Lowering your emissions
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PROJECT
REPORT

DfE 10x Economy: Open Call for Research

Transport Energy Research Project 1:
Transition to EVs

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Prepared for:

Department for the Economy
Adelaide House
39-49 Adelaide Street
Belfast, BT2 8FD

Prepared by:

Peter Speers
Principal Technical Specialist

Approved by:

Andrew Benfield
Country Manager - Ireland

Company Details

Cenex
Holywell Building
Holywell Park
Ashby Road
Loughborough
Leicestershire
LE11 3UZ

Registered in England No. 5371158

Tel: 01509 642 500
Email: info@cenex.co.uk
Website: www.cenex.co.uk

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Document Revisions

No.	Details	Date
1	Initial release to DfE	19/04/23
2	Revision following feedback	26/06/23

Contents

Abbreviations

BEV	Battery Electric Vehicle
BSP	Bulk Supply Point
CCC	Climate Change Committee
CO_2	Carbon Dioxide
EV	Electric Vehicle
EVI	Electric Vehicle Charging Infrastructure
EVSE	Electric Vehicle Supply Equipment
GW, GWh	Gigawatt, Gigawatt Hour
HGV	Heavy Goods Vehicle
HRS	Hydrogen Refuelling Station
kW, kWh	Kilowatt, Kilowatt Hour
LA	Local Authority
LGV	Light Goods Vehicle
NIEN	Northern Ireland Electricity Networks
RSTN	Regional Strategic Transport Network
SONI	System Operator for Northern Ireland
ZE	Zero Emission

1 Executive Summary

This report is produced for the Energy Group in the Department for the Economy and aims to investigate the potential uptake of EV cars and vans and associated recharging/ infrastructure requirements to 2040. The investigation uses three scenarios for EV car and van uptake in NI to 2040 from SONI[1] and Steer[2] and associated recharging infrastructure uptake based on Cenex modelling. The scenarios are underpinned by the need to achieve Net Zero in NI in line with UK government policy.

Vehicles

- All scenarios show the number of EVs in NI growing rapidly from 2025 onwards. In the most ambitious scenario – SONI's Accelerated Ambition (AA) – the number of EV car and vans is projected to reach 776k in 2030 and 1.18m by 2040. The SONI Addressing Climate Change scenario anticipates lower uptake of 606k by 2030 and 940k by 2040.

Energy demand

- The greater energy efficiency of ZE vehicles compared to conventionally fuelled equivalents means that the overall energy demand from cars and vans will fall substantially as EV equivalents are adopted. In the SONI AA scenario daily car and van energy requirements will fall from 32.5 GWh in 2020 to 10.7 GWh in 2040.

Infrastructure uptake scenarios

- Currently there are fewer than 400 public charging points in NI marked on Zap-Map[3], with no available data on how many are operational.
- The transition to EV cars and vans will require a massive expansion of the public charger network. According to Cenex's modelling, by 2030 the SONI AA scenario will require the deployment of over 10,000 public chargepoints. By 2040 this will increase to almost 25,000.
- Standard 7 kW units primarily designed for overnight charging account for around 90% of the total chargepoint needs.
- Rapid (50 kW) and ultra-rapid (150 kW) charger numbers will also need to grow substantially. Under the SONI AA scenario 50 kW unit needs are projected to be 500 by 2030 and 750 by 2040. As EV uptake grows and technology continues to develop, ultra-rapid charging is expected to dominate fast charging needs, and 150 kW unit numbers are projected to be 430 in 2030 and 1,300 by 2040.

Electricity supply needs

- Mapping the distribution of fuelling station locations and the current supply network and demand headroom (the demand headroom is the difference between the rating of the supply and the current demand from consumers) shows that the substations around the fuelling stations have headroom.
- In the future, it is likely that users of the fuelling network will favour rapid and ultra-rapid charging as most home or at base charging will be overnight using standard 7 kW chargers. Mapping the fuelling station locations closest to the RSTN shows that most of the fuelling stations are near substations with some demand headroom, but it is noted that many of those have a relatively limited amount available and that therefore electricity supply upgrades may be required at these locations in future.

Discussions and caveats of the analysis

The current energy demand numbers produced by this analysis are accurate as they are based on the energy usage of the current vehicle parc.

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[1] TESNI-2020.pdf (soni.ltd.uk), SONI, 2020
[2] Development of Electric Vehicles in Northern Ireland (qub.ac.uk) Steer for Department for Infrastructure, 2021
[3] https://www.zap-map.com/

The number of EVs in the future vehicle parc is however uncertain, with key variables including the availability, cost and performance of EV replacements and the cost and availability of associated recharging infrastructure.

Next steps

The scenarios presented here have shown the potential scale of national EV uptake and the associated energy demand and refuelling requirements. Among suggested next steps are:

- To survey in detail the locations of key refuelling to understand the electricity supply requirements and how EV recharging infrastructure can be accommodated alongside existing fuelling equipment during the EV transition. This will help identify where “quick wins” for building infrastructure can occur and where business case modelling will be required to justify any grid upgrades to meet future demand of infrastructure.
- To understand how renewable electricity can be provided to key points of demand, and the role of bi-directional charging and battery storage in mitigating electricity network capability requirements and associated costs. This will ensure that investment in the network is placed appropriately, alongside ensuring that the carbon associated with electricity production is reduced for its application in electric vehicles.
- To further develop the data and mapping in this report into a National Chargepoint Registry of all chargepoints. The current lack of accurate and up to date on the number and location of existing chargers:
    - reduces confidence for both private drivers and companies considering purchasing EVs that the public charging exists and is growing.
    - makes it difficult for the chargepoint operator industry from easily identifying market potential, reducing private sector investment in provision compared to other areas.
    - means that national and local policymakers struggle to understand the size of the gap between need and provision, develop strategies and plans for new charging, and to assess future electricity needs.
    - Stifles technology innovation around the provision of EV charging data by 3rd party suppliers and wider research into EV uptake.

2 Introduction

2.1 Introduction to Cenex

Cenex was established as the UK's first Centre of Excellence for Low Carbon and Fuel Cell technologies in 2005.

Today, Cenex focuses on low emission transport & associated energy infrastructure and operates as an independent, not-for-profit research technology organisation (RTO) and consultancy, specialising in the project delivery, innovation support and market development.

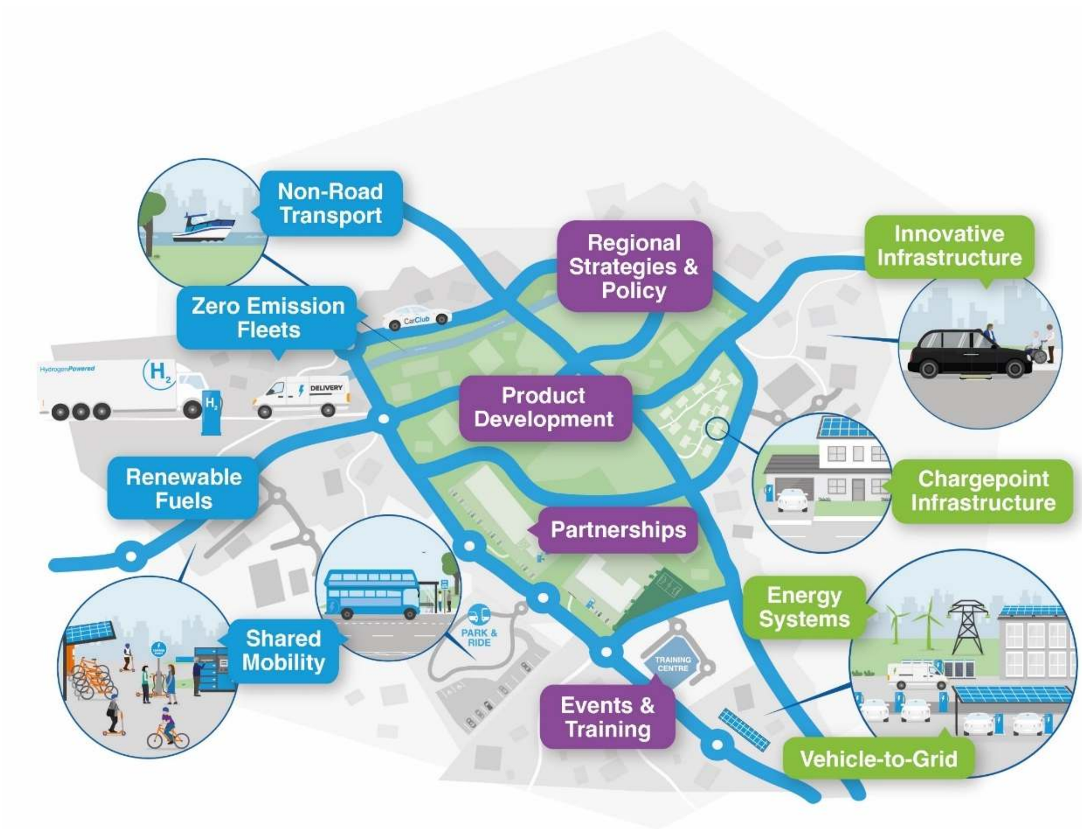
We also organise Cenex-LCV, the UK's premier low carbon vehicle event, to showcase the latest technology and innovation in the industry.

Our independence ensures impartial, trustworthy advice, and, as a not-for-profit, we are driven by the outcomes that are right for you, your industry and your environment, not by the work which pays the most or favours one technology.

