High Visual Efficiency for Low Carbon Lighting –
De-carbonising Street Lighting

Lead authority:

East Riding of Yorkshire Council (ERYC)

Elevator Pitch:

Over 50 years of siloed interventions and regulations for road lighting have created significant and unmeasured carbon impacts (construction and energy use). These practices demand a total re-think that will reduce carbon impact and drive down UK street light energy costs (which currently exceed £1bn annually). Potential savings are constrained by the limitations of current regulations and guidance and by outdated thinking. Driven by our vision towards zero carbon, cutting edge approaches including next generation signs, lines and solar road studs, will create enhanced visual outcomes for all road users. Subject to strict milestones, and linked to hard evidence and academic rigour, we will create a framework for alternative practice in highway lighting, signing and road marking that provides enhanced visual perception. Street furniture will thereby evolve around the specific ambition to reduce energy consumption.

Project Overview:

This project proposal began with an intention to decarbonise an area of highway design that is largely unchanged in living memory: the realm of the visual environment. This is a sector that is driven by two main statements:

- "That's just how it's done"
- "Highway Standards says that's how we have to do it"

However, as we refined this Live Lab from inception, submission, and now this SOBC, we are increasingly clear that whilst there have been significant advances in material development and localised, risk-based approaches to carbon reduction, energy reduction and asset utilisation, the sector is still underpinned by British Standards, siloed thinking, and risk aversion.

Driven by a vision towards zero carbon, cutting edge approaches including next generation signs, lines, and solar road studs, we will create enhanced visual outcomes for all road users. Subject to strict milestones, and linked to hard evidence and academic rigour, we will create a framework for an alternative practice manual for highway lighting, signing and road marking that provides enhanced visual perception.

East Riding and our partners will create a new UK baseline that unpacks the UK wide annual £1bn energy cost and at least a further £1bn installation, renewal and annual maintenance activity across the UK's 214 Highway Authorities.

The UK's 7.2m street lighting columns have created a replacement cost legacy exceeding £7bn. With a design lifespan of 40 years, on average 180,000 columns need replacing annually, *albeit many Councils do not have funds to meet this cost.* As shown by the UK State of the Nation report (UKRLG[1]) energy consumption has improved from 2.6 GWh (2010) to 1.88GWh. However, street lighting energy costs still exceed £1bn annually and are a major contributor to Highway Sector CO_2 emissions; adding 478,000 tons per year. Often overlooked, bollards and signs represent only 10% of lit assets but can consume up to 20% of the lighting cost.

The Councils included in East Riding's Live Lab represent over 10% of the UK inventory and unrivalled experience of road lighting.

- City of York Council & Hull City Council
- Cambridgeshire County Council, Derbyshire County Council, Lancashire County Council, Oxfordshire County Council, Westminster City Council
- Northern Ireland Department for Infrastructure - Roads
- Pembrokeshire Council
- Aberdeenshire Council

Initial data exchanges between the partners have shed a light on contrasting approaches and underpin a compelling case to look afresh at choices being made across the UK to understand the optimum solution: both right now in terms of scope to reduce costs and carbon, and over the course of the Live Lab. Transparency across the Live Lab partners will be key to providing a substantive evidence base to ensure this carefully selected cohort of Highway Authorities is representative of the sector as whole.

Working hand in glove with the Institute of Lighting Professionals (ILP), this Live Lab will be inclusive from the outset and seeks to challenge the sector to achieve high visual perception under the most extreme conditions in all parts of the UK. The Live Lab is focused on 11 Highway Authorities, but is open to input, challenge and support, from across the sector as we aim to create new thinking that might make 2023 the energy-peak year for the UK's 7.2m street lighting assets.

[1] United Kingdom Roads Leadership Group 2020 Street Lighting Report

We acknowledge that, since the post war era, street lighting and the highway visual realm has evolved from the simplistic purpose of their use of providing road users with the ability to perceive hazards as stated in BS5489. It now has deep rooted social aspects and a multitude of interested stakeholders, including economic and residents' groups, law enforcement and security (eg CCTV). This highlights the deficiencies in the current British Standards and emphasises the cultural change required not only within the sector, but with the wider population. It is our intention to explore this and bring the human element into highway visual design, whilst achieving substantive carbon reduction.

Streetlights will always be with us. In some places we may need to evaluate and increase lighting to meet modern requirements, which dated standards have neglected, and take the opportunity to incorporate equality and diversity aspects into British Standards. By engaging with protected characteristic groups through community engagement, stakeholder group engagement and user satisfaction surveys, we can bring a design-led approach to lighting. Conversely, we expect to evidence that for many parts of the UK we can match or exceed high visual appreciation of the streetscape with lighting targeted only where needed. Replacing tick box approaches to lighting schemes, a new safety centric and carbon focused approach will put lighting professionals firmly in the spotlight.

Our baseline understanding of carbon is, however, extremely low. The lighting sector comprises the columns, lanterns, installations and maintenance components that should be readily mapped, but this has unfortunately not been achieved. Accordingly, it falls to the Live Lab to baseline the current status quo. Intuitively by virtue of creating an environment and street scape that is less dependent on steel and aluminium, the carbon footprint from energy intensive production will be positive. Equally, by removing the need for lit assets the energy from streetlighting will be markedly reduced.

As we continue to investigate the sector and the visual environment in greater detail, it is clear that we face a number of challenges that need to be overcome in order to achieve the goals for this project. We have however, identified several opportunities aside from the underlying goal of highway decarbonisation. There are trail blazers within the lighting sector advocating for change but restricted by standards: these voices can be channelled through this Live Lab. We have also identified a methodology that could help standardise the design of the entire visual environment based on standard road typologies. This will be developed as part of this Live Lab as an easy use tool for highway designers encompassing all elements of visual information for all users, whilst acknowledging the social aspects of visual provision.

This Live Lab provides the right opportunity at the right time. The Climate Emergency and current energy crisis dictate that the sector cannot continue to operate based on its two historic statements. Providing the sector with a method to baseline its carbon impact and affect change, which is supported through academic rigour and evidence-based solutions, will offer highway authorities not only the chance to show positive effects on its carbon footprint but provide greater value for money for all their users.

The Strategic Case

How your proposal meets Live Labs 2 Vision and Principles

The primary focus on this Live Lab will seek to test and challenge how we create striking visual appreciation of the public realm such that we can reduce and ideally replace (and stop installing at the current volume) street lighting, and mains powered bollards and signs.

The scale of the challenge is as great as the scale of the CO_2 opportunity, and we must iterate across a myriad of key factors and activities:

- Public information and engagement around the Live Labs objectives
- Compound impact of decisions from Engineer, Specifier, and Designer elements
- Baseline evaluation of Scope 1,2, & 3 emissions across street lighting
- With supply chain partners, create a transparent and detailed breakdown of how key components and operational practices might provide choice around carbon impacts
- Academic assessment, and public engagement across key UK regions of lighting levels, sign reflectivity and road marking visual perception on a range of road types
- Baseline user perception of existing visual environment to guide proposed test beds
- Academic assessment and measurement of visual perception of road markings and signage in non-lit areas and user perception studies of these areas to baseline existing visual highway environments and guide proposed test beds
- Market ready innovation from commercial partners to support early delivery
- Iterative test-bed trials of new road markings, studs, and modified lighting
- Permanent removal of street furniture as appropriate following Live Lab findings.

The key underlying principle of road lighting is to improve safety for pedestrians, active travel and vehicles. Road safety, and user perception, is a combination of many factors across the public realm environment. The construction of a road and associated street furniture is guided by individual sets of regulations governing individual aspects of highway design. There is significant scope for decarbonisation through a reassessment - using measurable and repeatable outcomes - of all factors that impact road safety and how they work in conjunction with each other.

How it meets national, sub-national and local policies and strategies

This work will be undertaken in conjunction with key members of the UKRLG Street Lighting Board and, through willing partners, will create clear evidence to transform Traffic Sign Regulations & General Directions: bringing together a sector group that is committed to support and underpin improvements to casualty reduction but within an explicit wider policy ambition to manage cost and carbon through innovative and fresh thinking.

New policy statements from some Councils support an approach where street lighting infrastructure is only provided when justified, and only switched on when needed. This Live Lab will create a new basis upon which forward thinking Councils can lead a process, using the Well Managed Highway Infrastructure Code of Practice, to evidence a new risk-based approach that describes how the sector must evolve.

Public perception of safety and fear of crime will demand careful consideration through Equality Impact Assessment. This Live Lab ties in with several contrasting national policies and strategies, such as habitat, environment, safer-streets initiatives, dark skies and habitat, which combine to demand new and fresh practical approaches to embedded mindset and culture. Councils need support to remove embedded carbon across highways and provide lower economic and carbon cost alternatives. We aim to provide an equally safe if not safer highway environment by testing the assumption that a lit road creates the safest road.

Myriad national and local policies are stacked and often conflict, eg net zero; active travel; safer streets; interventions to reduce gender-based violence; the wider ambition for a more inclusive society and night-time economy. Design-led lighting, rather than assumptions that a street light creates a safe environment, will create a low carbon 'visually alive' public realm. This will be a defining and long-lasting outcome of this Live Lab, as it exhibits practical and replicable interventions that achieve change now.

Our focus on reducing the carbon burden of the highway visual environment, along with scrutiny of current British standards regarding lit assets in all environments means that this Live Labs project falls directly within the scope of a number of national, sub national and local policies, some of the key policies on all levels are listed in the table below:

Policy	**Link**
Net Zero	UK Net Zero Research and Innovation Framework: Delivery plan 2022-2025 (publishing.service.gov.uk)
	NZR - Final Report - Published version.pdf (publishing.service.gov.uk)
Improving safety of public spaces for Women and Girls/night-time economy	Build Back Better High Streets Report (publishing.service.gov.uk) P31
	Tackling violence against women and girls strategy: progress update - GOV.UK (www.gov.uk)
Anti-Social Behaviour/Safer Streets	Anti-social Behaviour Action Plan (publishing.service.gov.uk)
National Disability Strategy	National Disability Strategy (publishing.service.gov.uk)
Delivering New Economic Infrastructure to drive improved outcomes for people and nature	IPA_TIP_A3poster_infrastructure.pdf (publishing.service.gov.uk)
Government 25 year Environment Plan	At a glance: summary of targets in our 25 year environment plan - GOV.UK (www.gov.uk)
East Riding of Yorkshire Council - Climate Change Strategy	ERYC Climate Change Strategy 20
East Riding of Yorkshire Council - Local Transport Plan *(6 appendices not included)*	ERYC Local Transport Plan 2021
UK State of the Nation Report (UKRLG) *'Saving costs and carbon by investing in street lighting'*	transpro_january2021_ukrlg.pdf (ciht.org.uk)

How it addresses future challenges not covered above

The Live Lab is centred around street lighting however the inputs are primarily centred around deploying other assets and interventions. This reflects not just current technology, but also ageing populations creating new and different needs to be supported, alongside a recognition of vehicle-based systems (including high output LED vehicle headlamps) as well as lane assist and in car 'HUD' systems displaying signs and warnings and, longer term, self-driving cars. This Live Lab will be cognisant of these changes (well beyond the time horizon of the project), but which create an ongoing test bed of change considering deep seated perceptions of the fear of crime in some areas.

The academic rigour, in terms of primary research of different road users, and insightful intervention from differing engineering principles, will be at the heart of this cross cutting and multi-disciplinary

work. Understanding and accounting for public perceptions, and embedded default professional mindsets will be uppermost for Council legal, risk, procurement, and communication teams.

Confirmation of partners and respective roles

Principal Term Maintenance Provider, Supply Chain Partners and our national partners

The East Riding is one of the largest unitary authorities in England. Our internal delivery team provides a flexible, well trained and well-equipped workforce. We intentionally aim to exploit the greatest value for money from the highway, whilst ensuring there is a robust inspection, repair, and renewal programme managing the risks associated with highways management.

The 10 additional partners selected in forming this Live Lab represent a deliberate decision to be geographically representative of every part of the UK and contrasting environments. Rural Northern Ireland, Dark Skies of Pembrokeshire, and challenges over the Pennines, contrast with shires, urban and suburban road types, and places such as Westminster, Oxford, Cambridge and Beverley where the night-time economy plays a key role.

Each public sector partner has a defined role in respective Working Groups themed around key areas of work which are described more fully in the Management Case.

Our Live Lab structure is underpinned by six different Working Groups to oversee and scrutinise individual elements of the project. The Working Groups ensure the Project Manager and Project Board can drive detail and secure oversight. Each of the Working Groups is responsible for a key area of the project under specific terms of reference. Each Working Group has a specific scope relevant to that section but linking in with all other Working Groups throughout the project. For example, the scope drafted for the Carbon Reduction and Habitat Working Group is as follows:

> *This Working Group has a clear focus on carbon baselining of existing materials in the highway, understanding of carbon evaluation tools currently available, and opportunities available to encourage biodiversity around the highway within the life cycle of the asset.*
>
> *It will work with manufacturers, suppliers and researchers to scrutinise carbon generation figures and link with other Live Lab cohorts and the wider sector to collaborate, assess best practice and knowledge share around carbon reduction.*
>
> *It will also have oversight and scrutiny for our Live Labs proposals from a carbon reduction and biodiversity view point.*
>
> *The Chair of the Working Group will report its progress back to the Project Manager and Project Board at regular intervals.*
>
> *It must ensure that it is fully inclusive for all Live Labs partners yet also accessible for non-partners.*

Working Group members and chairpersons have been selected from across ERYC and its partners to incorporate skill sets and experience within those specific areas, be this having undertaken carbon reduction initiatives, drafting and overseeing complex procurement contracts, or road safety. Within our Live Lab, we have members who participate on British Standards Governance Boards along with several other significant organisations such as UKRLG, LCRIG, LGTAG, APSE where we can raise awareness of our programme and the benefits it can bring along with recognising the needs of British Standards in terms of research, evidence and process.

The inclusion of all partner authorities across the range of Working Groups also ensures buy in and commitment across all 11 Council partners along with enabling our Live Labs to reach a wider network of highway professionals and key decision makers.

Funding sources / leverage

The £3.28m from Live Labs will be matched with local contributions and value benefits. Direct cashable savings have been identified amounting to a Net Present Value of £700k from street light reductions and energy savings along the core Live Lab corridors. A further £734k of capital works and revenue activities will be fundamentally reshaped to underpin our Live Lab ambition. This is further defined in the Finance business case.

Early-stage collaborator input has created a solid project expectation, albeit a recognition of starting from a very low baseline. Contrasting progress across column stock, LED lantern adoption and dimming and trimming have centred on cost savings with little understanding of carbon choices. Moreover, budget lines in areas that need to be enhanced – lines, signs, road studs – are siloed from typical street lighting budgets.

The Live Lab will secure annual savings to the lighting budget on the specified trial corridors of the A1079 and A164 as the defined test beds for radically different types of intervention. This will however not be solely about switching one intervention (street lighting) to other interventions. The Live Labs will ensure better and higher quality interventions at more precisely defined locations. The implementation of the overall scheme will focus on the application and long run maintenance of signs, lines, and cats-eyes along this key route within the East Riding as the initial trial location.

