







Options and recommendations to meet the RED transport target

Final report

Study commissioned by the LowCVP

29/05/2014

Author
Element Energy Limited

Disclaimer

While the authors consider that the data and opinions contained in this report are sound, all parties must rely upon their own skill and judgement when using it. The authors do not make any representation or warranty, expressed or implied, as to the accuracy or completeness of the report.

Acknowledgments

The authors would like to thank all the industry stakeholders who took part in the consultation, and the members of the Steering Group, who provided valuable peer-review of the analysis.

Authors

Celine Cluzel, Principal Consultant

celine.cluzel@element-energy.co.uk

Sara de la Serna, Consultant

sara.delaserna@element-energy.co.uk

Reviewer

Alex Stewart, Associate Director

alex.stewart@element-energy.co.uk

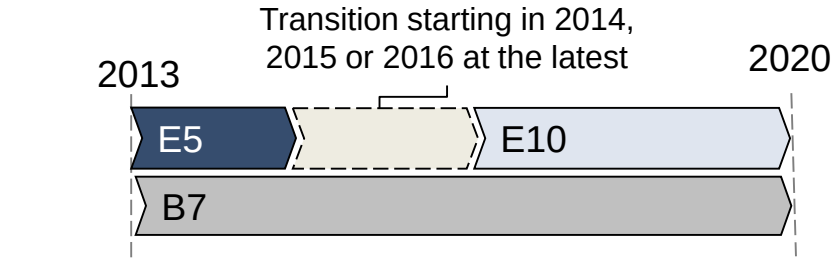
Executive summary

- The LowCVP commissioned this study in order to bring clarity over the UK options to meet the Renewable Energy Directive (RED) 2020 transport target (minimum 10% renewable energy), and it will provide evidence for the Department for Transport's current review of the UK biofuel policy framework
- Element Energy investigated four strategies to reach the 10% target through a model able to simulate different levels of uptake of various fuels and energy vectors. Model inputs were validated by an industry stakeholder consultation
- The four investigated strategies are:
  - **NO NEW BLENDS**: no blends higher than E10 and B7, and relying on double counting fuels
  - **DEPOT FOCUS**: E10, B7 and high biodiesel blends for trucks and buses refuelling at depots
  - **NEW FORECOURT BLENDS**: bring higher blends to the forecourts (E20 and/or B10 and/or E85)
  - **COMBINATION:** new higher blends at both depots and forecourts
- For each approach, one RED scenario was derived based on analysis of cost effectiveness and respecting defined constraints. This results in four RED scenarios that differ in their reliance on feedstock/fuel availability, sensitivities to accounting rules and implementation challenges
- **In all cases, the implied uptake of new blends/vehicles and/or supply of double counting suggest an ambitious implementation program and incentives will be necessary.** Industry consultees highlighted the risk of such a support framework not being developed in time to meet the 2020 target
- In all cases, **the supply of double counting fuels (FAME/HVO from waste oils, Ethanol 2G, Biomass To Liquid diesel) is critical**

Executive summary

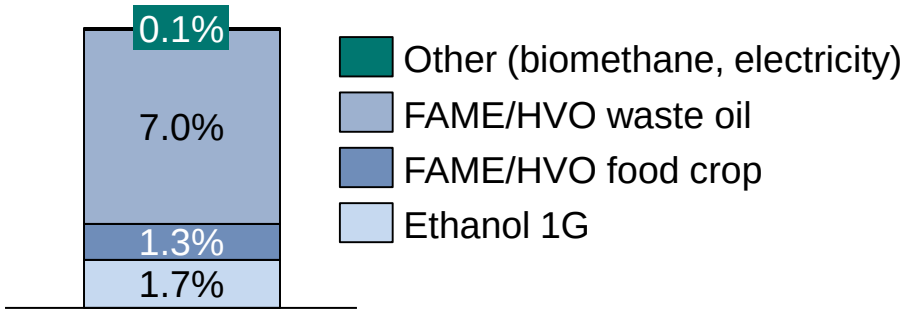
- The emerging conclusion from modelling and industry consultation is that the **E10&B7 scenario** ('No new blend' approach) **is the most probable case,** despite the implied critical role of waste oils & fats (mainly Used Cooking Oil today)
- There is a disconnect between some of the options and efforts needed to reach the RED target and the criteria for a UK fuel roadmap beyond 2020. The suggested role post-2020 for fuels made from non-food crops, with low Indirect Land Use Change risk, indicates support should be put in place even if their role will be limited before 2020 as the current production capacity is still modest
- The emerging recommendations for the UK to reach the RED target are to:
  - Roll out E10 and increase the biodiesel blending up to the existing B7 specification
  - Maximise the use of double counting fuels that do not use food crop feedstock; this implies a high reliance on Used Cooking Oil and other waste fats, as fuels based on other feedstock will still be in limited supply by 2020
  - Despite the limited role of drop-in fuels for the 2020 target, a supporting framework should be put in place, as they offer a better prospect to decrease emissions than current biofuels in the long term

E10&B7 scenario overview



Key supply assumptions: UCO FAME/HVO: no supply cap; No BTL, no E2G

Contribution to RED target in 2020 – E10&B7 case



Structure of the report

1. Introduction
Introduction to the RED target and associated challenges associated and report objectives

2. Scope and approach
Powertrain and fuels in scope, modelling approach, main outputs and stakeholder consultation contribution

3. Fuel pathways
Assumptions regarding supply caps, costs and WTW GHG emission savings of biofuels

4. RED scenarios
Approach to RED scenario design, presentation of four alternative RED scenarios to reach the target and comparison of their outputs, barriers and challenges for their implementation and presentation of the most probable and recommended RED scenario

5. Recommendations
Actions and next steps for the implementation of the recommended RED strategy

6. References and acronyms

Technical Appendices are provided in a separate document, published along this report.

Introduction and objectives of the study

- The Renewable Energy Directive (RED) sets a target of 20% of the EU energy to come from renewable sources by 2020, with a sub-target for the transport sector: **at least 10% of the final energy consumption in transport must come from renewable sources**
- Meeting this target is challenging, given that coordinated changes and actions will need to be undertaken among a wide range of stakeholders (i.e. vehicle manufacturers, refiners, fuel distributors and retailers; consumers), driven by changes in the policy framework specific to each Member State that ensure long term certainty
- At the UK level, a clear strategy has not yet been developed, as the current mechanism, the Renewable Transport Fuel Obligation (RTFO), sets the target at ~5% biofuel blending by volume. There are some longer term policy measures in place, but they are not directly relevant to the RED target (e.g. support for electric vehicles and related infrastructure)
- The LowCVP commissioned this study in order to bring clarity over the UK options to meet the RED transport target by the **analysis of 'RED scenarios': levels of uptake of different fuels and energy vectors that would allow the UK to meet the RED transport target,** in the most cost effective way for consumers and avoiding 'lock in' effect in a strategy not compatible with the UK longer term vision for transport
- The analysis aims to provide a clear comparison of options, their associated costs and challenges, and make recommendations for delivery of the most adequate scenario. It will provide evidence for DfT's current review of the UK biofuel policy framework

1. Introduction

2. Scope and approach

3. Fuel pathways

4. RED scenarios

5. Recommendations

6. References and Acronyms

A. Powertrain and blends across vehicle class
B. Biofuels scope
C. Model, degrees of freedom, baseline
D. Outputs and related rules
E. Industry consultation

A. Vehicles and powertrains in scope for 2020 horizon

- The transport modes in scope for the study are road vehicles (cars, vans, Heavy Goods Vehicles and buses) and Non Road Mobile Machinery (NRMM)[1]. Aviation transport is not covered in this study. The table below shows the modelled powertrains per vehicle class.
- Gas vehicles are modelled only through a dedicated Internal Combustion Engine (ICE) powertrain. Industry stakeholders see the uptake potential of dual fuel gas vehicles as very limited, because the EURO 6 specification will severely restrict the supply of these vehicles.
- **Two powertrain pathways are proposed: a 'Base' and a 'HighAFV' case**, where there is a greater uptake of alternative powertrains (hybrid, PHEV and BEV for cars and vans; hybrid and dedicated gas for HGVs). Powertrain pathways are detailed in Appendix C

