## Welcome to

## BCIMO'S CLEAN FUTURES ACCELERATOR

## CHALLENGE SUPPORT WORKSHOPS

## **CHALLENGE 5 – FUTURE FUELS**



## 14:00 – 14:15 INTRODUCTION TO THE VLRNIC & THE CLEAN FUTURES ACCELERATOR



#### Name:

Naomi Arblaster

#### Job Title:

• Head of SME Development

#### Organisation:

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## INTRODUCTION TO THE VLRNIC & THE CLEAN FUTURES ACCELERATOR HOUSEKEEPING

- No fire alarm planned / in the event of a fire:
  - Turn right out of room and right again through the double doors take the stairs to Level 0 (lifts will be out of action)
  - Take your nearest exit and make your way to the Upper Car Park
- Location of toilets
  - Turn right out of room and right again through the double doors toilets are on the landing



## INTRODUCTION TO THE VLRNIC & THE CLEAN FUTURES ACCELERATOR AGENDA

- 13:00 14:00 Lunch & Networking
- 14:00 14:15 Introduction to the VLRNIC & the Clean Futures Accelerator
- 14:15 14:30 Railway Industry Architecture
- 14:30 14:45 Introduction to Challenge Theme 5
- 14:45 15:45 Guest Speakers
  - Beverley Nielson Chairman, Ultra Light Rail Partners
  - Spencer Williams Head of Consulting, Rhomberg Sersa Rail group
- 15:45 16:45 BCIMO Facilities Tour
- 16:45 17:00 Wrap up & Close



## The History of Rail



## THE CASE FOR VERY LIGHT RAIL

As we saw in the opening video...

- Rail has played a key role in the transportation of people since **1807**, when the Swansea and Mumbles Railway became the UK's first fee-paying passenger railway service
- The railway industry went through its biggest period of innovation and growth between the 1840's and the 1890's
- By the mid-**1950**'s the railways had fallen into significant decline, coinciding with the start of the phase of mass motorisation
- Despite government interventions, including the Modernisation Plan, Beeching Cuts, privatisation and the subsequent formation of Network Rail, this decline continued until 2008, when, due to the challenges of climate change, the need for a shift from cars back to public transport was identified



### THE CASE FOR VLR – POLITICAL, ENVIROMENTAL & LEGAL DRIVERS

Since 2019, when the Climate Change Act was amended to legislate net zero emissions by 2050, there has been a major push from the UK government towards the *decarbonisation* of transport, achieved in part through the provision of *better-connected, rail-based,* public transport solutions:

Clean Air Strategy 2019	Call for Evidence 2019	Future Mobility: Urban Strategy 2019		Future of Transport Programme 2019		
Reducing air pollution, including particulate and plastic pollution from brakes, tyres, and road wear	Reviewing ways to integrate Light Rail, and other rapid transit solutions, into future transport networks	Maximising the b transport innoval transport techno business models towns	eenefits from tion (emerging logies and ) in cities and	Stimulating innovation in the transport sector - creating new markets, ensuring a 21st-century transport system, and securing the UK's position as a world- leading innovator		
Transport Decarbonisation Plan 2021	Great British Railways: Williams-Shapps Plan for Rail - 2021		Future of Transport: Rural Strategy Due 2022			
Decarbonising the entire transport system	Making the railways the backbone of a cleaner, more environmentally friendly, and modern public transport system		Delivering the benefits from transport innovation in rural areas – tackling mobility issues, improving connectivity and accessibility, increasing low carbon travel options and providing more integrated transport services			



## THE SOLUTION VLR

In summary, while the rail industry continues to innovate, there is a strong case for a new mode of rail-based public transport, that addresses these drivers...

#### That mode is called Very Light Rail (VLR)!

VLR can be used to supplement existing rail networks, delivering the following key benefits:

- Low or zero emissions
- Lower-cost (to build, operate & maintain)
- Fewer disruptions
- No unsightly overhead lines or concrete guideways
- Safety engineering appropriate to use case
- Improved urban and rural connectivity
- User-centred design
- Digital DNA
- Future autonomy



## HUB-TO-HOME JOURNEYS

VLR is being developed with the wider journey in mind, allowing passengers to take an integrated, seamless, and personalised journey from a central hub direct to their front door, using multimodal public transport solutions

BCIMO uses the analogy of a tree to represent the UK's public transport network and a potential **Hub-to-Home** journey, as shown in this next video...





#### INTRODUCTION TO BCIMO THE VLRNIC IS BORN







### INTRODUCTION TO BCIMO PURPOSE OF THE ORGANISATION

The Black Country Innovative Manufacturing Organisation (BCIMO) is a not-for-profit company limited by guarantee and the driving force behind the Very Light Rail National Innovation Centre, a brand new, state-of-the-art R&D facility based in Dudley in the West Midlands

This £32m multi-purpose centre, situated at the heart of the Black Country, offers a host of unique facilities including:

- A Rail Development and Test Site
- Serviced Office Spaces
- An Events Suite
- Engineering Laboratories *to be fitted out over the next 12 to 24 months*



### INTRODUCTION TO BCIMO AREAS OF FOCUS

BCIMO is the central cog in this wheel of development activity, helping to *shape* and *accelerate* future industries, supporting government policy relating to *net zero, the future of transport* and *regional levelling up* 