Educational / academic / research partners:

[redacted] and his colleagues from the Lighting Research Group, University of Sheffield, lead research on how lighting affects our perception of space and our ability to perform visual tasks. A main application for this work is lighting for pedestrians and cyclists. This has led to new national and international guidance for lighting design and this UK Live Lab will take that one step further. Their inclusion on this Live Lab brings experience and focus to the level and type of research required within the highway visual realm: particularly within the realm of British Standards given that [redacted] has advised, and still advises, British Standards regarding highway lighting.

Despite reduced funding from the Live Lab, we continue to prioritise the academic rigour and evidence to underpin changes to dated British Standards. Research options include:

- Recruit a PHD student to assist the programme over the course of the three years - *the costliest option and possible only with additional funding or commercial sponsor*
- Targeted post-doctoral researcher on a part time basis.

There are pros and cons for each of these options, but the budget limitations will dictate the final research option decision. Further detailed discussions with Sheffield University are required to understand fully the research requirements for a project of this magnitude within this field and the level of academic assessment needed to support our overall objectives.

Where Sheffield will focus on human perception, Edinburgh Napier University will bring rigour to the physical measurement of reflectivity consistent with their renowned work on road markings and road studs, which will be drawn into and expanded upon within this Live Lab. Napier are also suggesting the use of multiple MSc research projects targeted at distinct strands, eg consultation methodology, road safety risk, equality impact, etc.

Leveraging vital customer insight from 1 million responses (over a decade) to the National Highways & Transportation (NHT) survey, Measure2Improve data (and their association with Leeds University) can also be used to assess historical understandings of previous lighting interventions. With most Live Lab partners using NHT we can readily gauge trends.

Alongside academic support and insight

- The Institute of Lighting Professionals (ILP), the sector advisory body of lighting specialists drawn from all sectors of external lighting, are keen to support us to share sector knowledge and scrutiny of approaches and outcomes. They will support wider sector engagement and dissemination of early findings for challenge and review.
- The UKRLG – especially the Street Lighting Board – provide a vital part of this Live Labs. They represent a control environment of senior-most professionals with considerable experience.
- LTP Consultancy is a local consultancy to East Riding who will resource practical initiatives and consideration of typology and the safe application of initiatives.

A description of the drivers for change

The UK's 7.2m street lights, across 214 Highway Authorities, consumes 1,887 GWh energy and produces 478,000 CO_2 tonnes annually. UKRLG[1] shows improvement with gradual roll out of LEDs and other initiatives to dim and trim. There is however no national timeline, with slow adaptation rates illustrated by (eg) National Highways at barely 20% LED (UKRLG 2020) and some PFI lighting contracts at only 1%. However, whilst 100% LED would cut electricity, total carbon footprint would remain high.

Early-stage collaborator input has created a solid focus on project expectations. At present we are perhaps typical of a sector that is starting from a very low baseline. Contrasting progress across column stock, LED lantern adoption and dimming and trimming have centred on cost savings with little understanding of carbon choices. Moreover, budgets in areas that need to be enhanced – lines, signs, road studs – are outside typical street lighting budgets.

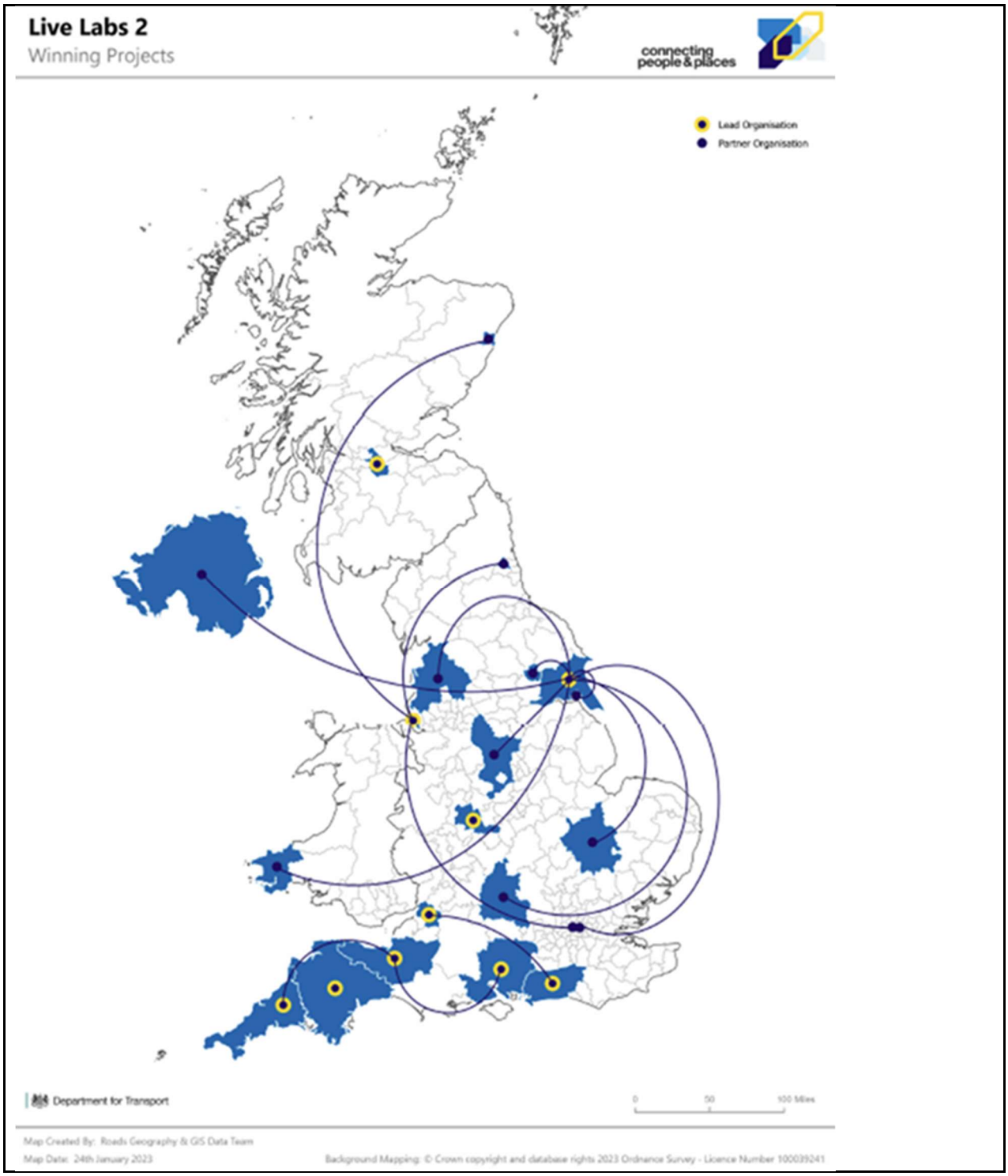
Lighting columns have an average design life of 40 years, which creates a replacement programme of circa 180,000 columns per year. Heavily reliant on steel, each replacement column creates 185Kg of carbon and each lantern 38Kg. 223Kg per street light creates a cumulative manufacturing impact exceeding 40,000 tonnes of CO_2 per annum. These figures exclude transport and other related carbon emissions (primarily due to a sector wide lack of demand for this insight). As a crucial first step this Live Lab will explore and unpack the full carbon impact.

The average cost to replace a street light is £1,000 - albeit Westminster reporting up to £12k for historic column replacement. Exceeding £7.2bn gross replacement cost, the sector needs to be radically rethought through a lens of carbon, cost and customer experience. Outdated British Standards are driving rigid and silo thinking, restricting innovation, and increasing carbon emissions. This project aims to create safe and attractive highways, that sit harmoniously within their environment, with sustainability as a core design principle.

Alongside economic drivers, the need to update current lighting standards to reflect the human social aspect is needed along with the environmental impact that excessive CO_2 brings. Carbon intensive infrastructure must be challenged and a shift in British Standards from a blanket approach to a design led culture change is a desired Live Lab outcome.

Local communities also expect much more now from their night-time highway environment. Residents, particularly those of protected characteristics, need lighting that is fit for purpose within their localised area to encourage more active lifestyles, safety, and active travel. Lighting can be used to support night-time economies, aid first responders, enhance CCTV and provide a feeling of safety to a multitude of user groups. Whilst these are non-quantifiable drivers, they underpin a shift to modernised lighting and potential non-illumination of certain highway typologies. The development of dark skies tourism economy would also see massive benefit from revised lighting standards.

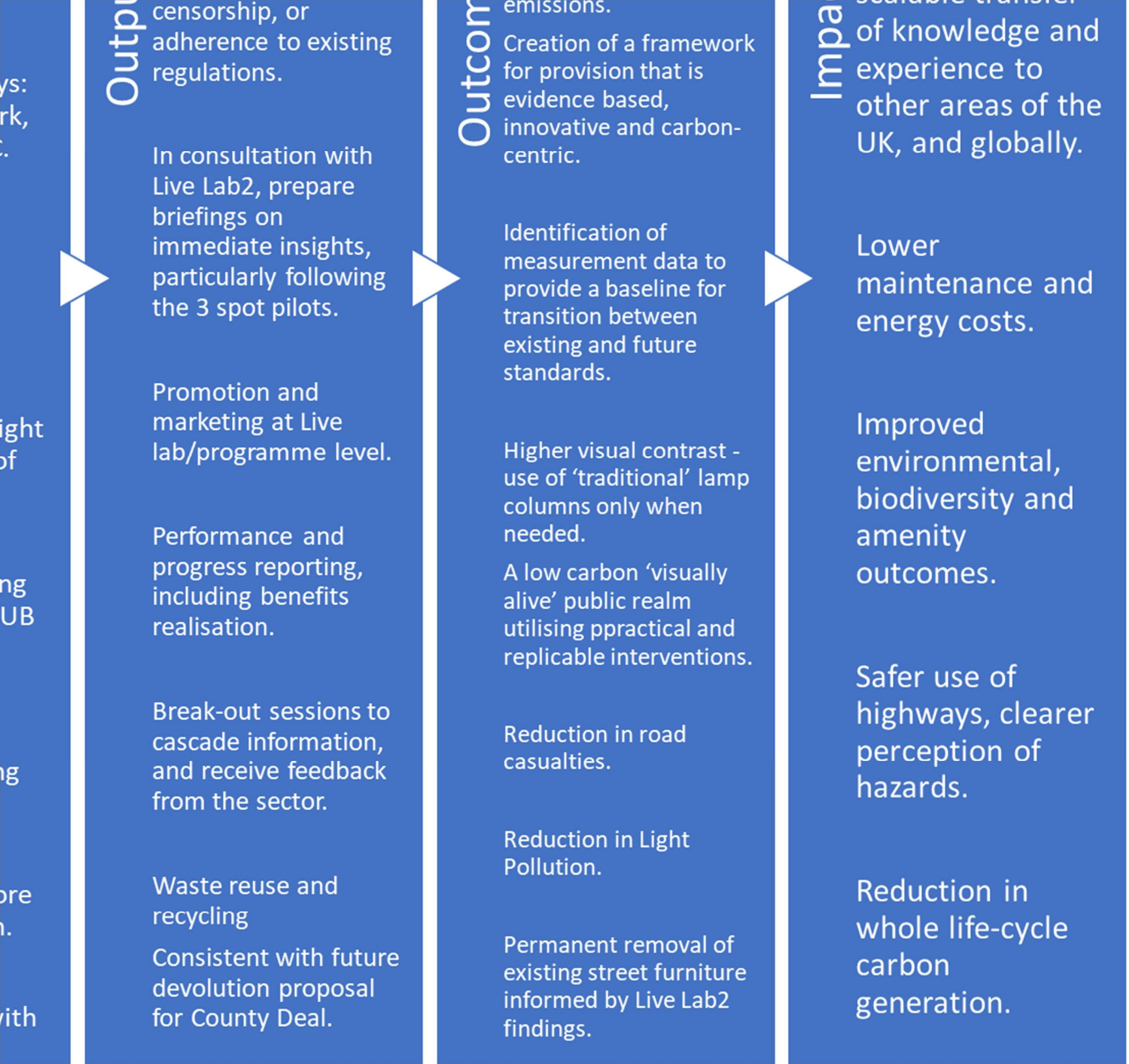
Details of process / locational maps where appropriate



This Live Lab collaboration brings together partners across all regions of the UK. A central Project Board will oversee partners and a Project Manager will be supported by Working Groups.

The project will be run through a system of scheduled Working Group meetings – chaired by the relevant expert and supported by the Project Manager.

Information will be disseminated throughout the project with quarterly full partner meetings to update the wider group on project matters. The Management Case describes the interaction and roles of the respective partners.


Outputs
censorship, or adherence to existing regulations.
In consultation with Live Lab2, prepare briefings on immediate insights, particularly following the 3 spot pilots.
Promotion and marketing at Live lab/programme level.
Performance and progress reporting, including benefits realisation.
Break-out sessions to cascade information, and receive feedback from the sector.
Waste reuse and recycling
Consistent with future devolution proposal for County Deal.
Outcomes
emissions.
Creation of a framework for provision that is evidence based, innovative and carbon-centric.
Identification of measurement data to provide a baseline for transition between existing and future standards.
Higher visual contrast - use of 'traditional' lamp columns only when needed.
A low carbon 'visually alive' public realm utilising ppractical and replicable interventions.
Reduction in road casualties.
Reduction in Light Pollution.
Permanent removal of existing street furniture informed by Live Lab2 findings.
Impacts
of knowledge and experience to other areas of the UK, and globally.
Lower maintenance and energy costs.
Improved environmental, biodiversity and amenity outcomes.
Safer use of highways, clearer perception of hazards.
Reduction in whole life-cycle carbon generation.

From the Logic map on the previous page, we detail below five key outputs. We will achieve these outputs via a multitude of cross-linking routes however we have identified key routes to focus on:

1. Guidance and standards for lamp columns, signs, bollards, road markings, surfacing and studs developed when carbon reduction was not a priority. Creation of a framework for provision that is evidence based, innovative and carbon-centric, with reliable and scalable transfer of knowledge and experience to other areas of the UK, and globally (defence-checked with legal advice, but with risk appetite not constrained by self-censorship, or adherence to existing regulations).

2. Changing mindsets from fixed, energy-intensive assets: 3 spot pilots before route application; performance and progress reporting, including benefits realisation; Live Lab findings will drive permanent removal of existing street furniture - lower cost maintenance and energy

3. Reducing contributions from 478k tons of CO_2 per year: 3 spot pilots before route application; reimagining waste reuse and recycling; 'sector reset' focusing on reduced carbon emissions; improved environmental, biodiversity and amenity outcomes.

4. Guidance and standards for columns, signs, bollards, road markings, surfacing and studs developed when carbon reduction was not a priority: £3.3m for the development of ideas and the retrofitting of strategic highways - A1079 Hull to York, other routes TBC; in consultation with Live Labs, prepare briefings on immediate insights, particularly following the 3 spot pilots; road collision data used to identify paths to safer use of highways, clearer hazard perception

5. Carbon impact of current activities poorly understood: monitoring and evaluation oversight from University of Sheffield who, in consultation with Live Labs, prepare insight briefings, particularly following the test bed trials; generating a low carbon 'visually alive' public realm utilising practical and replicable interventions; driving reductions in whole life-cycle carbon.

