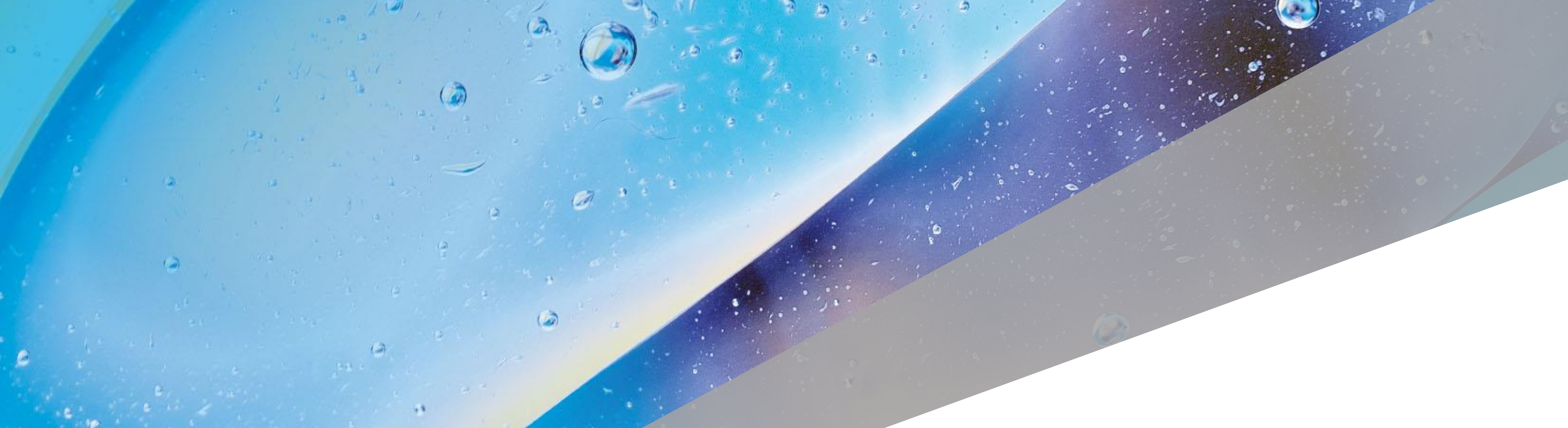
ENERGISING A SUSTAINABLE FUTURE

8th July 2020

LowCVP Low Carbon Vehicle Partnership

ADVANCED PROPULSION CENTRE UK



UK POSITION: SUSTAINABLE LOW CARBON FUELS AND ROLE OF REGULATION

Carly Whittaker

LowCVP
Low Carbon Vehicle Partnership

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Department for Transport

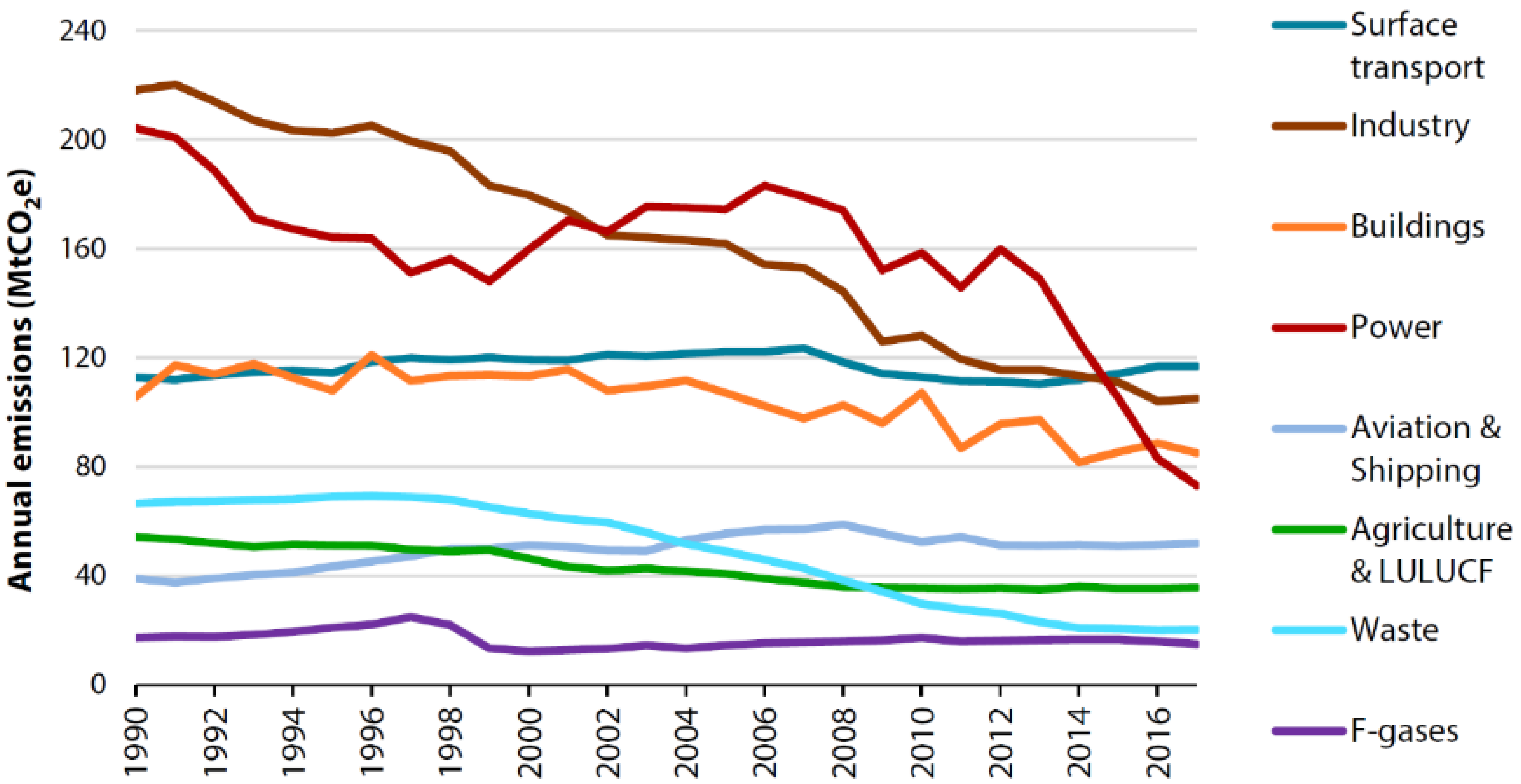
Department for Transport

Overview: Renewable Transport Fuel Obligation

- Transport challenge
- Demonstration competitions funded by UK Government
- Objective of the RTFO
- Strategic direction
- Key fuels and statistics
- Regulation of the RTFO
- Next steps: RTFO

Transport Challenge

Transport Challenge: Transport GHG emissions not falling



BEIS (2019) Final UK GHG emissions national statistics

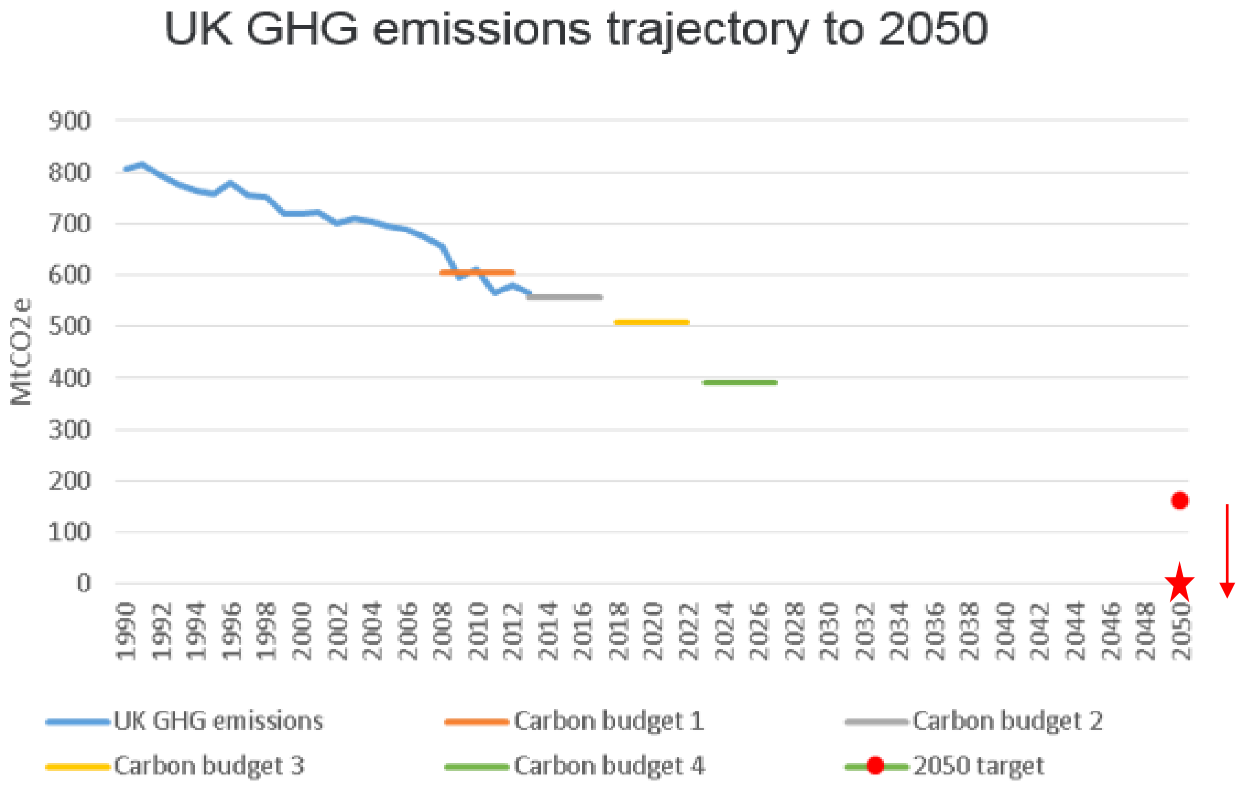
UK Policy challenge: Reducing emissions from transport

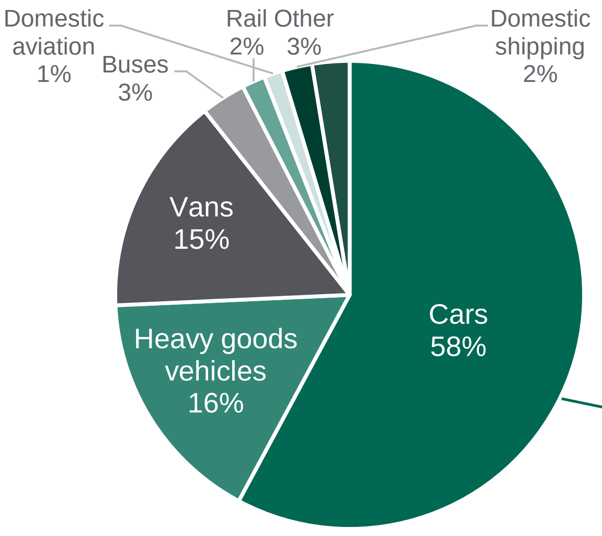
June 2019: Announced Net Zero target

- Will require the UK to bring all greenhouse gas emissions to net zero by 2050, compared with the previous target of at least 80% reduction from 1990 levels.

Challenge is
Reducing GHG emissions

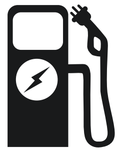
(Reducing energy demand)





Emissions from UK transport

There is a need to focus on reducing GHG emissions from modes of transport that are **more difficult to electrify**



Demonstration Competitions

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Encouraging commercial development through demonstration competitions

Advanced Biofuels derived from wastes and residues can:

- turn low-value wastes into high-value, low-carbon fuels;
- tackle the hard-to-decarbonise aviation and HGV sectors; and
- underpin a world-leading UK industry, creating jobs and growth.

Objectives: Boost domestic deployment · Enhance UK production

Benefits: Decarbonise transport · Support UK PLC

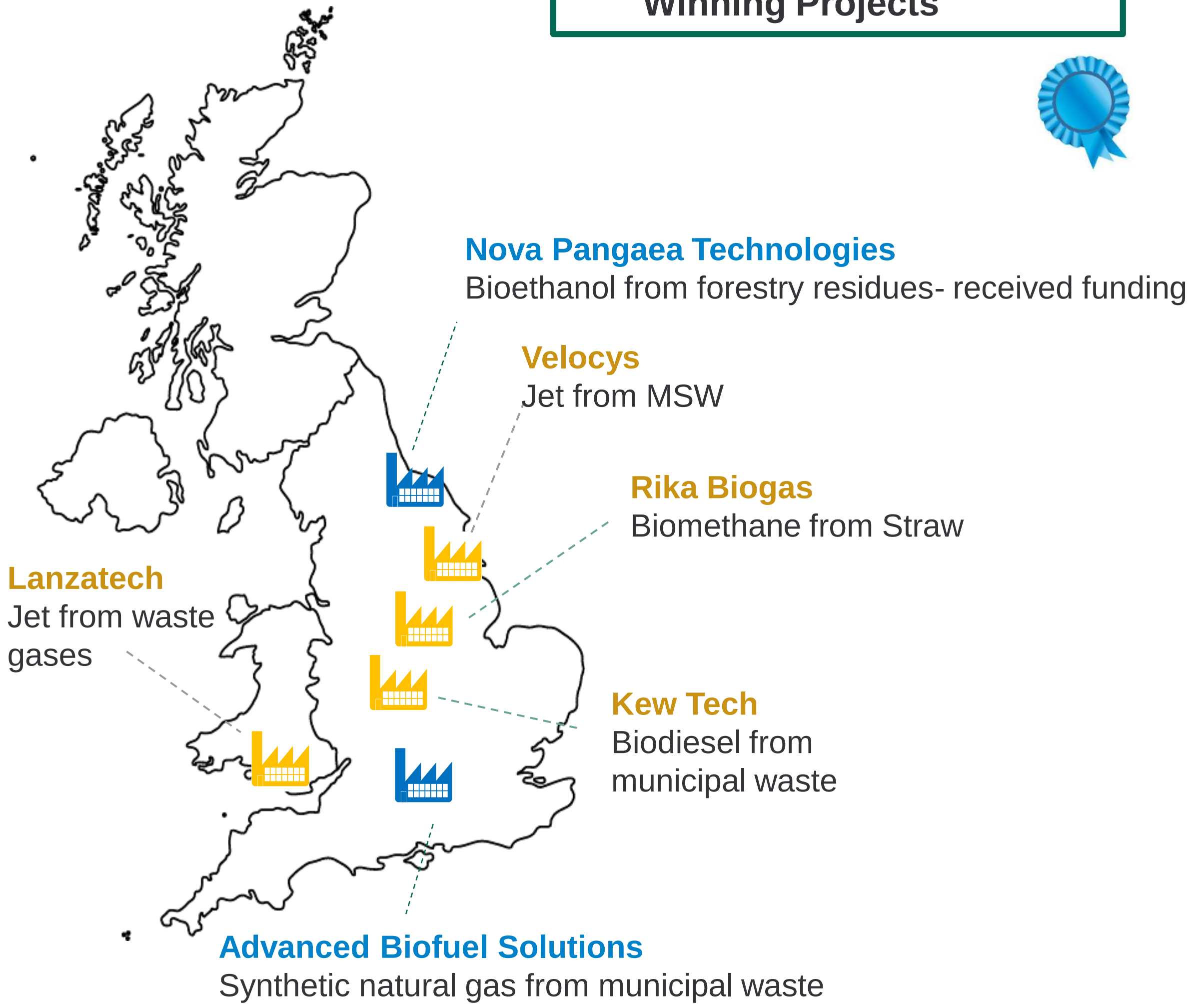
Competition 1 – "ABDC" - winning projects underway:

- providing £18m of capital grants (matched by industry);
- demonstrating the commercial viability of novel technologies
- will see world-first plants built in the UK, using UK IP.