Modelled powertrains per vehicle class

	Cars	Vans (up to 3.5t GW)	HGVs (>3.5t GW)	Buses	NRMMs
Spark Ignition (SI) ICE					
Compression Ignition (CI) ICE					
Dedicated Gas ICE					
Hybrid ICE (SI)					
PHEV/REEV (SI)					
Battery EV (BEV)					

1- NRMM (Non Road Mobile Machinery) case, presented in Appendix B
BEV = Battery Electric Vehicle ; PHEV = Plug-in Hybrid Electric Vehicle; REEV = Range Extended Electric Vehicle

A. Fuels and fuel blends considered in RED scenarios 2/2

Modelled fuels or blends per vehicle class

	Cars	Vans	HGVs	Buses	NRMMs
E5 and E10					
E20					
E85					
B5 and B7[1]					
B10					
B30					
B100					
Biomethane			Dedicated	Dedicated	
Electricity					

- **Drop in diesel,** that can be blended in diesel at higher blend rates (within supply constraints) is also modelled
- The potential of bio-methanol, an oxygenate already blended in gasoline, is commented on in Appendix K
- Excluded from modelling as their contribution to 2020 RED targets would not be significant (but part of the existing or longer term UK transport mix):
  - **LPG / bio LPG,** the overall small share of LPG vehicles is <1% of the car and van fleet[2].
  - **Hydrogen.** UK H_2Mobility results indicate sales of 10,000s H_2 Fuel Cell vehicles by 2020, representing <0.1% of the 2020 fleet

1- B2 and B5 for NRMMs

2- 160,000 cars and vans currently on the road. Source: UKLPG

B. Biofuels in scope

Biofuels modelled

- Biofuels currently supplied are considered: **Ethanol 1G**, **FAME** (from food crops and non food crops feedstock), **biomethane**
- More advanced biofuels not yet supplied in the UK (or in marginal quantities) are also considered for the 2020 timeframe: **Ethanol 2G** (made from cellulosic feedstock) and **drop-in diesel**, namely Biomass To Liquid (BTL) and Hydrotreated Vegetable Oil (HVO)

The case of HVO

- FAME feedstock can be used to make HVO. Therefore, to avoid double counting of feedstock, only FAME is modelled while the share of FAME that could be HVO instead is a post-process calculation
- HVO can also be made from non-food FAME feedstock such as microbial, microalgae and tall oils. The supply prospect for this type of HVO is however very limited by 2020[1]
- Based on the current and announced plant capacity, projections of future roll out and competition from the aviation sector, the projected supply of HVO for the EU road transport sector in 2020 is 117 PJ (2.8 Mtoe)[1], from which 15 PJ (~450 Ml)[2] could be available for UK

Fuels excluded from the 2020 modelling timeframe

- Butanol and drop-in gasoline fuels are not considered for the 2020 timeframe as they are in early stage of demonstration compared to other new generation fuels that are in early stage of commercialisation such as HVO, BTL or Ethanol 2G

1- E4tech, 2013. 'An harmonised Auto-Fuel biofuel roadmap for the EU to 2030'. 2 - The UK 'fair share' is assumed to be 13%, this is the % of UK transport fuel consumption at EU level as per (ECN, 2011).

B. Biofuels categorisation used in the modelling 2/2

- The categorisation shown below is in line with RED sustainability criteria and accounting rules. The accounting column shows the factor used to calculate the energy contribution of a given fuel
- The feedstock shown below are as per the RTFO reports or RTFO guidance in the case of fuels not yet supplied to the UK market

Biofuel type	Feedstock	Accounting
Ethanol 1G	Barley, corn, sugar beet, sugar cane, wheat	1
Ethanol 2G	Agricultural residues (e.g. bagasse, cobs, straw, husks, nut shells, low grade starch slurry), forestry residues, non-food cellulosic and ligno-cellulosic material (miscanthus, Short Rotation Coppice)	2
FAME* food crop	Oilseed rape, palm, soy	1
FAME* waste oil	Used cooking oil (UCO), tallow category 1, brown grease, palm oil mill effluent, spent bleached earth	2
BTL	Wood energy crops, agricultural residues, municipal waste	2
Biomethane	Biogas / waste (e.g. Municipal Organic Waste)	2

*Same feedstock could be used to make HVO, as presented in the previous slide

Electricity is counted 2.5 times (efficiency factor), the share of renewable electricity is used to calculate electricity coming from renewable energy

C. Overview of the model developed by Element Energy for the study of the 2020 RED target

Fuel database 2013-2020

	p/MJ	WTW g/MJ	Supply cap MJ	RED accounting
Fuel 1				
Fuel 2				
…				

Powertrain uptake pathways
New vehicle compatibility rules

RED scenarios

Vehicles cost and MJ/km

Fleet size and km travelled

Existing stock

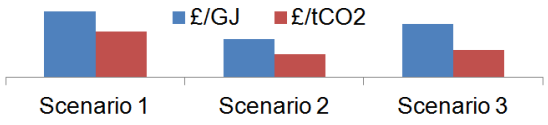
Fleet model

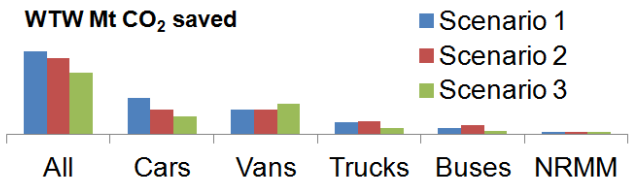
Biofuels use PJ
%PJ renewable

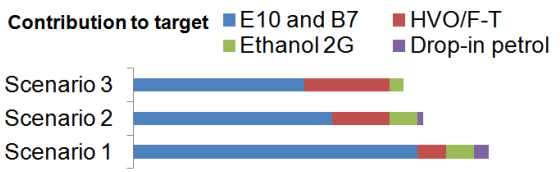
Check supply caps not exceeded and RED target met

OUTPUTS

ILLUSTRATIVE







C. Degrees of freedom for RED scenario design

- A RED scenario is a combination of:

  - **A fuel pathway**, composed of the following biofuel characteristics:
    - Cost [Low – Base – High]
    - Supply cap for E2G, BTL [High – Stretch] and UCO FAME/HVO [cap or no]
    - WTW emissions [Low – Base – High]
  - A set of **powertrain pathways**
    - 'Base' for cars, vans, HGVs and buses; or
    - 'High AFV' for cars, vans and HGVs. Under this pathway, there is a greater uptake of alternative powertrains (HEV, PHEV and BEV for cars and vans; HEV and dedicated gas for HGVs)
  - A **level of uptake of high blends** (B30, B100) and gas vehicles among depot refuelling fleets (HVGs and buses)
  - A choice of introduction dates for **new blends at the forecourts/new vehicles**: E10, E20, E85 and B10

For a more detailed description of powertrain pathways, see Appendix C

C. Baseline scenario and 2020 energy demand

Baseline modelling assumptions

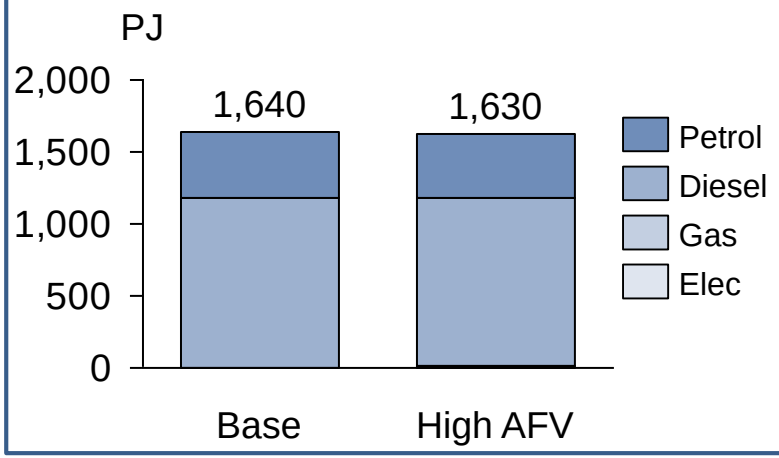
- E5 and B5 from 2014, constant to 2020 (B0 for NRMM).
- WTW GHG savings of biofuels starting at today's performance (see table), varying according defined pathways for ethanol 1G and biodiesel (blend of FAME crop and FAME non crop).