Finally, as trusted advisors with expert knowledge, we are the go-to source of guidance and support for public and private sector organisations along their transition to a zero-carbon future and will always provide you with the insights and solutions that reduce pollution, increase efficiency and lower costs.

To find out more about us and the work that we do, visit our website:

www.cenex.co.uk



3 Project Introduction

3.1 Background

The 2021 Department for the Economy (DfE) published *10X Economy – an economic vision for a decade of innovation* (https://www.economy-ni.gov.uk/publications/10x-economy-economic-vision-decade-innovation). In October 2022, the DfE published *A 10X Economy – Research Programme 2022-23 and Beyond* (https://www.economy-ni.gov.uk/publications/10x-economy-open-call-research-proposals) which highlighted the key research areas for the 2022-23 year, and beyond, as the Department seeks to deliver on its 10X Economy Vision and the Department for Infrastructure's EV Infrastructure Action Plan (https://www.infrastructure-ni.gov.uk/sites/default/files/publications/infrastructure/ev-infrastructure-action-plan-2022.pdf).

Queen's University Belfast (QUB) and Cenex were allocated funding from the Department for the Economy (DfE) to research on the decarbonisation of energy used within light duty vehicles (cars and vans), hereafter, Project 1 (HGVs are addressed in Project 3). The key relevance of this to DfE's policy vires is how decarbonising transport will reduce the current reliance on liquid fossil fuels and grow the demand for alternative low or zero emission fuels such as renewable electricity, green hydrogen or biomethane and their associated refuelling infrastructure.

3.2 Aim

To identify car and light good vehicle (LGV) fuelling locations across NI and assess the implications of the transition to EV recharging.

3.3 Challenges

There is a need for data to inform policy in:

1. Number of existing fuel outlets in Northern Ireland.
2. Petrol / diesel fuel capacity.
3. Electrical grid capacity at existing fuel outlets.
4. Projected and planned grid capacity expansion at existing fuel outlets.
5. Analysis of the growth of EVs to 2025, 2030 & 2035. `

3.4 Scope

- Cars and LGVs of 3.5t and under.
- While the energy demands of the car and LGV fleet as a whole will be assessed (i.e. covering home and public charging), the refuelling infrastructure requirements will be assessed in detail for *public refuelling only*. Based on Cenex's NEVIS model derived from data for the UK as a whole[4] (discussed in Appendix A), it is assumed that
    - 68% of charging is at home.
    - 32% of charging is public.
- Heavy goods vehicles (HGVs) are not included as they are addressed in a separate report.

[4] http://www.field-dynamics.co.uk/wp-content/uploads/2020/09/On-Street-Households_The-next-EV-Challenge-and-Opportunity-1.pdf

4 Project Methodology

As outlined in the Project 1 proposal, the project has been delivered as four Work Packages (WP) as follows:

4.1.1 WP1 – Data Gathering for Fuelling and Grid

Existing fuel locations in Northern Ireland: Cenex dataset obtained from discussions with NIEN that lists supply points of interest including 400+ fuelling locations together with postcode information. This data contains both how much electricity a station can supply and how much actual demand their currently is from consumers. The difference between these two figures is the demand headroom.

Grid connections and capacity: NIEN Network Capacity Map https://www.nienetworks.co.uk/connections/capacity-map

4.1.2 WP2 – Mapping of Existing Fuelling

The data from WP1 was mapped using GIS to show the distribution of fuelling stations as well as grid capacity at these locations obtained from the NIEN Network Capacity Map.

4.1.3 WP3 –Scenarios for EV Personal Car and Van Growth Through to 2035

The System Operator for Northern Ireland (SONI)[5] and Steer[6] separately produced EV uptake curves of the likely uptake of EVs in NI over the period 2020-2040. This analysis uses SONI's Addressing Climate Change and Accelerated Ambition uptake scenarios, and Steer's Addressing Climate Change scenario to provide uptake projections for EV adoption in NI to 2040.

4.1.4 WP4 – EVSE Requirement

The above vehicle uptake scenarios were input into Cenex's models to calculate the total energy demand required to serve the growing EV fleet and establish the requirements for Electric Vehicle Supply Equipment (EVSE) using the methodology described in Appendix B.

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[5] TESNI-2020.pdf (soni.ltd.uk), SONI, 2020

[6] Development of Electric Vehicles in Northern Ireland (qub.ac.uk) Steer for Department for Infrastructure, 2021

5 Mapping of Fuelling Station Locations and Electricity Grid Capacity

5.1 Introduction

This section provides a snapshot of current car, motorcycle and LGV fuelling in NI as context for how these locations might, in future, serve as public electric vehicle charging infrastructure (EVI) locations to serve the classes of vehicles that are likely to become battery electric in a Net Zero future. It then overlays the current electrical supply capacity headroom in these locations. This information is important as the rollout of EVI depends on the ability to provide electricity at the locations where it is needed.

5.2 Context

The 2022 report *Energy in Northern Ireland*[7] reported that energy use for personal transport in NI fell by almost 14% in the decade between 2009-2019 (latest data available). Although freight transport energy usage increased by 1.5% in the same period, overall transport energy demand fell by 10.5% between 2009 and 2019 showing the personal is the most significant element of transport energy demand in NI, accounting for 75% of the total in 2019 (compared to 64% in Great Britain).

The chart below breaks down the 2019 car, LGV, and motorcycle energy use at District Council (DC) level, showing that the energy usage is not evenly spread across NI; five of the DCs, led by Armagh City, Banbridge and Craigavon, account for 56% of the car, motorcycle and LGV energy use.

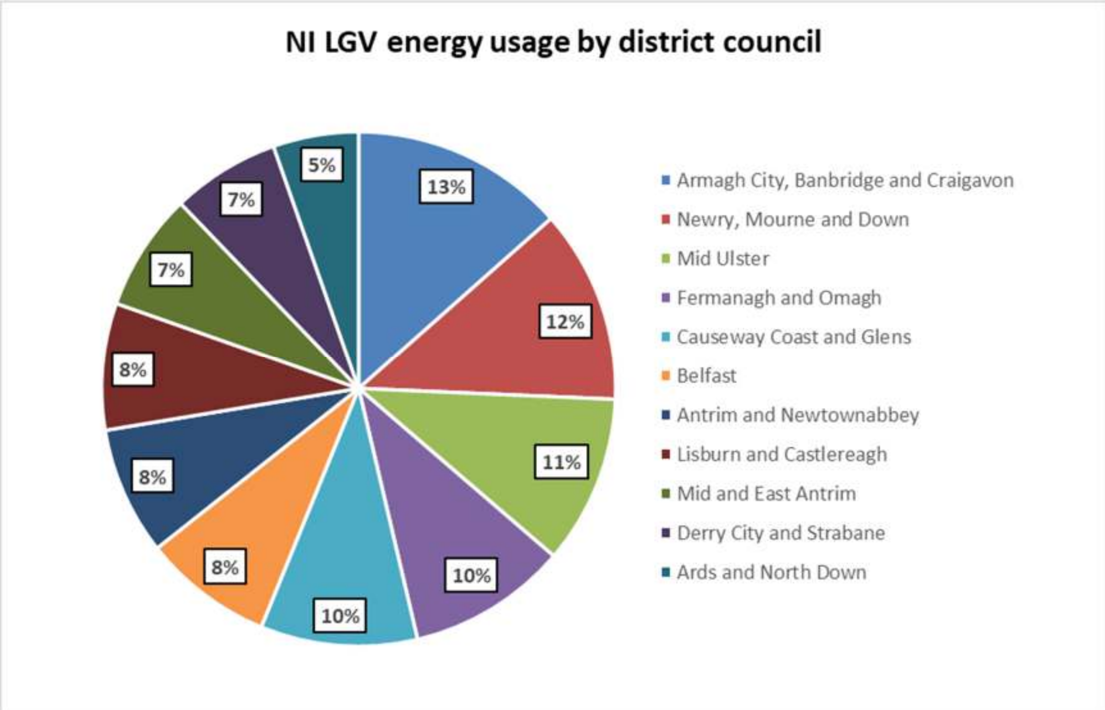

Figure 1: NI HGV Energy Usage by District Council

The report states that just under half (48%) of NI's petrol car and motorcycle energy use occurs on A roads, with only 9% on motorways and 43% on minor roads; for comparison the UK values are 43%, 15% and 42% respectively. The map below of the Regional Strategic Transport Network (RSTN)[8] illustrates the importance of the NI A road network and Key Transport Corridors.

The next section looks at the distribution of fuelling stations.