Competition 2 – F4C - grants being arranged with projects :

- providing £20m capital grants (match funded)
- target fuels that tackle the **aviation** and **HGV** sectors
- 28 UK based projects applied, some with backing from major industry players: **BA**, **Shell**, **Virgin**…
- Kew and Rika successfully in Stage 2

Winning Projects



Feasibility study

- **Feasibility study – Ricardo/E4Tech**

- **Targeted at aviation fuels**

- **Publish at the end of summer**

Objective of the RTFO

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The Renewable Transport Fuel Obligation

- Has been operating since 2008

- Is one of the Government's main policies for reducing GHG emissions from fuel supplied for use in transport

- Increase the amount of sustainable renewable fuel used in road transport (and non-mobile machinery) (e.g. 10% target by 2020). Have targets up to 2032 and beyond.

- Sustainable renewable must be renewable and meet minimum GHG emission savings and land use criteria

The RTFO: How it works

- **R**enewable **T**ransport **F**uel **O**bligation **(RTFO)**
  - Fuel suppliers to UK must provide a **% volume** of sustainable renewable fuel, based on their overall volume of fuel they supply to road transport
  - The % volume target **increases** over time
  - This is met by tradable Renewable Transport Fuel Certificates (**RTFCs**) that are awarded per litre of renewable fuel.

Suppliers can get RTFCs by:

producing renewable transport fuels

buying renewable transport fuel and getting RTFCs

or buying RTFC certificates

Or pay the 'buy-out' price

30p per certificate

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The RTFO: How it works

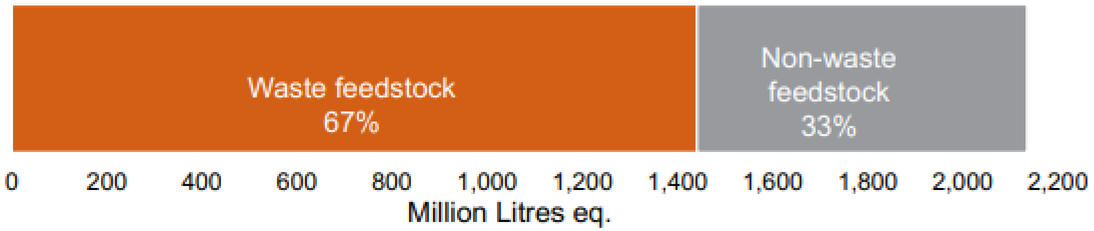
Current policies incentivise the use of wastes and residues.

- Fuels made from products
  - E.g. crops, industrial products

Per litre

- Fuels made from qualifying wastes and residues
  - E.g. food waste, used cooking oil, agricultural residues
- Fuels made from energy crops
  - E.g. willow, *Miscanthus*, switchgrass

Per litre



Strategic Direction

Development fuels

UK's long term strategic objective:
Need to focus on **sectors difficult to electrify (e.g. aviation, freight)** and will **stimulate investment** in the technologies needed to produce them.

In 2019 a new sub-target for development fuels was introduced.

They can only be produced from qualifying wastes and residues

80p per certificate

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What are development fuels?

Certain types of fuels

- ☑ Aviation fuel (avtur or avgas)
- ☑ Hydrogen
- ☑ Renewable-synthetic natural gas (SNG)
- ☑ "Drop in fuel" that can be blended at rates of at least 25% and still meet the relevant fuel standard

  i.e. EN228 for petrol, EN590 for diesel

☑ **60% GHG Savings**

Certain types of feedstocks

- ☑ Sustainable wastes or residues
- ☑ Renewable transport fuels of non-biological origin (electrofuels)

☒ *Not:*

Segregated oils and fats (e.g. used cooking oil, tallow)

Crops, including energy crops

Methane via anaerobic digestion

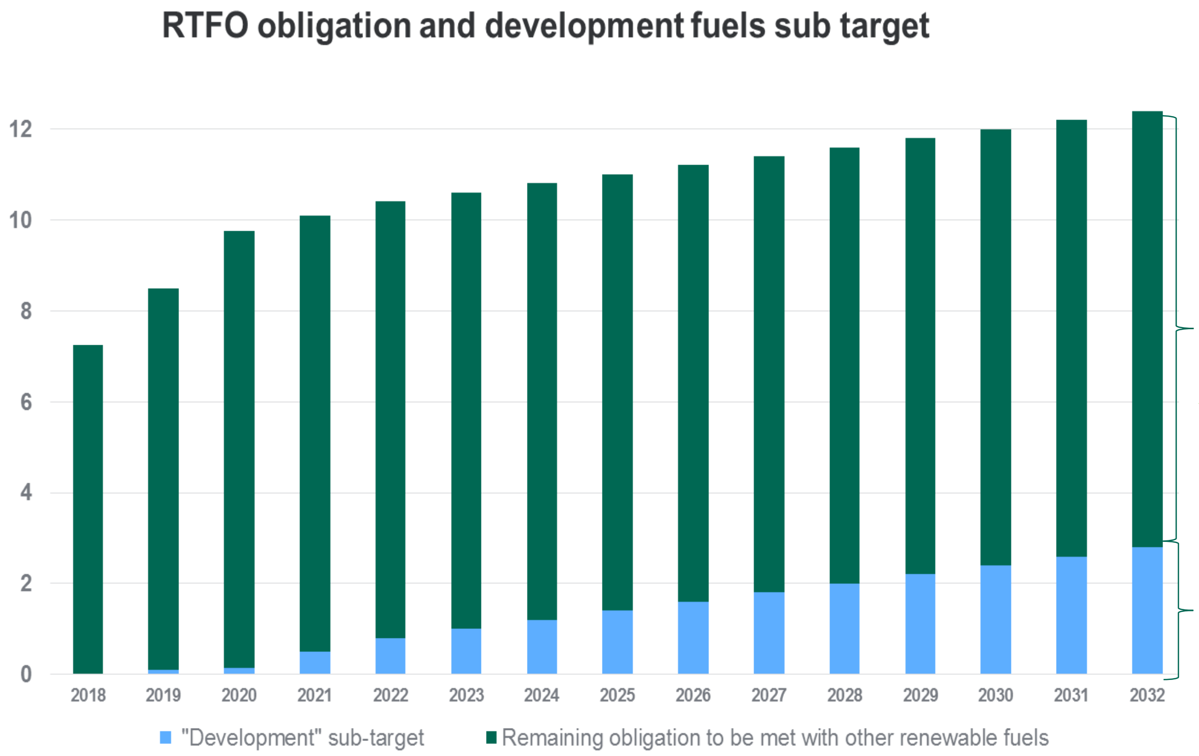
Summary: Main RTFO Obligation and development fuels sub-target

Main Obligation- conventional renewable fuels (green bars)

- 2019 – 8.4%
- 2032 – 9.6%

Development fuel sub-target (blue bars)

- 2019 – 0.1%
- 2032 – 2.8%



30p buy out price per certificate

RTFCs

Development fuel sub-target

*d*RTFCs

80p buy out price per certificate

Key fuels and statistics

Does not include development fuels- just main Obligation

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Renewable fuel statistics- Official statistics available online

- "Renewable fuel statistics"- https://www.gov.uk/government/collections/renewable-fuel-statistics
- Publish six 'quarterly' reports per Obligation year
  - The data becomes more complete in each report
  - Final report gives full and final account for the year

	2018 (April to December) statistics	2019 statistics	2020 statistics
August 2019	Fourth Provisional Report	First Provisional Report	
November 2019	Final Report	Second Provisional Report	
February 2020		Third Provisional Report	
May 2020		Fourth Provisional Report	
August 2020		Fifth Provisional Report	First Provisional Report
November 2020		Final Report	Second Provisional Report

Highlighted reports indicate summary report for the period.

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Key Statistics

- **Publish data tables: lots of data**
- **RTFO Tables** contain data on
  - Fuel supplied (fossil and renewable)
  - Renewable fuel 'verified' i.e. assessed and awarded RTFCs
  - Trades of certificates between different supplier account types (HO930, HO10, traders)
  - Carbon and sustainability data (GHG savings, feedstocks used, country of origin)
  - Voluntary schemes used to certify renewable fuels
- **GHG tables** contain data on
  - Fuel supplied
  - GHG credits awarded to renewable fuels, upstream emission reductions.
  - Trades of GHG credits between supplier types
  - Carbon and sustainability data (GHG savings)

Renewable fuel statistics 2019: Fourth provisional report

Supply of renewable fuels for January to December 2019.

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RTFO Statistics (https://www.gov.uk/government/collections/renewable-fuel-statistics)

Table RF 0101

Volumes of fuels by fuel type[1]: United Kingdom, 2019

Provisional data

Data is for information received by the DfT as of 18/09/2019 and is provisional. The final report for 2019 will be published in Nov 2020.

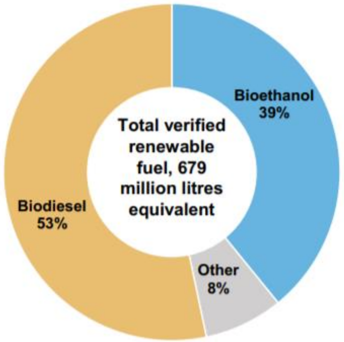
Volume, million litres eq.[2]

		Supply periods[3]										
	Fuel Type	**Jan**	**Jan - Feb**	**Feb - Mar**	**Mar - Apr**	**Apr - May**	**May - Jun**	**Jun - Jul**	**Jul - Aug**	**Aug - Sep**	**Total**	**Percentage of total fuel supply**
Fossil fuels	Diesel	960	2,347	2,232	2,506	2,290	2,386	2,281	2,315	0	**17,318**	54%
	Low sulphur gas oil	153	415	401	440	405	434	423	456	-	**3,128**	10%
	MTBE (fossil portion)	0	0	0	0	0	0	0	0	-	**0**	0%
	Petrol	588	1,287	1,225	1,314	1,350	1,394	1,303	1,361	0	**9,821**	31%
	Total	**1,702**	**4,049**	**3,858**	**4,260**	**4,045**	**4,214**	**4,007**	**4,132**	**0**	**30,267**	**95%**
Renewable fuels	Biodiesel FAME	37	102	86	117	132	165	157	166	-	**960**	3%
	Bioethanol	26	62	56	60	63	64	63	64	-	**460**	1%
	Biomethane[2,4]	-	-	-	3	-	-	5	-	-	**8**	0%
	Biomethanol	1	1	5	7	1	6	1	1	-	**24**	0%
	Biopetrol	1	2	2	-	0	3	2	2	-	**12**	0%
	Biopropane[2]	-	-	-	21	-	-	18	-	-	**39**	0%
	Diesel (origin bio)	0	1	1	-	0	1	1	1	-	**4**	0%
	HVO	0	1	0	0	-	0	0	-	-	**2**	0%
	Methanol (non-bio, renewable)	0	-	-	-	-	-	-	-	-	**0**	0%
	MTBE (renewable portion)	-	-	-	-	-	1	2	-	-	**3**	0%
	Off road biodiesel	1	5	4	5	8	9	8	8	0	**48**	0%
	Pure vegetable oil	-	-	-	-	-	-	-	-	0	**0**	0%
	Total	**66**	**175**	**154**	**213**	**204**	**251**	**257**	**241**	**0**	**1,561**	**5%**
Total		**1,768**	**4,224**	**4,013**	**4,472**	**4,249**	**4,465**	**4,264**	**4,373**	**0**	**31,827**	

Quarterly Statistics Report

- Publish 'infographic report'
- Bit easier to digest- built for the laymen

Figure 1: Volume of verified renewable fuel by fuel type (table RF_0105a)



Country of Origin

Figure 7: Top 5 countries supplying verified renewable fuel to the UK (table RF_0105a).

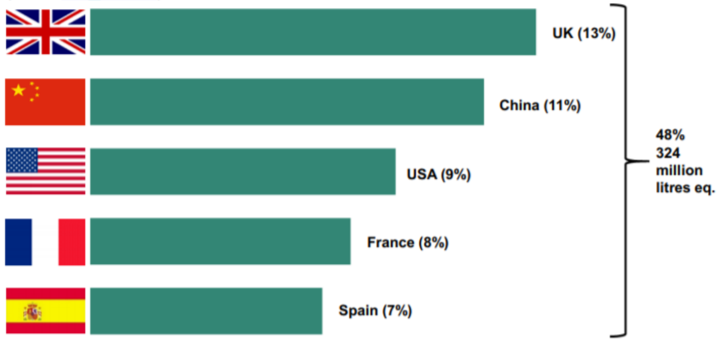
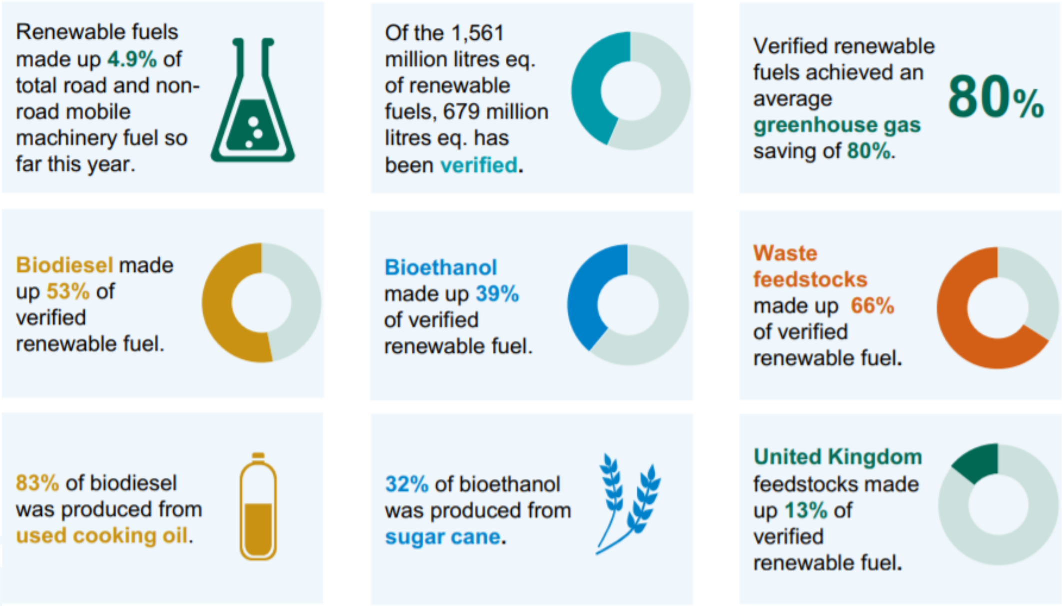