Current blends (RTFO Apr2012-13)

	%(vol.) biofuels	Average biofuels WTW savings
Petrol	4.7%	59%
Diesel	1.9%	80%

- Fuel cost: DECC central fossil fuel prices projections and assume they account for current blends. Fuel duty and VAT excluded from fuel cost in the modelling.
- For the fossil fuel carbon intensity, the RED values are used to 2020: 83.8 gCO_2e/MJ.

2020 UK road transport energy demand, PJ



- Overall demand of 1,640 PJ, equivalent to 14.2 billion litres of petrol and 32.7 billion litres of diesel
- Modest gas demand:
  - 110 kt (5 PJ) in base case
  - 203 kt (9.3 PJ) in HighAFV case
- Very modest electricity demand:
  - 304 GWh (1.1 PJ) in base case
  - 1,014 GWh (3.6 PJ) in HighAFV case

More detail on the demand modelling is provided in Appendix D

D. Outputs and related rules

OUTPUT: contribution of each fuel type to the 10% RED target

- The contribution of each fuel type to the target is consistent with the accounting rules in the RED (2009/28/EC)
- Scenario scores against proposed changes to RED accounting rules and sub-targets (EU Parliament Sept. 2013) are also presented, as a sensitivity test

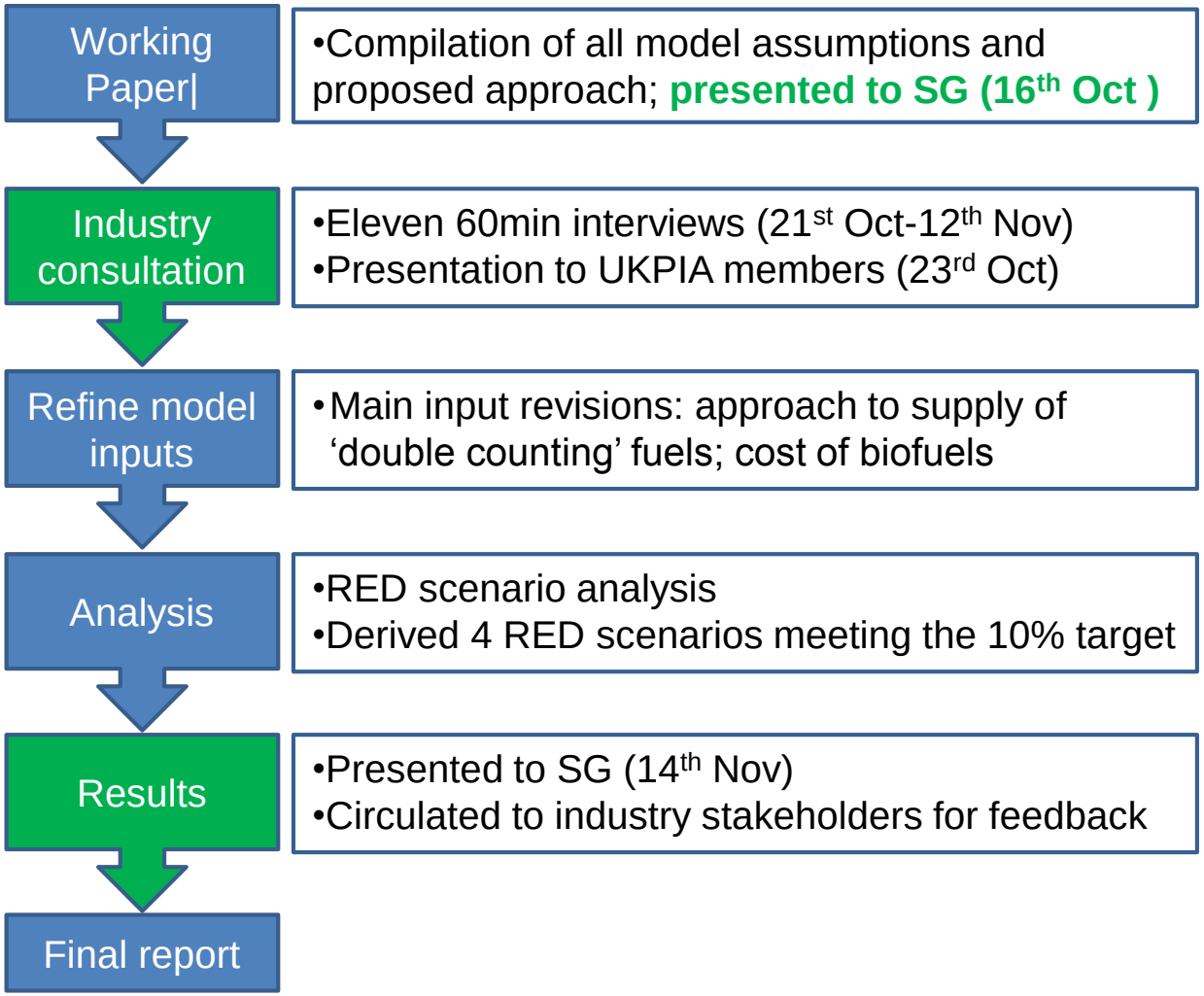
OUTPUT: Mt CO_2e saved per vehicle class and scenario

- The emissions (WTW MtCO_2e) are calculated over the lifetime of vehicles
- The abated emissions are the comparison of a scenario to the baseline case
- The cost and ('real world') energy consumption of vehicles are based on the projections compiled by Ricardo-AEA for the Committee on Climate Change (2012). These account for the improvement of the ICE, in consistence with the EC regulations on emissions

OUTPUTS: cost effectiveness (£/renewable GJ and £/abated tCO_2e)

- Baseline costs are calculated from the baseline scenario and are the sum of:
  - Capital cost of vehicles sales over 2014-2020 (except for NRMMs where only fuel filter replacement costs are used)
  - Energy expenditure of existing stock over 2014-2020
  - Energy expenditure of vehicles sold post-2013 over their lifetime
- The cost of scenarios is calculated from the same components plus marginal maintenance costs where relevant
- The price of petrol and diesel is higher than in the baseline when biofuels are blended in at higher blend than 5%(vol)
- The effectiveness is the delta cost (scenario-baseline) divided by the delta GJ or tCO_2e (scenario-baseline)

E. Industry consultation: for review of model assumptions and insights on key barriers and enablers



- The modelling and analysis carried out for this study is based on industry feedback and consultation, through:
  - The Steering Group, that has members from relevant industries
  - A consultation with a wider number of industry stakeholders
- The consultation provided insightful information about the key enablers which require government intervention and/or EC level decisions, and portrayed the general agreement among the most probable RED scenario

The consulted organisations and Steering Group (SG) members are listed in Appendix A