Details of how you will measure impacts and how this link with M&E activities

Gaining customer insight

For over a decade, most English Highway Authorities have been participating in the National Highways and Transportation survey (NHT), with over 3,300 residents annually surveyed in each participating Council. As well as perceptions on road condition, there is a long and detailed history of insight on perceptions of street lighting, lines, and signs. This database creates a robust baseline. Moreover, there is useful content where some Councils have undertaken large scale street lighting switch off. Working with Measure2Improve, and their relationship with University of Leeds, robust insight will be drawn from customer surveys.

In addition to this analysis, we will deploy identical questions from the national surveys in local communities, allied with additional lines of inquiry – creating consistency with national and local data sets as well granular and highly specific insight.

Detailed conversation in defined communities will be held to seek out attitudes and insight. Specific groups, as identified in our equality impact assessment, will see engagement with visually impaired, gender, and age groups.

Validating the technical interventions

The strategic road network (SRN), managed by National Highways (NH), operates in accordance with CS 126 - *Inspection and assessment of road markings and road studs*[2], found within the *DMRB*. Under CS 126, anything below 80 millicandelas (mcd) retro-reflectivity is classed as a defect,

because it has reached the threshold level for interventions. Regular NH surveys have shown more than a third of their network is below standard.

There is no standard and little data and insight on local roads. Local highway authorities do not expect signs, lines and studs to be considered and (at best) there is the over reliance on street lighting. It is not practical, and cost prohibitive, to undertake full retro reflectivity surveys across the Live Lab (before and after). We can and will however create a balance between a driven route that can provide technical insight – as well as stationary and 'lab like' analysis of stationary cars and special cameras to capture retro reflectivity. This will inform before and after evidence and long-term deterioration insight as to product longevity and optimum point of renewal.

It is expected that where there is large scale replacement of street lighting flowing from this Live Lab, then a Highway Authority must have an accompanying maintenance manual. This would enable the Council to deliver cashable savings on asset and maintenance, offset by a defined quantum for the upkeep of elements that would otherwise atrophy and make the road less safe.

Seeking out the points of failure

We will be confronted by 'this is an accident waiting to happen' mindsets. From the outset we will establish baseline statistics across each Lab and each intervention. We will also seek to test phased and optimum implementation. We also intend to deploy proxy and 'leading' indicators. This will include access to smart technology, especially harsh braking data held by companies [redacted], for live assessment of before and after trials as to the point where deceleration occurs on the approach to road hazards. This will provide insight as to changes (before and after) in traffic behaviour. For complex typology, there is also the potential to deploy cameras that will accurately track the position of vehicles in the road and the impact of lane position and turning.

We have already made a robust start in creating a baseline starting point, with the Academic input, early engagement from relevant Institutes, and considerable practitioner experience from within the Live Lab of 10 selected Council partners. The following represent initial consideration from across the partners and will form a key and vital part of building a coalition of interest:

- Literature search to identify associated research areas and latest innovations
- Assembly of all current guidance and standards documents for each component
- With commercial partners agree a 'palate' of test bed products and treatments
- Define baseline measurements and user perception methodologies
- Examine current inventory data collection methodologies, (ensuring consistency across the project partners) and identify refinements in data accuracy
- Develop detailed methodology to accurately capture Cost & Carbon of installation, energy and maintenance costs for street lighting, signs, road markings and studs
- Creation of baseline lighting level profiles along trial routes to enable before/after comparisons, including reflectivity of current signing
- Baseline evaluation of Scope 1, Scope 2 and Scope 3 emissions across the entire street lighting sector
- Road user perception study of existing situation to enable before and after analysis of visual environment, including lighting, road marking, signing and surfacing elements, for the different route typologies

- Evaluation of combined test bed using same methodology as used to define baseline measurements and user perception

- Development of a robust mechanism for carbon calculation by detailing CO_2 emissions across the entire supply chain, including for future maintenance activities

Building a network and forging an alliance

In forming this Live lab of 11 Highway Authorities, we have drawn together expertise from respected bodies and active organisations. Since the announcement of the seven shortlisted winners, we have been overwhelmed by a sector keen to work with us and through us. We will be open to partners who share our vision and who can support the ambition described in this strategic case, whilst carefully mitigating the risk of scope creep in our laser like focus on street lighting.

[1] UKRLG State of the Nation Street Lighting 2020
[2] CS 126 assessment

The Economic Case

A proposed value for money category(s) for the investment proposal reflecting the Benefit-Cost Ratio, non-monetised impacts and risks and uncertainties

This Live Lab seeks to improve both the visual perception and carbon footprint of the highway through a focused scrutiny of current British Standards. It spans all three value-for-money categories, Economic, Social and Environmental as set out in the Department for Transport Value for Money Framework. Through this Live Lab we will create a framework for cost saving by removal of costly highway infrastructure that will be replaced with lower cost alternatives.

All lighting assets require energy (ie revenue cost) and for life-expired columns a significant capital replacement cost. This proposal firmly sits within the Very High (and Financially Positive) value for money category. This is emphasised by the climate emergency and the ongoing cost of global energy, creating significant financial pressures. We seek to create an economic rationale that is consistent with social aspects of the highway visual environment such as fear of crime and impact on night-time economies, but consistent with, and moving beyond recent analyses, such as by the ILP[i].

Removal of street lighting driven purely by economic pressures may also, if not properly risk assessed and planned, lead to an increase in serious accident rates, leaving local authorities open to legal scrutiny and legal claims. Local Authorities need a new supportive framework, ie an alternative and evidence-based approach to maintaining public safety on the highway within financial constraints. We seek to create a virtuous circle of low carbon footprint and enhanced visual acuity.

Our early assessment of the likely interventions required to remove street lighting, whilst improving visual perception, has indicated that we can reduce embedded highway carbon at a lower Capital and Revenue cost. Through various tools and techniques, including new standard road typologies, we could rapidly scale this Live Lab nationally, thus underpinning immediate economic benefits. Providing evidence-based alternatives to British Standards, we will demonstrate long term economic benefits through changing highway lighting design. Disseminating early findings will ensure rapid validation and application of Live Lab findings.

Aiming to at least maintain current safety levels we intend to secure capital and revenue cost savings creating a Very High (and financially positive) economic case.

Projected Benefit-Cost Ratio(s) informing the value for money category

This Live Lab will baseline current embedded carbon, existing light and reflectivity levels at key locations, road safety and user perceptions. However, as there is currently limited or no carbon data for many of the Live Lab elements, this SOBC adopts a micro-level case study approach based on a single geography (which will inform the larger cost and carbon assessment). This provides a scalable benefits baseline although it is recognised that when applied nationally there will be regional variations across the UK in terms of costs for materials and labour, geography and microclimate.

Our case study scenario assumes a typical 100m of an inter urban bypass route within the East Riding of Yorkshire which is fully lit to current British Standards and that may typically require 3 columns (to light to 100m British Standard) and 2 non lit signs.

Capital and Revenue comparison costs for existing and Live Labs interventions:

	Existing		Live Lab forecast	
Supply, install, operate cost per 100 metres 40-year total	**Cap Ex**	**Rev Ex**	**Cap Ex**	**Rev Ex**
Three Columns @ £1,137each & DNO Connection	£3,412			
Three Lanterns @ £231	£694		£0	£0
Lantern Replacement Cost (after 20 years) @ 231	£694		£0	£0
Energy cost *3 lanterns (burning hours of 4,098 *47.5p per unit)		£14,015	£0	£0
Statutory Column Tests (every six year) 40-year total		£102	£0	£0
Column removal including service disconnection @ £514 each			£1,543	£0
2* non-lit signs (Live Lab figure = enhanced sign) replace every ten years	£338	£254	£468	£936
White lines as per two lane 50mph road for 100mt (9 x 6mtr line)				
Standard Thermoplastic (fit and forget)	£54	£982	£0	£0
Enhanced Future Live Lab (Eight yearly refresh- @ £196.31)			£112	£671
Stud replacement - replace every ten years	£405	£810	£796	£1,593
	£3,817	**£16,163**	**£2,919**	**£3,200**
Pro rata PA:	£95	£404	£73	£80
Total Cost:		£499		£153
Saving per 100m per annum:				**£346**

This initial assessment shows significant capital and revenue savings. The previous illustration assumes a life expired column which a Council would reinvest 'like for like'. Where a mid-life (20-year-old) column is removed and replaced with the new Live Lab standard, we will need to ensure our financial model can show the saving of 1.5 lanterns and energy.

Preliminary Live Lab assessment suggests a minimum 10% reduction in the current 7.2m columns equating to headline cost (not discounted to current values) of

	40 years	**pro rata per annum**
Capital	£215m	£5.38 pa
Revenue	£3.1bn	£77.78m pa

The £83m per annum saving, excludes savings from standardising dimming and trimming, on remaining 90% of lighting stock. An early deliverable from the Live Lab will be a full and detailed financial model of the entire lighting stock. Through our lead in this Live Lab, ERYC has estimated circa 25% reduction in total energy consumption (despite our existing high roll out of LEDs).

- 10% asset removal (saving the above £83m pa)
- Standardisation of all remaining lighting levels across retained lighting stock to a new, modestly adjusted lighting level.

That would increase the £83m saving to circa £250m – based on the £1Billion annual energy consumption. For some Councils who have been reticent to depart from British Standards, the saving could be considerably higher. The Live Lab is also likely to create focus around 'late adopters' to LED's - creating some wider benefit that is related to an element of this Lab. The volatility of energy pricing has prevented a full 40-year appraisal so current pricing has been used.

Whilst the specific highway related cost shows a significant positive benefit-cost ratio, there are wider economic benefits to our proposal. Improvements to the highway visual environment can have significant economic benefits on a range of less tangible aspects that, whilst impossible to quantify or estimate at this early stage, can form part of wider impact monitoring in the post evaluation phase of the programme. Such elements as night-time economy, public health, reduction in accident repair costs to the highway and dark skies tourism are examples of where improvements to the highway visual environment and a design-led approach to street lighting could benefit the wider economy as a whole.

Significant risks and uncertainties that might influence a scheme's value for money

There are several key risk factors and uncertainties that could impact this Live Lab. These are discussed below, however, despite their potential to reduce forecast benefits and savings it is expected that the value for money of this Live Lab will remain very high as the overall benefits resulting from the removal of carbon intensive and expensive capital items such as steel columns (that are also revenue hungry) will be significant.

Energy prices started to increase during 2021 and spiked following the Ukraine invasion. This is having a massive pressure on local authority revenue budgets. Key monetary risks are inflationary and the volatility of the global energy market. Instability in inflation and disparity of inflation across various markets could have significant impact on achievable interventions. Whilst the material interventions are comparatively low cost, our ability to provide an adequate evidence base to affect a change in standards or provide an alternative matrix that robustly stands up to legal and industry scrutiny, could be compromised.

Political intervention driven by public pressure is a significant uncertainty. The value for money ramifications due to loss of political will or negative public perception, have shaped our approach to enhanced engagement and risk management. Night-time accident statistics for the test bed areas

will be key, but harsh-braking data (before and after) will give early insight as to potential need for more expensive interventions being deployed (eg 100% solar studs) or ultimately a return to previous cost intensive interventions – turning lights back on.

Sensitivity testing to assess the impact of the risks and uncertainties

At the centre of this Live Lab proposal is the simple principle of removing existing highway infrastructure and the installation of new modern infrastructure in a revised way. Key economic risk factors surrounding this basic principle are identical to current replacement and maintenance regimes for the highway environment, these being inflationary pressures, funding regimes, direct and indirect material costs, labour costs and fuel costs. These are all issues that local authorities contend with constantly; albeit this Live Lab is seeking to have fewer of the more carbon intensive and costly assets ie street light columns and lanterns.

Highway authorities already mitigate risk within the uncertainty of global market demand for raw materials and instability within areas such as inflation and global economic pressures. Joint authority procurement across materials and fuel and committed funding profiles mitigate short term fluctuations in materials costs. Strategic buying and storage of materials can further reduce short term inflationary pressures.

This Live Lab will utilise newly developed products, which by their very nature can be more costly than existing, long-standing materials, the elevated costs of installing these modern materials brings pressure to existing funding streams. The increase in materials and installation costs within constrained budgets implies that a lesser amount can be delivered. This is mitigated in two ways.

- Lowering the overall cost of installation per kilometre by replacing the need for lighting, with lower costs options, thereby releasing much needed capital investment.
- Creating more demand for higher cost materials (eg solar studs) will inevitably reduce the long-term unit cost as we stimulate demand and market innovation.

Removal of costly electrical street furniture, and reduced energy costs will have a massive positive impact on the benefit-cost ratio. Cost and carbon savings will be significant against long term energy prices, and the current unprecedented cost of energy will ensure early payback and positive net present value: not only from short term capital and maintenance savings, but from the removal of long-term energy cost commitment. Energy costs are dictated by global market economics, and global instabilities since 2019 have been notable and significant (COVID, Semi-Conductor shortage, energy spike, Ukraine invasion).

Should energy costs return to pre-energy crisis levels, whilst making the proposals less economically attractive in the short term, street lighting installation remains a commitment to ongoing energy costs for that installation for its expected 40-year design life. Removal of lighting columns, even in times of moderate energy costs will still show a long-term economic saving, as no energy costs are better than low or moderate energy costs.

Sensitivity modelling

This Live Lab is based on an asset reduction figure of 10% which Live Lab partners feel to be quite a conservative estimate. During this mobilisation process we have been investigating the locations of the lit stock within ERYC, whose lit stock in relation to numbers of lit signs and LED conversions represents the average national picture according to the State of the Nation Street Lighting Survey. We have identified a range of areas of significant interest that could be considered for street lighting removal based on typology and following our Live Labs principles.

Whilst we appreciate that all local authorities vary in relation to lighting stock, density, rural and urban concentrations and funding levels, initial investigations have shown that East Riding has the potential

to remove 17% of its current lighting stock that light non-urban areas. This is without factoring in the impact of lit signs and bollards. If we can prove the viability of removing the requirement for lit signs and replacement with ultra reflective non lit signage, then on average that would reduce the lit stock nationally by a further average of 5% immediately.

On this basis and using the East Riding of Yorkshire as a template then identification of 10% of lighting with the capability to be removed either at end of life or prior subject to local funding, should be easily achievable, even taking into account regional variations. A lighting stock removal figure of 15% is also most likely achievable, however, without having a clear national picture or engagement of all local authorities across the United Kingdom it is difficult to confidently assume 15% is achievable.

Key metrics, ie projected costs, supporting costs, and costs per tonne of carbon saved

As the project is centred around removal of costly assets, or non-renewal of them when life expired, there should be a very positive net benefit. The key metric to be established through this programme is the baseline measurement of embedded carbon within the highway. This will drive the whole project and enable us to evidence that the changes we propose at the end of the programme have significant carbon reduction benefits alongside financial savings.