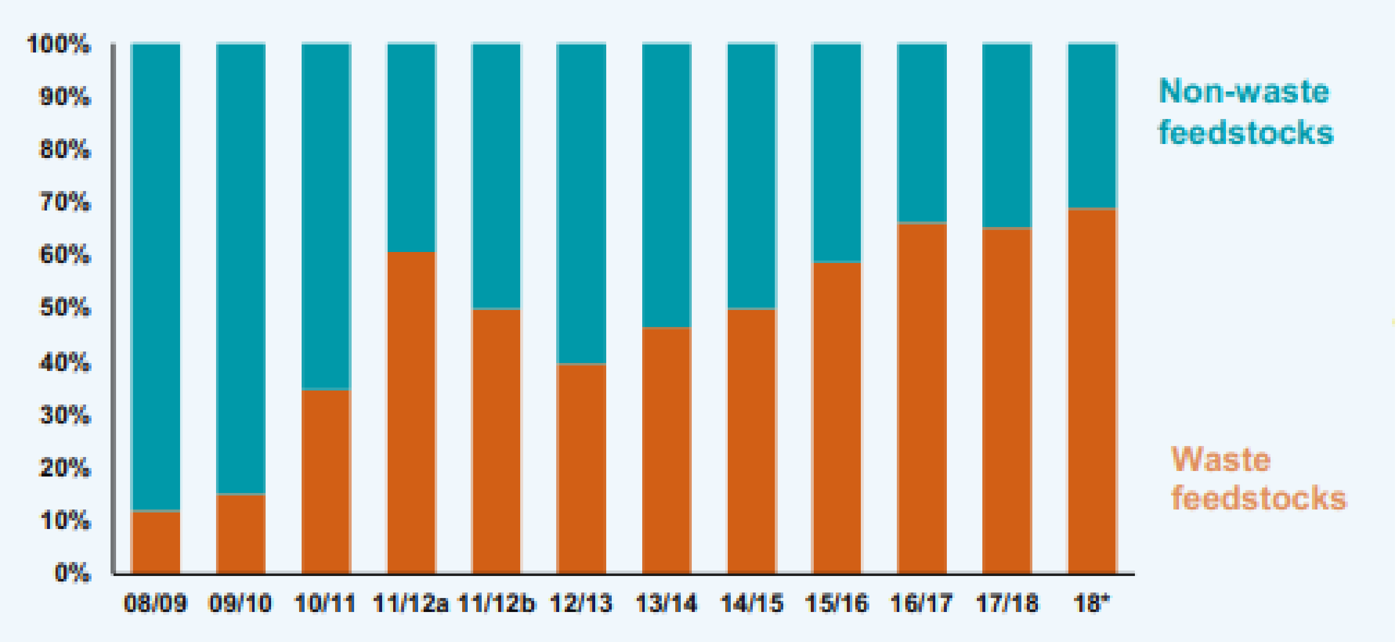
Figure 3: Highlights - 2019



Approved feedstocks

For example- As published by RTFO Unit
https://www.gov.uk/government/publications/renewable-transport-fuel-obligation-rtfo-guidance-year-11

- The RTFO Unit will assess new applications for development fuels- determine if feedstocks are **genuine wastes**



Wastes and processing residues

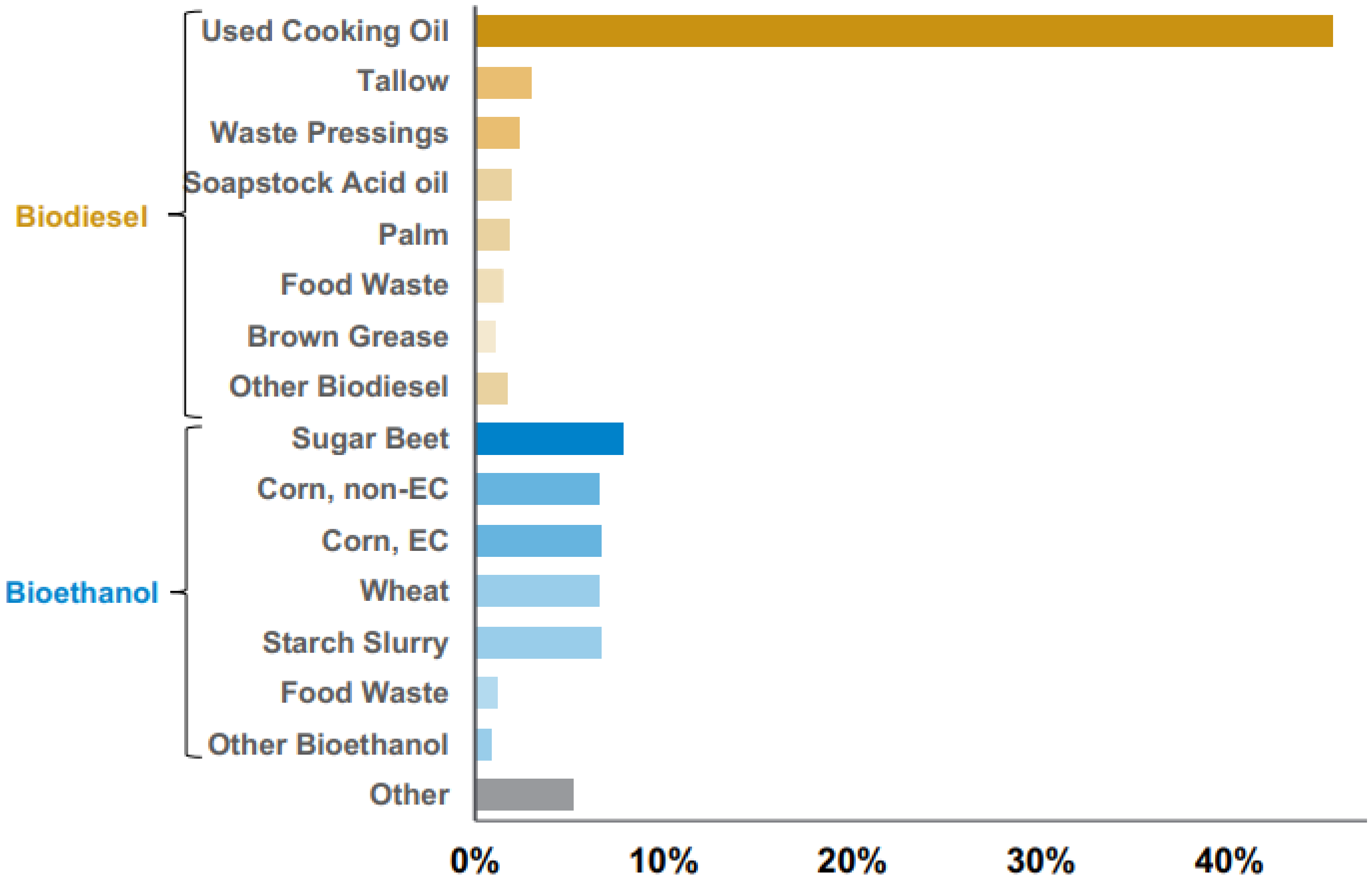
Table 3 contains a list of wastes and processing residues that are eligible to receive double the number of RTFCs for every litre/kg of biofuel.

Table 3 - Wastes & processing residues

Material	Description	Valid from
Brown grease	Brown grease is the grease that is removed from wastewater sent down a restaurant's sink drain. This is a waste. Material removed from sewers known as "FOG" (fats, oils and grease) should now be reported as "Sewage system FOG". Brown grease may use the waste vegetable or animal oil default GHG value.	15/12/11
Cashew nut shell liquid	Cashew nut shell liquid (CNSL) is a process residue. The material is squeezed from the shells of cashew nuts after the edible portion has been removed. There are other potential uses which may be affected by large scale use of CNSL for biofuel, therefore the Administrator will be keeping this decision under review.	15/05/14
Crude glycerine	Crude glycerine is specifically named as a residue from processing in the RED. (The RED treats refined glycerine from as a product - see above).	15/12/11
Empty palm fruit bunches	Empty fruit bunches from palm are a process residue. The palm fruits are separated from the bunches at the palm oil mill; and the bunches can then receive further treatment to extract low grade oil residues. There is no default carbon intensity for this feedstock, and so actual data need to be reported.	15/09/17
Food waste (unsuitable for animal feed)	Whether from manufacturers, retailers or consumers, this will be a waste. This may include food that is; i) Out of date (food that has exceeded its shelf life) ii) Out of specification (food that fails to meet the required end of use specification). As with all wastes, this material must be unsuitable for other non-	15/12/11

Top feedstocks

- Used cooking oil by far the most common feedstock
  - Dominates biodiesel supply
- Bioethanol produced by a mix of feedstocks
  - Sugary crops e.g. sugar beet, corn, sugar cane
  - Main wastes are starch slurry and food waste



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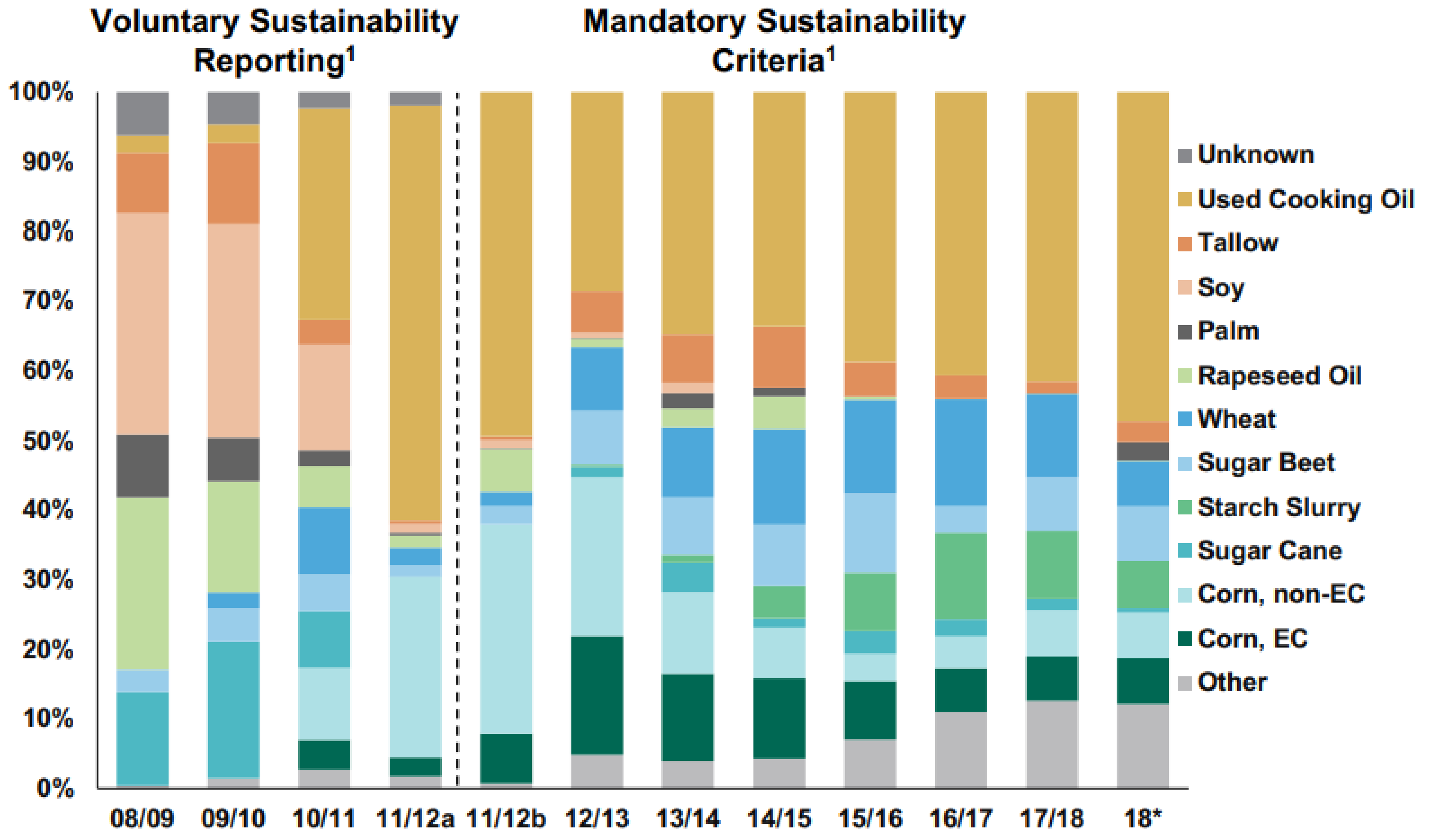
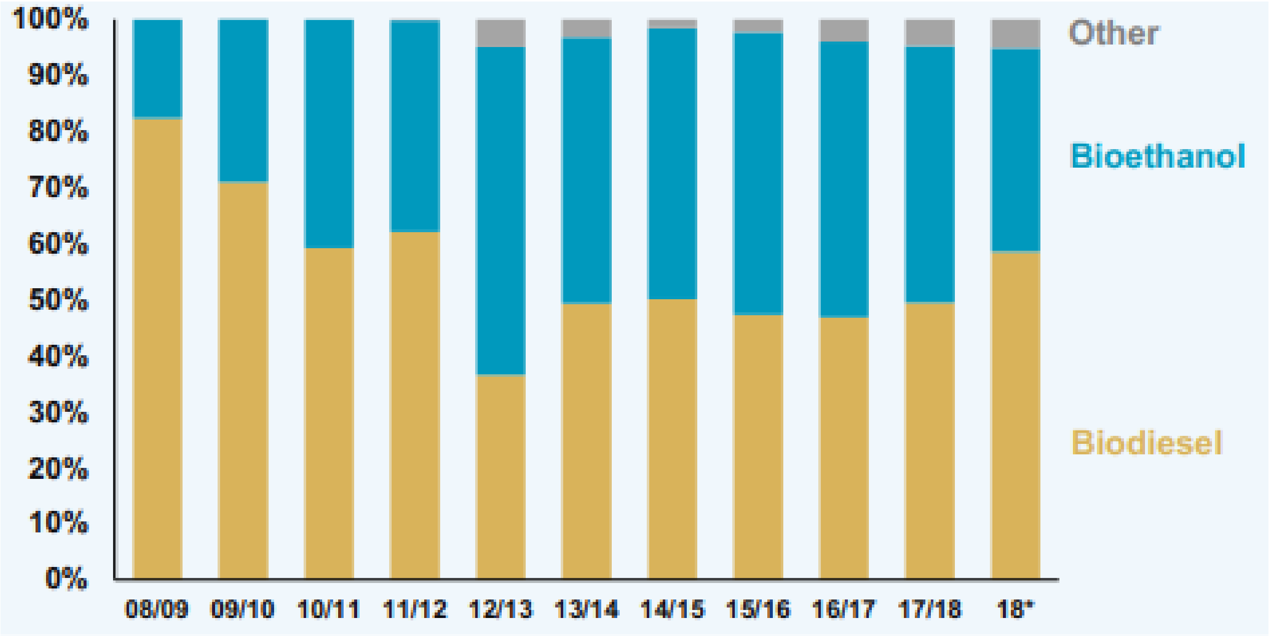
Top feedstocks

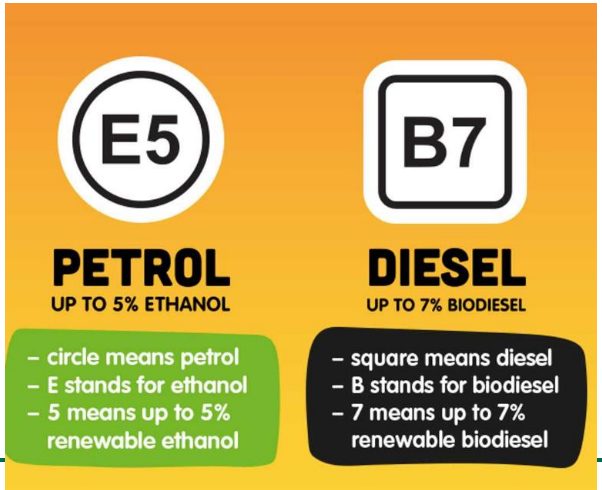
- UCO has been a dominant feedstock for a number of years
- Could say the feedstock mix is diversifying over time as targets increase
- In 2018 a total of 33 different feedstock types made up the renewable fuel supply (21 were wastes)



Top fuels

- Around 10 renewable fuels rewarded under the RTFO
- Bioethanol (31%) and biodiesel (61%) dominate the supply
- Bioethanol- currently blended up to 5%
- Biodiesel- currently blended up to 7%





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All Fuels

Third most commonly supplied fuel

Small but steadily growing supply

Chemically identical to diesel (also see biopetrol)

