00
- Daily mileage = 256 miles
- Opportunity charging in all weather (winter 0°C depicted on the graph below):
  - **109 min** charging during dwell times at **Kilngreen Car park** with a **100kW** charger.
- Sufficient 'buffer' time available in the schedule to increase charging time if required.
- **5 hrs** night-time charging with **25kW** plug-in charger shall be sufficient.



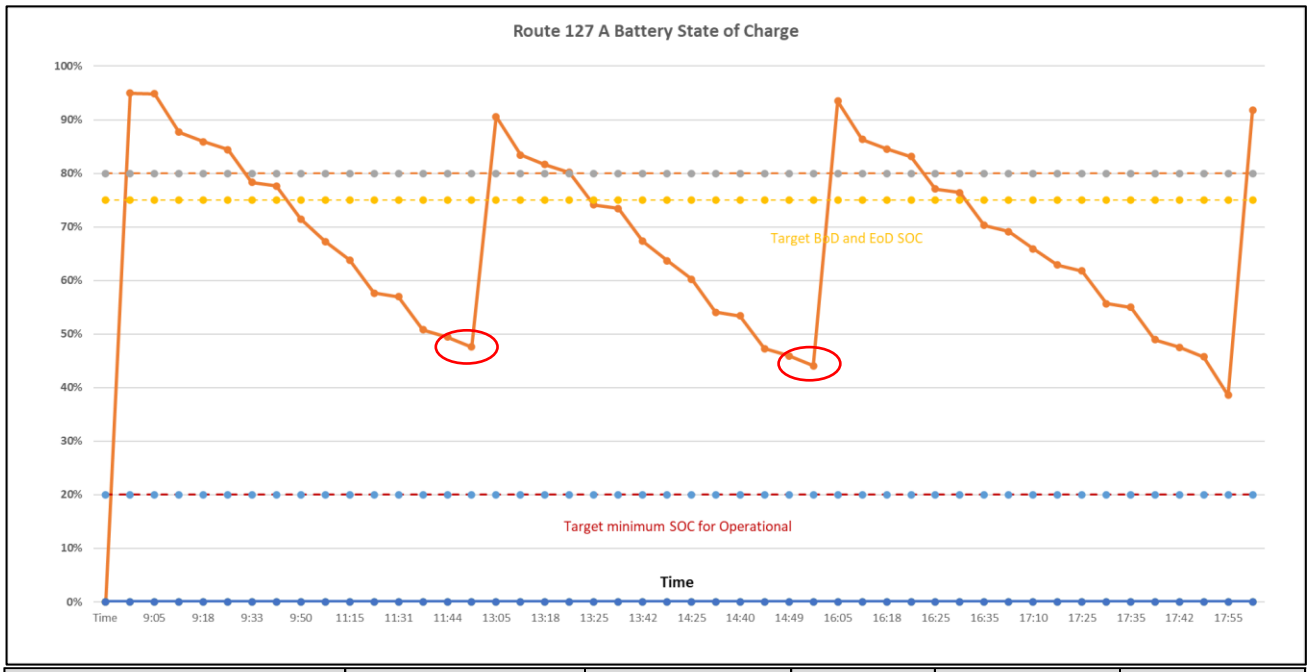
Stops/Potential Sites	Select Charger	Level-kW	Dwell Time	Max	Schedule
Kilngreen dwell time 1	Plug100	88.0	15.0	0:15:00	8:55-9:10
Kilngreen dwell time 2	Plug100	88.0	62.0	1:15:00	10:48-12:03
Kilngreen dwell time 3	Plug100	88.0	32.0	1:37:00	13:43-15:20
Telfords Depot -OVERNIGHT	Plug25	22.0	315.0	11:00:00	19:00-07:00

Figure 5.6.2 Energy Model Route 124

Google Maps Image 2 Car park at Kilngreen, Langholm
Infrastructure already available onsite for EV charging

Route 127A
(Mon, Wed, Thu example)

- Start time 09.00 - Finish at 18:00
- Daily mileage = 160 miles
- Opportunity charging in all weather (winter -6ºC depicted on the graph):
  - **85 min** charging during dwell times at **Newcastleton depot** with a **100kW** charger.
- Sufficient 'buffer' time available in the schedule to increase charging time if required.
- **2.5 hrs** night-time charging with **25kW** plug in charger shall be sufficient.