1. Introduction

2. Scope and approach

3. Fuel pathways

4. RED scenarios

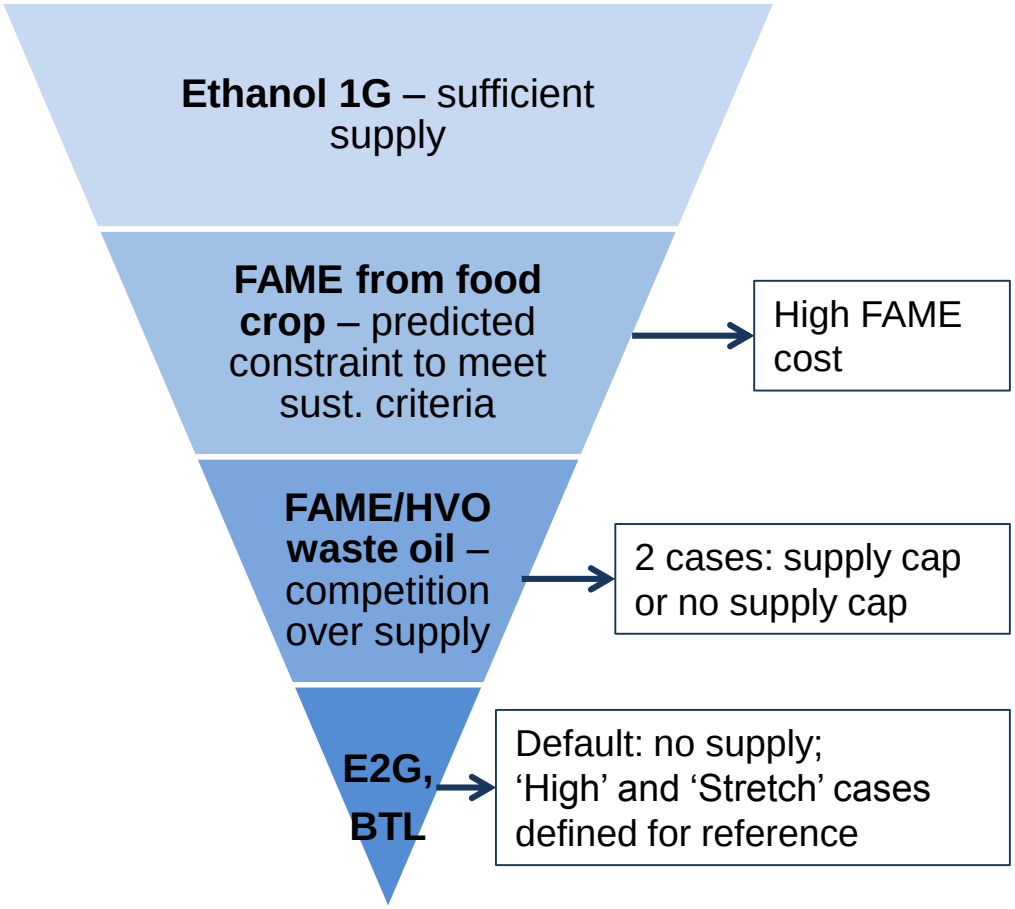
5. Recommendations

6. References and Acronyms

A. Supply cap assumptions
B. Fuel cost assumptions
C. WTW GHG emission savings assumptions

A1. Supply varies from large supply for ethanol 1G to very limited supply of drop-in fuels and ethanol 2G – key lever for results 1/3

Biofuel supply and model impact



- The UK supply of biofuels already relies heavily on imports[1] and this trend is expected to continue in the next decades[2]
- While there is sufficient supply of ethanol 1G, the supply of FAME from food crop *that can meet the 50% threshold* is predicted to become constrained: this is captured by a high FAME cost in the modelling
- **Results presented next are very sensitive to the supply assumption of double counting fuels**: waste oils (FAME or HVO), ethanol 2G, BTL diesel
- There are two main challenges for UCO (and other waste fats):
  - UK share of international supply
  - Fuel quality and associated infrastructure costs (if FAME)
- For ethanol 2G and BTL diesel, the feedstock supply is not a concern[3], but the investment in production plant is. High and Stretch supply cases were developed for measure of scenario feasibility

1 – 77% biofuels were imported in 2012/13, (2012/13 RTFO report) 2 – DECC Bioenergy Strategy 2012. Biomethane supply is also constrained, as incentives are diverting use to sectors other than transport, see Appendix E3 3 – Notably, supply of waste, Ecofys, "Low ILUC potential of wastes & residues for biofuels", 2013, ECF "Wasted, Europe's untapped resource. An assessment of advanced biofuels from wastes & residues", 2014

A2. Opinion was divided among industry stakeholders on the future supply and use of FAME made from waste oils and fats 2/3

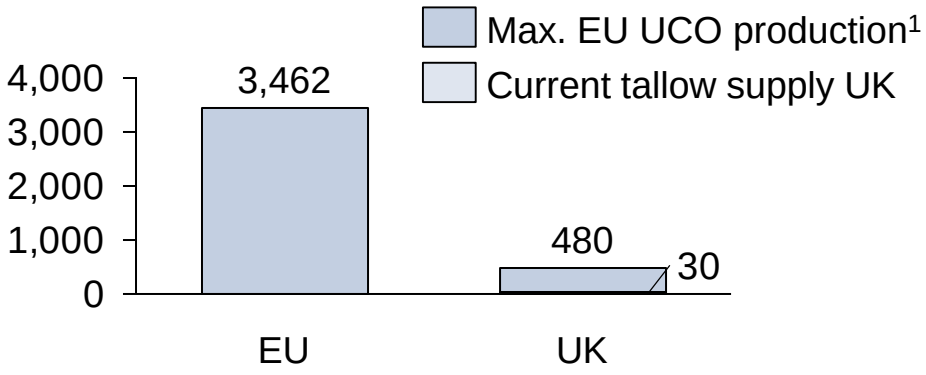
View 1: limited potential for increased use of UCO

- Limited production potential (estimated at 3,500 million litres / 117 PJ at EU level for UCO)[1] and competition from other Member States
- Fuel quality if 100% UCO FAME is blended in diesel, especially in winter
- Concerns over contamination of pipelines and storage; implies extra costs
- Concerns over fraud and lack of traceability

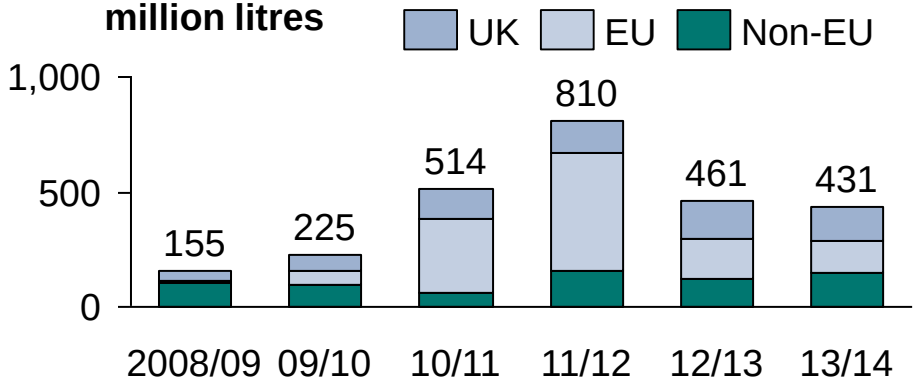
View 2: the UK can increase its use of FAME made from UCO and other waste oils

- It is a world market and import from overseas has little impact on WTW savings
- UCO can be refined into good quality FAME; at least 1 UK supplier has been using 100% UCO FAME in its B7 for the last 3 winters
- Certification standards already in place (e.g. ISCC EU) and in use by UK importers, developed with EC
- New stream of waste oils beyond UCO are emerging in the UK (e.g. brown grease, palm oil mill effluent)

Max potential for UCO and tallow FAME, million litres



UCO and tallow FAME from waste oil in UK[2], million litres



Two cases modelled:

- **View 1: supply limited at 450Ml UK share of UCO EU production + current UK tallow (16 PJ)**
- **View 2: No supply limit (10% target 'easily' met, thanks to double counting)**

1 – Ecofys, Low ILUC potential of wastes and residues for biofuels, 2013 (16%), see Appendix E4

2– RTFO reports; mostly UCO (80%) and tallow

ISCC: International Sustainability and Carbon Certification

A3. Summary of identified 'high' and 'stretch' supply for double counting fuels other than fuels based on waste oils 3/3

- The availability of waste feedstock is not a barrier to the production of E2G and BTL (literature reports availability in the order of 1000PJ at EU level[1]), but the investment in production plant is very high
- **High and Stretch supply cases developed for measure of scenario feasibility:**
  - 'High' case is an ambitious case: optimistic best case scenario considering regulatory framework and investment challenges
  - 'Stretch' case is a very ambitious case that would require very strong intervention
  - A scenario that requires supply over Stretch limits is labelled unfeasible.
- Drop-in diesel: only BTL considered, as HVO feedstock already captured in non-food FAME

Summary of indicative supply caps (PJ) for RED scenarios

Fuel type		2017	2020	Notes
Ethanol 2G Million litres [PJ]	High	60 [1.3]	120 [2.5]	• 2017: similar size than Crescentino plant (Italy) • 2020: ramp up to 2 plants, or 1 plant + import
	Stretch	60 [1.3]	240 [5.0]	• Large import / fast ramp up in production globally
BTL diesel Million litres [PJ]	High	32 [1.1]	127 [4.3]	• 2017: 50% of output from UK based Solena plant • 2020: 1 large FT plant (750kt) at EU level, UK taking 'fair share'
	Stretch	32 [1.1]	253 [8.6]	• 2020: 2 large FT plants at EU level, UK taking 'fair share' (13%)

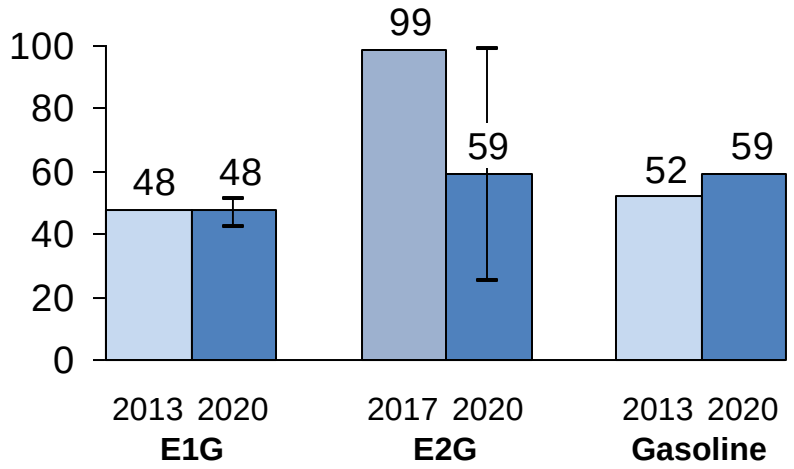
- **Total 'High' cases contribution = 6.8 PJ in 2020; this represents 0.8% of transport demand**
- **Total 'Stretch' cases contribution = 13.6 PJ in 2020; this represents 1.6% of demand**

Further details for E2G and BTL diesel in Appendix E1 and E2. 1 – (Ecofys, 2013) and (ECF, 2014)
Reminder: the 'fair share' refers to share of UK transport fuel consumption at EU level as per (ECN, 2011).

B. Fuel cost assumptions

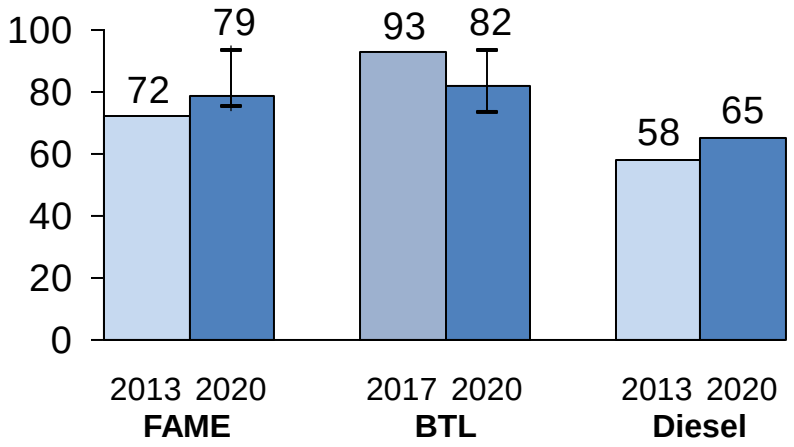
Ethanol and gasoline

p/L, 2010 GBP



Biodiesel and diesel

p/L, 2010 GBP



Main assumptions

- Gasoline and diesel costs as per DECC central projections (DECC,2012); E1G and FAME as per observed prices (Platts) for 2013 values
- Ethanol 1G cost assumed to be constant for central scenario
- Common expectation that FAME costs will increase due to rise in feedstock (oil/protein) costs and to supply constraints arising from tighter sustainability criteria
- There is uncertainty on these dynamics, due to the dependency of fuel costs on a wide range of factors. This is more pronounced for new generation biofuels (as shown by the error bars in the graphs)

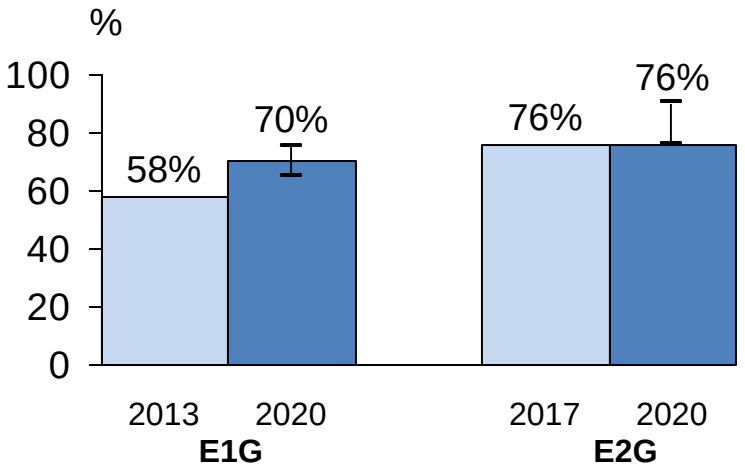
Main sources for cost projections

- DfT Impact Assessment, literature projections for E2G and BTL (sources for assumptions are provided in Appendix F)
- Cost projections were discussed with industry stakeholders to understand the current market dynamics of biofuels

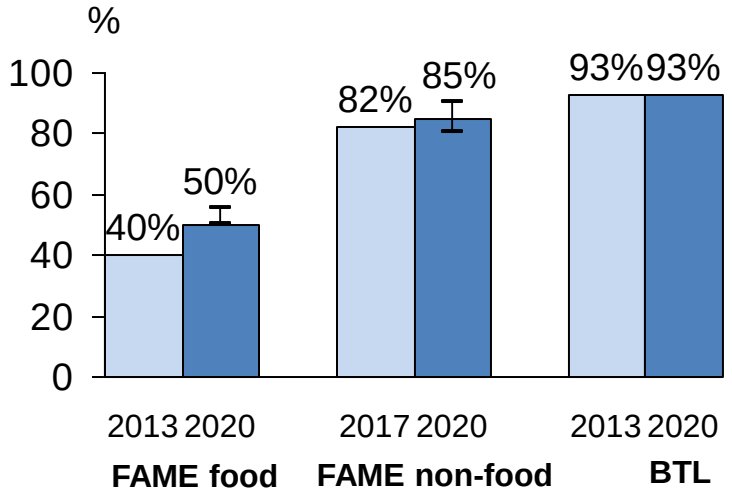
E2G and BTL assumed to enter UK market in 2017.Error bars show the Low and High costs, used for sensitivity analysis.
Assumptions for gaseous fuels and electricity are provided in Appendix F