RFNBO Methanol

		Volume, million litres eq.[1]	
	Fuel Type	**Total**	**of total fuel supply**
Fossil fuels	Diesel	**21,064**	56%
	Low sulphur gas oil	**3,832**	10%
	MTBE (fossil portion)	**0**	0%
	Petrol	**11,512**	30%
	Total	**36,408**	**96%**
Renewable fuels	Biopetrol	**11**	0%
	Biodiesel FAME	**887**	2%
	Bioethanol	**552**	1%
	Biomethane [1,2]	**8**	0%
	Biomethanol	**24**	0%
	Biopropane[1]	**20**	0%
	Diesel (origin bio)	**4**	0%
	HVO	**2**	0%
	Methanol	**0**	0%
	Off road biodiesel	**11**	0%
	Total	**1,519**	**4%**
Total		**37,927**	**100%**

2018- Final Report

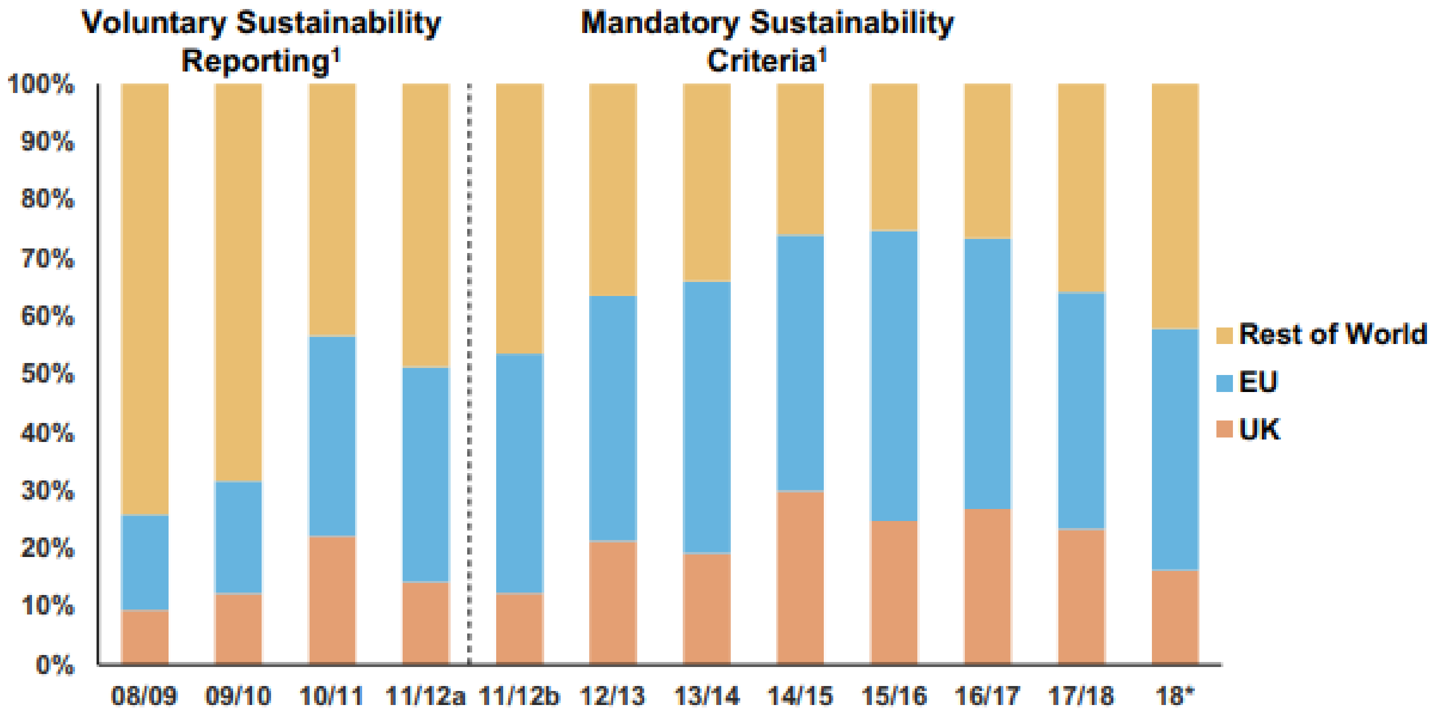
Department for Transport

Origin

- Import ~80%+ of renewable fuels

- In 2018 imported renewable fuels from 76 countries

- Current top 5 countries (2019 Report 4):
  - China (21%)
  - UK (12%)
  - USA (9%)
  - Spain (6%)
  - France (6%)



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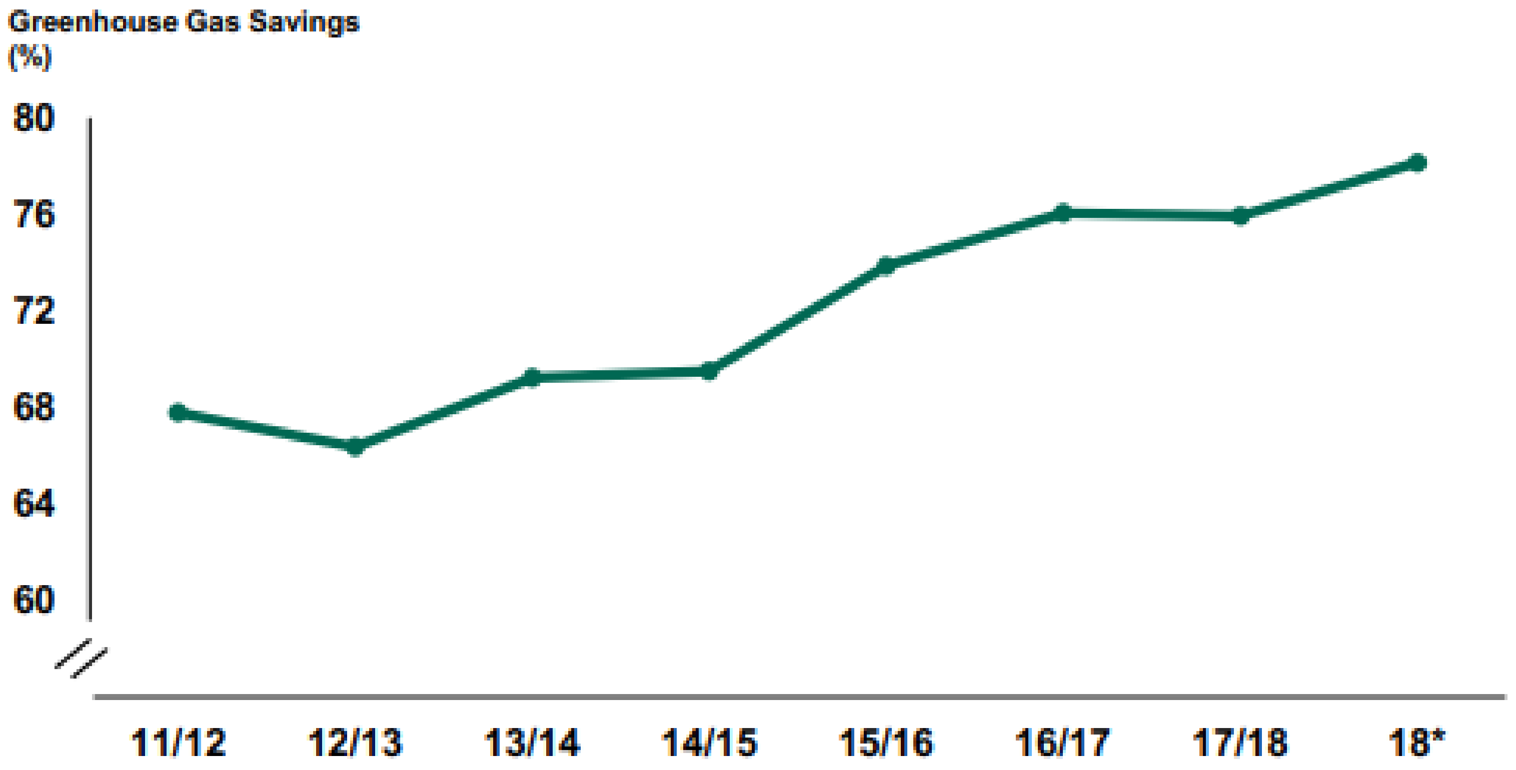
GHG Emission Savings

- Steady increase in GHG emissions over time
- GHG emissions savings reached 82% in 2019
- Started at 46% in 2008/09
- GHG emissions are compared with ‘fossil fuel comparator’
  - 83.8 g CO_2 eq./MJ
  - 94.1 in REDII



Regulation

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The RTFO: How we regulate it

- Any fuel supplier of more than 450,000 litres per obligation period must register an account with the RTFO- they automatically fall under the RTFO Obligation
- We regulate fuel suppliers – they must meet their RTFO obligation
- For their fossil fuel supplied they will need to redeem RTFCs for a given % fossil fuel
- We also regulate that any renewable fuel meets the sustainability criteria
- We provide a IT platform for applying for RTFCs and for trades of RTFCs

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The RTFO: How we regulate it

- The RTFO Unit gets around 1,000-2,000 consignments of fuel per month, covering ~300-400 million litres of fuel
- Consignments are for specific fuel-feedstock-country combination
- They must provide carbon intensity figure (CI) for their fuel and must meet GHG emission saving of 50 or 60% (depending on when plant started operation)
- All applications must be verified by third party independent verifier
- Validate volumes of fuel with fuel duty data from HMRC

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How we regulate it?

- When an RTFO Application is received they have to specify if they have used ‘**default**’ figures or ‘**actual**’ data to calculate the carbon intensity
- **Default figures -** provided by RED, based on typical studies.
- **Actual data**: means they’ve done their own calculations (seeing more of this)
- If we see actual data is declared: compare against default data and investigate if “odd”
- Always investigate
  - Where no voluntary scheme has been used
  - ‘High risk’ combinations e.g. palm from Malaysia at a high risk of land use change
  - New country/feedstock combinations
  - Random checks
- When we investigate we ask to see full Chain of Custody details

Next steps

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Next steps: RTFO

- Planned updates to RTFO
  - Introducing recycled carbon fuels: Fuels made from solid or liquid fossil wastes which cannot be re-used or recycled, or from waste fossil gases that are unavoidable
    - E.g. feedstocks could be municipal solid waste (fossil portion), end of life plastic, industrial flue gases
  - Looking at how we reward different types of renewable hydrogen
  - Changes to buy out
  - Update sustainability criteria to be consistent with REDII requirements
  - Consider changes to main obligation level

- Timing
  - Consultation in 2020
  - Implementation in 2021

Thank you for listening

- You are welcome to contact me on: Carly.Whittaker@dft.gov.uk

A community led approach to understanding decarbonised transport futures – Cross sector energy and propulsion roadmaps

Dr Penny Atkins

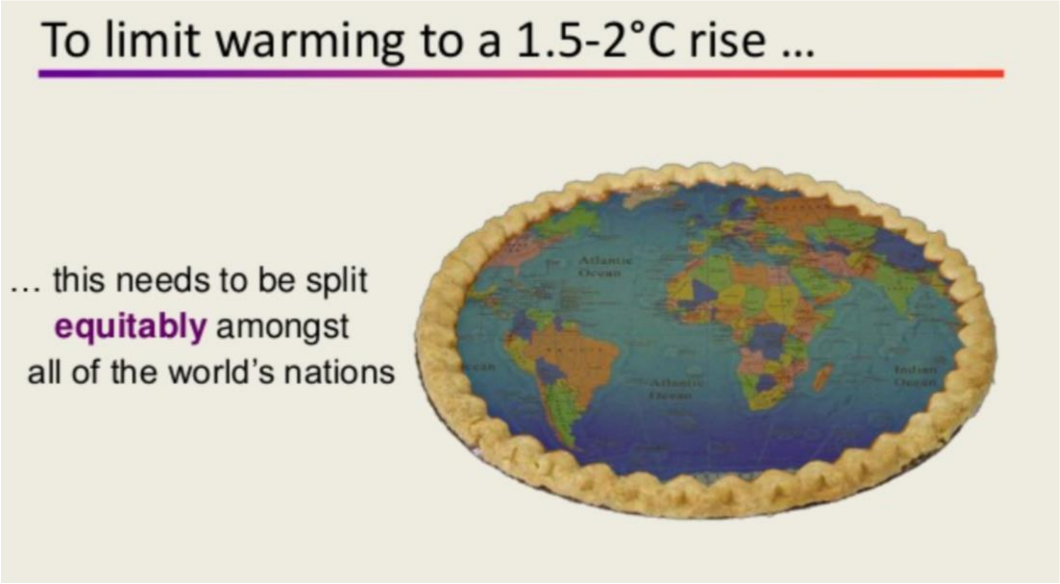
LowCVP Low Carbon Vehicle Partnership

ADVANCED PROPULSION CENTRE UK

University of Brighton
Advanced Engineering Centre

There is an urgent need to decarbonise transport rapidly to support hopes of restricting global warming to 1.5° – 2° C

- The UK needs to reach net zero GHG emissions by 2050
- The Tyndall Institute at Manchester University illustrates the urgency of near term carbon reduction

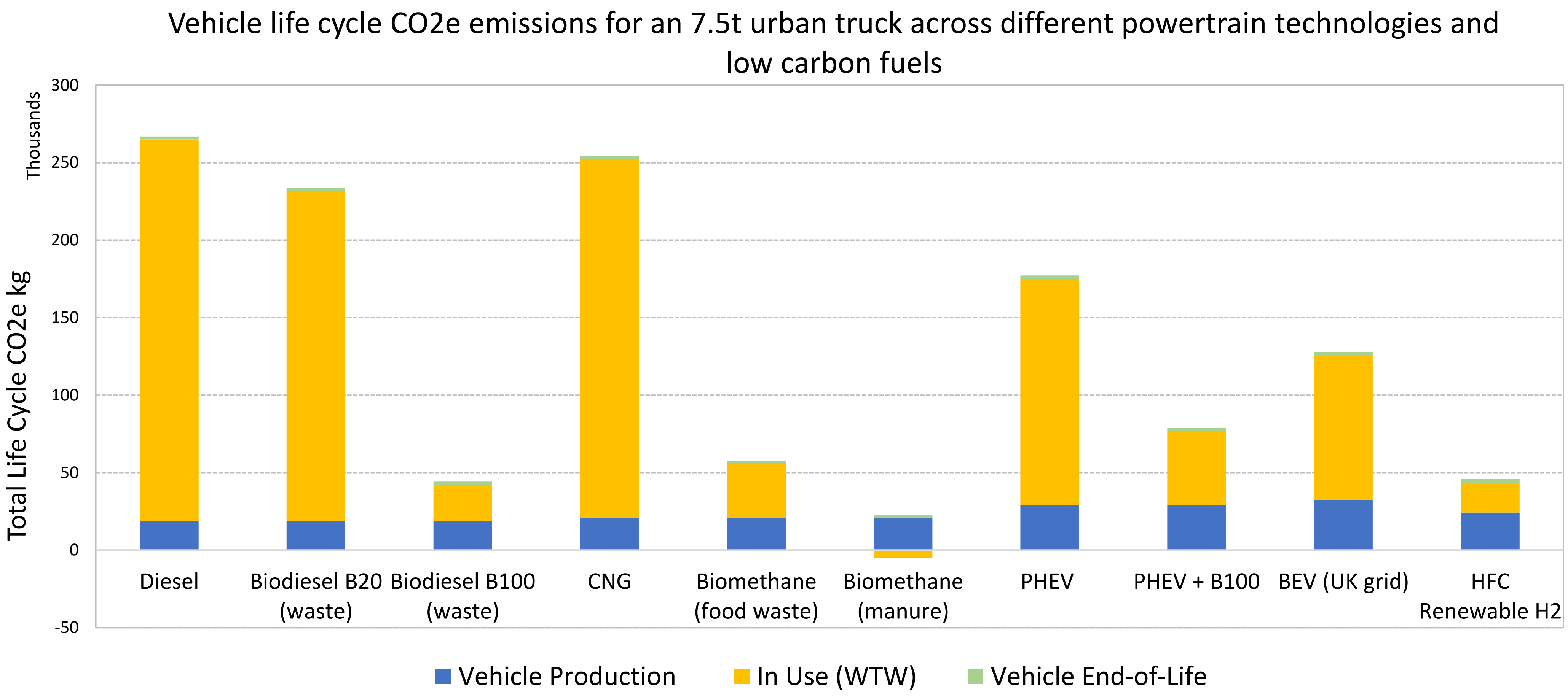


This means the UK needs to ramp up rapidly to a reduction rate of 13% per year

Splitting the global carbon budget equitably and calculating the UK's fair share gives < 9 years at our current rate of carbon emissions