Stops/Potential Sites	Select Charger	Level-kW	Dwell Time	Max	Schedule
Newcaslteton -break1	Plug100	88.0	40.0	1:08:00	11:57-13:05
Newcaslteton -break2	Plug100	88.0	45.0	1:03:00	15:02-16:05
Telfords Depot -OVERNIGHT	Plug25	22.0	180.0	11:00:00	18:00-6:00

Figure 5.6.3 Energy Model Route 127A

Google Maps Image 3 Telfords Coaches, Newcastleton depot
Infrastructure onsite will have to be supported by microgrid generation.

6. Project Financial Evaluation and Implementation Timelines

6.1 Concept Trial

Energy models confirm that all routes heavily rely on opportunity charging throughout the day, particularly in winter temperatures, as graph examples above clearly demonstrate. Operating in milder temperatures around 10°C, and using opportunity charging allows the state of charge at the end of the day to improve to an average of 60% and even further to nearly 80% in summer when ambient temperatures reach 18-20°C.

Therefore, the desk-top energy model confirms that average annual split between opportunity charging and depot charging is 50:50. Although, financial evaluation below shows that with microgrid generation farm at the depot it would be more beneficial for buses to prioritise depot charging and aim to return to the depot at the end of the day with an average of 20% state of charge.

Figure 6.1.1 below shows the impact of a Kleanbus repower of the target x5 Mercedes Sprinters to electric. Accounting for the vehicle repower costs, battery and then the operational cost of running the electric fleet, compared to diesel fleet, there is an overall financial benefit.

Over a 7-year period, the savings of adopting these recommendations are calculated as £502,761.

	Kleanbus Repower Costs				Diesel Op. Cost	Kleanbus Op. Cost	Saving
	Kleanbus Repower costs Mercedes Sprinter	*Kleanbus Repower costs Mercedes Sprinter fleet*	*Kleanbus Repower battery lease 7-year fleet total 115 kWh*	*Kleanbus Repower Double Decker x16 vehicles fleet*	*Total Operational Cost x5 diesel Minibus Total 7 years*	*Total operational cost x5 Kleanbus minibus Total first 7 years*	*7-Year total operational cost saving, including repower costs*
	Single Vehicle	*x5 Vehicles*	*Battery as a Service*	*Repower + Battery*	Mercedes Sprinter	*Electricity + MS&R*	
Standard Kleanbus Repower	£85,000	£425,000	£176,400	£601,400	£860,349	-£243,812	£502,761
	Assuming £1.65 diesel costs per litre					Including £0.144 NSG	
	Assuming 80% charging at Telford's financed microgird at £0.00 and 20% charging in public dwell point charge sites at £0.36						

Figure 6.1.1 Return on Investment

The x5 Mercedes minibuses complete between 130-256 miles per day. If 20% of the charging is obtained from the opportunity charging locations, then either of the proposed depot microgeneration solutions will successfully sustain the fleet of concept trial electric vehicles.

Note that 80% “free” energy, if provided from a financed solar farm, including £0.144 per km NSG takes the Kleanbus service operations into negative cost!

It takes the cost to £0.02/km and therefore -£0.12 per km including NSG.