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[7] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Energy-in-Northern-Ireland-2022.pdf

[8] https://www.infrastructure-ni.gov.uk/articles/regional-strategic-transport-network

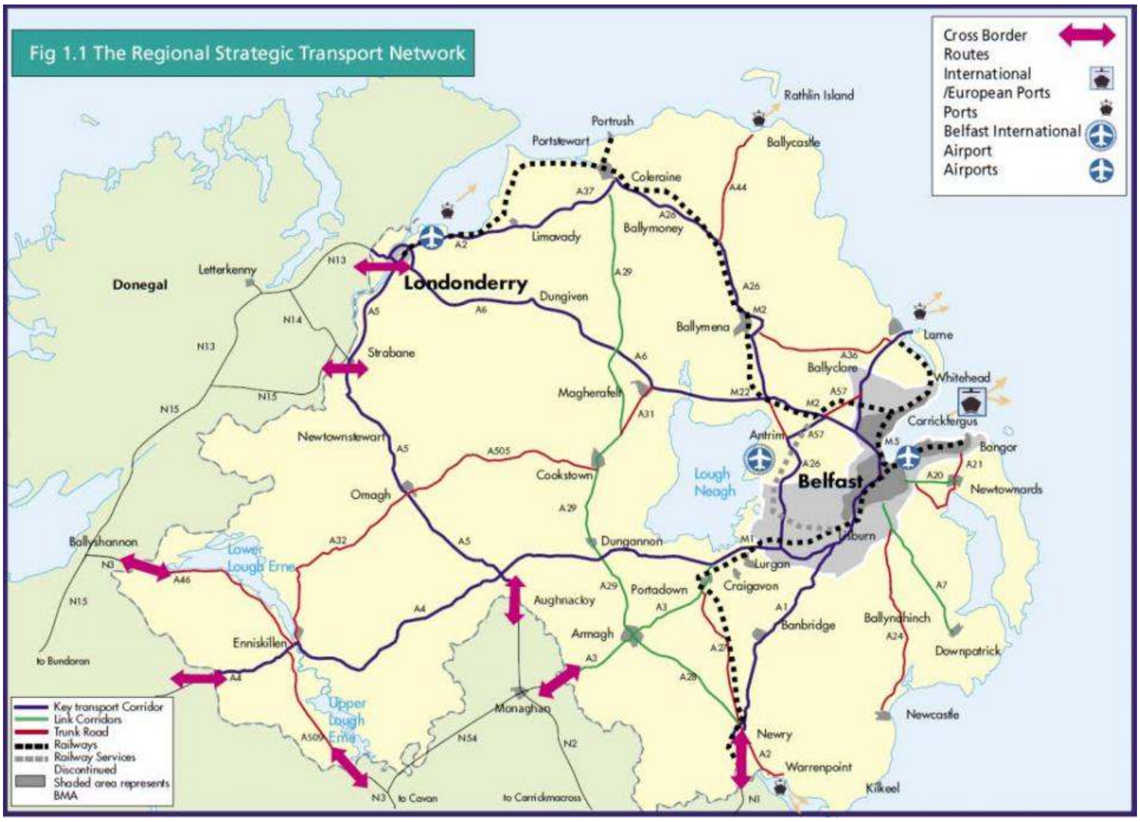

Figure 2: Regional Strategic Transport Network

5.3 NI National

For all maps described in this section, the underlying GIS files have been provided separately to the DfE to allow detailed inspection of individual locations.

Figure 3 shows the 465 NI fuel station locations made available to Cenex.

Figure 4 shows the distribution of NI electrical substations (red) plus a heatmap showing where the demand headroom (difference between how much electricity a station can supply and how much actual demand there currently is from consumers) is. The heatmap shows green at locations where there is significant demand headroom.

Figure 5 overlays the two figures described above to show fuel stations and a heatmap of the available electrical demand headroom in NI.

As expected, fuel station locations show clustering around Belfast and other cities and the RSTN Key Transport Corridors.

The electrical supply maps follow population, with supply points clustered around cities. In terms of supply headroom, the maps show that, in terms of absolute value, the most demand headroom is around Belfast – which again reflects the national population distribution (18% of the NI population live in Belfast)[9]. There is a reasonable alignment of the location of fuelling stations on or near the RSTN and the provision of electrical supply. Some of the more remote fuelling points are relatively far away from the nearest substation.

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[9] https://populationdata.org.uk/northern-ireland-population/

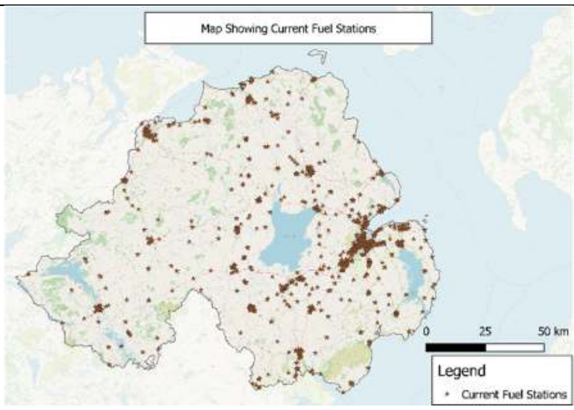

Figure 3: NI Fuel Stations

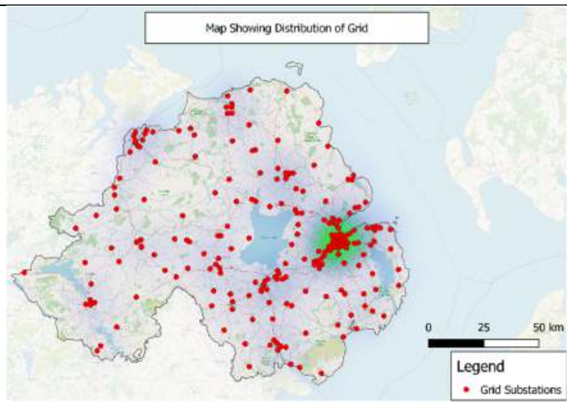

Figure 4: Substations (Red) and Electricity Headroom Heatmap (Green) [10]

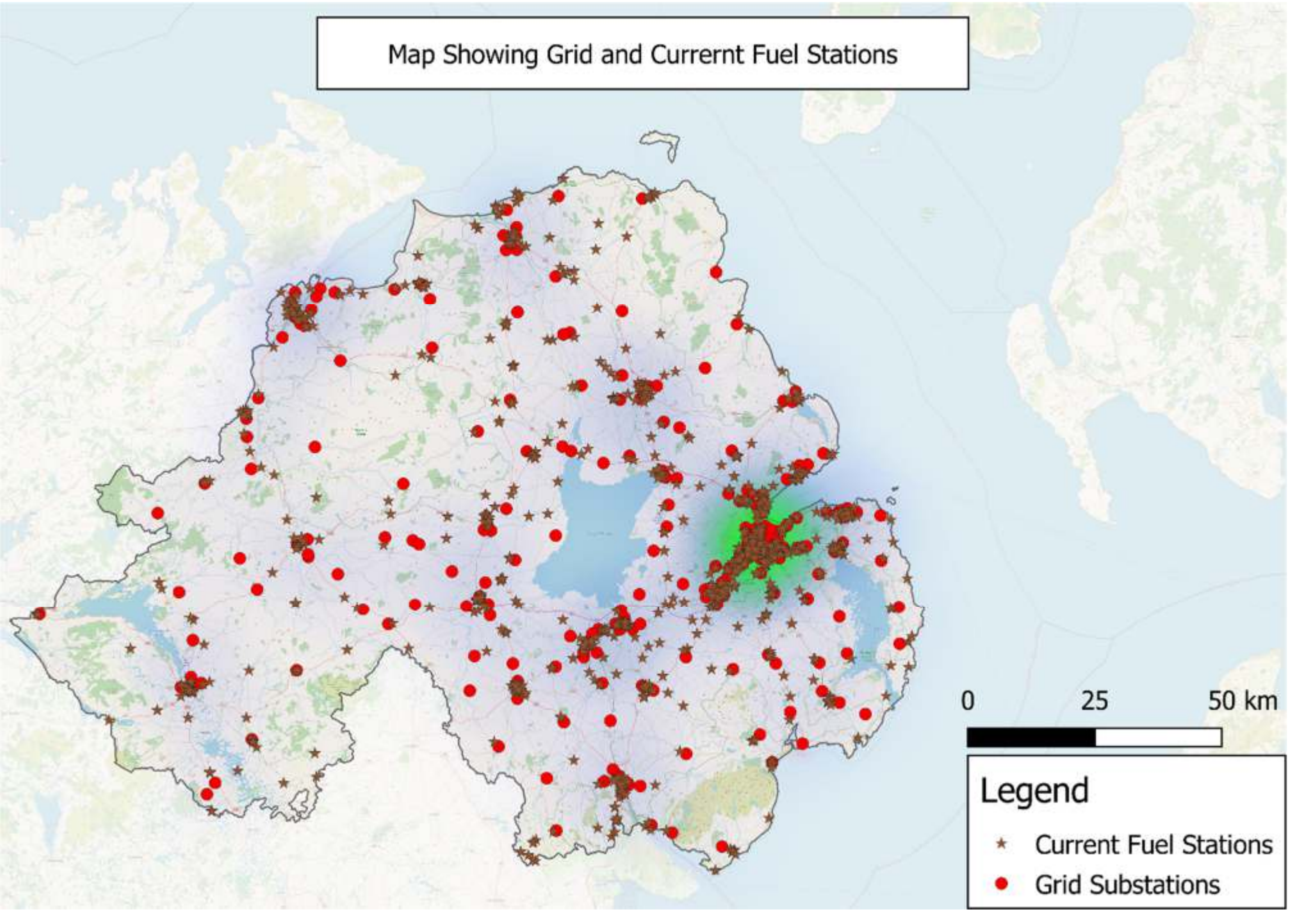

Figure 5: NI Fuel Stations and Electrical Supply Heatmap Obtained by Superimposing Figures 3 & 4[3]

5.4 Fuelling Stations and the RSTN

In the future, it is likely that users of the fuelling network will favour rapid and ultra-rapid charging as most home or at base charging will be overnight using standard 7 kW chargers. To understand how the current fuelling network could transition to sites for rapid chargepoint deployment, the fuelling

[10] *Bulk supply points (BSP)* connect the transmission network to the distribution network; power comes in at 132kV and is transformed to 33kV, before being distributed to *primary substations*, where power is transformed from 11kV or 6.6kV. The heatmap shows green at locations where there is significant *demand headroom* (the gap between the rating of the supply and the actual demand)

station and electricity supply data shown above was colour-coded to indicate the potential demand headroom at the closest primary substation, and superimposed on the RSTN, as shown in Figure 6.