There are several additional baseline metrics to be developed alongside the primary carbon baseline. One of these metrics will include a breakdown of road typologies to enable granular research of individual highway settings and a clear understanding of what interventions to apply to these typologies. An early-stage deliverable of the Live Lab partnership, the proposed road typology will evolve into a matrix by which highways designers could apply a simplistic approach to highway infrastructure design and has shown a potential commercial opportunity in terms of developing this into a software-based tool.

Accident statistics will enable us to evidence success of the interventions put in place, with user satisfaction and perception surveys guiding the social aspects that surround lighting and the provision of lighting and reflectivity and ambient lighting measurements. These are key baseline metrics as they provide empirical data regarding the existing visual condition of the highway to provide a base for the social aspect baselines along with current accident rates.

As the programme develops there will be other metrics that, whilst not immediately obvious now, will develop and inform the programme. Such metrics are valuable albeit they come with distinct context. One evidential metric that is extremely contextual is the metric of cost per tonne of carbon saved, particularly when dealing with infrastructure within the highway visual realm. It is relatively easy to calculate energy carbon savings, but the precise calculation of carbon used when travelling to each column to undertake structural column tests every six years is more complicated. Equally the carbon impact of having enhanced and more frequent white lines might be positively juxtaposed to the more carbon intensive impact of ‘leaving the light on’ for 40 years.

Cost of materials and labour are determined both locally and on a global economic scale and can, as has been seen in recent years to be subject to sudden variation. This metric will be a helpful evidential metric. However, given our national reach with partner authorities and utilising materials that are sourced globally, it needs to be understood across relevant local, time-stamped, contexts.

[i] https://theilp.org.uk/publication/energy-crisis-guidance-for-street-lighting-authorities/

The Commercial Case

Clear statement of the projected procurement / intellectual activities

As this Live Lab proposal has developed from initial conception, the scale of the proposal and potential for significant carbon and cost savings have come into sharp focus. Throughout this time the procurement requirements have evolved in line with the scale of the proposal.

The procurement strategy for this project has been broken into three distinct requirements in line with the key elements of the project; Research / Academic Input, Materials, and Labour. These key procurement themes reflect the nature of this proposal, as there is a heavy emphasis on researching and baselining several thematic elements of the highway, such as carbon baselines, user perceptions and user behaviour, whilst many materials being proposed are commercially available or imminently available.

Serious consideration has been given to the labour provision aspect of this proposal with regards to installation of interventions and skill sets required for this. Current investigations have shown that materials being proposed for use in any intervention and removal of redundant equipment sits within the current agreements, with incumbent term maintenance providers or existing direct labour (DLO) structures, and as such no further procurement exercises will be required. Things such as installation of white lines, signage and install or removal of street lighting are commonplace practises and the new materials to be installed or removed fall within current scopes.

This proposal also requires additional skilled applications and activities that do fall outside the current skill set of existing project team members and as such specialist services will be procured to ensure rigor and transparency. These activities will include existing sector research, collation of data and trend analysis, visual acuity data and several user surveys, incorporating all demographics identified for scrutiny, to ensure that any interventions undertaken provide benefit for all highway users. These activities are not exclusive or exhaustive.

Procurement for research activities will commence after SOBC confirmation. This area is both exciting and vital such that our programme dictates replicable baselining, data collection and user surveying be undertaken pre and post intervention. Use of Sheffield University for visual perception, along with Napier for physical property testing (retro reflectivity) and Measure2Improve (in conjunction with Leeds University) will create rigorous contestability in methodology and approach. Early engagement with British Standards will ensure that all research and data collected is peer reviewed ‘along the way’ such that the sector as a whole is engaged with arriving at a new and better British Standard. We cannot simply operate in a silo and present our work in 2027: rather those people who might check or challenge need to be brought on board as we evolve.

Leveraging value of historic data where lighting changes have occurred to date will be complemented by customer surveys undertaken without bias and swiftly shared with the wider highway authority sector for challenge and review.

Procurement routes for key outputs, activities and delivering Live Lab ambitions.

There is no existing research contract for the scale and nature of this Live Lab. All research activities will be undertaken through an East Riding led procurement exercise, available for access by all participating authorities.

Materials procurement will be undertaken through purchasing organisations or national purchasing contracts such as Local Council Roads Innovation Group (LCRIG) and the Yorkshire Purchasing Organisation (YPO). We do not foresee a requirement for a specialist contract to be initiated by East Riding of Yorkshire and such an exercise would be counterproductive in terms of national access and wider collaboration. The use of purchasing organisations will enable full national access by any highway authorities that wish to be early pioneers of our Live Labs 2 methodologies and outcomes, regardless of existing local procurement arrangements.

The use of larger procurement groups for materials specification and purchasing based on clearly defined specifications will allow for standardised pricing that can be accessed by Live Labs partners and non-partners alike. The potential for volume based, centralised, collaborative procurement, rather than localised arrangements will help to ensure cost stability. Whilst the proposed materials are relatively new to market and currently supplied across local authorities in relatively small quantities, volume purchasing through centralised contracts will enable standard market forces to help restrain or reduce overall costs. This will help maintain the positive savings projected through the initial cost savings investigation, the main impact on these savings will then originate from the volatility of energy pricing.

Intellectual services procured through an ERYC procurement exercise will ensure that all data generated through this Live Lab will be the property of ERYC and as such will be made available to all partner and non-partner authorities in line with Live Labs visions and principles.

As previously stated, there is no specific procurement exercise planned for installation labour. Installation and maintenance requirements for the proposed interventions are covered within current DLO or term maintenance provision as they are identical to existing provision: it is simply the nature of the material that will vary. These materials have no bespoke installation requirements. As such the installation labour costs will have no bearing on any benefit-cost exercise undertaken locally.

How the proposed approach will comply with procurement, subsidy control

All procurement exercises undertaken within this Live Lab will be overseen by either the ERYC Procurement Team or by partner procurement teams. Localised arrangements for operational labour provision will be checked by local partner procurement officers to ensure compliance within existing contract arrangements.

Multi-partner items such as proposed new materials will be procured through purchasing organisations to ensure full access from all partners and early adopters. This procurement exercise will be subject to approval by procurement officers from all partner authorities. Any procurement for specific use within the Live Labs project such as intellectual procurement will be generated by ERYC and their internal procurement teams, ensuring compliance relative to expected value. All contracts issued either directly by ERYC or through procurement groups will conform to Public Contracts Regulations 2015 and the Public Contracts Directive 2014/24/EU.

State aid regimes inc. Section 151 / 73 officer sign off

The nature of interventions does not impact state aid. All interventions forming this Live Lab are existing activities that Councils deliver. The key element, subject to appropriate risk management, is the replacement of lit assets with lower carbon and more highly visual interventions. S151 approval to receive and be accountable for the Live Lab funding has been received.

The sourcing options available and the rationale for the preferred option

The truly nationwide partnership of this Live Lab demands a clear approach that allows local delivery of specified products. As shown from current trials, there are various suppliers to ensure contestability and product demonstration. This will be overseen by strong and transparent academic rigour and oversight from the lead authority.

There are several sourcing options available, ranging from the employment of one single contractor to provide all the ranges of services and materials; the exclusive use of procurement groups; or the use of centrally created bespoke procurement contracts for all elements. Use of one single procurement method does not ensure value for money across the various elements to be procured (across all four corners of the UK).

With the scale of this Live Lab now starting to coalesce, it is evident that a single term contractor to provide all services is not an option given the variety of services and materials to be employed and utilised as well the local geography, distance and travel time. The use of local existing contracts where possible, particularly for labour, reduces the burden on the Live Labs project groups and retains existing working relationships along with localised management of these activities whilst proving that our interventions can be undertaken by incumbent workforces without the need for specialist contractors.

In respect of the academic assessment and customer insight, a centrally created and managed procurement for specialist intellectual services will be fully compliant with procurement regulations to ensure a bespoke specification to Live Labs. Market engagement with procurement organisations has shown that there are no current contracts in place for these services and as such we have no alternative but to issue a specific bespoke framework contract encompassing all intellectual services under a Lot system given the urgency of this procurement and the speed at which locally created contracts can be created and issued compared to other routes such as procurement groups.

Assessment of the requirement of materials across the partners has established that the accessibility of procurement group DPS frameworks is the preferred route. This enables all partner authorities' easy access to a central, fully compliant procurement route. Many of the proposed materials are currently available through these routes. Combined purchasing power will be brought to bear along with the insistence with manufacturers of new products over the life of the Live Lab that any potential purchasing of the product will only take place through these frameworks. This route will also enable early adopter authorities to install Live Labs interventions without the need for bespoke procurement contracts

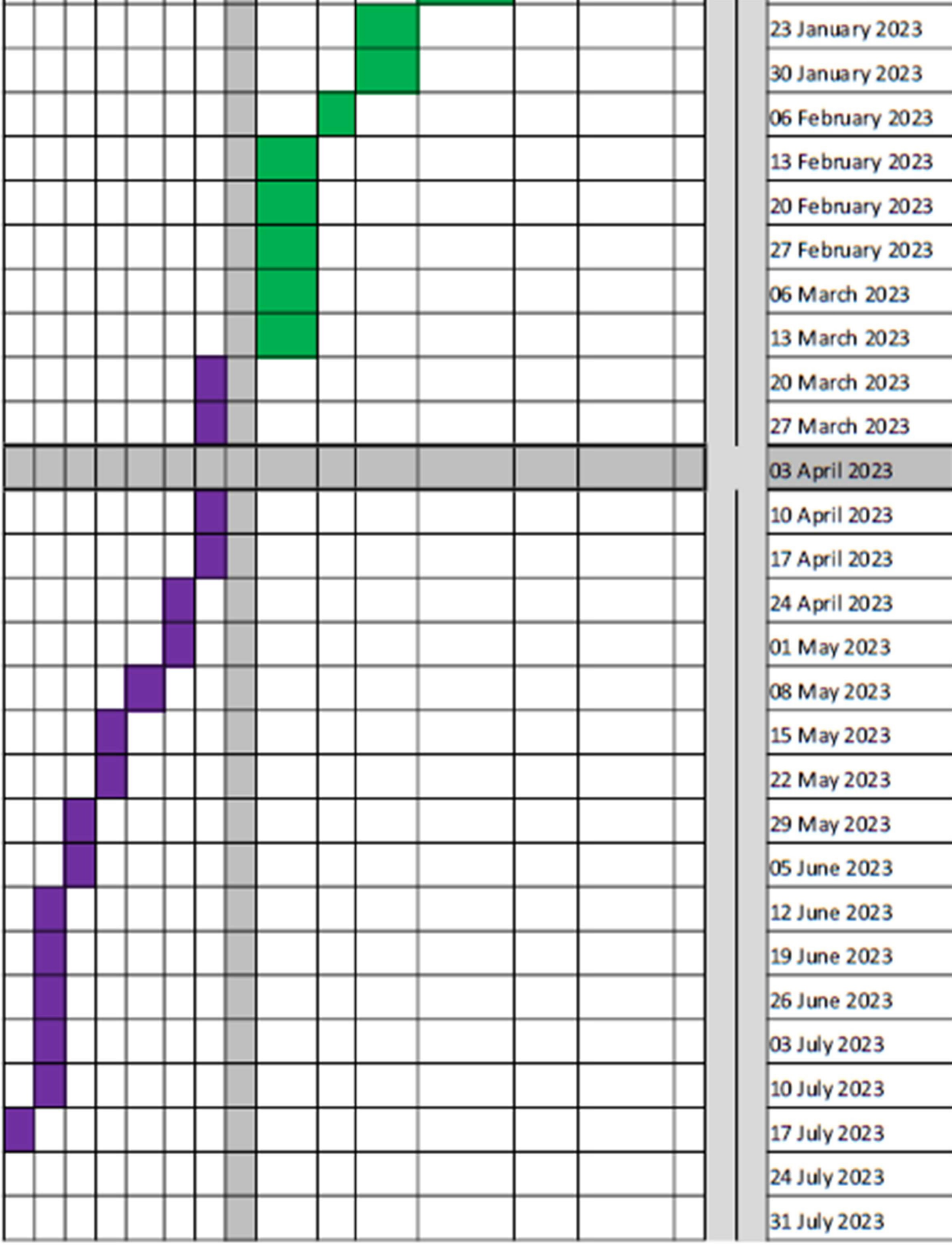
Early consultation with the supply side and partnership arrangements

Prior to commencing Live Lab there has been sustained engagement with various suppliers across the range of highway visual sectors. We have undertaken significant premarket engagement not only with materials suppliers but also with sector academic experts and current suppliers to the sector for a range of existing intellectual services. Partner authorities that operate term maintenance arrangements have also undertaken early engagement regarding labour provision.

This premarket engagement has enabled us to put the commercial sector on alert for this Live Lab and its potential which has been warmly received. We have linked with multiple universities that specialise in the highway visual realm. We have also had extensive discussions with Measure2Improve who undertake the annual NHT survey on behalf of local authorities to ensure we leverage historic survey data of over one million customer surveys held for highway authorities. We seek to engage with them to undertake the detailed surveying that will be required for this Live Lab and Measure2Improve have also indicated that they may incorporate some of the detail we intend to survey in future NHT surveys.

We have engaged in preliminary discussion with incumbent street lighting providers to ERYC and other partner authorities, [redacted] to begin research and development on street lights with more targeted light, particularly for footway only lighting. Engagement has also taken place with white line providers with regards to new materials, costs and trial areas already applied which has been followed up with meetings with the highway authorities in these areas to discuss their ongoing analyses of these materials.

This premarket engagement is enabling us to develop detailed specifications for materials and intellectual services and explore the most appropriate route to procure these goods and services. We have identified existing procurement availability of several goods and services such as reflectivity measurement, reducing the need for additional contracts as there is no point reinventing the wheel.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The aforementioned programme has been impacted by the delays to announcement. In addition, the point at which this SOBC will be approved, and funds released, is having a bearing on the above programme. It is notable that the reduced quantum of funding for this Live Lab has markedly reduced the specific demonstration projects – which would have required specifically procured contractors. However, the lower funding is instead being routed through existing supply chain arrangements on currently programmed works *albeit they will use the higher standard interventions*

Outline output / outcome-based specification

At such an early stage of this Live Lab journey it not possible to detail a pre-determined output other than to state that the overarching ambition is to provide a replicable and scalable alternative to current British Standards governing the highway visual environment, enabling a consistent and sustained reduction in carbon footprint for the highway whilst maintaining the safe use of the highway.

We can at this early stage provide some outputs for constituent elements of the project. This project will need representative surveying of defined user groups across a range of age demographics, user types and protected characteristics. These surveys must be undertaken without any bias, and it will be role of our survey company to formulate surveys based on Live Labs requirements, undertake these surveys and then provide detailed analysis of the survey groups both pre and post intervention.