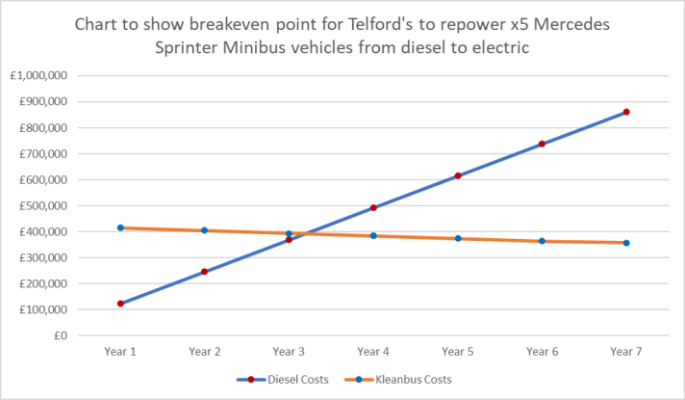


Figure 6.1.2 Breakeven point with the depot microgrid generation farm

If capital financing or grant support funding were available to develop the microgrid generation farm at Telford's then, it could electrify vehicles with significantly lower operational costs.

The payback return on the investment to repower will occur after year 3.

We see an up-front investment which then delivers saving over the remaining life of the vehicle.

It is envisaged that the initial concept trial, once funded and deployed, would take 3-6 months to validate assumptions in the existing approach.

6.2 Implementation Timeline

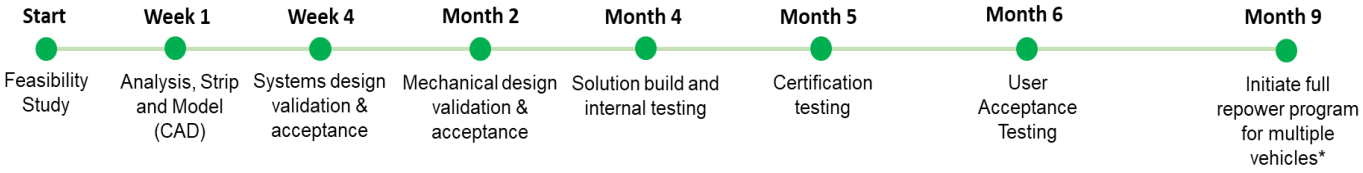


Figure 6.2 Kleanbus Repower Timeline

Subsequent vehicles of the same type can be repowered in less than a week.

It is worth noting that that Kleanbus componentry within these vehicles could highly likely be re-purposed into another Mercedes Sprinter, for a second repower at the end of the initial vehicles' life, or in the event of a vehicle being written off (for any reason which did not impact the Kleanbus modular "bolt-in" solution).

6.3 Phase 1

Phase 1 of the deployment would be to replicate the concept completed with improvements to the remainder of the fleet and repower coaches using Kleanbus solution. Also introduce opportunity charging into some of the coach tour schedules.

The next Telford's vehicles which come into focus are the Ford Transit 16-seat school buses. A number of options exists, however current thinking would be to dispose of these Ford vehicles and acquire (via purchase or lease) a set of new electric buses or pre-owned repowered ones of the similar specification.

It would be feasible to upgrade the microgeneration farm at Telford's and introduce additional wind turbine and more solar panels on the land to accommodate more charging stations.

Using the same assumptions within the Kleanbus-modelling tool, including the fleet type composition, daily distance travelled, plus the current daily energy rate it is possible to dramatically reduce the cost of daily operations at Telford's.