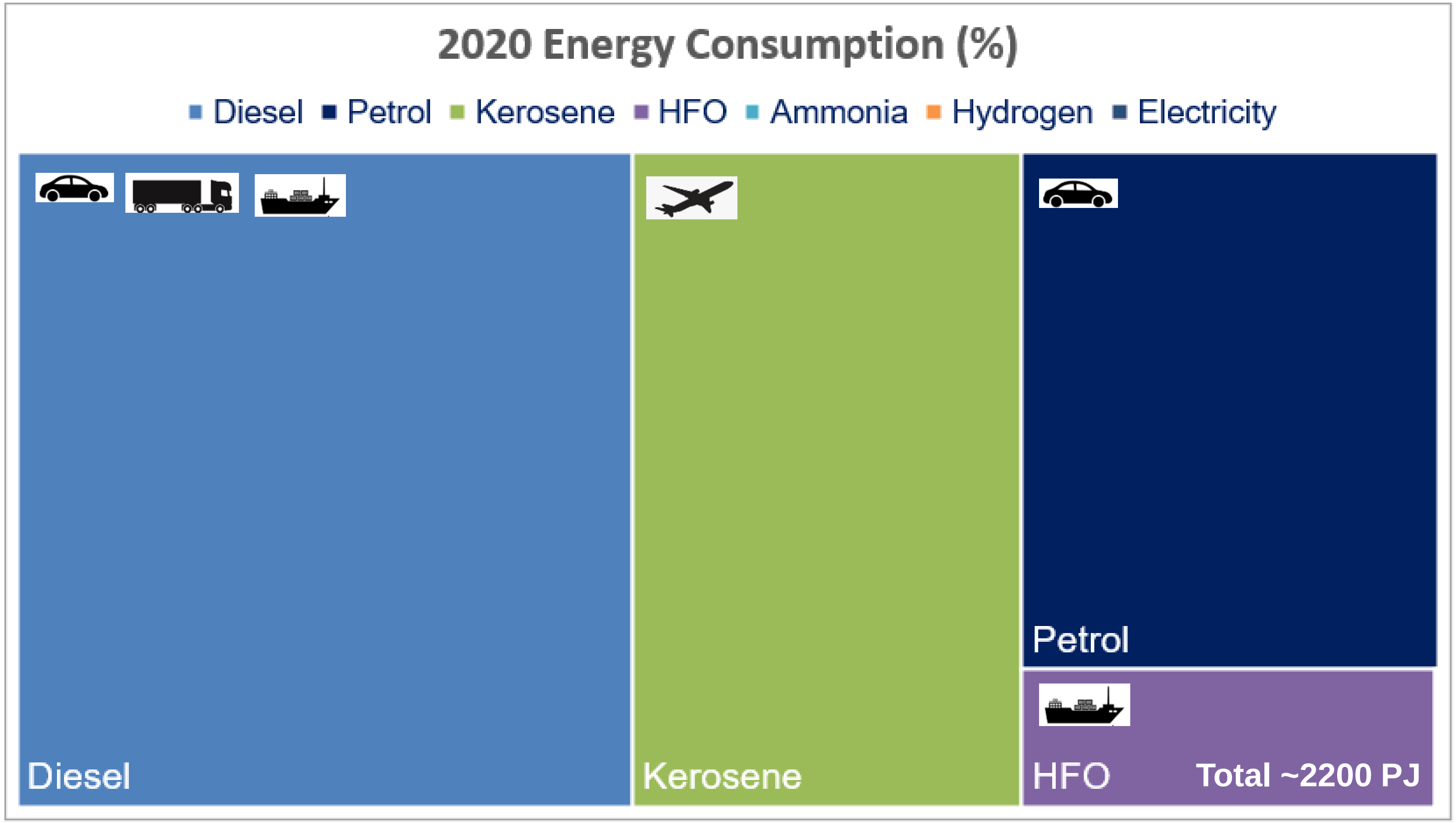
Picture source: https://www.slideshare.net/DecarboN8/aligning-uk-car-emissions-with-the-paris-agreement-152c, accessed 2.7.2020

Genuine GHG reductions are needed to influence climate change - considering emissions over the vehicle's lifecycle is essential as demonstrated by this data for a 7.5t truck



LowCVP in house life cycle GHG analysis tool, assumes vehicles are produced and operated in the UK today, Fossil fuel and electricity derives from BEIS GHG emission factors, Renewable fuels combination of RTFO statistics, RED default factors and LowCVP calculations

Analysis of current energy use in passenger car, heavy duty on road, marine and aviation shows the dominance of fossil fuels



In the UK the use sustainable fuels is limited:

- Road and non road machinery fuel – average 5.1% renewable fuels in 2019
- Electricity use in pass car is growing (4.3% share of car sales in May 2020), although vehicle parc penetration remains low (0.3% in 2019)
- Sustainable fuel use in marine and aviation is low, <0.5% of aviation fuel is sustainable currently

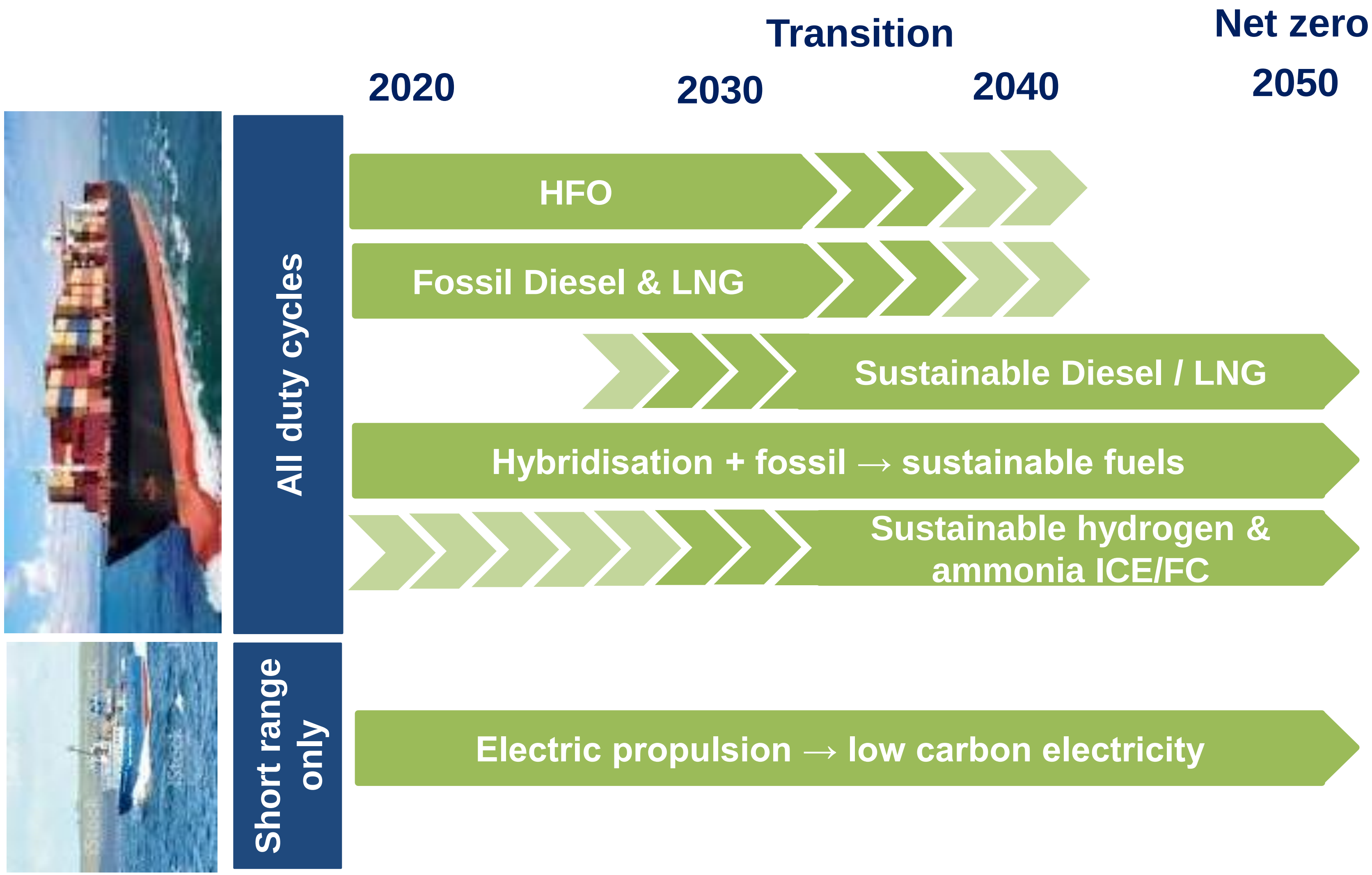
Sources: University of Brighton analysis, BEIS, SMMT, Sustainable Aviation

This presentation shows the high level roadmaps developed following Transport Energy Network workshops and a scenario for energy use in transport in 2050

- Transport Energy Network is hosted by University of Brighton as part of its APC spoke role, supported by APC and LowCVP
- The network aims to aims to accelerate transport decarbonisation by focusing on cross sector collaboration (eg targeted collaboration between communities such as fuels, powertrains and energy systems).
- Three workshops were run in a collaboration between University of Brighton, APC and LowCVP, they asked questions about scenarios for net zero transport in 2050 across all transport sectors
- These events were attended by a wide range of stakeholders:

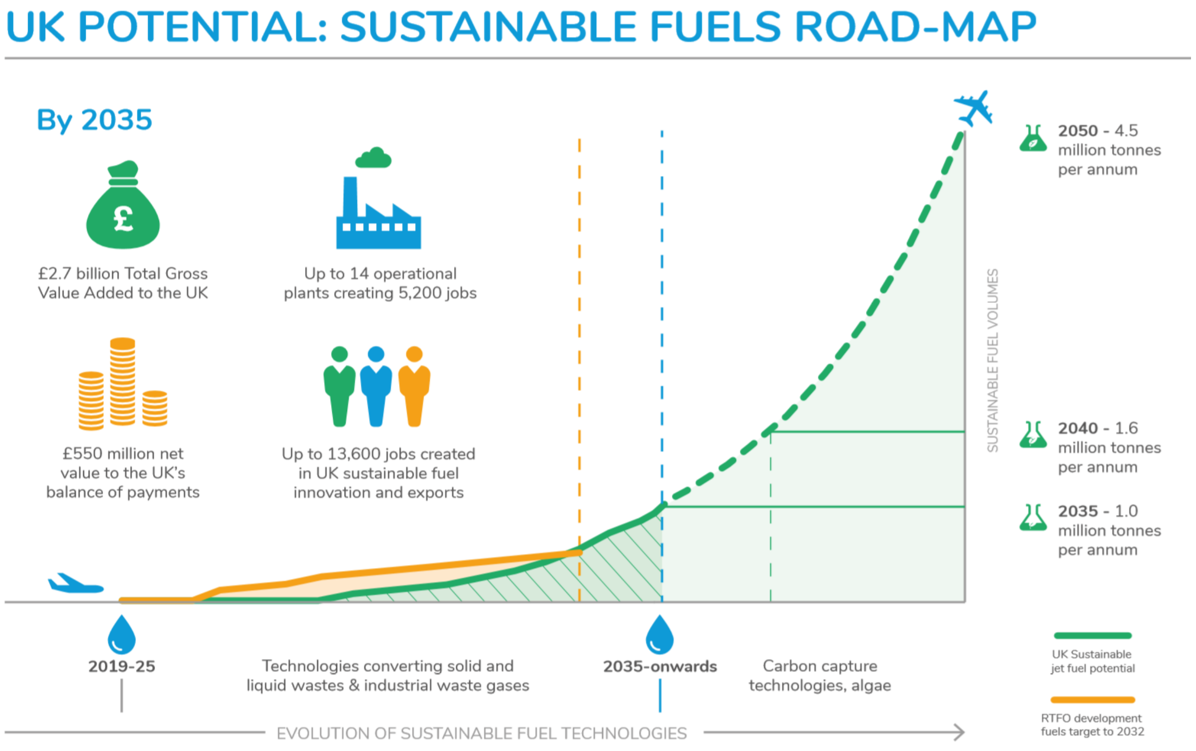
Ricardo, Newcastle University, Millbrook, EY, Manufacturing Technology Centre, Ford Motor Company, PES Ltd, SMMT, Jaguar Land Rover, WMG, Nissan Technical Centre Europe, Jonathan Lee, TfL, LowCVP, Coryton Advanced Fuels Limited, Benammann Ltd, Libertine FPE Ltd, Honda R&D UK, University of Cambridge, Lloyd's Register, Shell, ADBA, AVL, Brunel University London, Guthrie Consulting, TaBA Associates, Tata Motors European Technical Centre, University of Hertfordshire, MAHLE Powertrain Ltd, Faurecia Clean Mobility, Cosworth Limited, Steamology, SCE, School of Engineering - University of Warwick, Coventry University, Grayson Thermal Management Systems, Zenith Prototype Components Ltd, Delphi Technologies, Grainger & Worrall, Mechadyne / Rheinmetall Automotive, University of Birmingham, Caterpillar, Imperial College London, University College London, JCB Power Systems, Brunel University London, Supergen Bioenergy Hub, Johnson Matthey, APC, Autac Products, RS Clare & Co Ltd, JSI / Krempel Group, The Hartree Centre, Preston Technical Supplies, XAIN AG, Liverpool LEP, Forteq (UK) Limited, Chemicals Northwest, Teo Group, BCA Group, ETAS Ltd, Afirmotive Ltd, Hylomar Ltd, Irish Pressings, Mergon International, Melo Word Ltd, University of Sussex, Roadgas, Univesity of Nottingham, University of Bath, Nissan, Loughborough University, Mahle Powertrain Ltd, Energy Systems Catapult, Shell Global Solutions, KTN, Low CVP, The Litus Foundation, Ford Motor Company, Brighton & Hove Bus and Coach Company Limited, Oxford Brookes University, University of Kent, UK Petroleum Industry Association, JouleVert Ltd, David Lemon Consultants, REA, C J Day Associates, University of Birmingham, Flexible Power Systems, Intelligent Energy, Department for Transport, University of Surrey, BEIS, IAAPS University of Bath, Aerospace Technology Institute, Cox Powertrain, INNOVATE UK, F1 Manufacturing, E4tech, NatWest, Knibb Gormezano Limited, Scania, KTN, FTI Consulting, CPI

In the marine sector, Transport Energy Network stakeholders envisaged a range of future energy vectors, depending on duty cycle