For context, the table below explains how many chargepoints headroom values relate to. For further detail see the Appendix.

Size of Installation	Small	Medium	Large
Headroom Required	0.1 kVA	0.2 MVA – 1.0 MVA	>1.0 MVA
Number of Chargepoints*	1-3 fast chargers, or 1 rapid charger	10-50 fast chargers, 4-20 rapid chargers, or 1-6 ultra-rapid chargers	50+ fast, 20+ rapid, 6+ ultra-rapid

*a fast charger is 22 kW, rapid 50 kW, Ultra-rapid 150 kW+

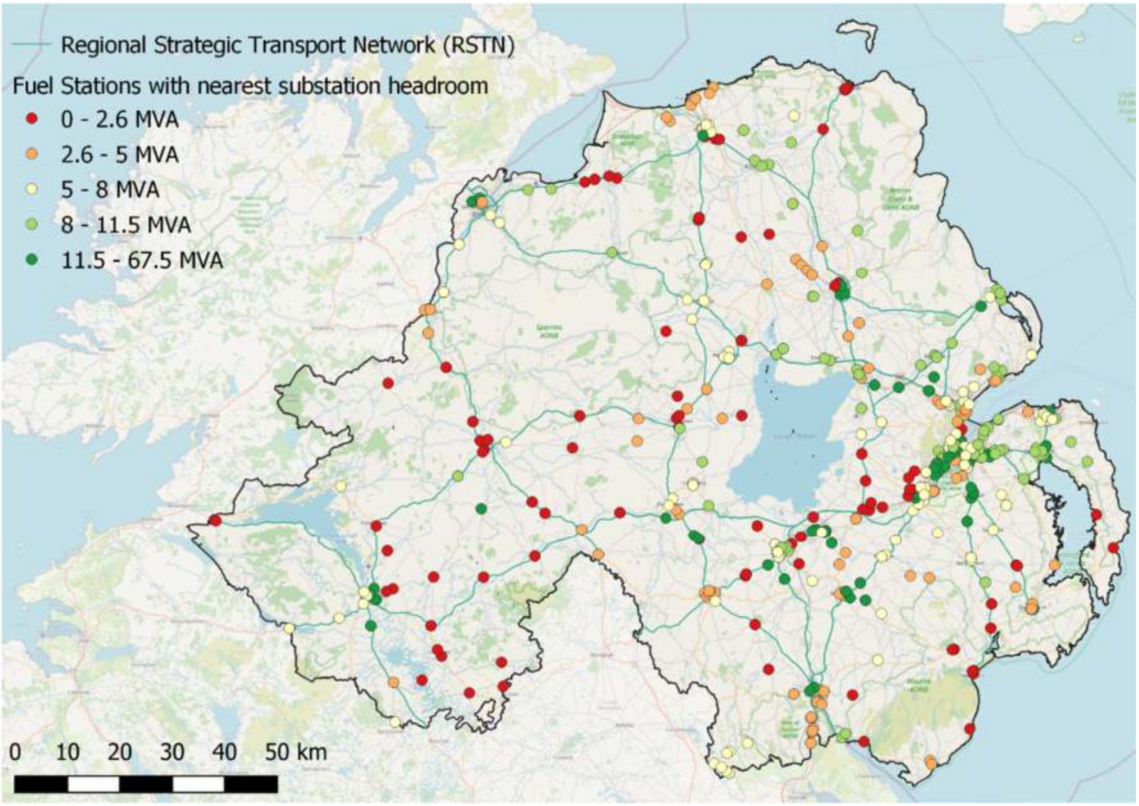

Figure 6: NI Fuel Stations Colour-Coded Based on Demand Headroom of the Nearest Primary Substation

A buffer of 4km was mapped around the RSTN to encompass areas within a 5-minute drive of the network. From prior research this is found to be a typical distance that drivers are willing to travel in order to refuel, whilst still being convenient. This was used to reduce the number of fuel stations to only show those within this buffer zone. This reduced the original number down to 384 fuel stations as shown in Figure 7.

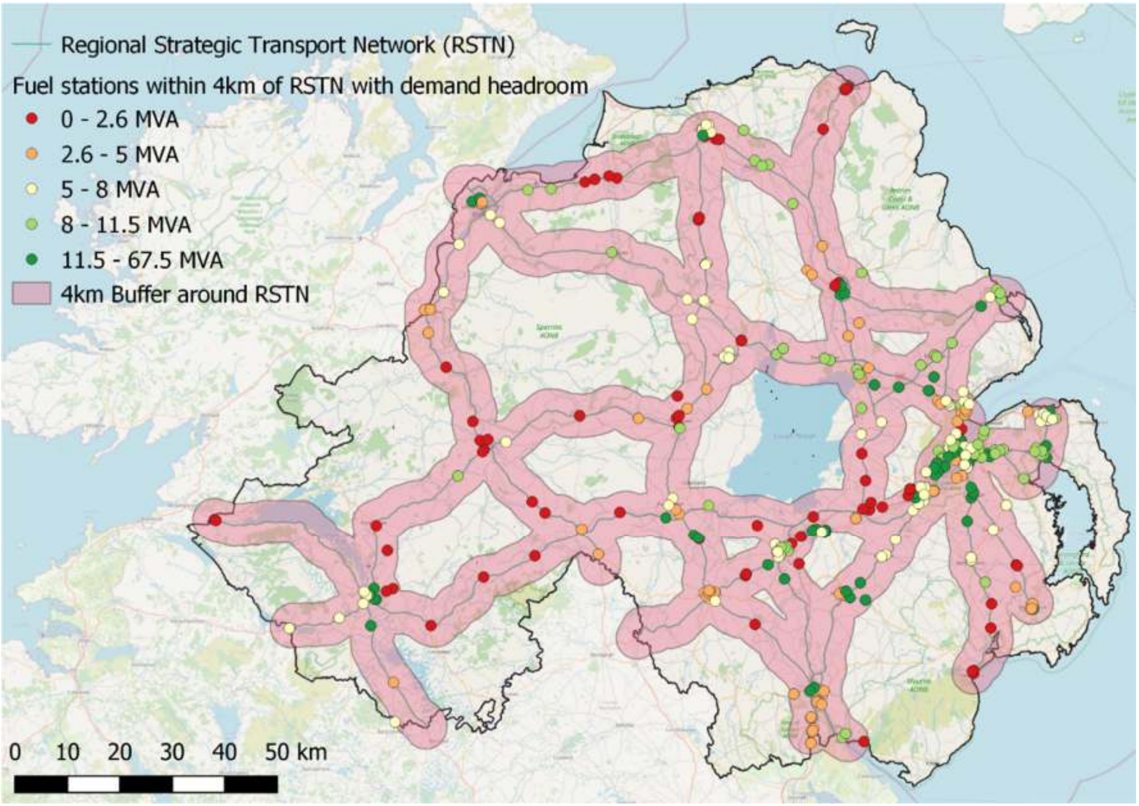

Figure 7: NI Fuel Stations Within 4km of the RSTN

The maps shows that most of the fuelling stations are near substations with some demand headroom, but it is noted that many of those shown are red indicating a relatively limited amount is available. As a final step the existing rapid and ultra-rapid chargepoints in NI were plotted along with the planned installations under the FASTER project and those announced by Nicholl Fuels. With these mapped, areas and stations within a 5-minute drive of existing or planned rapid or ultra-rapid chargepoints were excluded, to allow for a wider spread of rapid and ultra-rapid chargers by prioritising areas not within a 5-minute drive of existing infrastructure. This reduced the number of fuel stations down to 173. These are shown in Figure 8. A simplified version is shown in Figure 9. Those sites which show a high demand headroom (green) can be seen as quick win installations, where demand will be high and the grid will have sufficient capacity to install chargepoints without the need for costly grid upgrades. Those with less headroom/critical headroom capacity (red) will require more planning to ensure that the demand is truly there before any action is taken to increase the headroom capacity at these sites.