#### TECHNOLOGIES OF THE FUTURE TESTING, DEMONSTRATION & COMMERCIALISATION OFFER

#### **TECHNOLOGY READINESS LEVEL (TRL)**

ENT	9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT		
OYM	8	SYSTEM COMPLETE AND QUALIFIED	<b>RBD</b> Advisory	
DEPL	7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT		
ENT	6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT	<b>BCIMO</b> <sup>™</sup>	
OPM	5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT		
DEVE	4	TECHNOLOGY VALIDATED IN LAB		
Н	3	EXPERIMENTAL PROOF OF CONCEPT		
SEAR	2	TECHNOLOGY CONCEPT FORMULATED	UNIVERSITIES/RI	
RE	1	BASIC PRINCIPLES OBSERVED		





# **G** CLEAN FUTURES

Supporting the West Midlands to be at the heart of the Green Industrial Revolution

# ROAD MAP

#### **SME Selection**

Selecting the best 20 SMEs with innovative solutions that meet our challenges

### Development & Testing Design

The SMEs will work with partners and to create operationally sound project proposals for testing their solutions.

### Evaluation & Impact

Impact and value add of the programme will be evaluated, for the SMEs, partners and WM region.

### **Challenge Setting**

Working with our ecosystem to select addressable market challenges that will achieve maximum impact

#### **Catalyst Launch**

Introducing our community that will foster collaboration and unearth opportunities and create our legacy.

## Development & Testing Delivery

SMEs will carry out their development and testing projects in collaboration with partners. Commercial support will be delivered.

## BENEFITS

We're excited to work with you!

Gain access to front line innovation and industry insight that will accelerate your business.

•	Up to £50k cash contribution for development and testing	•	Use of world leading test facilities from BCIMO and Coventry University	•	Join a community to forge new collaborations
•	Commercial support to help your business grow	•	Opportunity to showcase solutions to key industry stakeholders	•	Increase investment readiness
•	Insights from buyers and supply chain	ľ	Access to cutting edge research	•	Respond to real world challenges from industry leaders



### CLEAN FUTURES ACCELERATOR BCIMO WINNERS SUPPORT PACKAGE

#### Commercialisation Support Package (up to 10 days of support)

- Up to 10 days of specialist rail support focused on commercialising your product into the rail sector
- Facilitated client & partner introductions on site
- A profile-raising advert / feature in Rail Business Daily
- A video demonstrating the SMEs technology and journey at the centre

#### *Engineering Support Package (10 days of trial & demonstration support)*

- Access to the Rail Development and Test Site facilities for trial & testing
- Bespoke support to develop a trial & demonstration plan
- Engineering support to trial & demonstrate your technology solution on site

#### Additional Services & Support (over the project lifetime)

- Free access to the Commercial & Investor Hub
- Free access to hotdesking facilities in the Clean Futures SME collaboration space
- Access to support with an allocated SME Development Manager
- Discounted access to our wider Meeting, Conference and Event spaces





## 14:15 – 14:30 RAILWAY INDUSTRY ARCHITECTURE



#### Name:

• Alec Gillham

#### Job Title:

• Strategic Development Manager

#### Organisation:

• Black Country Innovative Manufacturing Organisation

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## RAILWAY INDUSTRY ARCHITECTURE





## RAILWAY INDUSTRY ARCHITECTURE







## RAILWAY INDUSTRY ARCHITECTURE CONTROL PERIOD 7

- Decentralised management of 5 regions £44Billion
- Each now has a regional MD
- Regions support the respective routes, 13 nationally
- 'A number' of NR services will be decentralised
- Product Acceptance remains a central function, led by the needs of routes / regions ( x no. Engineering leads > 13 RAMs)
- Greater agility in delivering NR's technical strategy
- More responsive to 'bottom up' innovation
- Better suited to local suppliers
- Lowers risk of 'fatigue'
- Closer to customers; better service for passengers
- N.B. detail subject to confirmation restructuring 'problematic'



#### (CP7): 2024-2029



## 14:30 – 14:45 INTRODUCTION TO CHALLENGE THEME 5



#### Name:

• Alec Gillham

#### Job Title:

• Strategic Development Manager

#### Organisation:

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## INTRODUCTION TO CHALLENGE THEME 5 CHALLENGE STATEMENT



## Challenge Theme 5 – Future Fuels

Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels.



## Description

While electrification is ongoing, alternative fuels can bridge the gap and reduce emissions versus traditional fuels. There are also applications where electricity is difficult to apply, such as for combine harvesters and rural transport with long travel distances and limited charging and supply. Biofuels also have the additional benefit in reducing waste.





We are looking at SMEs contributing to producing, transporting or storing biofuels, synthetic fuels and hydrogen in the West Midlands:

- Local production and transportation to increase the affordability of hydrogen fuels in the West Midlands, as well as reduce waste
- Focus on areas where electrification is a challenge, such as larger machines (e.g., combine harvesters, HGVs, tractors, refuse trucks and other maintenance vehicles)
- Solutions to retrofit vehicles today to be compatible with alternative fuels (only where vehicles have long life, such as HGVs and heavy rail)
- Applying alternative fuels for EV charging infrastructure, especially in places where charging infrastructure may be less accessible
- Accessibility of supply of alternative fuels for consumers and operators, for both on-highway and offhighway vehicles
- Efficient storage and transportation of alternative fuels, with reduced waste, space utilization and lower emissions
- Applying cleaner fuels from aircraft and maritime to automotive and rail



## **QUEST FOR FUTURE FUELS**

- Fuel resources that our planet hold is exhaustible and will end in the coming future
- Rapid industrialization and massive growth in population has increased the dependence and use of natural fuels
- Approximately 90% of our energy requirement are met by fossil fuels
- This increase in energy consumption particularly in the past several decades has raised fears of exhausting vital natural resources
- So this has placed a need for us to engage ourselves in search of fuels which would support us in the future when no fossil fuels are present











The UK's first multi-fuel, open access, low and zero carbon fuel refuelling station is now open and ready to receive commercial fleet, public transport fleet and private vehicles.