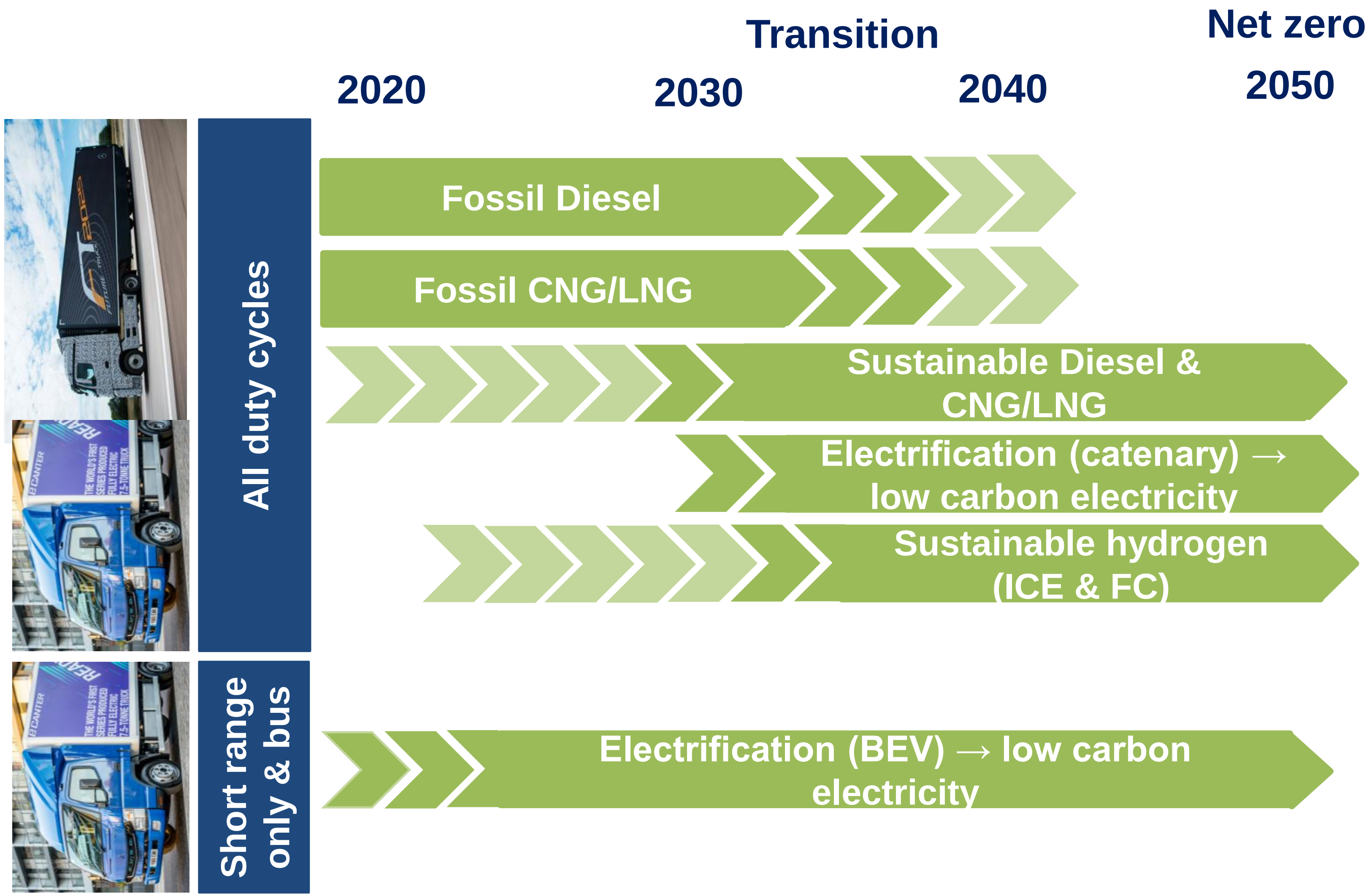
For aviation, sustainable kerosene is considered to be vital to decarbonisation, alongside increasing electrification

- Sustainable Aviation's recent report shows an increasing role for sustainable fuels
- Their scenarios indicated potential for UK produced sustainable aviation fuel to meet 32% of UK demand for kerosene in 2050 (4.5 Million tonnes of sustainable fuel pa)

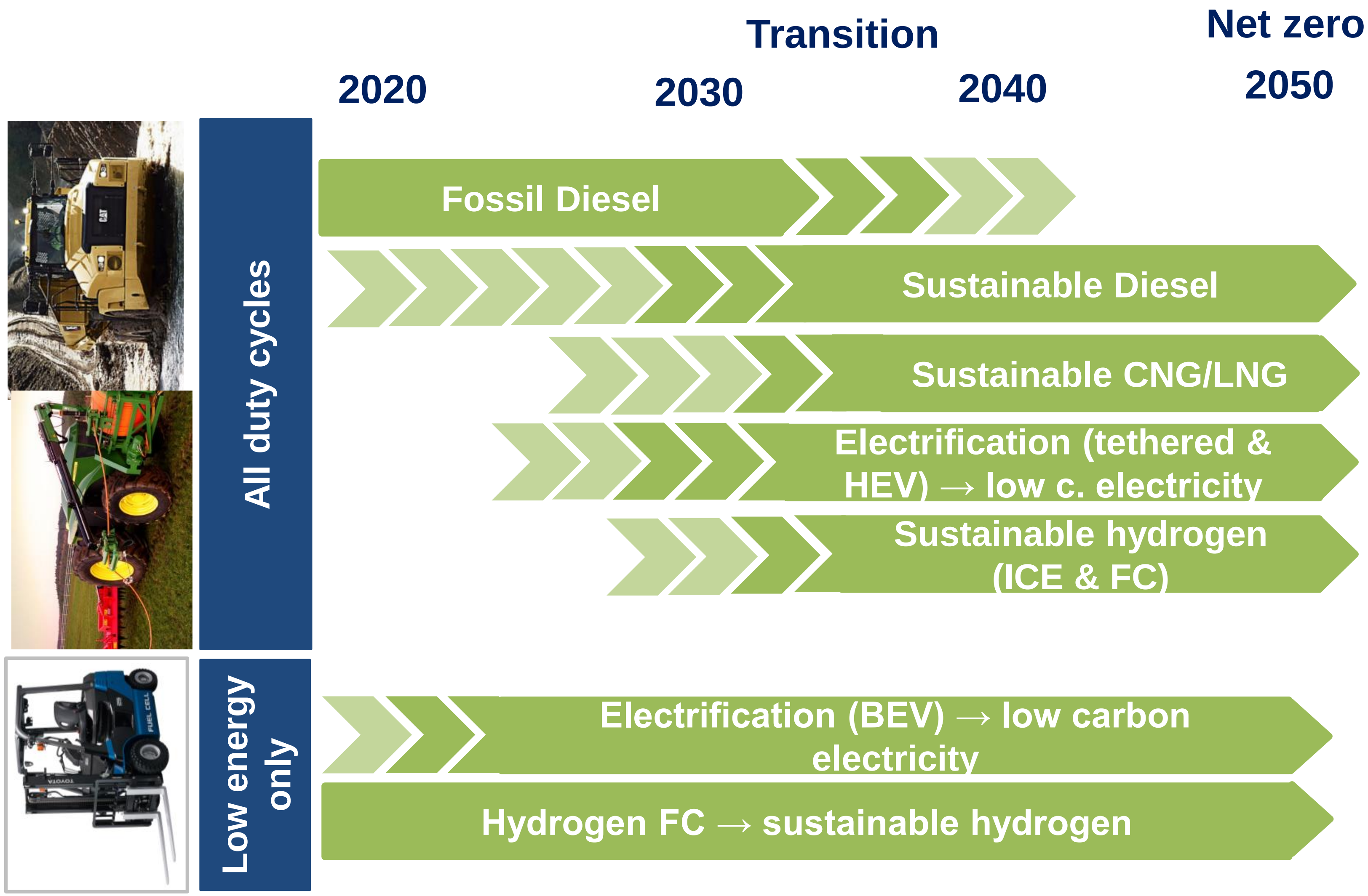


Source: 'Sustainable aviation fuels roadmaps, fuelling the future of aviation', Sustainable Aviation,

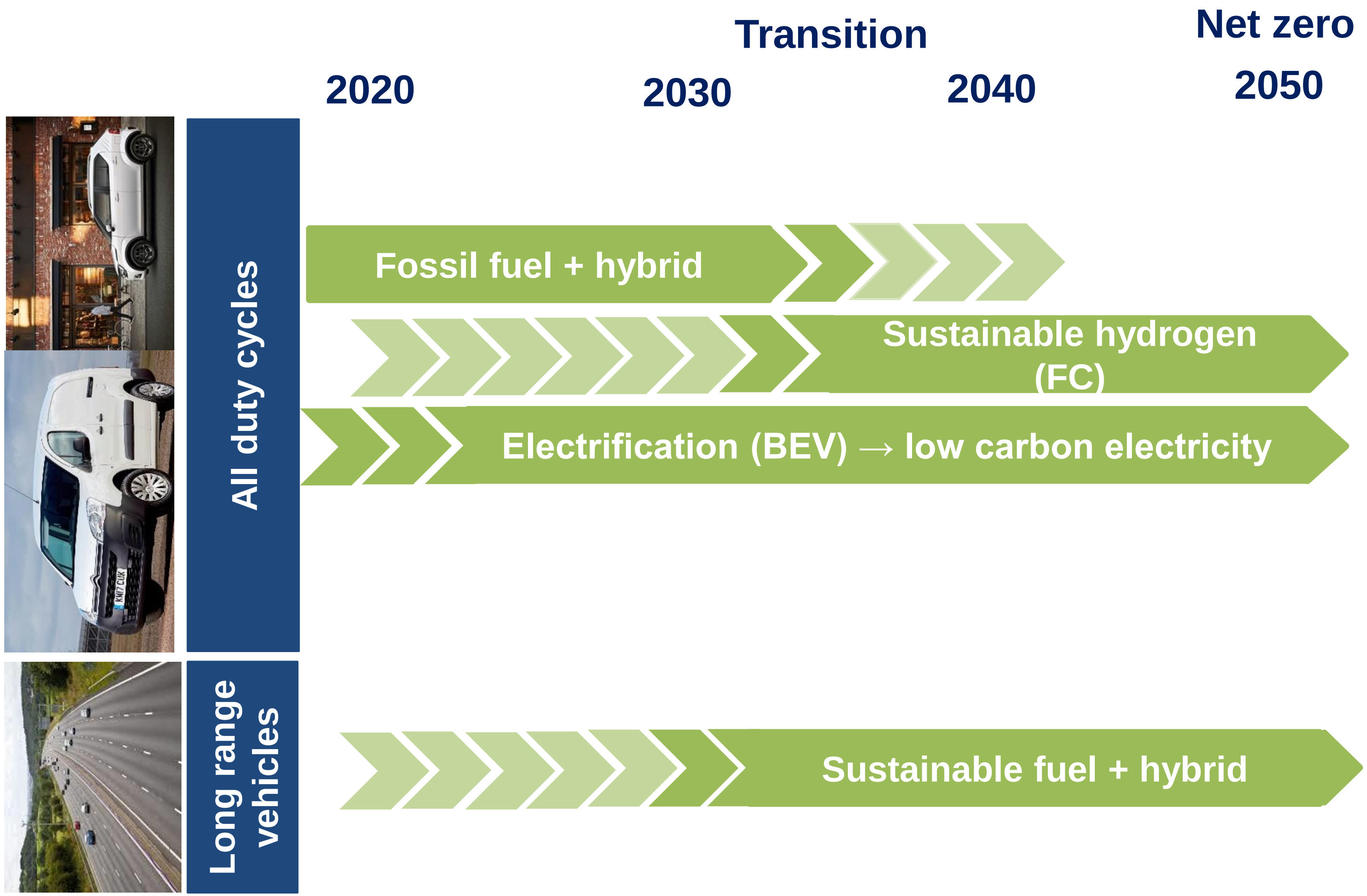
For Heavy Duty on highway applications, TEN stakeholders see sustainable liquid and gaseous fuels as part of a portfolio of solutions



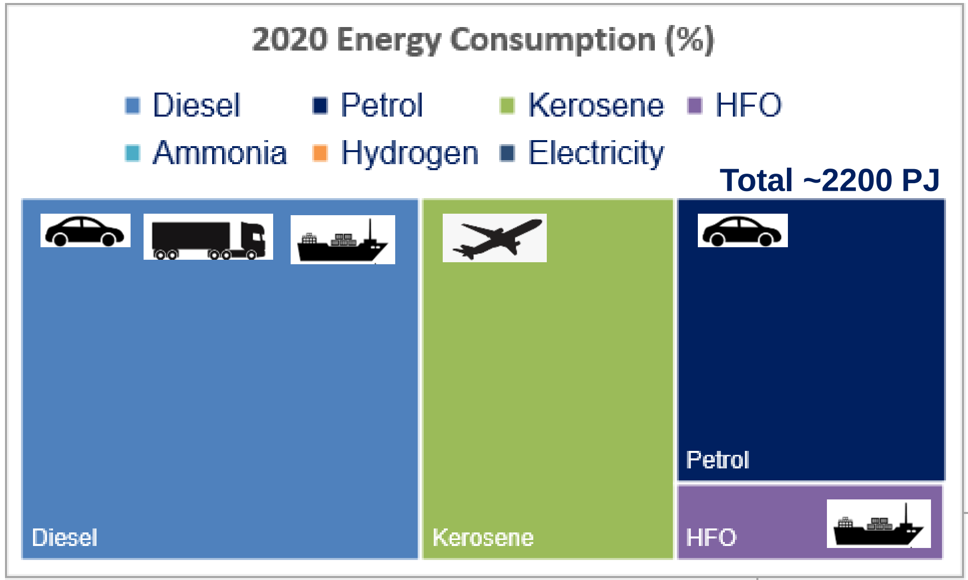
For off highway applications, electrical power could be supplied by a battery or by via a cable for high energy operations with limited movement



For light duty applications, zero tailpipe emissions solutions were expected to dominate in urban applications, with potential for sustainable fuels for long range duty cycles

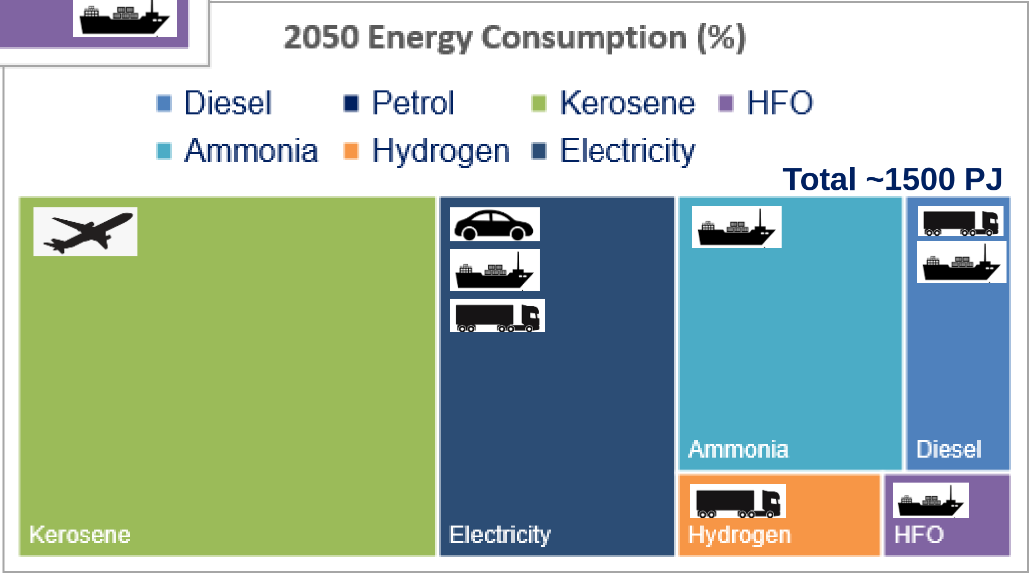


The stakeholder generated scenario for tank to motion energy usage shows the importance of sustainable fuels across marine, aviation and HD on road sectors in 2050