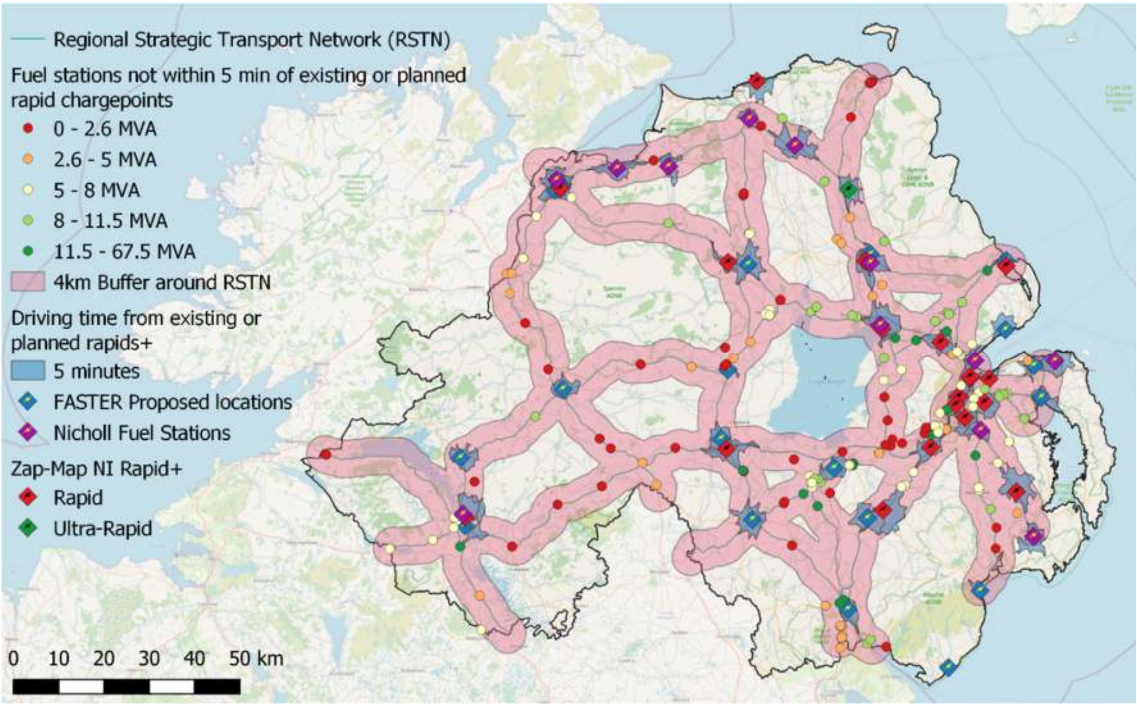

Figure 8: NI Fuel Stations Within 4km of RSTN, Not Within a 5-Minute Drive of Existing or Planned Rapids

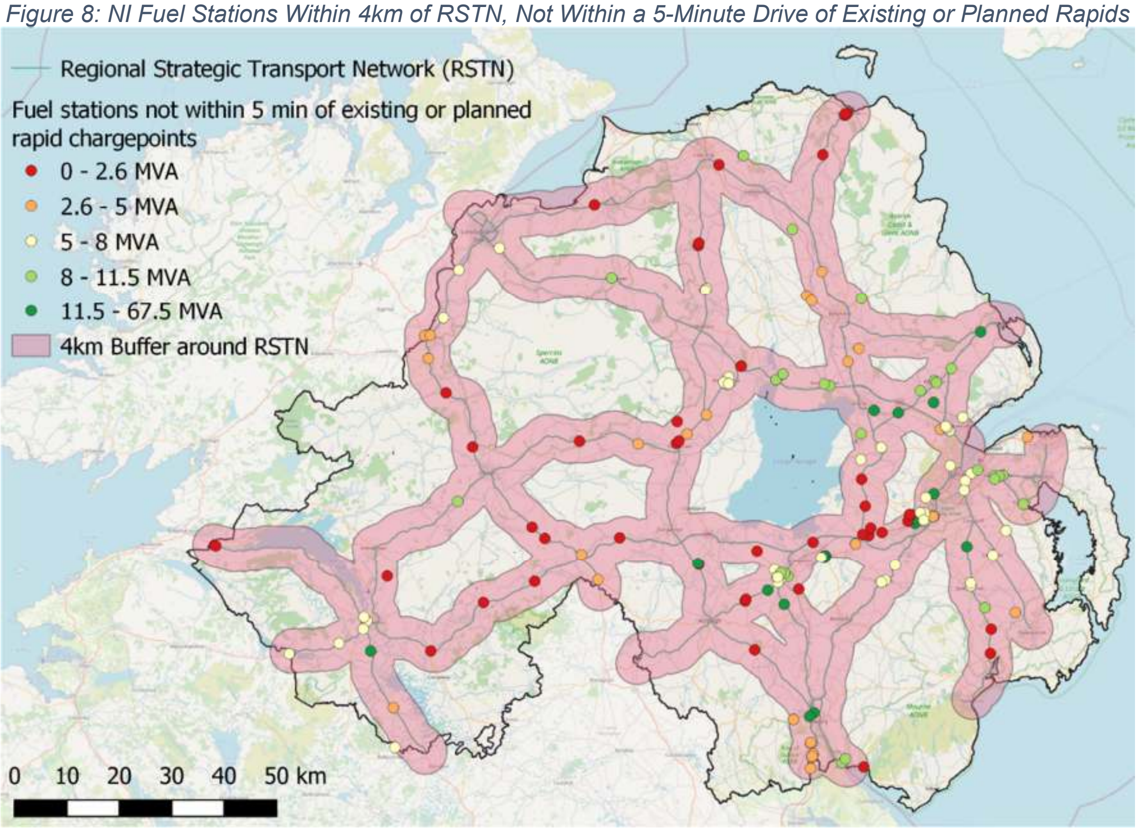

Figure 9: Simplified Figure 8 Showing Stations Not Within 5-Minute Drive of Existing or Planned Rapids

6 NI Zero Emission Car and Van Uptake to 2040

6.1 Introduction

The previous chapter looked at the current demand headroom throughout Northern Ireland at present. In order to project what the future demand might look like on the grid we first need to project the future changes in the uptake of electric vehicles (which will directly affect the future demand on the grid). This section presents NI EV car and van uptake scenarios which will feed into the energy and infrastructure requirement outputs in the next section of this report.

6.2 National EV Uptake

Figure 10 presents three car and LGV uptake scenarios:

- *SONI's Addressing Climate Change (SONI ACC)* scenario assumes the 2035 ban on fossil fuelled cars will be achieved and projects high levels of uptake in accordance with that scenario.

- *SONI's Accelerated Ambition (SONI AA)* goes a step further and assumes that the ban on fossil fuelled vehicle moves forward to 2032 and projects higher levels of uptake because of this.

- *Steer's Addressing Climate Change (Steer ACC)* is adapted from SONI's Addressing Climate Change scenario. It assumes light government interventions will be made in the short-to-medium term for example, awareness campaigns and encouraging private operators to install chargepoints.

Table 1: NI EV Car and Van Uptake Scenarios

	2022 Q3 (actual)[11]	2025	2030	2035	2040
SONI ACC	12,800	63,700	273,000	606,000	940,000
SONI AA		85,600	372,000	776,00	1,181,000
STEER ACC		38,200	409,000	706,000	1,003,000
Total Vehicles	1,150,000	1,160,000	1,184,000	1,189,000	1,198,000

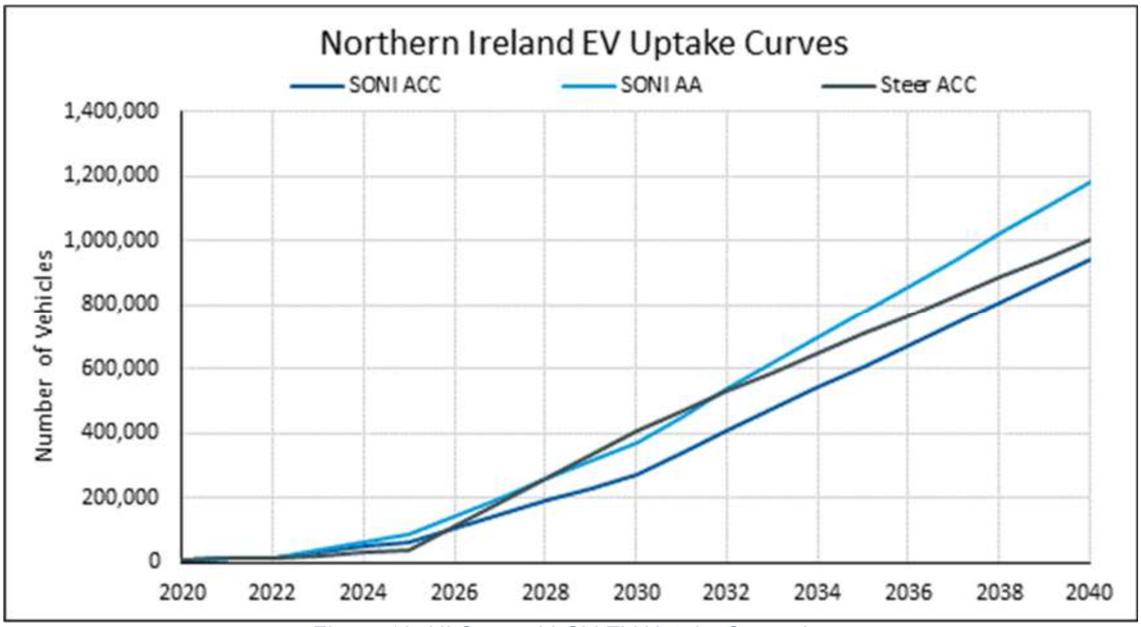

Figure 10: NI Car and LGV EV Uptake Scenarios

[11] DfT Statistics – Table VEH0105 & VEH1103

The scenarios each start from the current low levels of uptake, with EV uptake ramping up from around 2025 onwards. By 2030, the SONI AA and Steer ACC each project around 400k plug-in cars and vans, whereas the SONI ACC has lower uptake. The divergence continues to 2035 and 2040, with the highest uptake projected by the SONI AA at 1.18m vehicles, and the SONI ACC giving a lower uptake at 934k.

7 NI Public EV Car and Van Recharging Energy and Infrastructure Requirements to 2040

7.1 Introduction

This section provides the total energy requirement, infrastructure needs, and estimated costs based on today's prices for scenarios of EV car and van uptake in NI based on the SONI and STEER EV uptake scenarios presented in the previous section.