A 'carbon-busting' Class 66 locomotive fuelled with 100% renewable Hydrotreated Vegetable Oil (HVO) made a landmark journey on the UK rail network this week (Wednesday, December 16th). Network Rail in collaboration with DB Cargo UK









The UK's first Hydrogen Hybrid Train





National Express has deployed 20 hydrogen doubledecker buses purchased by Birmingham City Council, serving West Midlands route 51 to Walsall via Perry Barr from 6th December 2021 – the only hydrogen buses operating in England outside London.

### 14:45 – 15:15 INDUSTRIAL PRESENTATION ON THE CHALLENGES & OPPORTUNITIES



#### Name:

Beverley Nielson

#### *Job Title:*

• Chair

#### Organisation:

• Ultra Light Rail Partners

#### Contact Details:

<u>Beverley.Nielsen@bcu.ac.uk</u>



## Ultra Light Rail Partners – Credentials

- Independently powered trains and trams
- Hybrid and battery / flywheel powertrains
- Rail approvals and health and safety background
- **Designed and built 100+ unique gas-powered vehicles**
- Supervising IUK and EU projects to completion
- Collaborating with Pre Metro Operations Ltd, running the **Stourbridge Shuttle for 15 years carrying 6m plus passengers**

#### An experienced established integrated team:



#### Clive Hinchcliffe

Advisor ULRP, **Director BioUltra Transport** Solutions, Associate Member, The Charted Institute of Railway Operators. 20+ years senior railway management experience with London Transport and the private sector



#### **David Bridge**

Trains

Advisor ULRP. Rail Company Secretary, Engineer active from 1978 ULRP to 2022. Roles in design, Successful mechanical equipment, Entrepreneur in hybrid powertrains and healthcare and approvals within EWS, transport Network Rail and Angel



**Technical Director, ULRP** Chair, Organic Power Ltd Former Chair Global **Biomethane Congress** Designed and built 100+ biomethane vehicles



Chair ULRP, Director, BioUltra **Transport Solutions** Director, IDEAS, **Birmingham City** University, Social Entrepreneur, Councillor Lead Design Engineer, ULRP Former head Product Design QinetiQ; Award winning design engineer



ULRP

Ultra Light **Rail Partners** 

Director ULRP, Director **BioUltra Transport** Solutions CEO, Overseas NDC Rail innovator; **Pioneering the Bristol** Electric Railbus

1
#### **BioTram**

Gas-powered trains and trams Timeline



1998-2000 Bristol Electric Railbus 2008 Stourbridge Shuttle launched and operated by Pre Metro Operations Ltd

#### 2020

Biomethane tram trialled at Long Marston

#### 2021

BioUltra train and tram Designed 2023 BioRefuelling Station design



## Previous experience 1998-2000

- Bristol Electric Railbus an independently powered, all-electric railbus operated between 1998-2000 at Bristol Harbour
- Part of the Bristol Transport Plan
- Overwhelming support from the public frustrated by inadequate public transport and congestion
- Increasing evidence of health impacts of rubber tyre and brake wear emissions
- Carried over 50,000 passengers





## Stourbridge Shuttle Performance from 2008

- 15 years in operation in West Midlands operated by Pre Metro Operations Ltd
- LPG 70% cleaner than diesel
- 6 million + safe, reliable passenger journeys
- Highest passenger satisfaction levels
- Operating 1300 trips each week
- 184 miles drivetime without refuelling







## Designs – BioUltra and BioTram



#### **BioUltra Train: 120 passengers**



5

Ultra Light Rail Partners

## Innovations Machinery Integration

Large crumple zones (allowing track-sharing with heavier traffic)

Space frame design built with steel providing structural integrity

All machinery easily accessible for maintenance



## 120-person BioTrain - CH4 or H2 hybrid



Trend is for pure battery or hydrogen fuel cell - why the hybrid:	Increased range 1000km
	No interruption to service during the day and no need for regular charging equipment
	Lower vehicle investment
	Lower refuelling / recharging station costs
	Lower infrastructure costs 30-50% weight saving
	Smaller engines (0.9L) smaller than in a family car
	Performance and efficiency
wheels lependently ven methane engine	Siomethane/Hydrogen Divor Base State
Generator	Bogie Motor Batteries Biomethane/Hydrogen

### Retrofit market - cease using diesel-powered trains by 2040

Class 158 DMU, around 40t tare/55t crush with 90mph top speed - gas conversion of the existing 14 litre Cummins diesel engine





 Retrofit diesel-fuelled trains to run purely on biomethane/hydrogen using combustion engine

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- A total of 6,960 diesel trains in the UK, with thousands in operation overseas
- Retrofit parts of the lighter DMU fleet (Est) 2,500 vehicles
- 38% of the UK rail network currently electrified
- Only 48% projected by ORR to be electrified by 2039
- Only 60 miles rail lines electrified since 1997

## Green Gas Refuelling Station options



#### Source of gas for refuelling:

i)

#### **1.**In the case of biomethane

### [Draft]Transportable Gas Refuelling Station



Using gas from the national gas grid by way of the established green gas certification schemes a) from a high pressure part of this grid

b) from the normal low pressure distribution network

c) trackside generation options i) direct drawdown from anaerobic digesters

Trackside container stores, see 3.