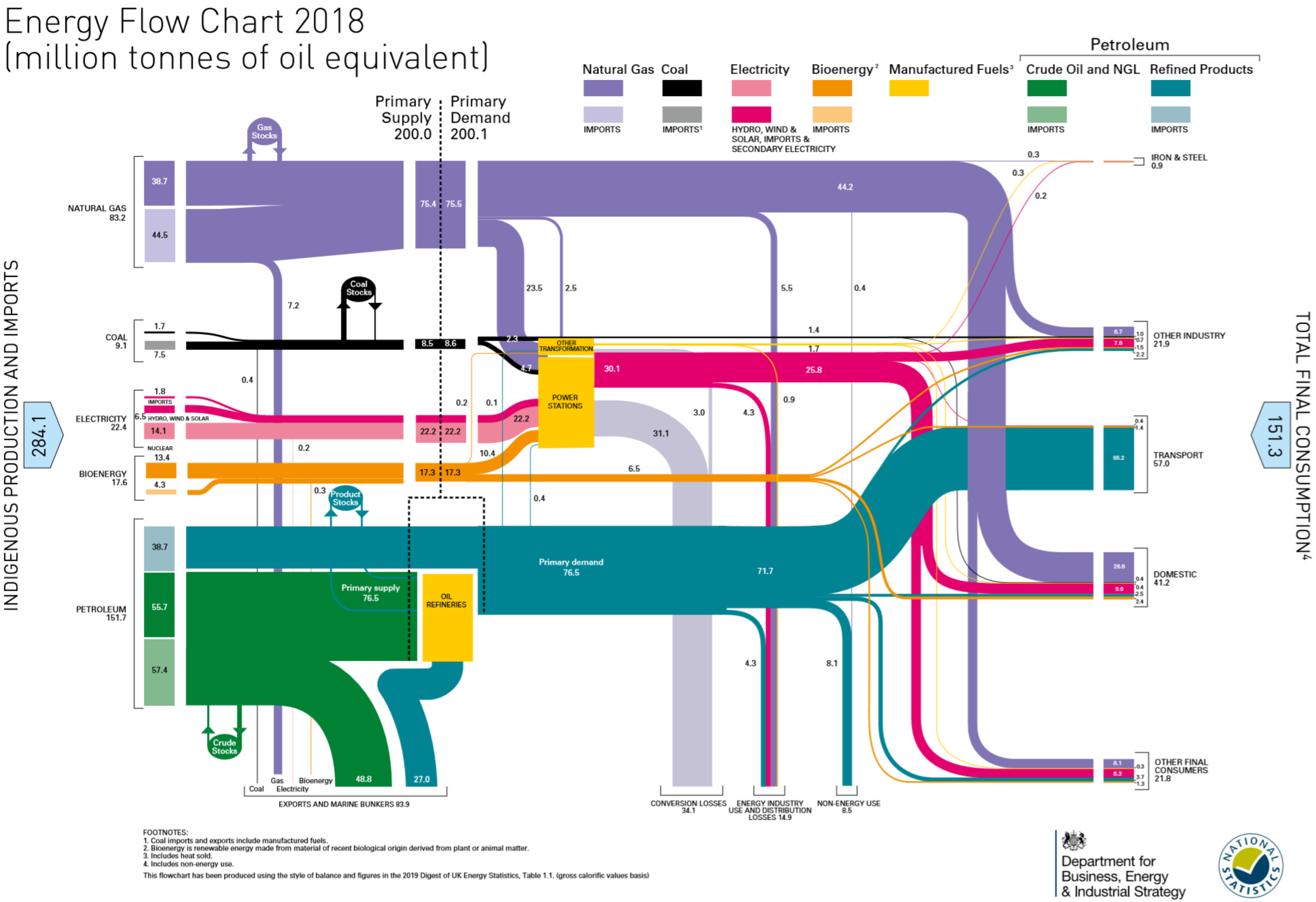


- Graphics show energy use by fuel for a scenario generated by TEN participants
- Diversification of fuel vectors is expected to meet carbon targets and sector needs
- To reach net zero, fossil fuels need to be replaced by an increasing proportion of sustainable fuels
- Other fuels, such as methane, could play a role in future transport although their current contribution is relatively small

- Estimates for tank to motion annual energy consumption were derived from sector specific references (see previous slides) and stakeholder input
- HFO in 2050 is made up of small quantities of HFO with the remainder low sulphur fuel oil, diesel includes marine diesel
- The role of electricity in aviation is unclear currently, so not included



Transport will compete with other sectors (industry, energy supply, business, residential) for sustainable energy vectors – how do we build supply volumes and prioritise use?



Picture source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818151/Energy_Flow_Chart_2018.pdf, accessed 1.7.20

Energy density is key for mobile applications, alongside commercial requirements, market acceptance, safety, air quality impacts, powertrain compatibility …….

Thanks for your attention

Transport Energy Network will be running consultations on cross sector R&D needs, sign up at https://www.apcuk.co.uk/planning-future-automotive/spokes/transport-energy-network/

Dr Penny Atkins (p.a.atkins@brighton.ac.uk)

LowCVP Low Carbon Vehicle Partnership

ADVANCED PROPULSION CENTRE UK

University of Brighton
Advanced Engineering Centre

Sustainability, feedstock and fuel

A whistlestop tour of why sustainability assessment is non-trivial!

Dr Chris Malins

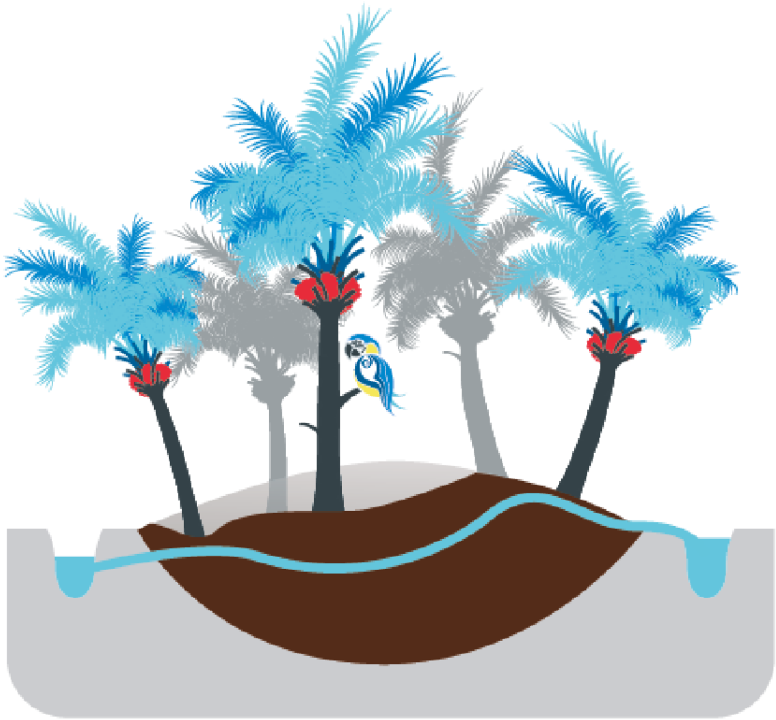
Cerulogy

LowCVP Low Carbon Vehicle Partnership

ADVANCED PROPULSION CENTRE UK

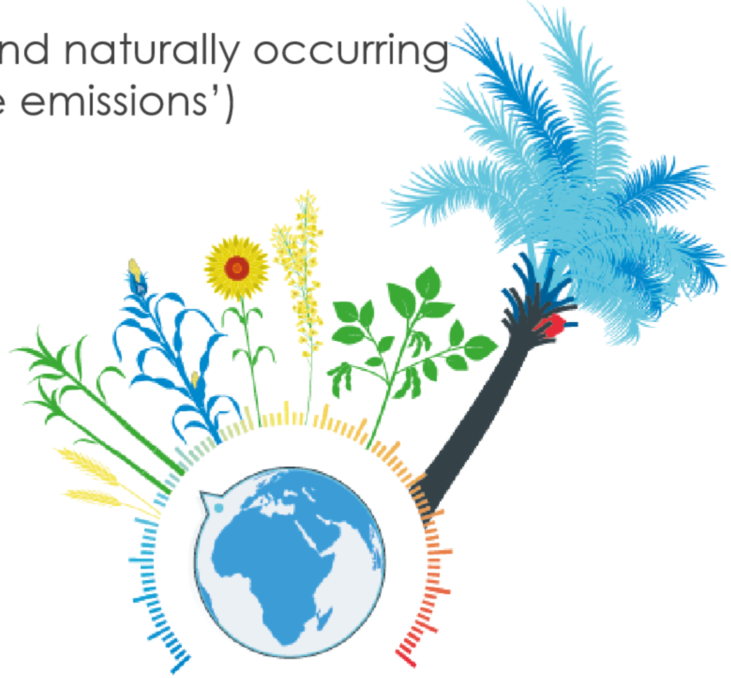
Different types of feedstock materials bring different issues

- Feedstock (the opportunities):
  - Farmed food crops (first generation biofuels)
  - Farmed biomass (second generation biofuels)
  - By-product materials with other uses
  - Residues with limited use
  - Wastes with no use
  - Fossil wastes (e.g. plastic, synthetic rubber)
  - Energy-carrying flue gases (carbon monoxide, hydrogen)
- Issues (the challenges):
  - Land requirements
  - Impact on other markets
  - Lifecycle analysis (LCA) methodology choices
  - Uncertainty and variability in the assessment
  - Non-climate concerns: biodiversity, water use, waste disposal, air pollution, impact on other prices and on livelihoods



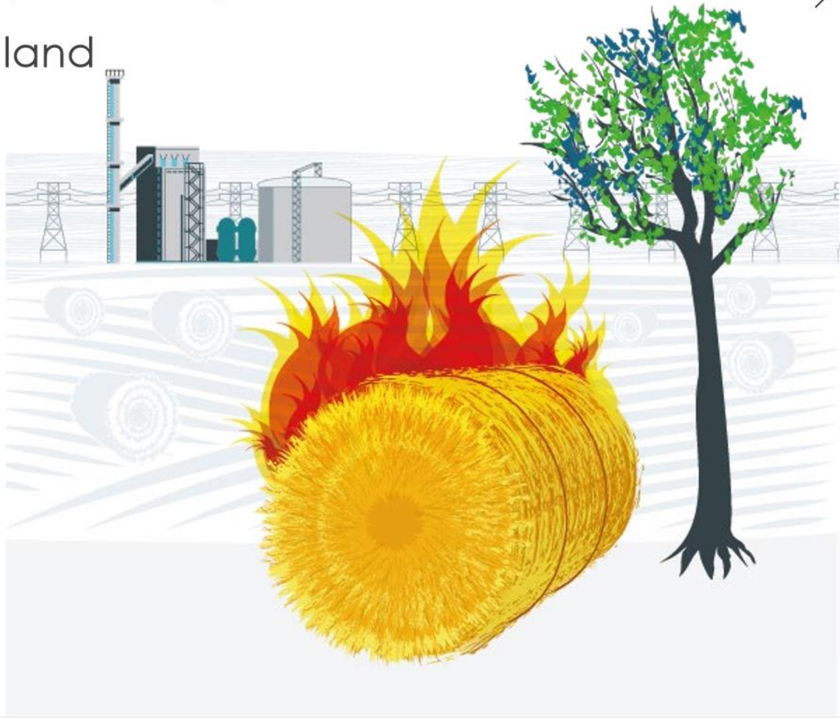
Farmed crops for first generation fuels

- Generally come from the same type of production systems as food
  - Ergo can compete with food production
  - Modern farming tends to exert a high environmental burden
  - Where farmed area expands carbon stored in soils and naturally occurring biomass are generally lost (‘indirect land use change emissions’)
  - Often produce more than one output
    (e.g. biofuel feedstock and animal feed)



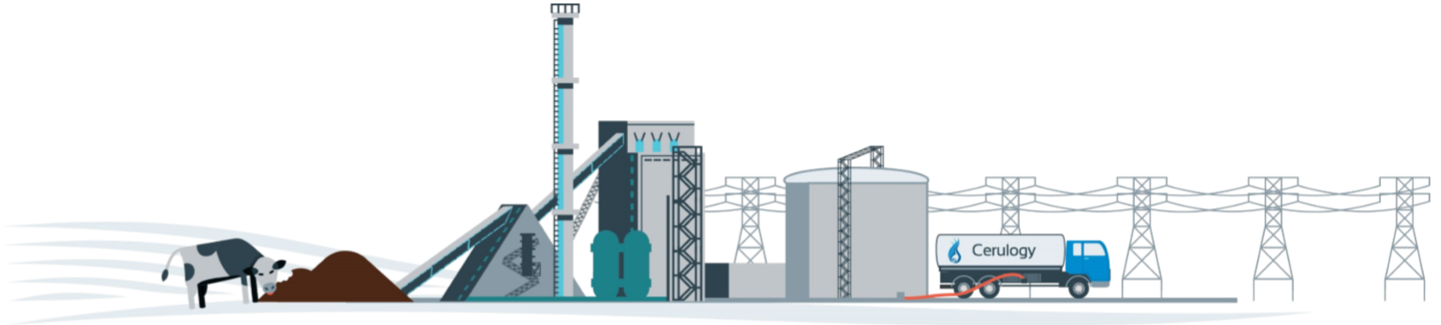
Farmed biomass for second generation fuels

- Production systems may have a different character than food crops
  - More likely to use plants that grow over several years (perennial) rather than annual crops
  - May require lower input intensity (fertiliser, water, pesticides)
  - May support more carbon accumulation on the land
  - May grow on less productive land
- But systems could also compete with food systems



By-products with existing uses

- Many materials that are not the main target of production still have significant value, e.g.:
  - Inputs for chemicals industries
  - Animal feed
  - Existing use for energy
- Using policy to pull these materials into biofuel production affects the existing industries
  - Potential for ‘indirect emissions’ (materials must be replaced)
  - Is there a good reason to prefer use as transport fuel to use elsewhere?

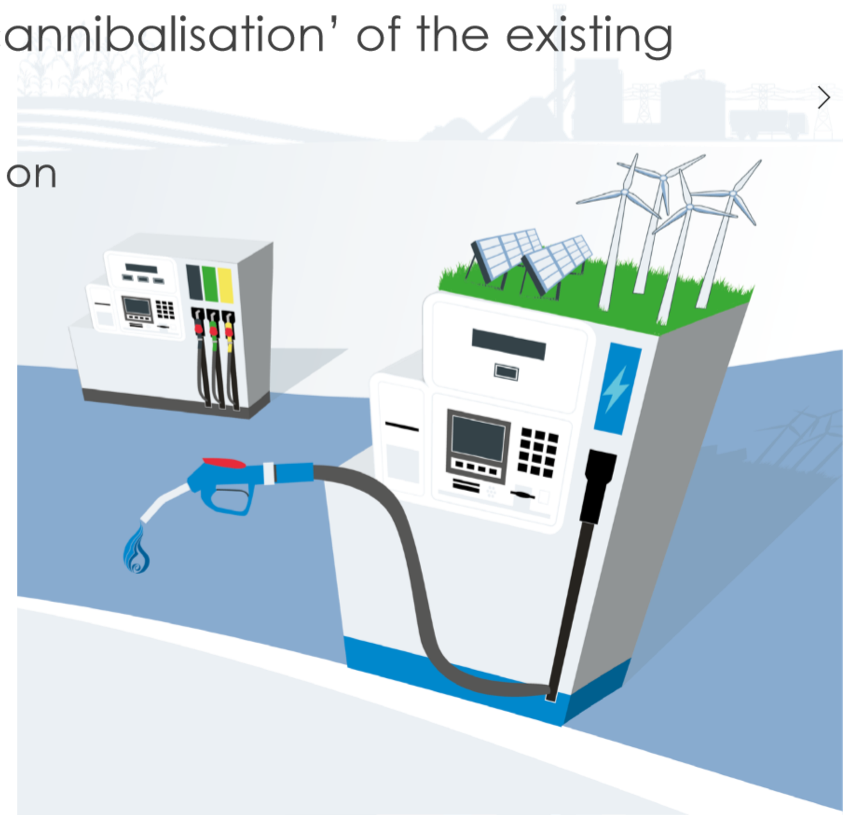


'Recycled carbon' fuels

- Turn residual fossil energy into transport fuel
- Is fossil carbon being released that would otherwise be stored (e.g. in landfill)
  - Is there a net CO_2 emission reduction?
- May replace existing energy recovery systems
  - Does the overall efficiency of fossil energy recovery/use increase?