C. WTW GHG emission savings assumptions. RED sustainability criteria expected to bring improvement in E1G and FAME WTW emissions

Ethanol WTW emission savings over gasoline



Biodiesel WTW emission savings over diesel



Ethanol 1G and 2G

- Current value for E1G as per RTFO 2012/13 weighted average.
- 2020 value for E1G based on observed best values and possible improvement reported by industry during the consultation. E1G from wheat produced in the UK achieves c. 70% WTW emission savings; this can be achieved by tracking feedstock origin, lowering use of fertilisers, maximising process efficiency or capturing CO_2
- E2G as per average RED default values

FAME and BTL diesel

- Current value for FAME, as per RTFO 2012/13 weighted average. Last reported RTFO values for oilseed rape, palm and soy derived FAME have been below 50%
- 2020 FAME food as per RED 50% threshold after 2017, this implies existing plants will report on their real performance (as opposed to use default values) and implement improvement measures
- 2020 FAME non-food based on RED default UCO values
- BTL as per RED default value (‘farmed wood FT diesel’)

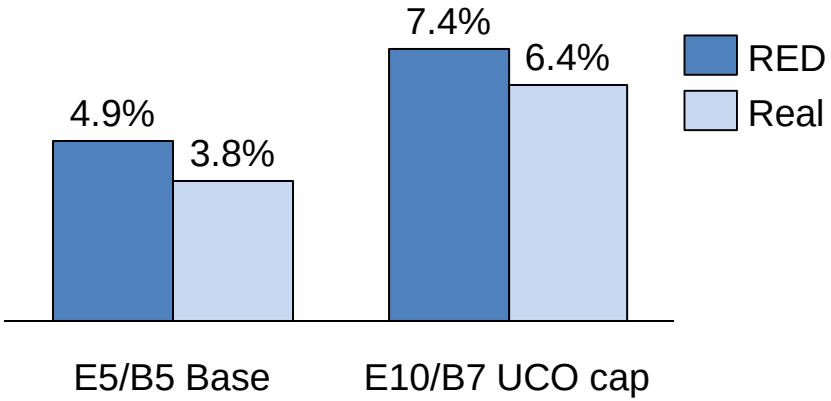
Error bars show the Low and High values, used for sensitivity analysis. Assumptions for WTW emissions of gaseous fuels are provided in Appendix G1, for grid carbon intensity and share of renewable electricity, see Appendix G2

1. Introduction
2. Scope and approach
3. Fuel pathways
4. **RED scenarios**
5. Recommendations
6. References and Acronyms

A. Renewable energy shortfall and approach to RED scenario design
B. Presentation of four RED scenarios to reach target
C. Model outputs and comparison
D. Comparison of barriers and challenges to implementation
E. Conclusion: presentation of most probable and recommended RED scenario

A. Under the E5/B5 baseline, 4.9 % renewable energy achieved in 2020. E10 & B7 bring the share up to 7.4% (if waste oil imports are limited) 1/2

Share of renewable energy in 2020



Base E5/B5

- Single counted ethanol; 33 % FAME/HVO double counted; i.e. capped UCO supply

E10/B7 with UCO cap

- E10 introduced at the pump in 2016 ramping up to 100% of forecourts by 2020[1]. E5 available until 2020. Effective blend 8.8%vol
- B7 with 19% FAME doubled counted; effective blend: 6.8%vol (limited UCO/waste oils supply)
- No ethanol 2G, no BTL diesel

- Under the E5/B5 baseline, 85.6 PJ of renewable energy missing to reach the 10% target.
- Bringing E10 and B7 only partially fills the gap: 42.2 PJ shortfall (if UCO/waste oils supply is limited)
- Four strategies investigated to reach the 10% target:
  - **NO NEW BLENDS**: no blends higher than E10 and B7. Options to increase renewable energy: double counting fuels and alternative fuel vehicles
  - **DEPOT FOCUS**: bring high blends in depot, use drop-in fuels if needed
  - **NEW FORECOURT BLENDS**: bring higher blends to the forecourts (E20 and/or B10 and/or E85)
  - **COMBINATION:** new higher blends at both depot and forecourts

0.2% point tolerance implemented; e.g. E10 is modelled as 9.8%vol blend
1 - Although all forecourts offer E10, sales of E10 are modelled with a cap at 80%, as some drivers will prefer to refill with E5

A. Approach to RED scenario design

- Based on a literature review and feedback from industry, four strategies were devised. Out of each strategy, one RED scenario was derived, through the use of the Element Energy fleet model.
- Out of the resulting four RED scenarios, this study makes a recommendation on the approach the UK should take to meet the RED transport target.

Define four broad strategies

- Literature review[1]
- Industry consultation

Analysis of possible scenarios

- Element Energy fleet model
- Variation of levers (defined in slide 14)

Selection of best scenario in each strategy

- Criteria: cost effectiveness, implementation barriers

Recommended RED scenario
Recommendations for its implementation

1- CE Delft and TNO report for DG Energy, 2013 ; AEA Biofuels Modes Project 3 for DfT, 2011; JRC/EUCAR/CONCAWE, EU renewable energy targets in 2020: analysis of scenarios for transport, 2011

B. Presentation of scenarios: incremental scenarios

Achieving the target is highly dependant on the volume of double counting fuels, either waste oils based fuels or E2G/ BTL diesel

Strategy	Lever	Findings	Resulting scenario and key assumption
NO NEW BLENDS no blends higher than E10 and B7	■ Powertrain pathway ■ Supply of UCO: capped or not capped ■ Supply of E2G and BTL	■ The HighAFV powertrain pathway offers little and not cost effective contribution to target ■ Meeting the target with E2G and BTL would require volumes beyond the 'Stretch' limits	**Name: E10&B7** ■ Target met through high use of FAME waste oil (1.7 bl, which is 50% of identified EU UCO FAME production potential)
DEPOT FOCUS higher blends in depots, for HGVs and buses	■ B30 or B100 ■ Share of uptake among depot fuelling vehicles ■ Supply of E2G and BTL	■ If depot uptake is limited at 10%, required volumes of E2G / BTL are beyond the 'Stretch' limits ■ B30 more cost effective than B100 ■ Depot uptake of B30 must be 36% if 'Stretch' supply of BTL is available	**Name: DepotB30** ■ Target met through high B30 uptake at depot (36% of depot refuelling vehicles) and 'Stretch' E2G and BTL supply

The NRMM gas oil blend is at kept at B2 in all scenarios – the level where impact on storage and engines and thus associated costs are estimated to be manageable, based on industry feedback

B. Presentation of scenarios: high blends at forecourt scenarios 2/3

Double counting still key to meeting the 10% target.