#### 2. In the case of hydrogen

- green hydrogen sources
- Hydrogen from chemical ii) processes otherwise unused, interim
- 3. In the case of either **biomethane** or hydrogen -
- i) From gas store refuelled via road or rail tankers

## Biomethane – a readily available solution



#### **Challenging emission targets Erdington Birmingham M6 – Net Neutral Emissions**

- Cut 78% by 2035
- Net Zero by 2050

#### **Clean Air Zones**

• In place or planned for 12 cities (Birmingham 2021)

#### **Congestion and emissions**

- Productivity : economic costs
- Health impacts: 30k-99k deaths pa UK

### **Birmingham biomethane cluster**

Strong position for West Midlands with costeffective access to high pressure gas grid

#### **Food Waste Collection**

Mandatory 2025 Biomethane buses, refuse trucks in use in Bristol, Nottingham, Reading, Peterborough



**Technology transfer:** 23 million vehicles operating on CNG worldwide

Nottingham Anaerobic **Digestion and Biomethane Buses** 

### Established Biomethane depots CNG Services Ltd and CNG Fuels

Ultra Light **Rail Partners** 





**Erdington Birmingham** 

North

The Ha

Paris

.



## **Current Biomethane Public Transport Services**



### Bristol

Nottingham

Reading Sunderland

Darlington Merseyside 99 biomethane buses servicing the city centre including Cribbs Causeway (2020)
120 biomethane double decker buses providing transport to the centre and greater Nottingham(2020)
100+ biomethane buses running since 2014
17 biomethane double decker buses servicing limited routes

**11** Arriva biomethane buses on limited routes**9** Arriva biomethane buses on limited routes

## Birmingham – 124 Hydrogen buses



#### Hydrogen buses

Made by Wrightbus in Northern Ireland, each double-decker includes six Kevlar-coated aluminium tanks which store the hydrogen to fuel the driving of the bus (rather than a tank full of diesel!)

The bus can be refuelled within 10 minutes and the hydrogen is used when the buses fuel cell battery (yup, they run on electricity too!) capacity falls to 80%.

Since December 2021, National Express West Midlands has been operating Birmingham City Council's 20 hydrogen buses on the 51 route from Birmingham to Walsall via Perry Barr.

## Tyseley Energy Park Hydrogen Refuelling





## BMW Hydrogen fuel cell electric vehicle (FCEV)

![](_page_49_Picture_1.jpeg)

- Hydrogen fuel cell powertrain
- Need to use "the full spectrum of technologies to do the decarbonisation job."

Ultra Light Rail Partners

- FCEV needs 100kg less raw materials than a BEV and 90% less 'critical raw materials'
- Existing petrol stations can be modified to include H<sup>2</sup> pumps and don't require massive infrastructure upgrades like banks of new EV chargers would require

## Available road-based solutions - Mobile Refuelling Unit

![](_page_50_Picture_1.jpeg)

![](_page_50_Picture_2.jpeg)

![](_page_50_Picture_3.jpeg)

![](_page_50_Picture_4.jpeg)

![](_page_50_Picture_5.jpeg)

![](_page_50_Picture_6.jpeg)

#### In-House Design, Build & Commission

Trailer based refueling solution Compressor / twin dispenser unit Tried and tested technology

#### **On-Site Installation**

Minimal site works to allow installation – installation can be completed in 1 day

#### Operation

Filling process identical to a grid connected station Remote monitoring of system

#### **Continuous Improvement**

Continuous improvement in updating systems and equipment as technology advances (e.g.Scada technology)

![](_page_50_Picture_15.jpeg)

![](_page_51_Picture_1.jpeg)

![](_page_51_Picture_2.jpeg)

![](_page_51_Picture_3.jpeg)

- A three slot stillage design
- No need for a large gas store on site or any transfer of gas between tanks
- lightweight composite tanks holding over 50% more biomethane (CH<sub>4</sub>) or green hydrogen (H<sub>2</sub>) than conventional steel containers
- atmospheric buffer to lock the gas tanks into position
- Tanks have a 30 year design life
- No requirement for cranes or forklift lifting equipment. Restocking the refuelling station is a manual operation involving the sliding of the wheeled tank cage from the delivery vehicle
- Aerogel insulated composite tank-based system also increases the safe storage time of biomethane or green hydrogen in liquid form, enabling even more space efficiency, longer storage time and significant cost benefits
- No requirement for the gas tank delivery drivers to have HGV licences
- No requirement for an inspection every 20 days to which normal fuel tankers are subjected.

![](_page_52_Picture_1.jpeg)

![](_page_52_Picture_2.jpeg)

![](_page_53_Picture_1.jpeg)

![](_page_53_Picture_2.jpeg)

![](_page_54_Picture_1.jpeg)

![](_page_54_Picture_2.jpeg)

![](_page_55_Picture_1.jpeg)

![](_page_55_Picture_2.jpeg)

## Renewable Gaseous fuels

ULRP Ultra Light Rail Partners

Patented Gas Storage System

![](_page_56_Figure_3.jpeg)

# Cutting Methane emissions best way to slow global warming – UN Report

"Cutting methane is the strongest lever we have to slow climate change over the next 25 years and complements necessary efforts to reduce carbon dioxide. The benefits to society, economies, and the environment are numerous and far outweigh the cost" Inger Andersen, the UNEP Executive Director

Methane is responsible for around 30% of warming since the pre-industrial era.