6.4 Phase 2

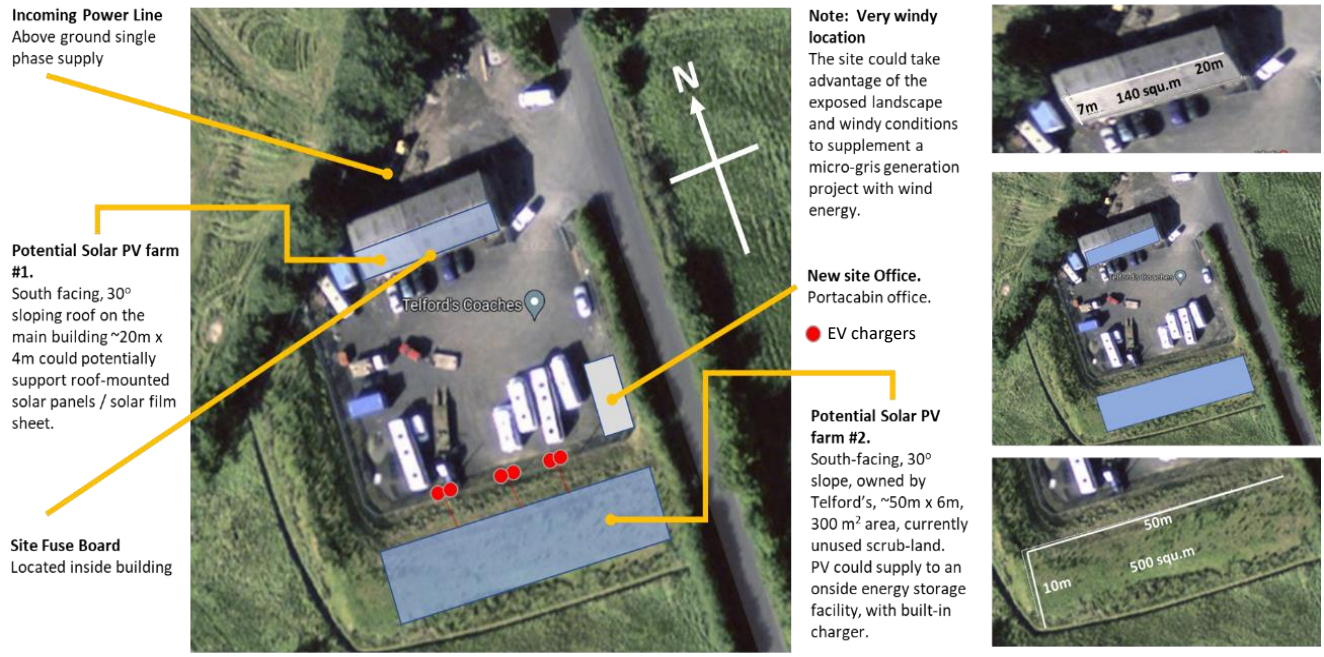
Phase 2 and the final step would be to introduce opportunity charging to more coach tour schedules.

Telford's operate a fleet of 14 large coach vehicles, which operate for private hire and also service luxury coach holidays. These unpredictable duty cycles (unknown distance per day) represent a significant planning challenge, as they are clearly dispatched to very different venues and locations daily.

The recommendation here is to form a consortium of all luxury coach holiday providers who operate within Scotland. The recommended path forward is as follows;

1. Engage an independent body (e.g. CTZ Ltd.) to form a consortium of target fleet operators.
2. Together as a total fleet representative body, establish the x50 most common venue locations for coach holiday in across Scotland. This would need to include the overnight parking areas provided for the coaches, whether at the hotels or otherwise.
3. Model the daily and annual demand for charging at all sites throughout the year for the combined fleet.
4. Use these two lists to engage with the major utilities and charge point operators, to provide the infrastructure to be able to opportunity charge these electric coaches at as many locations as possible.
5. Align the electrification of vehicles with the deployment success of opportunity charging at the appropriate locations.

Appendix A. Telford's Coaches Newcastleton Depot



Newcastleton depot microgrid generation farm, sketch proposal drawn on a Google Maps image.

Incoming single-phase supply, from the North end of the site.