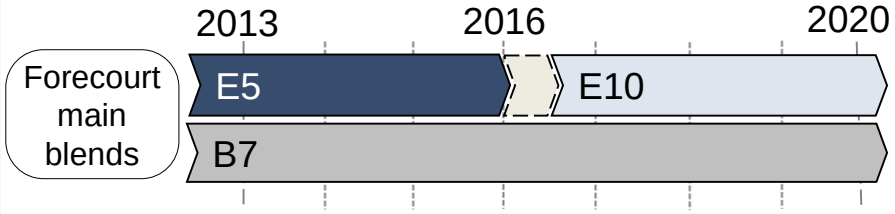
Strategy	Levers	Findings	Resulting scenario and key assumption
NEW FORECOURT BLENDS Higher blends than E10 or B7	■ New blend: E20, B10, E85 ■ % fleet compatible ■ Supply of E2G and BTL	■ Scope for E20 and B10 too limited for 2020, would require supply of E2G and BTL over 'Stretch' limits ■ E85 most promising option but still relies on some E2G or BTL	**Name: E85case** ■ Target met through 6% of fleet using E85 (10% forecourts offering E85) and 'High' level of E2G (5%vol of total ethanol) and 'Stretch' BTL
COMBINATION new higher blends at both depot and forecourts	■ Share of B30 uptake among depot fuelling vehicles ■ % fleet compatible with E85 ■ Supply of E2G and BTL	■ Possibility to meet the target within Stretch supply at a cost effective level ■ High challenges associated with implementation of measures both in forecourts and depots	**Name: Depot&E85** ■ Target met through 'High' E2G level and BTL level in between 'High' and 'Stretch'. 10% forecourts offering E85 and 10% depot refuelling vehicles using B30

See Appendix I4 for the E85 deployment assumptions

B. Summary of RED scenarios

All scenarios:
- 100% forecourts serve E10 by 2020
- B2 for NRMM

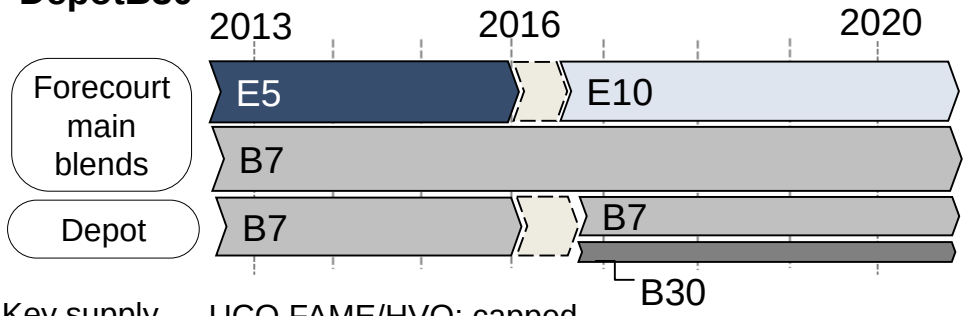
E10 & B7



Key supply assumptions: UCO FAME/HVO: no supply cap; No BTL, no E2G

Key uptake assumptions:

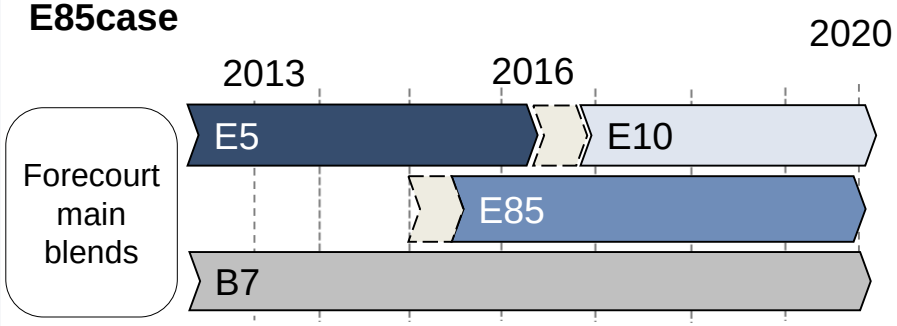
DepotB30



Key supply assumptions: UCO FAME/HVO: capped; Stretch BTL and E2G

Key uptake assumptions: 36% of depot refuelling B30 to HGVs and buses by 2020

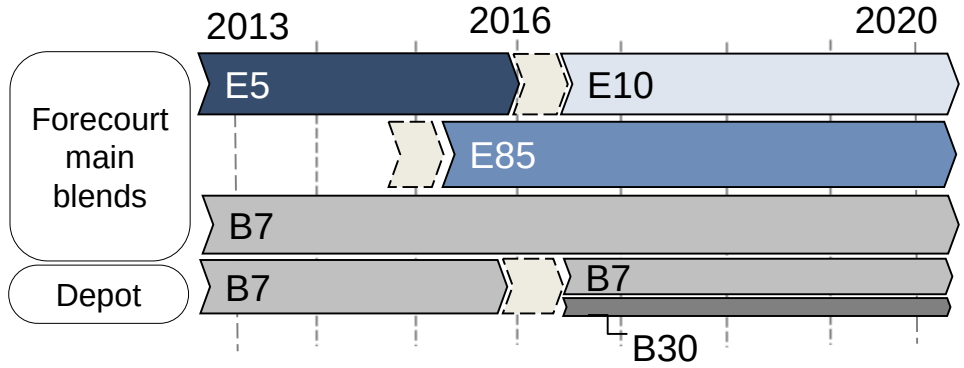
E85case



Key supply assumptions: UCO FAME/HVO: capped; Stretch BTL and High E2G

Key uptake assumptions: 6% of car fleet use E85 by 2020

Depot&E85



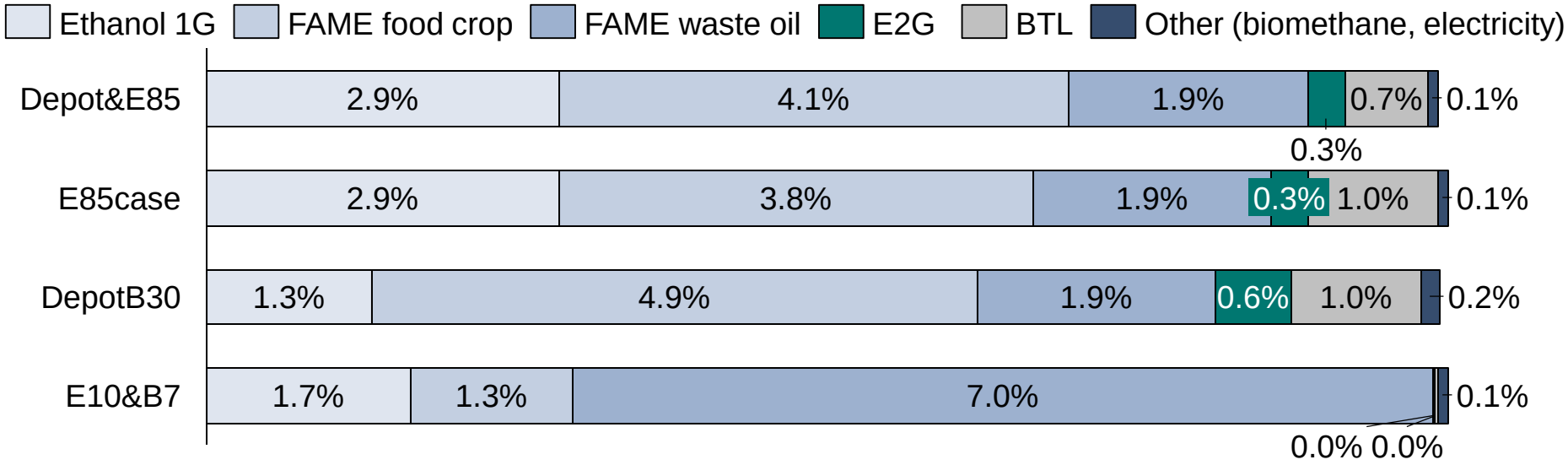
Key supply assumptions: UCO FAME/HVO: capped; High BTL and E2G

Key uptake assumptions: 6% of car fleet use E85 by 2020; 10% of depot refuelling B30 to HGVs and buses

E10 rollout start could be in 2014, 2015 or 2016. 2016 is perceived as the latest year for a rollout start as that year E10 become the certification fuel. The E10 rollout start was modelled from 2016 on this basis.