We will require a detailed embedded carbon baseline for visual infrastructure existing on the highway based on representative sections across ERYC and our partner authorities. It will be the role of the universities employed to undertake this analysis along with other research activities such as detailed accident and crime data analysis, identifying accidents and crimes relating to the highway and during the night-time period, overlaid against the provision of street lighting, along with speed and braking data analysis.

Materials outputs and specifications are still being formalised to identify and verify current manufacturer claims along with Live Labs requirements, balancing maximum carbon benefits, with value for money and maximum reduction on revenue activities. These materials specifications will be outputs based, for example white lines will be specified with an end-of-life level of reflectance greater than the current 30 millicandela British Standard but for a replacement period enabling least impact on revenue budgets.

Reflecting the effort, energy, and costs associated with site visits we are seeking to develop products with high levels of longevity as well as retro-reflectivity. Where some products boost very high levels of initial millicandela, there is anecdotal evidence to suggest this requires refreshing within 24-36 months. Ensuring an appropriate complementary product mix of signs, studs and lines to create assets that might need replacement only every eight – or ideally ten – years should drive the market (set within the shared and early findings of this Live Lab) to create the right blend of products for a given road typology as described in the M&E section below.

The adoption of a new alternative standard to British Standard, or the modernisation of BS to reflect this Live Lab, will ensure that visual acuity can be enhanced and through a maintenance manual that would accompany a location or area adopting the new standard, regular renewal at specified intervals can be assured.

The Financial Case

The table shows the proposed budget breakdown of this Live Lab.

Live Labs Costings								
	Year 1		Year 2		Year 3		Year 4	Year 5
Live Labs Interventions	**CapEx**	**RevEx**	**CapEx**	**RevEx**	**CapEx**	**RevEx**	**CapEx**	**CapEx**
ERYC Corridor	£250,000		£850,000		£200,000			
Partners	£80,000		£200,000					
Challenge Fund			£370,000					
Intervention Match Funding								
ERYC	£175,000	£34,000	£775,000	£34,000	£150,000	£34,000		
Partners			£200,000					
Academia and Research								
Academic Support	£90,000		£50,000		£50,000		£20,000	
Research & Surveys	£160,000		£90,000		£140,000		£40,000	£20,000
Regulatory Research	£90,000		£85,000		£95,000		£14,000	
Project Management								
ERYC Project Management	£125,000		£90,000		£90,000		£5,000	£5,000
Project Dissemination			£25,000		£25,000		£25,000	
Total Budget	**£970,000**	**£34,000**	**£2,735,000**	**£34,000**	**£750,000**	**£34,000**	**£104,000**	**£25,000**

Project and risk management

The Project Manager and SRO will be accountable for local budget monitoring and agreeing with partners, individually and collectively, the support available to each Live Lab component.

The inherent ability to scale inputs will ensure that risk is always managed by virtue of the quantity of inputs at any site, or programme of works, is constrained to the funds available. This is likely to result in X00 metres of works having the clear scope to be scaled above or below X. So long as minimum level of inputs (signs, lines, studs) is achieved, testing and validation as a component of the overarching Live Lab can be assured.

This will build risk management directly into heart of each site. Partner Councils will be given an initial modest fixed sum to enable the 'extra / over' cost of new materials or products that they use instead of traditional products. More significant works, linked to the requirement to test a certain typology, will be defined in detail by the Council and their supply chain and risk will sit with that Council. Equally from this approach, the precise match contribution from each partner can be assessed and assured. Above a certain minimum threshold (ie we are keen to have a minimum of two or three test beds per key typology) the extent of local match will be a key determinant: albeit we will do this collaboratively and open book with all partners to select the best sites.

This Live Lab seeks to provide the sector with a set of matrices by which it can determine the appropriate interventions for the relevant location dependant on a range of factors, and to provide detailed information regarding carbon saving and whole-life costs savings. These whole life costs and savings will be determined for a section of highway by the typology of that section and the range of interventions that are required. Examples of whole life savings in both capital and revenue costs can be found in detail in the Economic Case section of this document where direct comparisons and detailed costs are provided.

Match funding being provided by the local authority.

This Live Lab has secured significant match funding from ERYC and its partners which gives an indication of the commitment that this Live Labs has amongst the group of assembled local authorities and evidenced in our budget breakdown and statements of commitment.

> *As overall budget holder for highway capital investment, I am pleased to be able to support this innovative Live Labs project.*
>
> *We have discussed with the Live Labs team their strategy regarding match funding and are happy with this approach.*
>
> *I look forward to seeing the outcomes and associated carbon and cost savings that this Live Lab project could bring.*
>
> *Kind regards*
>
> [redacted]

Current cyclic maintenance estimates are based on replacement of 2.5% of stock per annum on average which equates to an annual spend contribution of approximately £34k. The maintenance funding used to undertake this work will form part of the matched funding figure to be contributed by ERYC. The scheme also allows for inlay resurfacing to support the low carbon aspirations of the trial and the locations identified will allow for additional match funding of £700k to be drawn from our capital resurfacing budget by acceleration of this scheme. Several sections of carriageway have also been identified for surface dressing /rejuvenation works. These represent a low carbon 'blank

canvas' approach to test sites in terms of surfacing monitoring and reinstatement of upgraded markings. This will also provide an additional match funding figure of £200k.

Due to the reduction in funding from our initial bid proposal, we have reassessed the nature of the match funding being provided to maximise the funding received through Live Labs. Rather than the Live Labs funding total road surface and visual infrastructure, we will now adopt an approach whereby our capital resurfacing programme will undertake programmed works within its original budget allocation from existing capital funding streams and Live Labs funding will contribute the over and above cost to install the enhanced materials that we are proposing.

This approach will enable our reduced budget for interventions and testing to be spread over an increased amount of road typologies and scenarios to enable maximum impact in terms of data collection. By utilising this funding approach, we have been able to retain the significant academic engagement, which is vital to validate our final outcomes, whilst still permitting a significant number of test bed locations.

Alongside the contribution from the highway capital replacement budgets, ERYC will also contribute £200k of funding from its street lighting capital replacement budget. This funding stream will contribute towards lantern replacement in areas where current levels are deemed inappropriate, but lighting is required to be maintained, or for total lighting and lit sign infrastructure removal, with particular focus on costly electrical service removal which is required by law after twelve months of de-illumination.

The focus of the initial Live Lab work will be on the 50Km long A1079, from Hull to York, the majority of which is within the East Riding. It should be noted that following the announcement of reduced funding, we have yet to fully understand the extent to which all desired interventions are possible along the two chosen corridors. Some degree of scaling or use of alternative sites with similar road typology may be preferable following discussion with supply chain and academic assessment.

Our Live Lab collaborators will adopt the same approach in testing interventions on similar and contrasting roads that provide national scaling of emerging results. Partner Council match contributions of circa £200,000 are expected, albeit this cannot be validated at this early stage in the Live Lab. This would increase the overall project to a value of £4.686m, £3.284m from Live labs, £1.202m from ERYC and a further £200k from other Councils.

The partner match funding will be provided under the same principles as the ERYC match funding. It is also our intention to provide a challenge fund of £370K which our Live Lab partners can access on a bidding basis. The allocation of this funding will be determined on the needs of the main project, and road typology, where for example, evidence may be lacking from the initial test beds. This funding will be under the condition that there will also be an element of local match funding provided and will be assessed and agreed through the main Project Board. Funding will be distributed to the partner authorities through ERYC grant frameworks; prior agreements have been used in recent years to distribute grant funding on cross boundary Local Enterprise projects where ERYC was the lead authority and budget holder. These agreements have been legally scrutinised within ERYC.

Details on accepting financial responsibility for the project going forward and background on sources of other funding contributions, and how funding has been secured

As lead authority ERYC accept overall financially responsibility for this Live Labs programme. Financial oversight will be provided by our main Project Board in conjunction with ERYC Finance department and form part of our capital programme, with oversight from our Capital Programme Board. Direct daily oversight will be undertaken by the Project Manager along with the various Working Group chairs where expenditure relates specifically to their areas.

Partner funding distribution will be undertaken through existing and legally compliant agreements between ERYC and the relevant partners, similar to previous multi authority funding arrangements

where East Riding was lead authority. These arrangements will be undertaken with sign off from the relevant finance officer from the partner authority and evidenced as per the Department for Transport grant requirements.

Additional funding sources are being provided through our existing capital expenditure programme whereby Live Labs will fund the additional costs for the improved interventions we intend to apply. This has been agreed amongst all partners and within ERYC. We are not seeking external funding sources at this time.

Long-term viability and how our proposal will be sustained beyond the life span of the Live Lab

This Live Lab focusses on the removal of existing highway infrastructure and replacement with alternative long-term infrastructure, whether that is the removal of lighting to be replaced with highly visible alternatives or the alteration of street lighting infrastructure to provide a visually improved highway. As evidenced within the Economic Case, we can show that removal of highway lighting and replacing with lower cost alternatives can result in significant reduction in cost burden to both capital and revenue budget streams.

Our initial investigations have indicated a number of enhanced materials that could be utilised to improve the visual perception of the highway for all types of users, however these are not 'fit-and-forget' materials and require periodic refresh or replacement. As shown within our Economic case there are significant revenue savings to be made, in our example circa £350 per 100 metres and £77.78m per annum nationally based on a 10% lighting stock reduction. This 10% figure is a conservative estimate and will vary from region to region however it is not unlikely that a national picture of 15% reduction is achievable. In this instance savings shown would be £525 per 150mtrs and £116.67m per annum.

Whilst it is our intention to affect change within British Standards, or as a minimum to provide evidenced based alternative solutions to current street lighting standards, this will come with a stipulation that the removal of lighting comes with a commitment to maintain the installed alternatives as per their manufacturers' recommended life and that an element of the revenue savings made is committed to existing revenue budgets for such maintenance. This will redress the current limited focus of line and sign renewal, but in areas adopting our typology will be a requirement for permanent light removal.

Such a reduction in revenue cost burden on already financially restricted local authorities while retaining safe highway use will ensure long-term project durability. For highways adopting the new standard, there would be an 80% reduction in revenue costs over a forty-year period ensuring these interventions are self-funding and scalable over the long term, beyond the scope of the Live Labs project. Similarly, reductions in capital investment costs compared to replacing existing infrastructure like for like will enable existing capital budgets to be targeted on a wider expansion of the Live Labs outcomes. Based on the example costs shown in the Economic section, for the same capital cost to install 100 metres of current intervention, our new Live Lab approach would achieve a 25% improvement, ie 125 metres: including the one-off removal cost of electrical connection (revenue is considered below).

We may however through this Live Lab evidence areas where there is a requirement to improve the existing lighting. This will be offset with investigation and recommendation around dimming and trimming regimes or investigating a standardised switch off regime for areas where there is a conflict between dark skies initiatives and residents' requirements. We aim to evidence a 15% reduction in overall energy consumption through this avenue of research, although this will vary throughout regional variations of existing national lighting stock and its current efficiency.

As shown within our Carbon section, with the cost of the country's street lighting energy consumption currently over £1bn annually, a 25% reduction in overall energy cost burden alone will vastly exceed the revenue burden of the new materials and methods being explored through this Live Lab and

allow for sustained investment in future years in reducing the overall carbon and cost of the nation's highway infrastructure. It is impossible to accurately state the current energy costs of the nation's street lighting stock, given the volatility in the energy markets and the wide regional variances in energy pricing. Similarly, it is impossible at this point to provide a detailed savings value for these same reasons. However, it is obvious that with energy prices remaining at a relatively high level for the foreseeable future, such a significant reduction as is being proposed will promote scalable project outcomes and sustained delivery regardless of the obvious carbon benefits this project brings.

The Management Case

Key roles, lines of accountability, resourcing and Senior Responsible Owner

The Senior Responsible Officer for this Live Lab is [redacted], Executive Director for Communities and Environment at ERYC. Alongside [redacted] on the overall Project Board are senior representatives from ERYC from both the service delivery and political realms, along with senior representation from the Live Labs partners in [redacted], Assistant Director of Highways at Cambridgeshire Council and current President of LGTAG.

Beneath the Project Board and accountable to the Project Board is the Live Labs Project Manager (PM). It is the role of the Live Labs Project Manager to have full oversight of the project. With specialist consultancy support, the Live Labs project can evolve in such a way as to achieve the required outcomes. The Live Labs PM will have overall financial and operational responsibility in agreement with the Project Board and will maintain day to day responsibility for all aspects of the project.

To ensure that full attention is given to the project manager role for this Live Lab, the East Riding of Yorkshire Council's Street Lighting department has been restructured to accommodate Live Labs. The Live Labs project manager role will be accommodated alongside the street lighting service manager role by delegating 70% of the service manager role to senior staff, with a cascade of duties down the street lighting structure. The Live Labs project will fund 70% of [redacted] time and this will enable three days a week with the sole focus being Live Labs management.

This working arrangement is agreed for the full duration of the Live Lab and salary cost saving within the street lighting team has enable the street lighting department to fund an uplift of salary for all staff based on the increased levels of duty and an administration apprentice that will also support the Live Labs project manager. The Live Labs project has also secured consultancy time for the next three years totalling two days a week with gives daily coverage of Live Labs management and ensures a consistent impetus and management presence for the program.

The Project Manager, [redacted] Service Manager for Street Lighting and Traffic Signals at ERYC will report on the project to the Project Board at regular intervals along with reporting to the internal capital project and financial monitoring groups within ERYC to ensure external scrutiny is maintained.

East Riding has created a structure that is inclusive and engaging which is based on Council partners leading on specific working groups. Accountability for project goals is shared across participating Councils. Chairs will work collectively to moderate and drive change which de-risk against the creation of work silos.

These Working Groups ensure continued engagement with all partners and span a depth of knowledge throughout several sectors. The Working Groups will engage with their terms of reference which are under development and will ensure linkage between Working Groups and seeding of ideas and information throughout the project.

The Working Group participants as shown in our structure diagram have been selected based on their existing skill sets and areas of expertise along with their representation across the wider sector and experience of similar involvement in other large-scale projects. The chairpersons of each Working Group have been picked specifically for their detailed knowledge of that specific areas and additional wider reach they bring outside of the specific Working Group. For example, the chair of the Carbon Reduction and Habitat Working Group, [redacted], is the Climate Change Manager for ERYC and has been instrumental in formulating our climate change strategy along with undertaking projects similar to other current Live Labs projects exploring verge management and biofuel possibilities prior to joining East Riding. [redacted], who chairs the Street Lighting Working Group is also a member of British Standards committee for street lighting and allows this Live Lab

unique access into British Standards and enables us the insight into what is required to effect lasting change.

These are two examples of the specific choices that have been made into the structure of the Working Groups and the logic behind these decisions. Not only do we provide inclusivity across the partners but we bring together a breadth of knowledge and wider sector reach. Participation in these Working Groups will be resourced locally by ERYC and other partner authorities as it is not anticipated to impact significantly on members' daily roles. However, should this change over the course of the Live Lab, there is scope for the Live Labs project to fund the time commitment from its Working Group members.

The Live Labs project will directly fund both the Project Manager roles and the consultant support as it is these roles that will have the greatest involvement in the project and the greatest impact on their time alongside other daily duties.