The energy demand represents the total for all cars and vans across private (i.e., home and depot) fuelling, plus public refuelling. As explained in Appendix B, the *infrastructure numbers and costs are for public refuelling infrastructure only*, based on the assumption that 68% of charging will be done at home.

The overall change in energy demand as vehicles switch from conventional petrol and diesel vehicles to electric vehicles should be used to project what future upgrades are required to the current grid system and how much extra electricity generation will be required to meet this demand.

7.2 NI EV Car and Van Energy Demand Scenarios

The figure below displays the total energy demand required per day to service the SONI ACC EV car and van scenario (chosen as an example) presented in the previous section. It is noteworthy that the total energy demand from the vehicles falls significantly in all scenarios due to the enhanced efficiency of EVs compared to ICE vehicles, falling from daily value of 32.5 GWh in 2020 to 10.7 GWh in 2040 in the SONI ACC scenario (compared to 12.7 GWh daily in the SONI AA scenario) as ICE vehicles are replaced by electric equivalents.

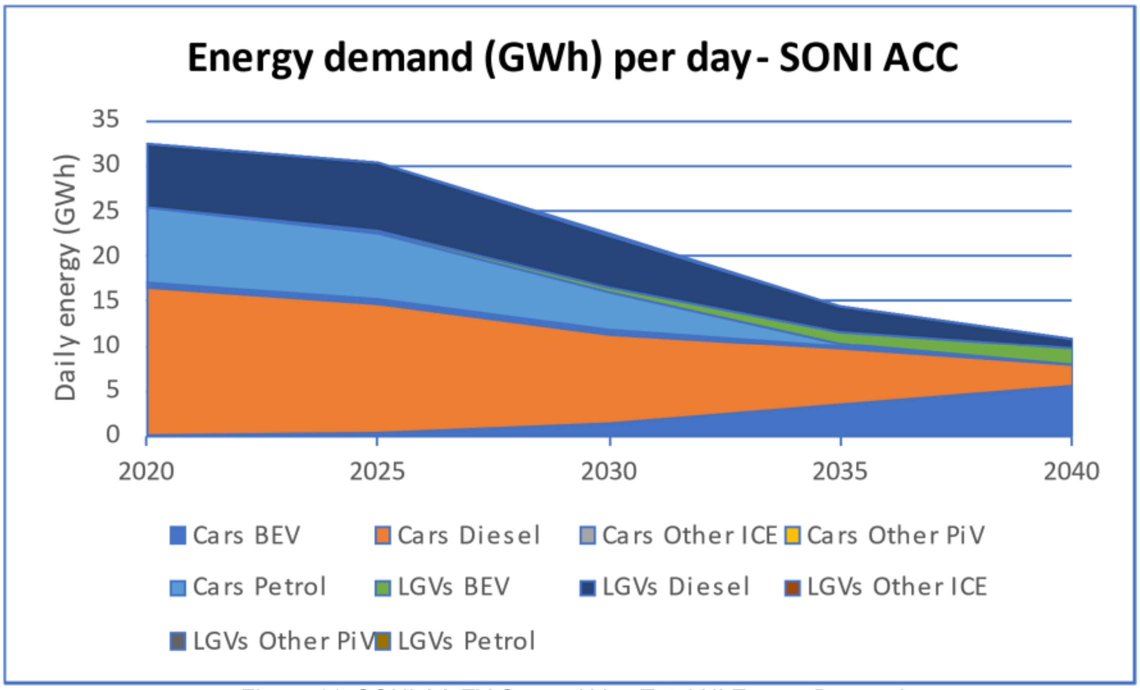

Figure 11: SONI AA EV Car and Van Total NI Energy Demand

7.3 NI Recharging/Refuelling Infrastructure Requirements Scenarios

Figure 12 shows the required publicly accessible infrastructure (equivalent to today's petrol and diesel forecourts) for cars and vans to 2040. For comparison, the current NI chargepoint numbers obtained from Zap-Map[12] are shown in Table 2, indicating that a considerable acceleration in public chargepoint provision will be required by 2025 to reach the requirements of the scenarios.

[12] https://www.zap-map.com/

Table 2: Current (2023) NI Chargepoint Numbers (source: Zap-Map)

	7 kW	11 kW	22 kW	50 kW	150 kW
Number of chargepoints	67	14	278	23	0

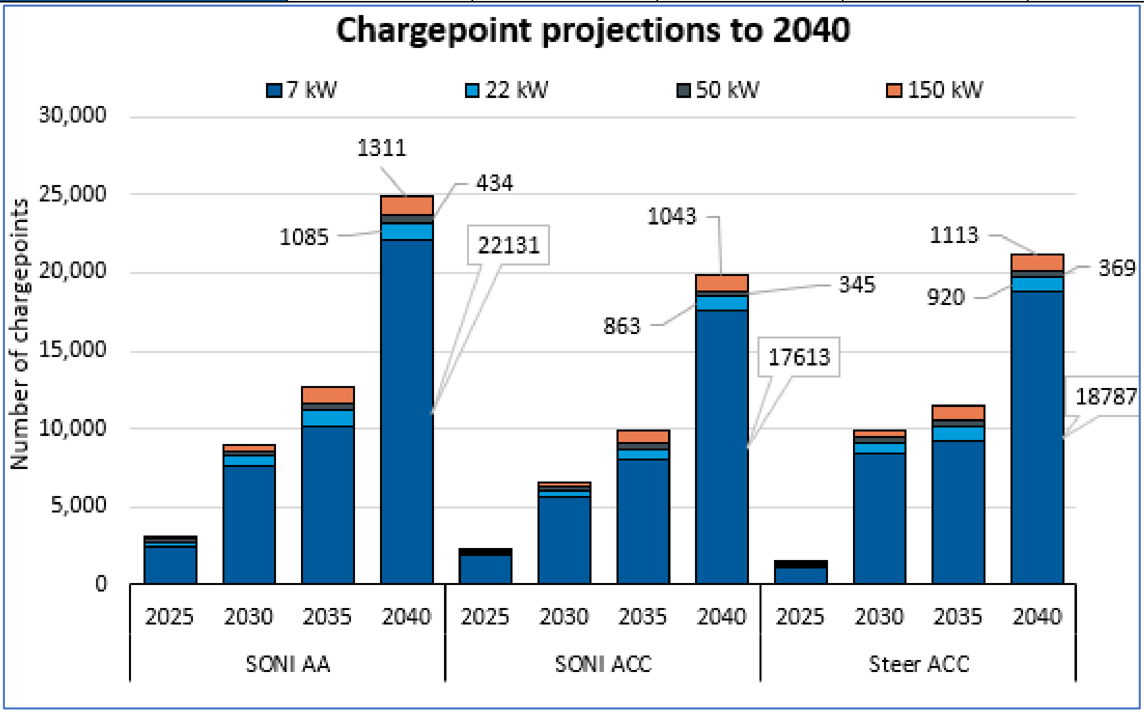

Figure 12: NI EV Car and Van Infrastructure Scenarios

Around 90% of the chargepoints required in 2040 in the SONI AA scenario are 7 kW standard units. These are likely to be the most common choice for overnight charging at or near homes and businesses, but since these chargepoints deliver less power, vehicles will be plugged into each chargepoint for longer, necessitating a larger volume of deployments.

Figure 13 focuses on rapid and ultra rapid chargers, of which fewer are needed due to shorter dwell times allowing for higher throughput. In all scenarios in the long term, ultra rapid charging (150 kW or above) dominates and fewer 50 kW units are needed.

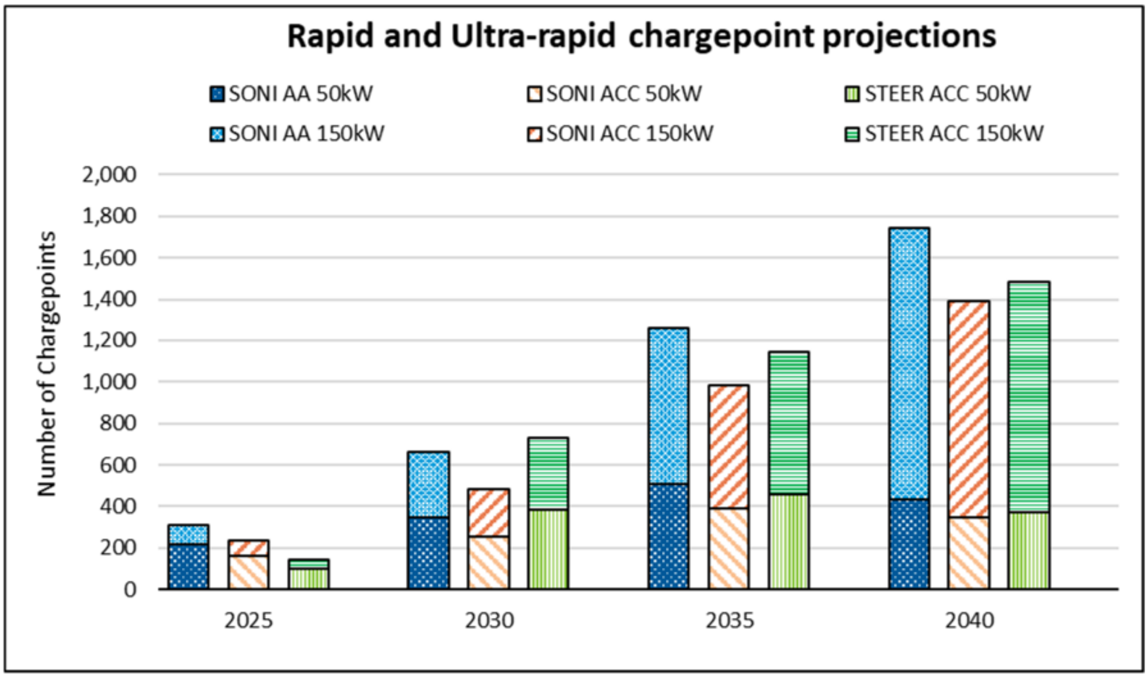

Figure 13: NI Public Rapid EV Car and Van Chargepoint Scenarios

The figures below show the estimated costs (based on current prices as described in Appendix B) for the EV charger deployments in 2030 and 2040 showing that considerable total investment will be required to meet the scenario projections. Given the UK national requirement to transition the NI vehicle fleet to ZE it is unlikely that Devolved Governments or local councils will have to fund publicly accessible infrastructure entirely by themselves. Private industry investment will likely provide a large proportion of these costs as and when economically viable for their business case (as more EVs are deployed, the commercial viability of sites will improve), but this approach is unlikely to achieve the accelerated uptake demanded by policy.