Methane Pledge signed by 150 countries: 30% cut to methane emissions by 2030

Unlike  $CO_2$  which stays in the atmosphere for 100s of years, methane starts breaking down quickly, with most of it gone after a decade. Cutting methane emissions now can rapidly reduce the rate of warming in the near-term.

Agriculture responsible for 30% of methane emissions globally.

Cutting methane emissions would prevent 255,000 premature deaths, 775,000 asthma related hospital visits, 73 billion hours of lost labour from extreme heat, and 26 million tonnes of crop losses globally each year.

![](_page_57_Figure_7.jpeg)

![](_page_57_Picture_8.jpeg)

## Biomethane: locally controlled circular economy

ULRP Ultra Light Rail Partners

**Global Warming** Prevents fugitive methane emissions 86 times more harmful than CO<sub>2</sub> emissions – 'better than zero' solutions

#### **Secure Phased Approach**

 Run tram on biomethane from the grid
 Build AD + use existing filling stations
 Produced naturally from local resources using local labour providing total security of supply

![](_page_58_Figure_5.jpeg)

Power for trains, HGV, cement lorries, refuse trucks, trams and coaches

![](_page_59_Picture_0.jpeg)

### • Biomethane, Technical Note, Climate Change Committee

This technical note supports the transport chapter of the report Meeting Carbon Budgets - 2016 Progress Report to Parliament.

• 'Biomethane could be used to displace some ... natural gas to offer ... significant savings, but **in the long term supply will be limited** and there will be competition from other sectors.'

• '...our assessment suggests that the total biomethane resource is likely to remain significantly lower than total natural gas demand, such that any increase in demand for gas from HGVs would be met by fossil natural gas at the margin.'

• "Russian gas could be directly replaced with home-grown biomethane within **the next 4 years.** By 2030 the UK's AD sector could generate an estimated 55-76 TWhs of biomethane - over 2-3 times the amount of gas the UK currently imports from Russia."

• ADBA, March 2022

Biomethane –

UK policy and

Sweden

### • Biomethane for decarbonising transport: the Swedish example

• *"Biomethane represents one of the lowest greenhouse gas intensive pathways when the whole emissions lifecycle is measured.* 

• *"However, when nations implement bans on internal combustion engines* to cut the use of fossil fuels they are also blocking the way for biomethane in transport. Instead, legislation should stimulate the deployment and availability of renewable fuels.

• And **CO2 emission performance standards should consider the whole lifecycle**, not just what comes out of the vehicle's tailpipe." Methane emissions can be cut in half now: Prof Ilissa Ocko MethaneSat can monitor all emissions

![](_page_60_Picture_1.jpeg)

![](_page_60_Picture_2.jpeg)

<u>Ilissa Ocko: The</u> <u>fastest way to</u> <u>slow climate</u> <u>change now | TED</u> <u>Countdown -</u> <u>YouTube</u>

## Role of Hydrogen in achieving Net Zero

Any future use of hydrogen will be limited rather than universal.

It is likely to be best suited to applications or places which are:

- Hard to electrify—such as some parts of the rail network;
- Uses that do not require the creation of an extensive refuelling network—such as local bus services operating out of a fixed number of depots; and
- Users who are adjacent to, or accessible to, places where hydrogen is produced, such as industrial clusters.

In addition, hydrogen has important potential uses as:

• a means of energy storage; and

• a source power for energy intensive industries like steel, glass and mineral production

![](_page_61_Picture_9.jpeg)

House of Commons Science and Technology Committee

# The role of hydrogen in achieving Net Zero

Ultra Light Rail Partners

#### Fourth Report of Session 2022–23

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 14 December 2022

Ocko I., Hamburg S., (2022) Climate consequences of hydrogen emissions Atmospheric Chemistry and Physics, European Geosciences Union 20<sup>th</sup> July 2022, <u>ACP - Climate consequences of hydrogen emissions (copernicus.org)</u>

- While zero- and low-carbon hydrogen hold great promise to help solve pressing energy challenges, hydrogen is also an indirect greenhouse gas whose warming impact is both **widely overlooked and underestimated**.
- Because hydrogen's atmospheric warming effects are short-lived lasting only a couple decades – and standard methods for characterizing climate impacts of gases consider only the long-term effect from a one-time pulse of emissions.
- For gases whose impacts are short-lived, like hydrogen, this long-term framing masks a much stronger warming potency in the near to medium term.
- This is of concern because hydrogen is a small molecule known to **easily leak into the atmosphere**, and the total amount of emissions (e.g., leakage, venting, and purging) from existing hydrogen systems is unknown. Therefore, the effectiveness of hydrogen as a decarbonization strategy, especially over timescales of several decades, remains unclear.