Reporting arrangements to provide key updates on progress and how this mesh with the Live Labs programme cadence

Live Labs Working Groups will meet at a minimum six weekly intervals for the first six months upon official commencement of the project. Within six weeks of the formal approval to proceed there will be a combined Workshop hosted by one of the partners - scheduled for early June 2023 to ensure drive and clarity that can be carried through the three-year programme. These initial meetings will take place under the stewardship of the working group chair with input from the Live Labs Project Manager and consultant support. The future frequency of meetings will be defined following this first six-month period when there is clarity around the level of input required for each Working Group.

In the interim period between Working Group meetings, the chairs of each Working Group will meet with the Project Manager to update on progress within the Working Groups, the direction of travel and feed their work into the wider collective. These meetings will review Working Group progress and check future profiles of work and information flow to ensure a collective impetus for the project, eliminate the risk of groups becoming siloed and allow for cross group knowledge sharing and linkage. There will also be quarterly update meetings between the Live Labs Project Manager and the Project Board. This will ensure appropriate oversight and scrutiny.

This frequency of meetings will ensure that updates required for Live Labs oversight will be fresh and current, particularly in the realm of communication across our Live Lab and with the wider Live Lab cohort.

This programme of project meetings will mirror the Live Labs update and meeting schedule and ensure that up to date information is fed back through technical meetings, communications meeting and Commissioning Board oversight meetings. Meeting and reporting frequency will be constantly reviewed based on need and the current position of the Live Labs programme. We will ensure that our Live Labs meeting cadence is timed as such to provide a real time picture to the Live Labs Programme Director and Commissioning Board.

The governance structure and key roles and responsibilities that will be in place to provide controlled and informed decision making

Our Live Lab structure, segmented into six different working groups to oversee and scrutinise individual elements of the project removes a significant burden from both the Project Manager and Project Board. Each of the Working Groups is responsible for a key area of the project under specific terms of reference. Each Working Group has a specific scope relevant to that section but linking in with all other Working Groups throughout the project. For example, the scope drafted for the Carbon Reduction and Habitat Working Group is as follows:

> *This Working Group has a clear focus on carbon baselining of existing materials in the highway, understanding of carbon evaluation tools currently available, and opportunities available to encourage biodiversity around the highway within the life cycle of the asset.*
>
> *It will work with manufacturers, suppliers and researchers to scrutinise carbon generation figures and link with other Live Lab cohorts and the wider sector to collaborate, assess best practice and knowledge share around carbon reduction.*
>
> *It will also have oversight and scrutiny for our Live Labs proposals from a carbon reduction and biodiversity viewpoint.*
>
> *The Chair of the Working Group will report its progress back to the Project Manager and Project Board at regular intervals.*
>
> *It must ensure that it is fully inclusive for all Live Labs partners yet accessible for non-partners also.*

Working Group members and chairpersons have been selected from across ERYC and its partners to incorporate skill sets and experience within those specific areas, whether it is having undertaken carbon reduction initiatives, drafting and overseeing complex procurement contracts or road safety. Within our Live Labs group, we have members who participate on British Standards Governance Boards along with a number of other significant organisations such as UKRLG and LGTAG where we can raise awareness of our programme and the benefits it can bring along with recognising the needs of British Standards in terms of research, evidence and process.

The inclusion of all partner authorities across the range of Working Groups also ensures buy in and commitment across all 10 partner organisations along with enabling our Live Labs to reach a wider network of highway professionals and key decision makers.

A clear statement of senior level support from any partner organisations

The Institution of Lighting Professionals and its Technical Committee are fully supportive of the East Riding Live Labs bid "**High Visual Efficiency for Low Carbon Lighting - De-carbonising Street Lighting"**

> *Given the current energy crisis and the pressure upon Local Authority lighting and energy budgets, this research and challenging of established thinking to reduce unnecessary lighting and trialling alternative road safety technology at night to save energy, could not be more timely. We look forward to further involvement during the technical scrutiny phase.*

A project plan that will be used to track the progress and delivery of the project and its resulting outcomes

The GANTT detailing our projected project activities is based on a commencement as indicated in the original timelines. The delays in announcement will require a revision of this GANTT chart to be drafted upon final confirmation of the project. As we do not yet know the formal commencement date we have retained the original timelines within this submission however our programme delivery elements and duration remain as shown.

	2023-24				2024-25				2025-26					
TASK	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	2026-27	2027-28
Determine academic measurement parameters and methodology														
Identify Areas of segmentation on primary test beds on A1079 and A164 (ERYC) and test bed locations in collaborating authorities														
Initiate and complete procurement contracts for goods and services														
Ongoing stakeholder and public consultation across lead authority and collaborating authorities														
Academic baseline evaluation of Scope 1, Scope 2 and Scope 3 emissions across the entire street lighting sector.														
Academic assessment, and public engagement across key UK regions of lighting levels, sign reflectivity and road marking visual perception on a range of road types and user perception studies to baseline existing visual highway environment and guide proposed test beds														
Academic assessment and measurement of visual perception of road markings and signage in non-lit areas and user perception studies of these areas to baseline existing visual highway environment and guide proposed test beds														
Existing market ready product assessment by engaging with commercial partners on immediate interventions that can form early delivery														
Assesment of Scope 1, 2 and 3 assesments and intervention planning														
Installation of identified interventions across lead and collaborator authorities														
Academic evaluation of test beds using same methodology as used to define baseline measurements and user perception														
Evaluation of combined test bed using same methodology as used to define baseline measurements and user perception														
Evaluation of collaborator test beds using same methodology as used to define baseline measurements and user perception														
Best Practice template for carbon evaluation and visually engaging highway														
Written reports and intensive engagement														

Project	Reporting

A first draft of what will be an active risk register

Event/Risk Title	Source of the risk - What is the cause?	Consequences of the risk	Inherent			Residual			Target/ Appetite			preventative & mitigating measures in place
Failure to secure broad based collaboration & incorporate academic rigor and geographical variation	Inability of project team to secure appropriate collaborators	Insufficient evidence base relating to outcomes	4	5	20	2	3	6	2	3	6	Written agreement from collaborators prior to bid Collaborators to have input into initial bid Collaborators to identify areas of value add to project
Collaborators fail to deliver required outcomes	Collaborator leads fail to implement required works	Unable to evidence replicability and lack of evidence for final conclusions	4	5	20	3	4	12	2	4	8	Collaborator leads to report to quarterly project meetings Collaborators to identify works to be undertaken Collaborators to identify delivery timescales
Proprietary materials/treatments installed on the network don't provide the appropriate life spans	Premature failure of the materials or treatments	Extra maintenance costs associated with undertaking remedial works	3	5	15	2	3	6	2	3	6	Engage with suppliers prior to the project start to identify key materials Involve maintenance teams in the selections of the materials Programming of the works during appropriate times for material requirements
One or more tasks required before the project can start is delayed causes knock on delays	Delays caused by project members or collaborators	Delay to project start date or during project delivery	3	4	12	2	4	8	2	4	8	Allow plenty of time prior to the project starting Co-ordinate works with other key stakeholders through regular meetings Regular project team updates and supplier engagement
Cost increases before or during the delivery of the project	Due to rising inflation of materials for the project	Unable to undertake all of the proposed works	4	5	20	3	4	12	3	4	12	Allow for inflation within the project costings Look at most cost effective services or products Secure fixed contract prices ahead of the works
Safety risks to the road users as a result of the project	Caused by the changes implemented within the project	Resulting in serious traffic injuries or deaths	4	5	20	4	5	20	3	4	12	Road safety expertise engaged prior to project start Undertake road safety audits (Stage 1,2 & 3) Monitor implemented changes on the network
A key member of our team leaves our organisation before the project starts or during delivery	Staff members with key skills leaving posts	Loss of essential skills and knowledge within the teams	3	4	12	2	3	6	2	3	6	Quarterly project team meetings with comfort action points addressed Team structure reshuffle/recruitment Appropriate technical support for project team members within their teams
Failure to deliver stated project outcomes	Project team fail to collaborate and deliver required works	Loss of reputation within the sector	4	5	20	2	4	8	2	4	8	Implementation of project program Quarterly project team meetings with updates & actions defined Monthly project leader updates to project manager

The Carbon Case

Expected carbon benefits and estimated carbon impact

Climate change is one of, if not the biggest challenge facing humanity. Its impacts are felt globally, nationally, and locally and we must all contribute to reducing greenhouse gases and building resilience to future impacts. The UK Government are leading the way on carbon reduction and were the first in the world to establish legally binding carbon budgets through the Climate Change Act 2008. To meet the legally binding targets laid out in the Act, the UK must reduce its greenhouse gas emissions by 78% by 2035 compared to 1990 levels and 100% by 2050. Transport was the largest emitter of greenhouse gasses in 2020 (data published in June 2022) responsible for 28% of the UK's overall emissions. Road travel accounted for 91% of domestic transport emissions in 2020.

Climate change remains high in the public consciousness and as a result the UK Government along with many other Government agencies and local authorities declared climate emergencies and set about developing plans to reduce emissions and adapt to the impacts of climate change at a greater pace than had previously been seen. The ERYC declared a climate emergency in 2021 and published its Climate Change Strategy in 2022. The Strategy highlights the Council's commitment to drive rapid decarbonization.

This project will seek not only to decarbonize the visual aspect of the highway but embed carbon reduction across five key areas (manufacture, installation, operation, maintenance and end of life), as well as consider the natural environment to ensure a holistic approach is taken. Conscious of the targets outlined within the Government's 25-year Environment Plan; the project will explore how we can ensure a positive impact on biodiversity drawing on links with other Live Labs projects where appropriate. This could involve habitat creation along verges or reduced animal disturbance. The opportunity to use the natural environment to sequester carbon will also be explored.

At this point in time it is impossible to give even an estimated figure of overall carbon reduction for this Live Lab project as there is currently no baseline for existing embedded carbon within the highway visual environment. This baseline is a priority task for the Carbon Reduction and Habitat Working Group to determine along with support from our manufacturing partners and academic colleagues. We can estimate carbon reduction benefits through energy saving as this is well documented and easily quantifiable however the country's energy generation profile alters annually with the increasing shift to renewable energy. We will update figures for this element in context, on an annual basis depending on the current conversion factors published by the UK Government, set against a baseline of 2022.

A key principle of this Live Lab is to view the highway as a holistic environment and to explore all opportunities to reduce carbon while retaining if not improving highway safety and use. Through our Carbon Reduction and Habitat Working Group we will strengthen existing links with other Live Labs groups in relation to verge habitat and the wider carbon opportunities available to use at minimal cost. Our Live Lab will take the opportunity to become early adopters of other Live Lab interventions regarding verge habitat and carbon capture through verge planting and habitat creation. Our Live Lab proposal does not sit in isolation of other Live Lab proposals, rather they complement each other and can be amalgamated into an overall carbon reduced approach to highway design and management.

Our approach to the measurement of all carbon scopes / lifecycle associated with our proposal proposed tools, methodologies and source data

Working with all appropriate sector carbon calculators (evolving and new) we will fully assess the embodied and in-use carbon emissions, now and in future years to create informed policy decisions that evolve with our understanding and further innovation. We will seek to understand the whole lifecycle carbon implications of all materials used to ensure carbon is minimized across every aspect of the project.

The Carbon Reduction and Habitat Working Group of this Live Lab project will explore six themes to build a broad picture of the carbon and environmental impacts of the visual environment using a lifecycle assessment approach. Each of the six themes will explore scopes 1,2 and 3 carbon emissions where appropriate. The key areas for investigation are defined below:

1. **Manufacture (embodied carbon)**

   Nationally, lighting columns have an average design life of 40 years, which creates a replacement programme of circa 180,000 columns per year. Heavily reliant on steel, each replacement column creates on average 185Kg of carbon (CO_2e) and each lantern 38Kg. 223Kg per street light creates a cumulative manufacturing impact exceeding 40,000 tons of CO_2e per annum. These are preliminary estimates based solely on published data for the carbon footprint of steel creation and do not take into account processing of the steel and full scope 1 and 2 of lighting column manufacture and installation. This baselining and detailed analysis of CO_2e generation is a primary focus of this Live Lab.

   Through initial market engagement, we have already begun to place the emphasis of carbon profiling products on to the manufacturers. We will reinforce this position through our procurement strategy by only accepting products with valid Environmental Product Declarations that are EN 15804 compliant. Manufacturers have an environmental responsibility, and these declarations will enable us to fully assess the carbon impacts and benefits of all proposed products, enabling us to make procurement decisions based not just on cost, but on environmental impact, they also enable the accurate baselining of post intervention embedded carbon in the highway.

2. **Installation (material required to install, transport to location)**

   The installation of highway assets also has carbon implications due to materials used and transportation to site. There is currently no established standard for calculating carbon emission from installation and this project will explore the various academic reports on the subject to establish common themes and develop a matrix that can be used to estimate carbon savings. Transport is a key aspect of installation and the variation in weight and distance required for installation will all have an impact. A metric will be required on a CO_2/mile basis.

   The carbon impact of the installation of any proposed materials will also have an impact on any proposed materials procurement. We will place the burden on the manufacturers to detail the specific installation requirements, temperature for white lines, the requirement for concrete foundations, or whether the materials require a clean and prepared site such as burning off historic white lining or its ability to overlay previous materials. Procurement of materials will factor in carbon impacts of installation.

3. **Operation (carbon cost per kWh)**

   ERYC owns and operates approximately 40,000 street lights and 2,300 illuminated signs with an annual energy consumption of 6.9 million kWh. This creates a combined 1,600 tons CO_2e

per year based on energy consumption alone, of which lit signs account for approximately 5% of all energy consumption. A clear carbon benefit from this Live Lab is the significant reduction in energy usage brought about by the reduction in street light numbers and the elimination of the need to light bollards and signs in lit areas.

Establishing a case for alternative signage and eliminating the requirement for lighting signs could represent an overall energy reduction of 20% on street lighting through the use of alternative interventions. With the removal of lit signs and bollards alongside street lighting reductions we could show an overall energy consumption decrease of 25%. This could reduce the overall consumption of East Riding Stock by 1.725 million kWh. This conservative estimate highlights the potential of energy and carbon reduction nationally.

Based on a reduction of 1.725 million kWh of energy using UK Government published figures of £52.56 per tonne of CO_2e as of January 2022 and the current 2021 carbon calculation factor of 0.23112 (electricity +transmission and losses factors) we would show a cost per tonne saving of circa £21,000 and 400 tonnes of CO_2e respectively. This estimated saving can be replicated across our partners or early adopters using the matrix of discrete parameters (defined through this project). The matrix will be developed to encourage highways colleagues to identify commonalities across their networks, enabling the development of a standard model underpinned by a suite of external factors common throughout the country. This standardization will facilitate the replication of carbon and energy reduction in any given location across the United Kingdom.

4. Maintenance – statutory visits every 6 years (transport – embodied carbon from replacement parts)

Similar to that of installation, maintenance has a carbon implication, often far higher than original installation due to transport to single sites, rather than a programme of installation. A metric will be needed that considers the nature of both a standard maintenance programme and a ‘one off’ repair on site. This matrix will factor in vehicle type and draw upon manufacturer declarations through published EPD documents for materials used in repair.