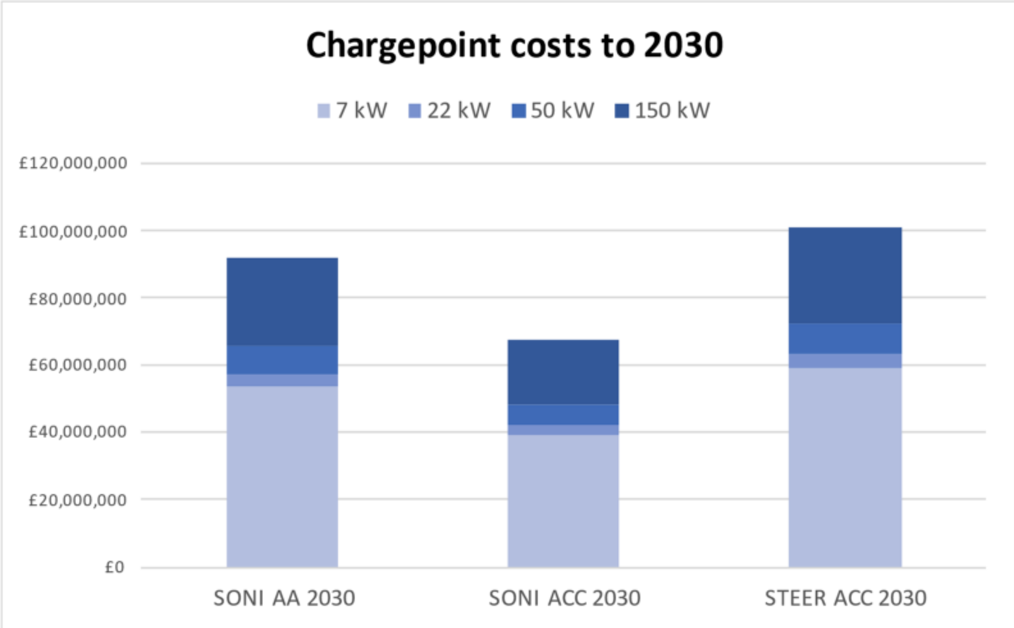

Figure 14: NI EV Car and Van Infrastructure Cost Scenarios to 2030

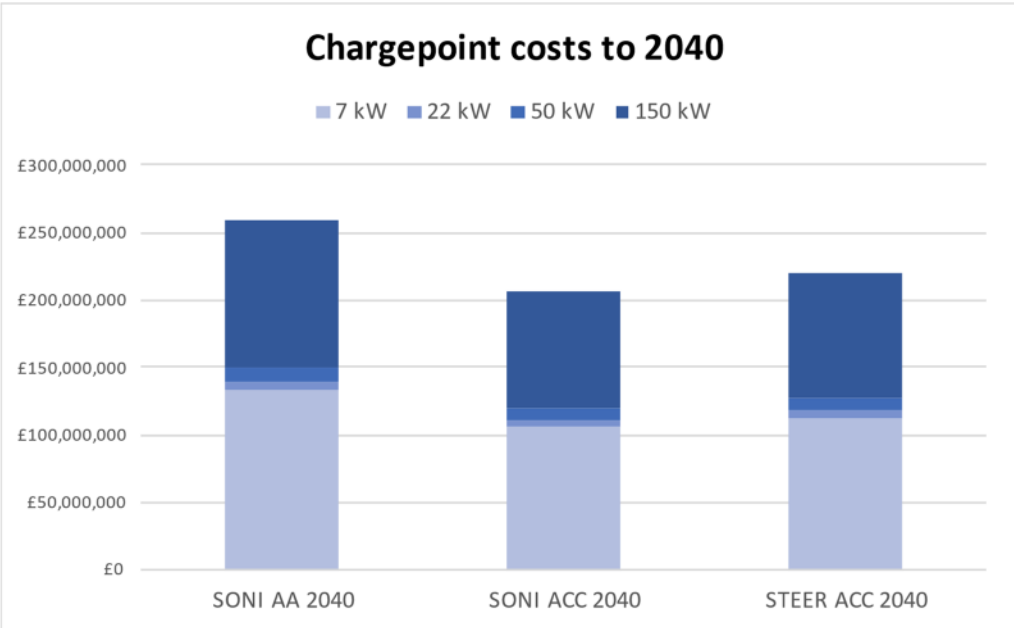

Figure 15: NI EV Car and Van Infrastructure Cost Scenarios to 2040

8 Conclusions and Caveats of the EV Car and Van Analysis

This study has presented three scenarios for EV car and van uptake in NI to 2040 from SONI and STEER and associated recharging infrastructure uptake based on Cenex modelling. The scenarios are underpinned by the need to achieve Net Zero in NI in line with UK government policy.

Vehicles

- All scenarios show the number of EVs in NI growing rapidly from 2025 onwards. In the most ambitious scenario – SONI's Accelerated Ambition (AA) – the number of EV car and vans is projected to reach 776k in 2030 and 1.18m by 2040. The SONI Addressing Climate Change scenario anticipates lower uptake of 606k by 2030 and 940k by 2040.

Energy demand

- The greater energy efficiency of ZE HGVs compared to conventionally fuelled equivalents means that the overall energy demand from cars and vans will fall substantially as EV equivalents are adopted. In the SONI AA scenario daily car and van energy requirements will fall from 32.5 GWh in 2020 to 10.7 GWh in 2040.

Infrastructure uptake scenarios

- Currently there are fewer than 400 public charging points in NI marked on Zap-Map.
- The transition to EV cars and vans will require a massive expansion of the public charger network. According to Cenex's modelling, by 2030 the SONI AA scenario will require the deployment of over 10,000 public chargepoints. By 2040 this will increase to almost 25,000.
- Standard 7 kW units primarily designed for overnight charging account for around 90% of the total chargepoint needs.
- Rapid (50 kW) and ultra-rapid (150 kW) charger numbers will also need to grow substantially. Under the SONI AA scenario 50 kW unit needs are projected to be 500 by 2030 and 750 by 2040. As EV uptake grows and technology continues to develop, ultra-rapid charging is expected to dominate fast charging needs, and 150 kW unit numbers are projected to be 430 in 2030 and 1300 by 2040.

Electricity supply needs

- Mapping the distribution of fuelling station locations and the currently supply network and demand headroom (difference between the rating of the supply and the demand) shows that the substations around the fuelling stations have headroom.
- In the future, it is likely that users of the fuelling network will favour rapid and ultra-rapid charging as most home or at base charging will be overnight using standard 7 kW chargers. Mapping the fuelling station locations closest to the RSTN shows that most of the fuelling stations are near substations with some demand headroom, but it is noted that many of those have a relatively limited amount available and that therefore electricity supply upgrades may be required at these locations in future.

Discussions and caveats of the analysis

The current energy demand numbers produced by this analysis are accurate as they are based on the energy usage of the current vehicle parc.

The number of EVs in the future vehicle parc is however uncertain, with key variables including the availability, cost and performance of EV replacements and the cost and availability of associated recharging infrastructure.

Next steps

The scenarios presented here have shown the potential scale of national EV uptake and the associated energy demand and refuelling requirements. Among suggested next steps are:

- To survey in detail the locations of key refuelling to understand the electricity supply requirements and how EV recharging infrastructure can be accommodated alongside existing fuelling equipment during the EV transition. This will help identify where “quick wins” for building infrastructure can occur and where business case modelling will be required to justify any grid upgrades to meet future demand of infrastructure.

- To understand how renewable electricity can be provided to key points of demand, and the role of bi-directional charging and battery storage in mitigating electricity network capability requirements and associated costs. This will ensure that investment in the network is placed appropriately, alongside ensuring that the carbon associated with electricity production is reduced for its application in electric vehicles.
- To further develop the data and mapping in this report into a National Chargepoint Registry of all chargepoints. The current lack of accurate and up to date on the number and location of existing chargers:
  - reduces confidence for both private drivers and companies considering purchasing EVs that the public charging exists and is growing.
  - makes it difficult for the chargepoint operator industry from easily identifying market potential, reducing private sector investment in provision compared to other areas.
  - means that national and local policymakers struggle to understand the size of the gap between need and provision, develop strategies and plans for new charging, and to assess future electricity needs.
  - Stifles technology innovation around the provision of EV charging data by 3rd party suppliers and wider research into EV uptake.