## Severn Trent Plc renewables and waste recycling business

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![](_page_63_Figure_2.jpeg)

Severn Trent Green Power Stourbridge Anaerobic Digestor – two days biomethane production required to provide sufficient biomethane to fuel Stourbridge Shuttle for one year

### TODAY's MARKET: The amount of food wasted in the UK

ULRP

![](_page_64_Figure_2.jpeg)

![](_page_64_Figure_3.jpeg)

## Environmental Impact Transport Energy Types

Ultra Light Rail Partners

Biomethane is 100% renewable, carbon neutral and causes no climate change.

It is available and under used. Of the 90m tonnes of animal manures produced each year in the UK only 3% is used.

![](_page_65_Figure_4.jpeg)

Barrel prices are comparable units of refined fuel. Duty is pence per litre

\* When produced from waste matter \*\* Current energy mix to make brown H<sup>2</sup> \*\*\* Doesn't account for power transmission losses.

# NZ Plans: Huge dependency on electricity

- Potential world shortages of **lithium** and cobalt as early as 2025 unless sufficient investments are made to expand production.
- Lithium use to increase 42 times by 2040 to support battery production.
- 400,000 -2m gallons of water required for 1 tonne of lithium produced
- 300 new mines projected
- Source: IEA

![](_page_66_Picture_6.jpeg)

![](_page_67_Picture_0.jpeg)

### NZ Plans: More Minerals and Mines Cobalt and the DRC

- Child labour
- Finite resource
- Lawsuit filed in Washington DC by International Rights Advocates against Apple, Google, Dell, Microsoft and Tesla
- Water pollution
- Local air pollution
- Environmental destruction
- Biodiversity loss

![](_page_68_Picture_0.jpeg)

NZ Plans: Moving from Dependency on Russia to Dependency on China – despite Critical Raw Materials Act 2023 and the 'CRM Club'

#### **Rare Earths**

China is the leading player at all stages of rare-earth production.

It holds the world's largest rare-earth reserves, around 37%.

Greater dominance downstream in the processed rare-earth minerals: Chinese firms are estimated to control more than 85% of the costly processing stage of the supply chain.

China provides nearly 98 percent of the EU's supply of rare earths.

Source: Monthly Review July 2021

#### **Polysilicon and PVs**

China currently controls more than 80% of all manufacturing critical to the production of solar panels, and could produce more than 95% of the world's polysilicon and wafers in the near future, according to IEA <u>report</u>.

Largest polysilicon makers in China's Xinjian Uyghur Autonomous Region participating in a forced labour program operated by Chinese government

Source: ACS Sept 2022

## Tailpipe Emissions – Various Fuels

ULRP Ultra Light Rail Partn<u>ers</u>

Regulated emissions from diesel (TDI, IDI); gasoline fuel (MPI, GDI); petrol (E85), methane (CNG) propane (LPG)

![](_page_69_Figure_3.jpeg)

![](_page_69_Figure_4.jpeg)

Biomethane has the lowest CO emissions and causes no climate change (Source: Dept for Transport)

Particulates from biomethane are dramatically lower than the other fuels

![](_page_69_Figure_7.jpeg)

## **Biomethane Emissions findings**

![](_page_70_Picture_1.jpeg)

### **Air Quality** NMHC Biomethane CH4 CO emissions – IVECO findings Particulate NOx Natural Gas ■Euro VI limits **EMISSIONS VERSUS EURO VI LIMITS** 70 % less NOx 99 % less PM 90 % Less NMHC 88 % less Methane

## 

#### Noise

#### 3 dB noise reduction

Piek Quiet Truck Certification (-72 dB)

#### Night time delivery possible

#### **Natural Gas**

IVECO

## **Tyre Particulate Emissions**

![](_page_71_Picture_1.jpeg)

![](_page_71_Picture_2.jpeg)

![](_page_71_Figure_3.jpeg)

- Tyre emissions 1,850 times higher than tailpipe emissions
- Research published in <u>the BMJ</u> highlights fossil fuel air pollution responsible for around 1 in 5 deaths, more than double previous estimates; 8.7m deaths worldwide
- Following death (2013) of 9 year old Ella Adoo-Kissi-Debrah Coroner Phillip Barlow emphasised there was "no safe level of particulate matter" in the air, calling for national pollution limits to be brought in line with WHO limits
- Around 300,000 tonnes of 'rubber' particulate materials are released every year from passenger cars in Europe and US, equivalent to over 40m new tyres
- **EU labelling** only rates *rolling resistance, wet grip and noise*; ratings blind to the environmental consequences of the tyre wear emissions
- European REACH regulations restrict toxic chemicals , but the number of chemicals affected is limited
- Chemicals measured from pure tyre emissions include:
- Alkanes (e.g. pentane) typically affect the lungs, liver, kidney and brain.
- Cycloalkanes (e.g. cyclohexane) lead to headaches and dizziness.
- **Terpenes** (e.g. limonene) are generally less problematic and are responsible for aromas
- Benzo(a)pyrenes) often carcinogens
- Nitrogen-containing compounds (e.g. quinoline) also carcinogens
   (Source Emissions Analytics)
## INTRODUCTION TO CHALLENGE THEME 5



# Challenge Theme 5 – FUTURE FUELS

Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels







#### Name:

• Chris Elliott

#### *Job Title:*

• Managing Director

#### Organisation:

• Experience in Rail

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# **Everything needs Fuel !**

Our bodies

Our homes

Our industry and our transport system.

BUT



How does it reach its final destination and where is it stored ?







CHALLENGE DESCRIPTION -THEME 5 – FUTURE FUELS



# Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels.