5. End of life – recycling, cost of scrap metal, costs of remanufacture, disposal of LEDs

Recycling highway components is an increasingly common practice with many local authorities choosing to recycle asphalt. Opportunities to explore a circular economy model approach for metal will be taken through this project and will model the carbon implications of such an approach. Different disposal routes will be explored to ascertain their carbon impact as there is currently no data regarding the carbon impact of recycling such items as LED’s which contain rare earth minerals.

6. Environmental Impacts (including biodiversity and habitats)

Our highways represent a unique opportunity to restore habitats and provide opportunities to sequester carbon through plant roots. Traditionally verges are covered in a layer of topsoil and seeded with grass, creating a maintenance cost to maintain a ‘neat’ verge with adequate lines of sight. Several different plant species have root systems up to 3 times the depth of grass and require much less maintenance. Flowering species such as kidney vetch and yellow rattle also provide much needed nectar for pollinating species vital for ecosystem health.

We will explore whole lifecycle carbon implications (scope 1,2 and 3) from each aspect of the visual environment, eg streetlighting, signage, bollards, lining and studs. There is currently limited understanding of the carbon impacts of the existing network, and this will form the basis for initial activity with a goal to calculate the existing carbon baseline. The baseline will

be developed with the input of partners to establish a matrix of discrete parameters relevant to all highways across the country.

Once an agreed set of parameters have been developed for the baseline, the project will move to establishing a set of metrics for carbon reduction including new and emerging technologies, reduction in lighting, or completely re-profiling the visual environment. Modelling carbon emissions in this way will enable authorities to fully appreciate both their current carbon impacts, but also their ability to reduce carbon (and energy) in the future by implementing one or more options. Estimated savings will be replicable and consistent across our partners or early adopters using the metrics developed and will facilitate a comprehensive understanding of the carbon impacts of highways nationally.

The potential impacts of the project will depend on the uptake and appetite for using the model, however with the UK's 7.2m street lighting columns and a replacement cost legacy exceeding £7bn there is likely to be considerable interest in exploring how cost savings can be made in a safe and environmentally friendly manner. With a design lifespan of 40 years, on average 180,000 columns need replacing annually, *albeit many Councils do not have funds to meet this cost.*

As shown by the UK State of the Nation report (UKRLG) energy consumption has reduced from 2.6 GWh (2010) to 1.88GWh. However, street lighting energy costs still exceed £1bn annually and are a major contributor to Highway Sector CO_2 emissions of 400,000 tons per year. With the backdrop of continuing energy price rises placing a considerable financial burden on local authorities, any easily implemented schemes that could reduce energy use (and therefore carbon) will be extremely attractive.

Where possible we will use already established data sources and conversion factors to enable replication across the UK and use a common language to describe carbon impact based on existing standards and data sources, eg Government published conversation factors using the most up to date published data, with conversion factors updated each year. Throughout the project we will incorporate the latest factors into the model to enable the most accurate estimates of carbon emissions at any given time. We will use environmental product declarations, where provided by manufacturers, and work with manufacturers where appropriate to understand the carbon impacts of their products.

Details of academic and industrial partners assisting in this process, their roles and commitment

Key to establishing a baseline of embedded carbon within the highway are the various manufacturers that supply the highway visual sector. We will work closely with our manufacturing partners and in line with our procurement requirements to identify the carbon impact of all proposed materials.

Our Carbon Reduction and Habitat Working Group will assist in the procurement evaluation of all products being proposed and assess the whole life impact to achieve best carbon benefit. Our preliminary market engagement has emphasised that this is not a cost race to the bottom but a project to promote carbon reduction throughout the highway and lighting sector. We have seen positive responses from suppliers and a recognition that carbon now ranks alongside cost in terms of procurement priorities.

These manufacturing suppliers, many with historical products on the highway, will be vital in providing detailed information regarding new and historical products to enable our carbon baseline matrix. We have received high level commitment from a number of manufacturing partners who view participation in this Live Lab as not only a commercial opportunity but also a significant opportunity to promote themselves as market leaders from a carbon reduction perspective. As such

they have given commitment for the provision of research and development resources along with access to all staff members and internal tools for carbon baselining.

This Live Lab will incorporate a range of academic and industrial partners for detailed carbon research. We will have input from both Edinburgh Napier University and Sheffield University and make use of research staff from both organisations to undertake detailed carbon analyses particularly around the areas previously identified and scope 3 impacts of existing and proposed infrastructure. Targeted research will bring social value and academic rigor into this part of the process, overseen by the Live Labs Carbon Reduction and Habitats Working Group. The university inputs will be secured through procurement contracts, with teams specifically selected for their expertise within the highway markings and lighting sectors.

This research base will complement our existing Carbon Reduction and Habitat Working Group to identify areas of research and existing baselining tools, along with significant areas of research regarding verge restoration and habitat creation. Utilising these two key areas of expertise will enable us to strike a balance between the effectiveness of the highway from a user perspective whilst maximising carbon reduction.

To understand the current carbon picture on a national level from a lighting and highway visual perspective we will be engaging with Measure2Improve who undertake the NHT survey. This access to national high-level data will enable trend analysis, particularly in terms of energy usage and will identify any areas where carbon reduction measures are being overlooked.

Through Measure2Improve, who have recently begun development of a highway-based carbon baseline tool, we can understand the process of developing a matrix and scrutinise this process. We can utilise NHT to develop detailed questioning of highway authorities on a national level with regards to carbon impact, raise awareness of our programme and give us a national picture of where carbon baselining and Live Labs interventions can provide even greater savings than exampled within East Riding and across our partners.

This combination of internal skill sets within our Carbon Reduction and Habitat Working Group, who will scrutinise all Live Labs proposals from a carbon perspective and ensure constant carbon focus to the project, manufacturing partner requirements and input and academic scrutiny, will ensure impartiality and accuracy to our carbon baselining, without which this Live Lab has no basis. This powerful cross sector input can provide a level of embedded carbon detail for the highway and a range of carbon positive habitat options that can be replicated across any highway authority across the country. This level of embedded carbon detail will also enable us to provide analysis of other carbon evaluation tools being used across the sector. Whilst this may be a controversial proposal given the levels of investment seen in a number of these tools, by providing detailed levels of carbon baselining accuracy, this Live Lab can potentially provide highway authorities with the confidence to use these tools knowing that either they are reasonably accurate or that there is a consistent percentage level of variance.

Equality Impact Assessment

Section 149 places a duty on public authorities to have due regard to advancing equality of opportunity between people who share a 'Protected Characteristic' and those who do not share it. The protected characteristics are listed below. Those that are considered to be impacted or potentially impacted by this Live Labs project are highlighted in bold:

Age, Disability, Gender re-assignment, Marriage and civil partnership, **Pregnancy and maternity, Race,** Religion or belief, **Sex,** Sexual orientation

In addition, public authorities have a general duty to have 'due regard' to key areas including eliminate discrimination, harassment, victimisation and other conduct prohibited by the Act; equality of opportunity between people who share a protected characteristic, remove / minimise disadvantage and foster good relations between people who share a protected characteristic and people who do not share it.

Engagement with stakeholders who represent people from protected characteristic groups

Changing street lighting arrangements may also impact on people and groups with no protected characteristics. In a way never considered forty years ago at the inception of British Standards, we will ensure that our engagement process identifies all such groups and that the impacts of the Live Labs work are comprehensively assessed for impact and equitably mitigated where appropriate.

EIA to include: stakeholders to be consulted; relevant research/data; potential positive equality impacts; potential negative equality impacts; mitigations to negative impacts; and how the impact on equality will be monitored throughout the lifetime of the proposal

This Live Lab proposes change to the highway visual realm and creates impact on multiple demographic and protected characteristics groups. Street lighting has the basic impact on visual and hazard protection as outlined in British Standards but has many social impacts and varies in its level of priority across these demographics and protected characteristics groups, along with impacts on a range of other non-protected groups such as leisure and commerce groups.

Many of the protected characteristics groups have organised representation through such groups as Royal National Institute for the Blind for example, or organisations such as SCOPE. We will utilise these representation groups to interact and gain insight from protected characteristics groups and utilise the breadth of research currently being undertaken by the National Centre for Accessible Transport along with evaluations undertaken from an equalities aspect from previous local street lighting switch-off policies undertaken across the country over the last twenty years.

Where organised representations do not exist for protected characteristic groups, for example in the realm of pregnancy and maternity, our communications approach will seek to identify user opinion from localised representative groups within the local community and potentially within our partner communities to gain understandings of the relevance of the highway visual environment, the importance of lighting and potential impacts of alteration or removal of lighting .

There are a range of data within the sector from localised de-illumination and decarbonisation initiatives, with links to active travel and other non-protected user groups which we will draw upon through sector body engagement and support. Organisations such as UKRLG and the ILP have cross sector reach and by co-ordinating research gathering through these bodies we can identify areas of best practise and either template these for use within this project to inform our approach to engagement or utilise the research already available to support our ongoing research.

We appreciate that the highway is used by commuters, cyclists, and pedestrians whether they are within the protected categories or not. There are a multitude of activities that take place on the highway and in our public spaces and that the visual environment plays a key role in this. As part of our ongoing community engagement throughout the course of the Live Lab programme we will engage with specific user groups such as cyclists, joggers and business groups to ensure we capture all social elements of the visual environment not simply the biomechanical aspects. There is a potential to introduce a multitude of positive impacts on all user groups of the highway environment, not just protected characteristic groups, from this Live Lab programme.

Forty years ago, the needs of protected characteristics groups were not considered within British Standards. We can create a contemporary template for highway visual design that improves use and safety whilst promoting inclusion and accessibility. Our research will provide safer spaces for younger age demographics whilst ensuring we provide safer road and pavement use for the interaction with vehicles and older age demographic groups, improved visibility around public transport points, research the impact of lighting on ethnicity and provide the research and solutions to provide the highest visual acuity for older age demographic road users whilst having the lowest possible carbon impact. A new design-led approach, building a requirement for localised 'place based' lighting will be more appropriate for all users and should be better than British Standards.

There are possibly negative impacts to such a proposed change. Changes and possible increases in lighting levels could have impacts on local residents that have a preference for darker skies and environments. Local lighting solutions can mitigate against the issues of close proximity lighting and disturbance, such as sleep patterns. Removal of lighting on previously lit sections of road may have a significant impact on user groups such as cyclists and non-vehicular recreational users, with concerns around safety. We will aim to mitigate these impacts through design choices and wider awareness and education programmes with these user groups through campaigns similar to the "Be Safe Be Seen" campaign and with early-stage engagements with these groups on a local level and national level where possible.

Similarly with protected characteristics groups such as the visually impaired. Through early engagement with representative groups on both national and local level we will seek in depth interaction regarding the need to engage with a programme of this nature on the wider environmental level, assess the feedback regarding the removal of lighting in areas where it is appropriate and explore the mitigations that can be effectively put in place for these users.

This programme is not simply a fit and forget project. Nor is it simply a programme that focusses purely on carbon and cost savings. We will undertake the user interactions and surveys prior to any alterations and physical testing takes place. The survey feedback and research from previous street lighting initiatives, will influence the varying interventions for each defined road typology. This will be followed up with regular returns to the user groups for post intervention feedback and evaluation from all protected characteristics viewpoints along with those user groups that do not carry protected status.

This evaluation will be central to our entire Live Lab not just with our monitoring and evaluation. We will use harsh-braking data as a predictor of future accident statistics and seek to understand emerging trends and make corrective adjustments. Police crime data on previous street lighting projects, and for each of our test beds, will inform our hypotheses of impacts of the interventions on crime and anti-social behaviour. We will ensure consistency of user surveys to establish data trends that not only account for physical aspects of the highway but also encompass social and equalities aspects of our proposal – leveraging value from relevant historical studies, our own work and as a foundation for continuous improvement.

Monitoring & Evaluation

Details of any local, tactical M&E activities proposed

Reflecting the lead Council plus 10 other Councils we recognise the need for the Live Lab to be well choreographed. Engaged and energised partners will be key to our success, and we have already described how our Working Groups will be chaired by the relevant experts that have been drawn into this Live Lab.

Over the six months this Live Lab has evolved, we have seen it change and grow into something that is exciting, ambitious and gaining sector traction. Equally we need clear accountability and rigour. Early approaches from supply chain partners showed how we can spend £5m on their products. Whilst this might create several high profile and attractive case studies, showcase the state of the art and prove some value to parts of the sector, it would not achieve the long-term success that this Live Lab seeks to create.

As we describe below, our use of defined road typologies is an early outcome of discussions with the core Live Lab team. This will need to be trialled, tested and then deployed at scale through the Live Lab. It will be accompanied with a local programme to monitor and evaluate sequentially each intervention to ensure rigour and follow on assessment, validation, or long-term monitoring.

Analysis and time invested to date, allied with traction from the wider sector since the announcement of Live Lab success, has shown that there is already a clear pocket of insight. None of this has been undertaken at scale, and interventions are often piecemeal, in isolation from other products, and in most respects are silent on carbon impact. This includes

- 99% adoption of LEDs – but no adjustment to lighting levels
- Trails on new retro-reflectivity of lines, but no longevity testing
- Sections of UK Motorway e.g., M62 where there are five different types of approach to providing visual acuity
    - Faded lines that do not meet the standard
    - New Lines and new studs
    - Traditional lighting
    - LEDs
    - No Street lighting at all
- Councils who have dimmed and trimmed
- Total switch off
- Councils who have accidentally had entire lighting networks lit to default basic standard *but which engineers and the public never noticed*

Details of methodologies / tools to be employed and any academics / suppliers associated with the work

Research undertaken as part of assessment by National Highways and Leicestershire County Council provide some insight as to how limited data and insight might be scaled. However, as the Council have no requirement to test the current reflectivity of lines and signs, there are no baseline data. The role of Napier University will be in leading such technical assessment to baseline and draw out recent reports to help calibrate our evidence base against earlier studies. For instance, an intervention in 2018 might warrant a targeted revisit that would enable evidence, insight and value to be leveraged from a longer period than this Live Lab.

Customer insight on attitudes is very limited. However, reanalysis of the 1 million customers surveyed over a decade will provide new insight into myriad highway and transportation services, many from communities where lighting has been changed. We will be able to establish early trends and insight from this data bank held by Measure2Improve and Leeds University.

Visual perception and the more detailed assessment as to how the human eye perceives the public realm is vital. Sheffield University will be central to providing insight and thought leadership on how we create appropriate criteria on which to test and validate new standards in a fashion inconceivable to the how the British Standards were created 40 years ago.

Segmentation and Typology

Initial assessment identifies over 30 different metrics which statistically generate over a million possible scenarios and combinations.