Electrofuels *[powerfuels/e-fuels/RF(O)NBOs]*

- Synthesis of transport fuels from electrolytic hydrogen
- Avoids sustainability issues related to agricultural expansion
- The main regulatory challenge is preventing ‘cannibalisation’ of the existing renewable energy supply
  - The climate benefit of electrofuels is dependent on additional renewable electricity generation



Setting LCA rules

- Regulatory LCA requires balancing:
  - Complexity – how simple is it for operators to apply the rules?
  - Consistency – can comparable rules be applied across the board?
  - Data availability – is information available to do the prescribed calculations?
  - Relevance – do we get a good characterisation of the real emissions impact?
- There is generally no such thing as the single 'correct' LCA answer
- Different types of LCA can answer different questions
  - The answer to "how much energy was used in producing this material?" may not be the same as the answer to "how much more energy does the world use now that we produce this material?"
- If the balance is wrong:
  - Analytical burden inhibits project investment
  - Fail to give meaningful characterisation of environmental performance

Recap

- Alternative fuel production systems are not created equal…
- …but lifecycle analysis does not give a single 'correct' answer
  - Two valid methodologies could give completely different answers if set up to answer different questions
  - Uncertainty runs through the analytical system
- 'Indirect' or 'displacement' effects can dominate net emissions
- Some of the most promising technologies are particularly difficult to regulate
- Simplifications made to support business can contribute to bad outcomes and regulatory uncertainty
- Interactions between policies can be crucial

Thanks! Questions?

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LOW CARBON HYDROGEN LCA IMPLICATIONS

Ben Madden

LowCVP Low Carbon Vehicle Partnership

ADVANCED PROPULSION CENTRE UK

UKH2MOBILITY

elementenergy

Lots of excitement is building around hydrogen as a fuel

Leaked: EU hydrogen strategy eyes €140 billion turnover by 2030

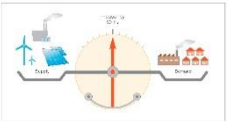
The European Commission has sent the European Green Deal on its way and a preliminary version of its anticipated hydrogen strategy has been leaked. The plan does not lack ambition, as the EU seeks to assert tech leadership in green hydrogen through coordinated efforts across the value chain.

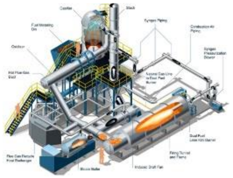
JUNE 19, 2020 MARIAN WILLUHN

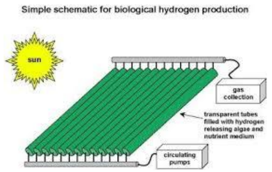
FINANCE | HYDROGEN | MARKETS | MARKETS & POLICY | POLICY | AUSTRALIA | CANADA | EUROPE | JAPAN

One of the advantages of hydrogen is the range of potential sources with low carbon footprints

A range of production options can lead to low carbon hydrogen







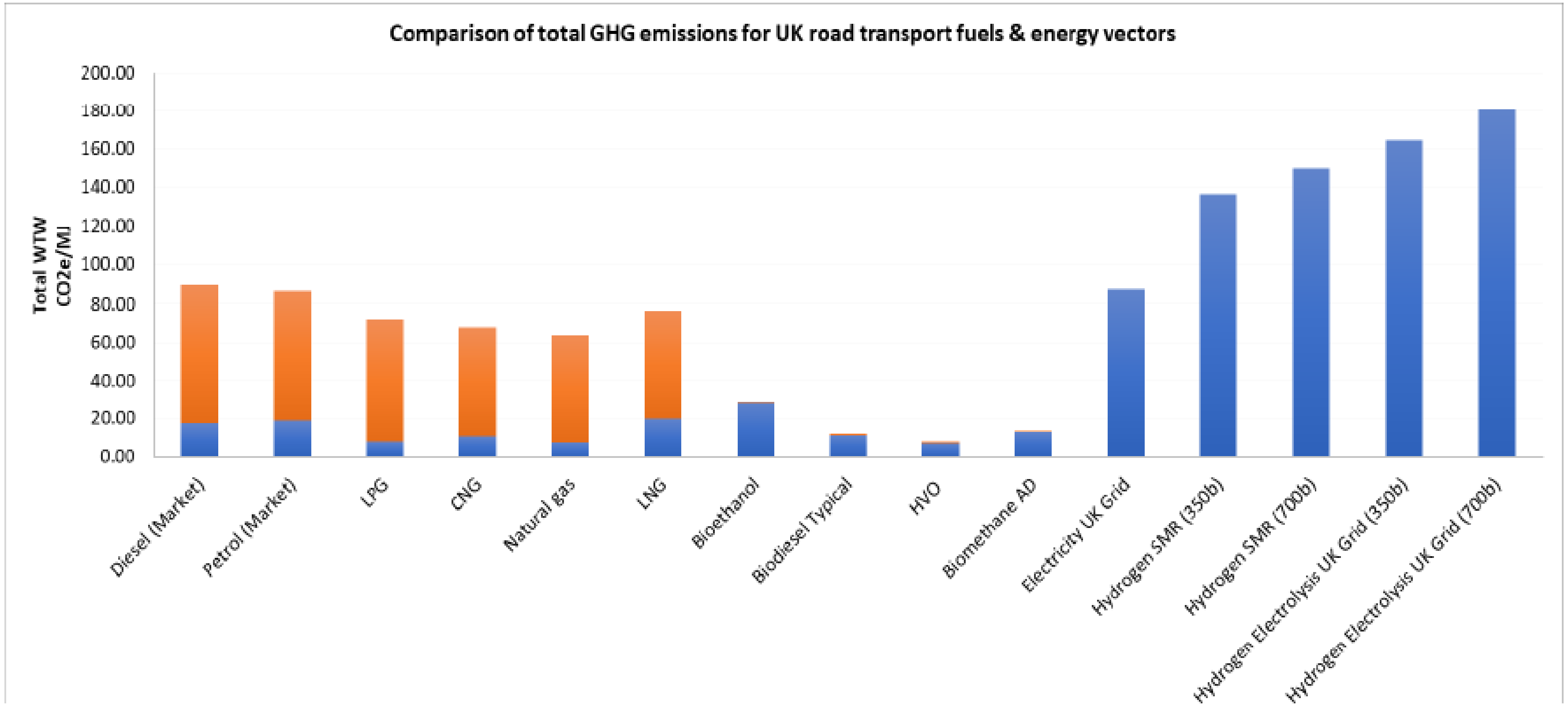
- Electrolytic production at the point of electricity production
- Electrolytic production close to the point of demand
- Production from biomass or waste
- Production from any hydrocarbon linked to carbon capture and storage
- Spare refinery or industrial capacity –often have spare capacity for hydrogen – can be cleaned and used for energy applications

Other green options are being developed, but remain at the lab scale and include:

- Photochemical
- Biological processes (light and dark reactions)
- High temperature thermo-chemical cycles (nuclear or solar)

Unfortunately, much of the debate around hydrogen still focusses on the high CO_2 incumbent "brown" sources

A recent example:



This is not consistent with developments in the hydrogen sector and risks affecting policy decisions

In reality, any successful hydrogen transport deployment will lead either to "green" hydrogen deployment……..

- A small selection of projects which have been announced.
- These are all coupled to large wind schemes.
- Offshore hydrogen is also receiving increased attention
- Major energy companies are now investing

ENERGY MAY 7, 2020 / 2:29 PM / 11 DAYS AGO

Shell has bid in Dutch wind tender, eyes Rotterdam hydrogen plant

1 MIN READ

AMSTERDAM, May 7 (Reuters) - Shell Netherlands said on Thursday it bid in a tender last week to build a 760 MW wind farm off the Dutch coast, and it hopes to couple it with a large new hydrogen plant it would build in Rotterdam.

Share Tweet Like 5

Düsseldorf, 19 July 2019

Uniper and its partners plan a large facility to produce and store green hydrogen in Saxony-Anhalt

- Review by Federal Ministry for Economic Affairs and Energy clears its initial hurdle
- Plans for an electrolysis facility generating up to 35 megawatts
- World's first cavern storage facility for green hydrogen
- Wind power can be stored as hydrogen providing for greater economic predictability

Tractebel unveil new offshore hydrogen platform

By Yoana Cholteeva

SHARE

Tractebel's offshore platform. Source: Tractebel

BP backs green hydrogen project in Germany

GET H2 initiative is upgrading the grid in Lower Saxony for production, storage and transport of the zero-carbon gas

18 March 2020 Other News [Image: APAC Hydrogen Association]

Shell unveils world's largest offshore wind plan to power green hydrogen

Oil giant links with Gasunie for NortH2 initiative off Netherlands that aims to have 10GW of turbines in place by 2040

We are seeing similar activity in the UK

- Numerous wind developers now see hydrogen as a key route to enabling the development of renewables
- We receive a call a week from UK wind developers stuck due to constraints of the UK electricity market and/or grid.
- This is a manifestation of **the energy system challenges** associated with relying on very large quantities of intermittent energy
- Hydrogen can help fix these:
  - An inherent energy store
  - Offers alternative markets (HD transport, industry etc)

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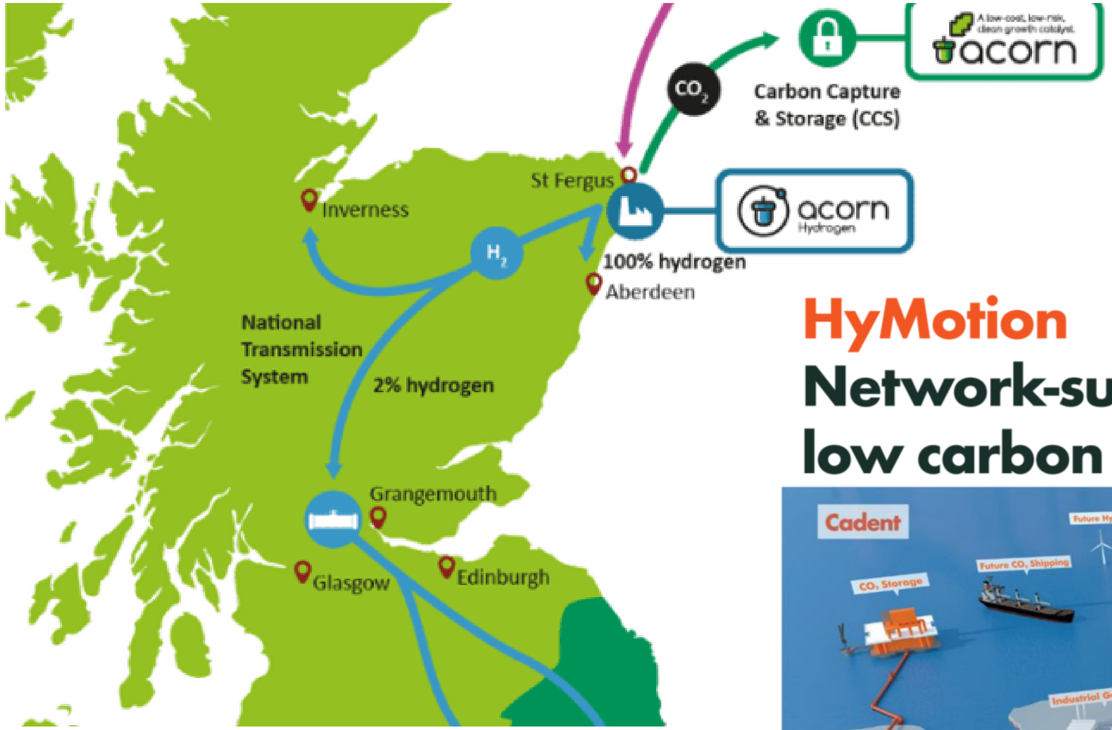
Industrial scale renewable hydrogen project advances to next phase

18.02.2020 11:03

GBP 7.5 million funding secured for phase two of Gigastack, which is to demonstrate low-cost, zero-carbon hydrogen in the UK to industrial scale. Project consortium includes ITM Power, Ørsted, Phillips 66 Limited and Element Energy.

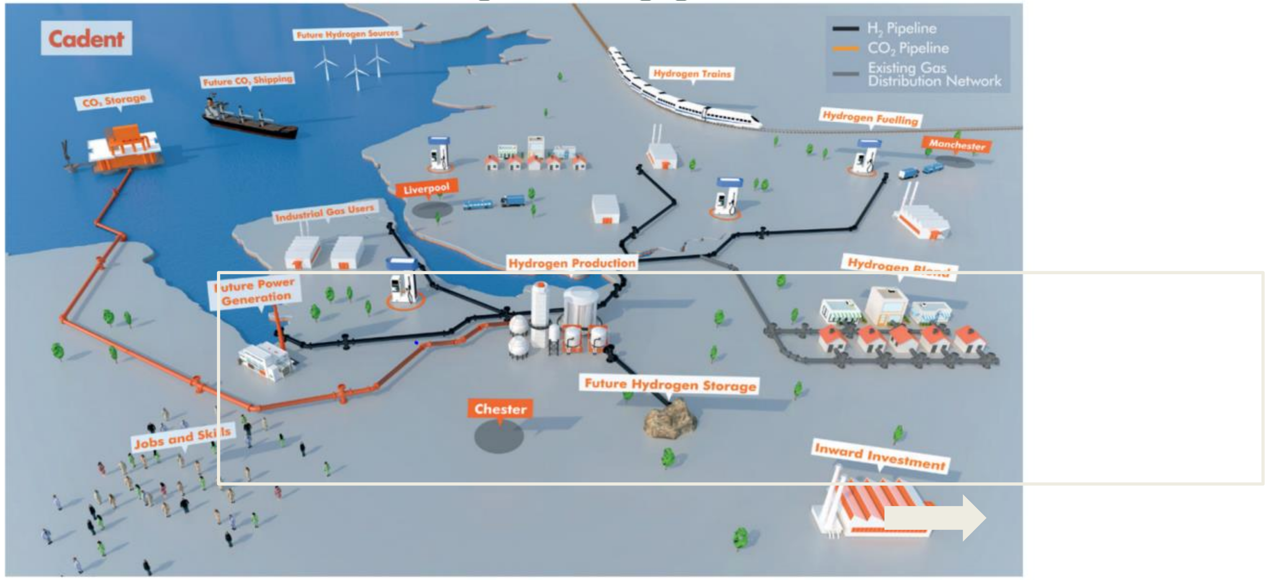
…… or blue hydrogen from hydrocarbons with carbon capture



acorn Hydrogen

HyMotion

Network-supplied hydrogen unlocks low carbon transport opportunities



The HyNet project produces low cost, low carbon hydrogen that is distributed via a new pipeline network to decarbonise heat, power and transport.

Defining and assuring these new hydrogen plant's CO_2 credentials creates a number of issues

Challenges around green hydrogen LCA

- Medium term energy systems aspects not recognised
- Additionality of renewable electricity:
    - Direct connections
    - Constrained power
    - "New" renewables
- Enable grid transmission (REGOs and PPAs)

Challenges for Blue Hydrogen

- Capture rates
- Upstream emissions

Methodological developments are coming through schemes such as:

- Renewable Energy Directive II (RED II)
- CertifHy (European project)
- Impact of RFNBO's in the Renewable Transport Fuel Obligation

In summary

- **Hydrogen as a fuel is now emerging as a serious prospect**, with major investment behind new large scale plant
- Any transport sector success will lead to **new production plant** – this will only be built in an ultra-low carbon fashion
- It is likely these new hydrogen projects will actively stimulate new low carbon primary energy sources (renewables, CCS)
- Existing assumptions and norms around the CO_2 footprint of hydrogen need to updated to reflect this reality
- There are complicated challenges to be worked through to develop a complete certification approach for thee new plants
- **An agreed framework accepted by the entire UK environmental community is needed**