- Electrification is ongoing and will take time in the railway infrastructure programme.
- Alternative fuels can bridge the gap and reduce emissions versus traditional fuels.
- Applications where electricity is difficult to apply, and rural transport with long travel distances and limited charging and supply infrastructure.
- Biofuels also have the additional benefit in reducing waste from crops which would otherwise rot into methane.
- We are looking at SMEs contributing to producing, transporting or storing biofuels, synthetic fuels and hydrogen in the West Midlands, and making them accessible to their consumers.



#### CHALLENGE STATEMENT 5

Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels

# **QUEST FOR FUTURE FUELS**

- Fuel resources that our planet hold is exhaustible and will end in the coming future
- Rapid industrialization and massive growth in population has increased the dependence and use of natural fuels
- Approximately 90% of our energy requirement are met by fossil fuels
- This increase in energy consumption particularly in the past several decades has raised fears of exhausting vital natural resources
- So this has placed a need for us to engage ourselves in search of fuels which would support us in the future when no fossil fuels are present



The UK's first multi-fuel, open access, low and zero carbon fuel refuelling station is now open and ready to receive commercial fleet, public transport fleet and private vehicles based in the Tyseley Energy Park.

CHALLENGE STATEMENT 5 Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels



https://www.tyseleyenergy.co.uk/tyseley-refuelling-hub/



CHALLENGE STATEMENT 5 Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels





CHALLENGE STATEMENT 5 Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels



A 'carbon-busting' Class 66 locomotive fuelled with 100% renewable Hydro-treated Vegetable Oil (HVO). Network Rail in collaboration with DB Cargo UK

https://uk.dbcargo.com/rail-uk-en/news/uk-news/DB-Cargo-UK-successfully-trialsnew-HVO-fuel-in-bid-to-decarbonise-its-operations-5764438



**Future Fuels** 



The UK's first Hydrogen Hybrid Train https://www.railway-technology.com/projects/hydroflex-hydrogen-train/

CHALLENGE STATEMENT 5 Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels

#### **Future Fuels**

**National Express** has deployed 20 hydrogen double-decker buses purchased by Birmingham City Council, serving West Midlands



https://www.route-one.net/features/national-express-where-hydrogen-is-fuelling-change/

CHALLENGE STATEMENT 5

Produce, transport or store alternative fuels such as hydrogen, biofuels or synthetic fuels

# Think **<u>Big</u>** but remember <u>Small</u>

To move an object requires power.

The heavier the object the more power is required.

More power requires more fuel.

The less efficient a product is, the more power is required.





What we hear:

This product will reduce your emissions by 10%, its super light-weight and it will only cost you a few pounds more than the one you already have.

The reality:

The environmental impact of producing the final products constituent parts can be high. (is it sustainable, recyclable, ethically sourced, locally produced?)

Can you produce a full production lifecycle analysis for your product?



### 11:45 – 12:00 INDUSTRIAL PRESENTATION ON THE CHALLENGES & OPPORTUNITIES



#### Name:

• Spencer Williams

#### Job Title:

• Head Of Consulting

#### Organisation:

Rhomberg Sersa Rail Group

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- TBC



# **CLEAN FUTURES – CHALLENGE 5 FUTURE FUELS**



# Challenge description

- While electrification is ongoing, alternative fuels can bridge the gap and reduce emissions versus traditional fuels. There are also applications where electricity is difficult to apply, such as for combine harvesters and rural transport with long travel distances and limited charging and supply infrastructure.
- Biofuels also have the additional benefit in reducing waste from crops which would otherwise rot into methane.
- How do Clients approach this challenge?





# #SUSTAINABILITY STRATEGY 2021-2030



# **Scale of IÉ's Decarbonisation Challenge**

larnród Éireann must reduce GHG emissions from 144,400 to 70,700 Tonnes CO equivalent by 2030



Diesel accounts for 85% of Rail & Road Traction

Public Sector 2030 Decarbonisation Target: -Required to reduce GHG Emissions

by 51% relative to 2018 baseline figure.

The ICR fleet accounts for more than half of IÉ Diesel use.



Net Carbon Zero

# **Decarbonisation Initiatives to 2030**

## **1. Reduce Reliance on Diesel**

- Retirement of older diesel railcars: -
  - 2600, 2800 & 29000 (75%)
- Alternative traction sources: -
  - Shift to electric operations.
  - Increased level of biofuels / HVO
  - Hydrogen operations

# 2. Shift to Electric Operations

- DART+ Programme electrification
- Battery EMU Charging facilities, Drogheda,
- Cork Area Commuter Rail
- Significant increase in electric fleet (EMU & BEMU)

InterCity Electrification post 2030

# **2030 Decarbonisation**



# **Ongoing Decarbonisation Progress (2023)**

#### <u>Fleet</u>

- Framework for up to 750 B/EMUs 185 on order
- ICRs/29000 engine/transmission trials ongoing
- Enterprise Fleet replacement project
- Hydrogen trials 2x071 locos ongoing for Tara Mines.
- HVO trials: 2x071 and 2x201 locos proposed trials

#### Infrastructure Manager.

- Energy audit of building stock & two exemplar stations.
- Trial of 100% Green construction site (HVO & Elec)
- OTM HVO ongoing trials 50% 2023 and 100% 2024
- Expansion of EV road fleet.
- Road fleet HVO trials: Inchicore, Portlaoise & North Wall
- Native tree Planting

#### **Capital Investments.**

#### • DART+

- West: An Bord Pleanála: Decision anticipated by year end
- South-West: RO launched & awaiting Oral Hearing
- Coastal North: RO planned lodgement late 2023.
- CACR:
  - Midleton double tracking waiting for oral hearing.
  - Signalling D&B contract award by year end.
  - Through running Kent platform commence works by year end.
  - Submission of PBC to NTA by year end.
  - Submit RO for remainder of programme by end 2024.