Internal master fuse, circuit breaker

100-amp site fuse

Site electricity meter

Appendix B. List of Active Vehicles

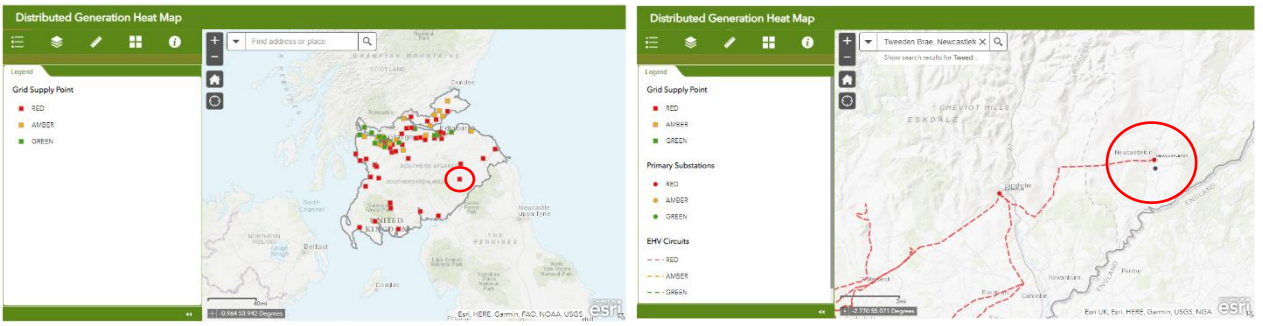
Reg No	Type	Year	Duty	Seating Capacity	Comments	Km	Kleanbus Evaluation
SN13DDF	Mercedes Vario	2013	Private hire	29 seat		357535	Too old. Replace by new
PO61LUR	Mercedes Vario	2012	Private hire	33 seats		494587	Too old. Replace by new
YN55WPM	Mercedes Vario	2006	Private hire	24 seats		245984	Too old. Replace by new
X4TCL	Volvo Lux Coach	2013	Private hire	53 seat	Euro5	581881	Suitable for repower
X2TCN	Volvo Lux Coach	2016	Private hire	53 seat	Euro6	340491	Suitable for repower
LK13CYT	Mercedes Sprinter	2013	bus service	16 seats		397752	currently off road. Too old. Replace by new
SC65WGC	Mercedes Sprinter	2016	bus service	22 seats		294392	680 Carlisle -Brampton Too old. Replace by new
PL18YKM	Ford-Transit	2018	Taxi transit	8 seats		74032	Too small Replace by new
LK13CYW	Mercedes Sprinter	2013	bus service	16 seat		364391	124 Newcastleton to Eskdalemiur Too old. Replace by new
YN54WCT	Mercedes Vario	2004	Private hire	33 seat		32643	Too old. Replace by new
MEZ1708	Mercedes Vario	2007	Private hire	33 seat		774107	Too old. Replace by new
SN61CXC	Mercedes Vario	2011	Private hire	24 seat		516176	Too old. Replace by new
SS11PCH	Mercedes Vario	2011	Private hire	24 seat		265289	Too old. Replace by new
X10JLT	MAN Coach	2017	Private hire	70 seat	Euro6	176788	Suitable for repower
X9TCL	MAN Coach	2018	Private hire	36 seat	Euro6	159589	Suitable for repower
HK69FXX	Ford-Transit	2019	school bus	16 seat		111991	?
KT15MTU	Mercedes Sprinter	2015	bus service	16 seat		94787	127A Newcastleton to Carlisle 5 times a day Too old. Replace by new
X3TCN	VDL Lux Coach	2019	Private hire	53 seat	Euro6	125683	Suitable for repower
X7TCL	VDL lux Coach	2013	Private hire	57 seat	Euro5	492220	Suitable for repower
NJ62LFU	Ford-Transit	2013	school bus	16 seat		145118	Too old. Replace by new
NL10BOH	Ford-Transit	2010	school bus	16 seat		348835	Too old. Replace by new
X8TCL	MAN Coach	2020	Private hire	36 seat	Euro6	85163	Suitable for repower
KM16KRU	Mercedes Sprinter	2016	bus service	16 seat		75473	128 Newstleton to Hawick 5 times a day + school runs Too old. Replace by new
HN62DZB	Ford-Transit	2012	school bus	16 seat		267119	Too old. Replace by new
LJ13VAV	Ford-Transit	2013	school bus	16 seat		225086	Too old. Replace by new

Appendix C. SP Energy Networks Distribution Heat Maps

Scottish Power Energy Networks Distribution Heat Maps application provides an indication of the potential opportunities to connect Distributed Generation (DG) to the 11kV and 33kV network in the SP Distribution plc license area (Central & Southern Scotland).