	Age	**Key identifiers**		**Speed**	**Type**	**Nature**	**Mode**	**Weather**
	5-15	male	Asian	20	Rural	Dual	Walk	Dry
	16-34	female	Black/ Caribbean	30	Inter Urban	Single	Cycle	Wet
	35-54	LGBTQ+	Mixed	40	Urban	M.Way	P2W	Day
	55-64	Disabled	White	50	CBD		Car	Night
	65-74	Car owner		60			Van	Snow
	75+			70			HCV	Frost
							Bus	
Total	**6**	**3 (min)**	**5 (min)**	**6**	**4 (min)**	**3 (min)**	**7**	**6 (min)**

The above does however illustrate a far more nuanced and insightful approach to understanding how people perceive (and are seen within) the public realm. Such granularity was never part of British Standards, and it highlights the potential value having a fine level of analytical detail, where appropriate, guided by initial trialling and testing of methodology.

The Live Lab will seek to aggregate where appropriate and seek to look through the current priorities where there are known issues.

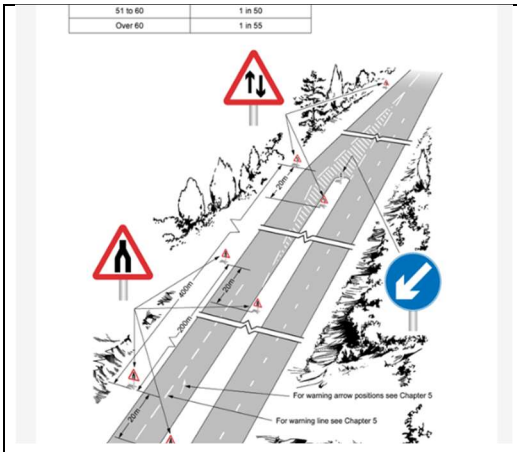
- Gradual loss of eyesight associated with ageing – and linked to this slower response times
- A major policy focus on active travel (walking and cycling)
- The role of street lighting on crime, especially gender-based violence
- The incident of road traffic collisions, often clustered, and occurring day or night

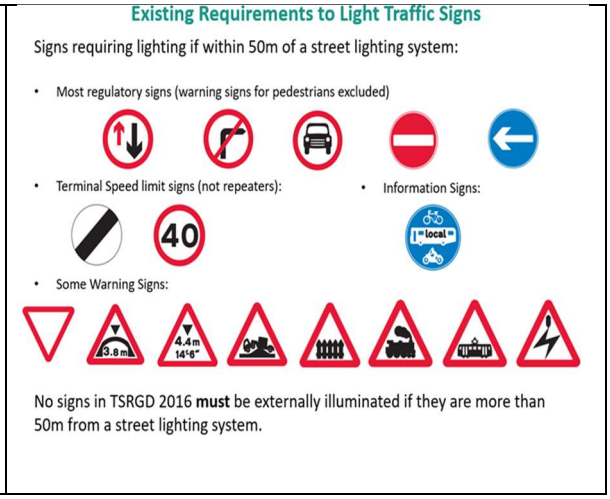
We expect to see some degree of clustering and amalgamation across these elements but as we fully mobilise the Lab and bring together for the first time all three academic / data areas and the 11 Councils, we will seek early traction on the methodology and sampling.

Road Typology

Drawing out the engineered and ‘fixed’ assets from the above table we can consider road type.

At the simplest level, a fully designed single direction road is the simplest asset to consider. This would be a motorway (we note motorways are outside this Live Lab but they comprise an important typology) but could also be a long inter urban dual carriageway with no joining roads or crossing.





As with the above image, the nature of the road may change and with it a need to make that change known to the road user. Pertaining specifically to decarbonising street lighting, we have found TSRGD defines the above signs need to be lit: a clear priority area for us to consider fresh alternatives using new and innovative reflectivity. Of course, recreating daylight condition (through street lighting and lit signs) does not create a road that will not have RTC's - many accidents occur in perfect conditions and could be influenced by different approaches to signs and lines (indeed the £47.5m recent Safer Road Funds is predicated on several interventions such as proposed in this Live Lab).

What the above road typology does permit is an understanding of the areas which are most likely to be contentious in any change to British Standards – or the adoption of a well thought out alternative '2027' standard. We are already giving thought to this, and it is including Road Geometry (eg left bend, right bend, northbound / southbound approach to each) and Climate region / Mountains & Coast – Aberdeenshire, N.I., Pembrokeshire, Pennines.

The above typologies are vital to this Live Lab. We must seek out both typical and extreme locations where real-world deployment of chosen interventions will be possible. Indeed, it is possible to use this Live Lab to input a given road and the prevailing geography and establish a databank of similar roads. This would provide reassurance as to the type of lighting that is already being deployed, thereby enabling database consistency with a new standard '2027', which would give confidence and context to a chosen scheme. We will decarbonise by building sector awareness and dissemination for new highly visual approaches that iterate with specific road features (speed, bend, location).

Our methodology will focus on those signs with the greatest specificity for being lit. However, we will work across all signs in the Live Lab area to provide context and confidence that the new approach, once validated, can be universally deployed.

Warning Signs	ERYC Examples on A164/A1079? (Yellow highlight = street lit)	ERYC Examples on Roads to be Resurfaced or dressed (Yellow highlight = street lit)	Partner Suggestions	Potential for Live Lab Demonstration
Sharp Bend < 90°	A1079, Bishop Burton			Core
Sharp Bend > 90°		Meaux Lane, Meaux		Potential
Crossroads	A1079, Bishop Burton			TBC
Staggered Cross Roads	A1079, Gardham/High Gardham Crossroads	Front St. Middleton-on-the-Wolds		
Major Junction				
Roundabout	A164, Willerby Roundabout			
Junction on Bend		Wood Lane, Brind		
Double Bend		Main St. Burstwick		
Gradient < 10%				
Gradient > 10%				
Level Crossing		Wansford Road, Driffield		
Chevrons		Meaux Lane, Meaux		
Two-Way Traffic	A1079, Hayton			
Height restriction				
Bridge Ahead				
Pedestrian Crossing		Station Road, North Cave		
School		Main St. Burstwick		
Cycle Route Ahead	A1079, A64 Rounabout Approach			
Traffic Signals Ahead	A1079, A64 Roandabout Approach			
Road Narrows		Melbourne		
Merging Traffic				
Queues Likely	A1079. A164 Junction			
Humps		Clementhorpe Lane, Gilberdyke		
No Footway				
Uneven Road Surface		B1228, Howden		
Uneven Road				
Opening/Swing Bridge	A1033, River Hull Bridge			
Falling/Fallen Rocks				
Slippery Road				
Tunnel Ahead				
Animals in Road		B1228, Howden		
Hidden Dip				
Humped Bridge				
Farm Traffic				
Road Liable to Flooding		Market Weighton Road, Sancton		
Prohibitary Signs				
Stop Sign		Clementhorpe Lane, Gilberdyke		
Prohibited Turn				
One Way	A164, Main St. Junction			
Speed Limit	A164, Willerby Roundabout			
No Entry	A1079, Weighton Hill Junction			
Refuge	A1079, Wilberfoss	Moor Road, Brough		
Single Carriageway	A1079, Hayton			
Dual Carriageway	A1079, Hayton			
Give Way				
Mini Roundabout		B1249, Wansford		
Height Restriction				
Give Way to Oncoming Traffic		Dolegate, Skripenbeck		
No'U' Turns				
No Overtaking				
No Motor Vehicles				
Weight Restriction		B1228, Melbourne		
Speed Camera	A1079, A164 Junction			
Backing Boards		B1249, Wansford		
Bus Lanes				
Cycle Lanes		Moor Road, Brough		
Pedestrian Zone				

Incremental Assessment of Interventions

We are building an approach that independently tests each key intervention incrementally.

We note the DfT tender for M&E *the framework should identify where counterfactual evaluation methods can be applied (where it is proportionate and practical to do so). For example, identifying measures where it is likely to be possible to compare against suitable areas, to provide evidence for what would have happened in the absence of the plans.*

Optimising the mix of interventions is vital to understanding asset combination (studs, lines, signs – with / without lighting).

In our chosen trial location, the following elements will comprise our approach – subject to final validation – and will be tested for several successive nights.

	Lines	**Signs**	**Studs**	**Lights**
Baseline survey	Dirty	Dirty	Only if present	On /Dim /Off
	Wet	Dirty	”	
	Clean	Clean	“	
Step One	New: Dry /Wet			On / Dim /Off
Step Two		New: Dry/Wet		
Step Three			New: Dry /Wet	

This will ensure that we can consider the mix and timing of interventions. In some Labs and similar typologies (see below) we may alter the sequence.

- Formulation of hypotheses for testing on different route typologies, eg
  - “street lighting on a rural 60mph link results in lower average speeds”.
- Collection of appropriate data to enable testing of hypotheses, eg
  - Collection of speed profile data, collision, traffic flow data, lighting levels, road marking/stud reflectivity and skid resistance, and traffic sign reflectivity.
- Identify typology of route – links and nodes, eg
  - 1 = rural, 60mph, unlit, few signs….5 = urban 30mph, lit, numerous illuminated and non-illuminated signs and bollards, including risk matrix etc.
- Comparison of above between the collaborators to produce framework for monitoring and analysing impacts of interventions.
- Review of current collection methodologies for above data sets to identify how volume, accuracy and costs of collection can be improved / reduced as part of the Live Labs project.

Survey techniques

We need a twin approach of rigorous camera-based and site-specific retro-reflectivity – using static and driven surveys. In addition, we will examine historic customer results from previous interventions since Essex first removed street lighting after 2005. The existing national survey for Highways and Transport is a vital barometer for us, with over 1 million people surveyed with over 180 questions posed – about 20 of which directly pertain to lighting, signs and lines.

Communities adjacent to Live Lab areas will also be surveyed using the same national questions, followed by specific Live Lab questions. We will use QR codes posted in targeted areas to achieve high sample returns, this will juxtapose this group for consistency with historic data sets, and aid validation at scale and over time.

Carbon Data

Monitoring and evaluation of carbon is described in the carbon case. We have deliberately focused here on the methodology to create replicable typologies which Councils nationally can adopt by simply comparing the road image with their local location.

Sharing, Dissemination and Working

Sharing and dissemination of early results to create robust and informed engagement, thought leadership and long term sector change.

In building this broad collaboration across the UK, we have reached out to all sector bodies including CSS Wales, SCOTS and Northern Ireland Roads. We are expecting confirmation of a few remaining Councils to ensure even broader representations.

At the outset we intend to open this Live Lab to create broad sector awareness, to draw out all examples of positive change and shared ambition. We start from the principle that there are likely to be other leading professionals who can find a platform through this Live Lab and input their expertise.

We also know that key aspects of our work impact other professionals including those relating to crime, fear of crime and various interest groups. These will not be seen as bodies to 'inform' but rather they will be included from the outset such that their views become our shared ambition of achieving a win:win.

We will seek to unpack and make transparent key staged work and publish interim findings. This will build an appreciation of what and why we are exploring key interventions. Any adjustments to core methodology will then be possible to ensure results can be replicated in the UK and globally.

We will work with planners in County and District Councils to identify emerging funding and how they can shape discussions with housing developers. This will seek to create sound ambient light and positive contrast such that any lighting is modest and relevant to the nature of travel.

Information dissemination will therefore not be about 'what we know' and 'what we have found' but rather focussed about energising an entire sector to replicate and test what we have found at key defined interim stages.

As Officers we know adjustments in technical advice frameworks require political leadership, especially where significant change is occurring. We will work with the Local Government Association such that cross party support and mentoring will be available. This is vital and incremental work that will seek to build an understanding that this is cross party and with implementations created across the UK and across differing geographies and microclimates to ensure replicability.

Detailed staged completion will be accompanied by full academic publication in relevant journals. This will ensure the broadest understanding of the Live Lab and build a basis of wider engagement at conferences and debates. We will design and implement a communication strategy, that will itself form a core part of initial consensus building and risk / opportunity mapping.

The end of project report will have a vital binding force in locking in the longer-term change required and creation of a new 'business as usual'. But reflecting the engagement of the UK Street Lighting Board we can be assured of iterative challenge and review as the live lab develops such that identified problems are redressed across this Live Lab journey.

We have reached out to Live Lab 1 projects and have already reached across the Live Lab 2 cohort seeking to be inclusive to the shared experiences they have in communication and creating change. It is our intention to shout this Live Lab from the roof tops and utilise all available methods of communication and information sharing at our disposal, including social media, local community engagement, sector white papers and industry conferences to facilitate the change in mindset that is required when attempting to enable scalable sector change.

We will use these communication channels to tell the hidden story of the carbon impact of the highway and highway activities and the rationale behind our Live Lab proposal. We will energise the industry sector by shining a light into a static sector and raising public awareness of the impact of the service being provided to the local authority and wider environment. We will tell the story of the carbon impact and facilitate the wider understanding of our Live Lab in a positive light.

Your proposals for marketing and communications activities to mesh with those at the strategic programme level including the use of local expertise

This Live Lab will base its communications and marketing strategy on the central Live Labs strategy to ensure continuity of message and activities. During the mobilisation phase we have set up a number of Working Groups to enable the various segments of this Live Lab to be properly explored and managed with one of these Working Groups being a Communications group.

It is the primary role of this group to oversee communications activities in line with the central strategy. They will explore key lessons learned from Live Labs 1 and from other local authorities that have undertaken programmes of work with similarities to this Live Lab - overnight street lighting switch-off for example - and bring examples of positive communication and marketing for politically sensitive subjects such as street lighting into our project.

This Working Group will scrutinise all proposed communication and marketing activities that are proposed for the project from a central point of view and advise and engage with local partner communications officers in terms of local delivery of central messaging or local detailed messaging.

This Live Lab has already engaged in and continues to engage with industry bodies such as UKRLG, LGTAG and the ILP to promote the Live Labs programme and encourage sector culture change along with local political messaging to promote the principles and details of the Live Labs programme, in conjunction with ADEPT and the Adept Communications Strategy and through communications teams' updates.

With a Live Labs project such as ours, communication is vital given how political the provision of street lighting can be and the perceptions that have grown up around street lighting over the years. We will utilise all forms of communication and marketing such as social and local media, sector engagement through industry bodies and conference activities. Through our Communications Working Group we will draw upon the wealth of experience across our partners and their communications teams in order to communicate the underlying principles of Live Labs and this particular Live Lab to encourage culture change within the public and the sector: to make carbon reduction and net zero an embedded element of funding and design decisions

A statement that you will adhere to the collaborative, open and sharing spirit of Live Labs 2 and in addition what you will bring to enhance that working

It is a deep-seated principle that this Live Lab be based on open information sharing and collaborative working, not just across the partners within the Live Lab, but across highway authorities, industry bodies, manufacturers and designers across the United Kingdom. Our Live Labs brings together a unique wealth of talent and experience from across the highway and highway visual sector with a single focus on not just how we provide safe, usable and cost-effective highways, but with a clear understanding of the carbon impact of this fundamental piece of national infrastructure and a willingness to drive that carbon impact down.

We welcome any highway authority, designer or industry body to share their wealth of knowledge with us, work with as an associated partner and early adopter, and in return we will make our developing research and knowledge open to all who wish to tap into this emerging, sector changing project.