#### Sustainable Energy Initiatives.

- CPPA: Consultant led study ongoing.
- Ongoing review of potential rollout of PV roof panels

#### IÉ Decarbonisation Glide Pathway to 2030 - Scenario Test



#### Decarbonisation Pathway to 2030 Key Assumptions: -

- 35% HVO Blend for passenger services \*
- 50% Freight operations either HVO or H2 \*
- 100% HVO for OTMs \*
- 20% ICR & 29000 engine / transmission improvements \*
- Retirement of older DMU fleets.
- Expansion of B/EMU fleets and supporting infrastructure.
- Displaced ICRs redeployed to strengthen InterCity services
- CPPA and PV roof panels \*
- \* Subject to successful trials.
- \* Subject to Business Case.



@RhombergSersaRailGroup



@rhomberg\_sersa\_rail\_group



# **The Wider Sustainability Picture**

Iarnród Éireann participation in the Minister's SDG Champion programme.



Enough – For All - Forever

# Promoting and Enhancing Biodiversity

- Major commitment to Biodiversity.
  - Biodiversity Guidelines issued for infrastructure staff.
    - Procedures for maintenance activities
    - Information on protected species and habitats
    - Information on invasive plant species
  - Full time ecologist to support on-site activities.
- 2030 targets.
  - 100 acres of native tree planting.
  - Roll out of pollinator plans for all stations and space permitting biodiversity / well-being gardens.
  - Other initiatives including less grass mowing, review of landscaping contracts, biodiversity champions.



## Biodiversity Guidelines for Infrastructure Staff

Promoting biodiversity and sustainability practices



### 15:45 – 16:45 BCIMO FACILITIES TOUR



#### Name:

• Tony Joy

#### Job Title:

• Head of Engineering

#### Organisation:

Black Country Innovative Manufacturing Organisation

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## BCIMO FACILITIES TOUR INTRODUCTION TO THE RAIL DEVELOPMENT & TEST SITE (RDTS)



## BCIMO FACILITIES TOUR RDTS SAFETY INDUCTION (WORKSHOP & TEST TRACK)







### BCIMO FACILITIES TOUR RDTS SAFETY INDUCTION (WORKSHOP & TEST TRACK)







## BCIMO FACILITIES TOUR RDTS SAFETY INDUCTION (WORKSHOP & TEST TRACK)

- A hi-vis vest needs to be worn when walking from the VLRNIC to the Workshop via the safe walking route.
- You must take special precautions when crossing the track using the level crossing. There will be occasions when there are rail vehicle movements along the Test Track and the level crossing.
- Pay attention to all barriers and warning signs. If there is a barrier, stop and look for vehicle movements.
- If there is a vehicle moving you must wait for the driver to sound the horn, raise your hand so that he knows you are there and wait for the vehicle to pass before you proceed to walk across the level crossing.
- After entering the Workshop sign into the visitors' book.
- The fire alarm is tested on Mondays at 11.30am. This will sound for less than 1 minute.
- Fire exits are clearly marked and located around the Workshop.



## BCIMO FACILITIES TOUR RDTS SAFETY INDUCTION

- On hearing the fire alarm, make your way to the emergency muster point, located in the Upper Car Park. There are two safe walking routes to the Upper Car Park, one behind the building beside the Tipton Road wall and one in front of the Workshop using the level crossing. Use the safest route.
- If you discover a fire, break the glass at the nearest call point to sound the alarm and make your way to the emergency muster point.
- At the emergency muster point the allocated fire warden will take a register to ensure 100% attendance.
- The allocated first aider will also administer first aid where required.
- If an accident occurs in the Workshop or on the Test Track this must be entered into the accident book in the Workshop.
- No unauthorised photographs are to be taken in the Workshop.
- When working in the Workshop appropriate PPE should be worn for the task being undertaken. For example. When entering the pitted area, minimum PPE requirements are hi-vis vest/top, safety boots, hard hat/bump cap and safety glasses.



## BCIMO FACILITIES TOUR RDTS SAFETY INDUCTION

- Before using any chemicals on site, you should read the COSHH sheet and wear the appropriate PPE required.
- Care is to be taken when moving around the Workshop and Test Track as vehicle movements are to be expected.
- All vehicle movements will be carried out by authorised personnel ONLY.
- Vehicle movements will be coordinated by the Site Supervisor.
- The Site Supervisor will brief visitors on any planned train movements on the day of arrival.
- Directional points on the Test Track are to be operated, locked/unlocked by authorised persons ONLY.
- When accessing the Test Track use Safe Walking routes when available, minimum PPE requirements are hi-vis vest/top, safety boots and hard hat/bump cap.
- You must take special precautions when crossing the track. Anyone who does NOT hold a personal track safety (PTS) certificate or have not been authorised by the Site Supervisor must be escorted by someone with PTS certification.



### 16:45 – 17:00 WRAP UP AND CLOSE



#### Name:

Naomi Arblaster

#### Job Title:

• Head of SME Development

#### Organisation:

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