9 Appendix A, Proposal of Work as Originally Submitted

Transport Energy Research Project 1: Transition to EVs

Project Background

The Transport Energy branch in the Department for the Economy (DfE) on policies and support relating to the decarbonisation of energy used within the Transport Sector. The key relevance of this to DfE's policy vires is how decarbonising transport will reduce the current reliance on liquid fossil fuels and grow the demand for alternative low or zero emission fuels such as renewable electricity, green hydrogen or bio-methane. This transition will have associated impacts on the vehicle refuelling infrastructure, the electricity grid's capacity and resilience, demand for green electricity and hydrogen and ultimately on the mode and cost of transport for both private drivers and businesses in Northern Ireland. A clear example of this is covered in the first action of the government's recently released EV Infrastructure Plan, which identifies DfE as responsible for future proofing electrical capacity at key strategic sites along key transport corridors.

QUB and Cenex are very clear that this research project, along with the other two projects being currently tendered, are interconnected and will provide informative evidence to support the role of DfE, while also recognising the roles of other key actors in Northern Ireland's transport stakeholder landscape such as the Department for Infrastructure, councils, Northern Ireland Electricity Networks (NIEN), the Utility Regulator, the EV owners association of NI (EVANI) and the CBI.

Understanding the Brief

The Transport Energy branch has stated that the Data required would be:

1. Number of existing fuel outlets in Northern Ireland.
2. Petrol / diesel fuel capacity.
3. Electrical grid capacity at existing fuel outlets.
4. Projected and planned grid capacity expansion at existing fuel outlets.
5. Analysis of the growth of EV's to 2025, 2030 & 2035.

For the purposes of this proposal, QUB and Cenex have assumed that 'fuel outlets' are defined as publicly-accessible petrol and diesel retail sites, and that the overall aim of this project is to identify key locations on the NI road network, currently used for fossil fuel refuelling, that could transition to providing electric vehicle charging (with associated electricity capacity requirements).

Methodology

QUB and Cenex will deliver the project objectives across five work packages:

1. **WP1 – Data Gathering for Fuelling and Grid:** We will utilise publicly available data on the overall capacity of the fuelling for ICE vehicles and existing Grid Capacity within NI. Cenex has contacts in the NI petrol retailing industry which will be used to possibly get data on average site capacities and splits between diesel and petrol. However, it is unlikely that we will be able to obtain site specific capacity for all forecourts and so demand at each forecourt will be split based on an assumption agreed with DfE. Each will be categorised as either Rural or Urban to understand the potential demand. Grid capacity data at each site identified will be obtained subject to data availability from NIEN.

2. **WP2 – Mapping of existing fuelling:** The data from WP1 will be mapped using GIS to show the distribution of fuel stations and electrical grid capacity within the wider network for the current year. Where relevant, data gathered around projected and planned electrical grid capacity expansion will also be mapped, subject to data availability from NIEN. As there are currently over 800 active fuel stations in NI, it will not be possible to provide exact locations for every individual forecourt in the timescale and resource available.

3. **WP3 – EV Growth for Personal Cars and Vans through to 2035:** Using Department for Transport data we will establish the current baseline of EVs within NI, according to the UK Department for Transport's VEH0131 dataset. We will then use SONI's "Tomorrow's Energy

Scenarios Northern Ireland 2020" and Steer's "Development of Electric Vehicles in Northern Ireland Report" from August 2021 as the basis for the EV uptake scenarios. If these uptake curves are agreed, then the penetration of EVs in the NI vehicle parc will be calculated through projecting the injection of new vehicles and accounting for scrappage.
These predictions will be cross-checked against Cenex's proprietary model, which has been reviewed by OZEV and is used in the LEVI (Local Electric Vehicle Infrastructure) Fund programme led by Cenex on behalf of OZEV. Forecasting data will be available for 2025, 2030 and 2035.

4. **WP4 – EVSE requirement:** Using the above forecasts we will calculate the total additional energy demand required to serve the increasing EV market penetration. This will be broken down into two main categories 1) energy demand from home charging, 2) energy demand from public and private non-home charging, effectively splitting out domestic charging requirements from public charging requirements. Public charging requirements will give a figure for total energy demand required from public charging and can be compared vs the capacity at the 800+ sites and be able to state whether there is enough capacity/what is the gap. This will indicate the scale of grid upgrades required throughout NI.

5. **Reporting:** We will produce a Report detailing the above 4 work packages as well as providing GIS mapping of existing fuelling for ICE vehicles and electrical grid capacity. We will also comment on the relative merits of each of the two forecasts for EV growth and a high-level overview of how a high uptake scenario could be ensured.

11 Appendix B. EVSE Uptake Scenarios

The Cenex infrastructure uptake model applies the following methodology:

1. Project vehicle mileages in NI up to 2040 using the most up-to-date UK Government Road Traffic Forecasts (2018)[13].
2. Convert vehicle mileage for each fuel type into quantity of fuel required. Cenex used its proprietary Fleet Advice Tool data for fuel consumption rates for each fuel and vehicle type.
3. Convert fuel quantities into energy demand using Defra's fuel energy density figures[14].
4. Construct scenarios for the infrastructure requirements for each fuel type for the years 2030 and 2040. This is for predicted **publicly accessible infrastructure only** (equivalent to today's petrol and diesel forecourts)[15] based on the assumption that 68% of charging will be done at home.[16]
5. The energy is divided between different EVSE types (standard 7 kW, fast 22 kW, rapid 50 kW and ultra-rapid 150 kW) that vehicles are capable of receiving. Different approaches can be taken to this process, depending on regional or local strategic approaches to on-street residential charging or fuel-station-style charging hubs. For this analysis, a blended approach was selected which assumes both charging use cases will be deployed in NI.
6. The energy utilisation of EVSE is estimated using real-world charging session data from 2020-2022. This shows that current utilisation of EVSE is low, likely due to EVSE being rolled out ahead of demand and some vehicles being unable to accept higher rates of charge. However, utilisation is growing over time and this growth is projected forwards to replicate the anticipated increasing usage of public chargers.
7. Energy utilisation is a ratio of the total potential energy delivery from a chargepoint and the energy that is delivered to EVs. This considers the time when a vehicle is plugged in and charging at a chargepoint, plugged in and not charging (PINC) time and, when no vehicle is plugged into the chargepoint. Multiplying the energy utilisation by the charging power determines the energy that one chargepoint will deliver per day.
8. Taking these factors together, the total number of public charging sockets required to deliver the energy needed to charge EVs can be calculated.

Infrastructure Costs

Finally, Cenex undertook a high level estimate of the **publicly accessible infrastructure costs only** (equivalent to today's petrol and diesel forecourts) for each scenario—this is in addition to any depot based refuelling which has not been included in this analysis. Public agencies will not have to fund publicly accessible infrastructure entirely by themselves and so these costs should not be read as required investment. Private industry investment will likely provide a large proportion of these costs as and when economically viable for their business case (as more low and zero emission vehicles are deployed, the viability of sites will be realised). Costs are based on today's prices with no adjustments made for inflation or falling costs as more infrastructure is deployed. Estimates use the following data and assumptions:

[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873929/road-traffic-forecasts-2018-document.pdf

[14] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

[15] Publicly accessible infrastructure is equivalent to fuel forecourts which are set up and managed by the private sector, and are open access for use by fleets and drivers

[16] http://www.field-dynamics.co.uk/wp-content/uploads/2020/09/On-Street-Households_The-next-EV-Challenge-and-Opportunity-1.pdf

- **EV Chargepoints:** Cenex has estimated total capital costs for chargepoints from an average of three quotations provided by industry contacts. Costs include equipment, electrical connection costs, enabling works and miscellaneous installation costs. Table 3 shows a cost summary. Potential grid or connection upgrades are not included in the calculations, which are more likely for large installations, however Table 4 shows indicative costs based on the size of installation.

Table 3: Capital cost and enabling works for chargepoints

	7 kW Standard Charger	22 kW Fast Charger	50 kW Rapid Charger	150 kW Ultra-Rapid Charger
Capital cost of chargepoint	£2,000	£2,000	£20,000	£80,000
Enabling works and electrical connection[17]	£4,000	£4,000	£4,000	£4,000
Total	£6,000	£6,000	£24,000	£84,000

Table 4: Indicative costs for major connection upgrades

	Medium (200 kVA – 1 MVA)	Large (>1 MVA)
Number of charge points	Up to 15 rapids	Above 15 rapids
Connection time	8-12 weeks	6 months+
Connection cost	£4,500 - £75,000	£75,000 - £2 million
Other considerations that may affect cost	Street work costs, legal costs for easement & wayleaves.	Street work costs, legal costs for easement and wayleaves. Planning permission & space for a substation.

[17] Costs quoted here include an electrical connection (feeder pillar, Residual Circuit Breaker with Over-current device (RCBO), RCBO housing, RCBO protection, Miniature Circuit Breaker (MCB) installation, fixings and an assumed 5m electrical cable run), enabling works (foundations, 5m of ducting & surface reinstatement, guard raid/crash protection, bay markings, signage, and branding) and warranty.

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Knowledge & Enterprise

Cenex
Holywell Building,
Holywell Park,
Ashby Road,
Loughborough,
Leicestershire,
LE11 3UZ

Tel: +44 (0)1509 642 500
Email: info@cenex.co.uk
Website: www.cenex.co.uk
Twitter: @CenexLCFC
LinkedIn: Cenex