Each substation and circuit have been assigned one of the following categories:

Category	Description
Green	All operational factors are within tolerable limits and so opportunities may exist to connect additional Distributed Generation without reinforcing the network (subject to detailed studies).
Amber	At least one factor is nearing its operational limit and hence, depending on the nature of the application, network reinforcement may be required. However, this can only be confirmed by detailed network analysis.
Red	At least one factor is close to its operational limit and so installation of most levels of Distributed Generation and a local connection is highly unlikely. It may also require extensive reinforcement works or given the lack of a local connection, require an extensive amount of sole user assets to facilitate such a connection.



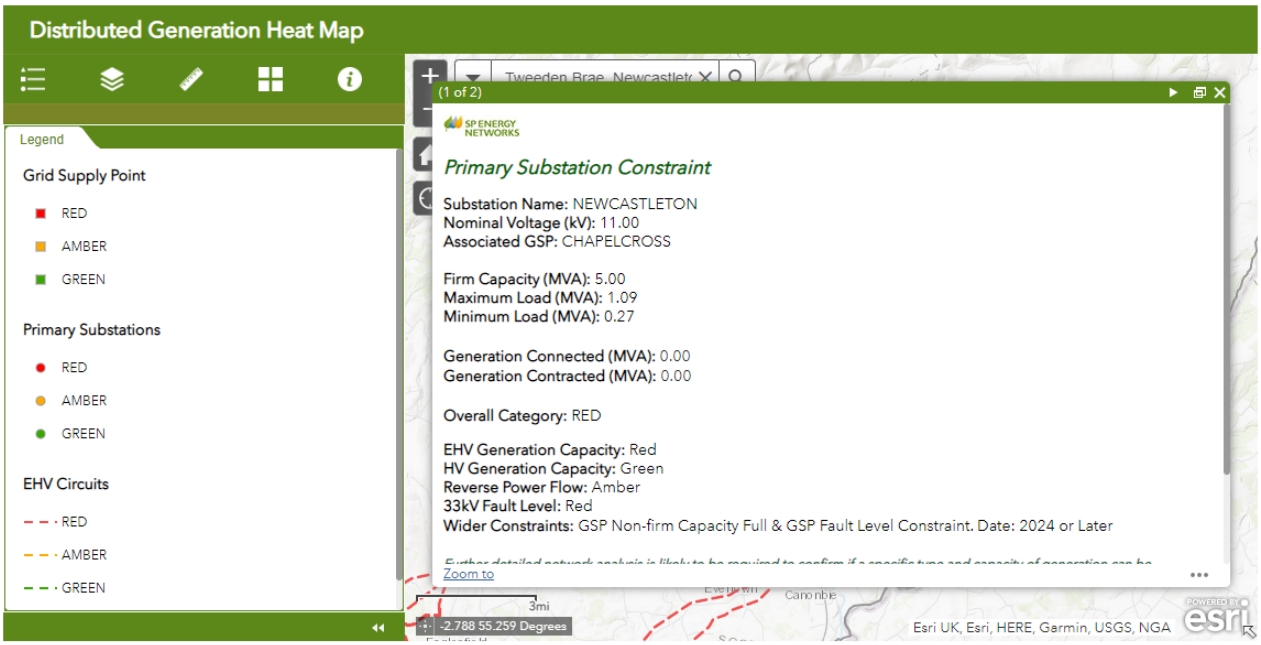


Figure C1 Telford's depot Newcastleton supporting sub-station