C. Contribution to RED target comparison

Contribution to RED target



- The high use of FAME from waste oils differentiates the E10&B7 case from other scenarios, that all see a significant contribution of
  - FAME made from food crop (1.9 -2.5 billion litres)
  - E2G and BTL diesel (E2G: 120-240 million litres; BTL: 162-253 million litres)

HVO case

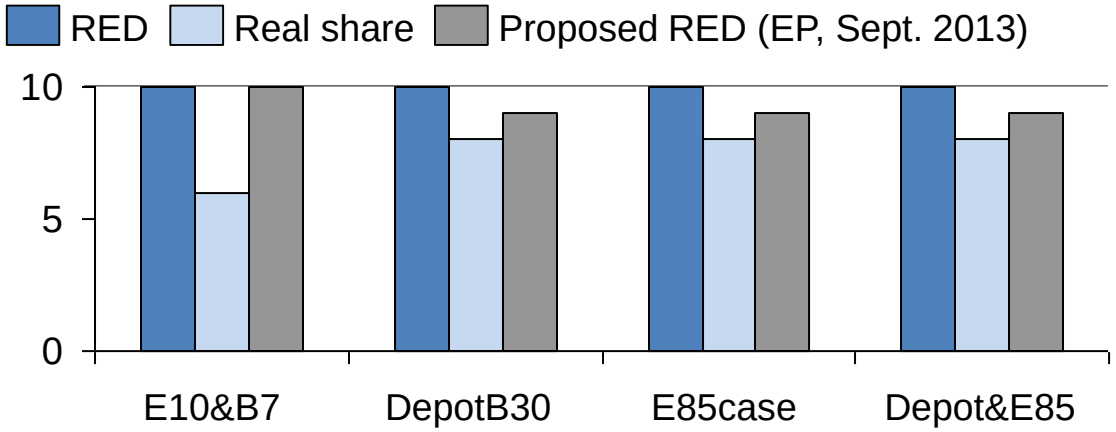
- Under the projection of 15 PJ (~450 Ml) of HVO for the UK road transport sector[1], ~15-20% of the FAME used for the RED scenarios could be HVO, where ~5% would be HVO coming from non-food feedstock and ~15% from food feedstock[2]

1 – See slide 11

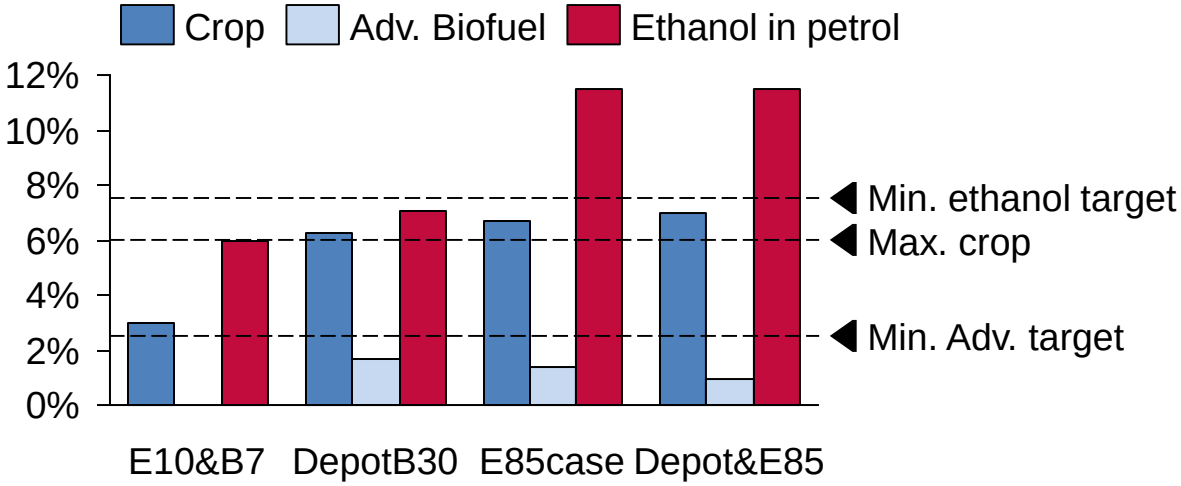
2 – Split HVO from food vs. non food feedstock based on current EU plant capacity, Element Energy analysis

C. RED targets comparison: E10&B7 has lowest real renewable energy % but only case immune to proposed change in RED accounting rules 2/4

RED targets comparison, % renewable energy in 2020



Proposed RED sub-targets (EP, Sept. 2013) - %energy in 2020

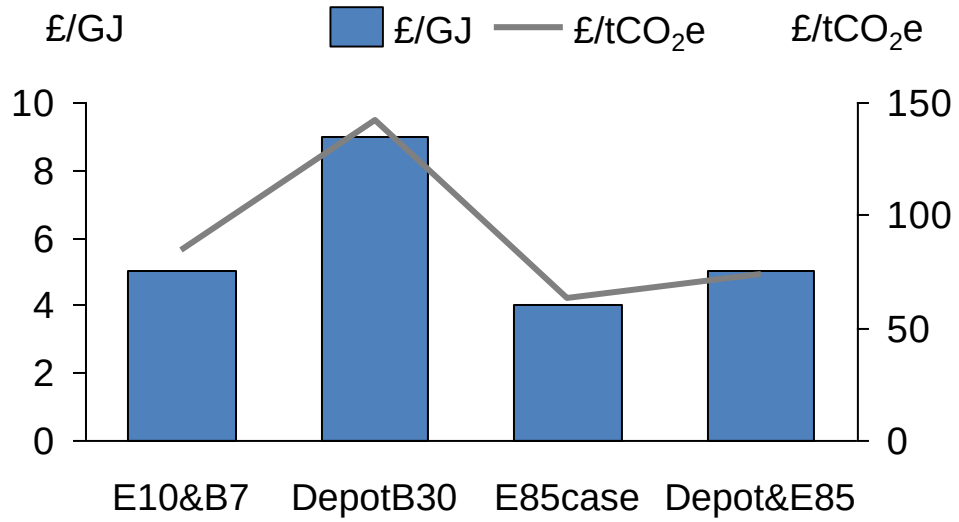


- The reliance on double counting fuel means the real renewable energy share is only 6-8%
- Only one scenario (E10&B7) would meet the 10% target under the proposed change in RED accounting rules (European Parliament Sept. 2013)
- However, the proposed RED sub-targets (EP Sept. 2013) are proving challenging in all cases:
  - Advanced fuel target is never met
  - Cap on crop fuel respected only under E10&B7
  - Ethanol target met only through use of E85

EP: European Parliament

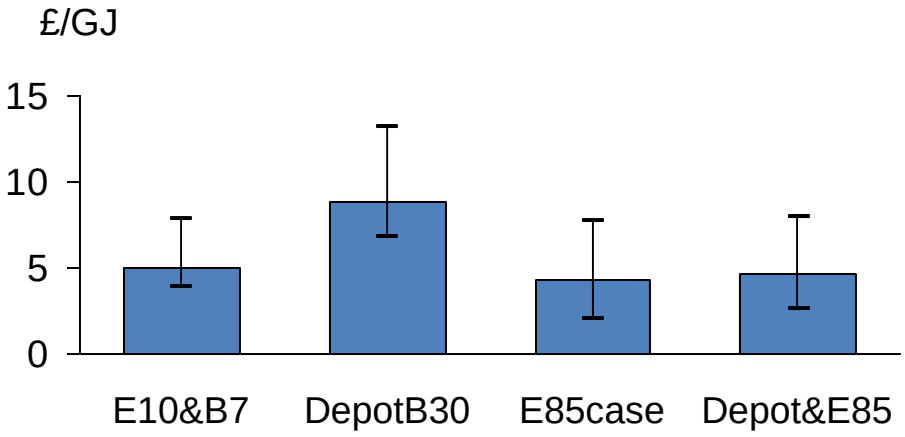
C. Cost effectiveness is similar across the scenarios with the exception of the more expensive Depot30 case. 3/4

Cost effectiveness comparison

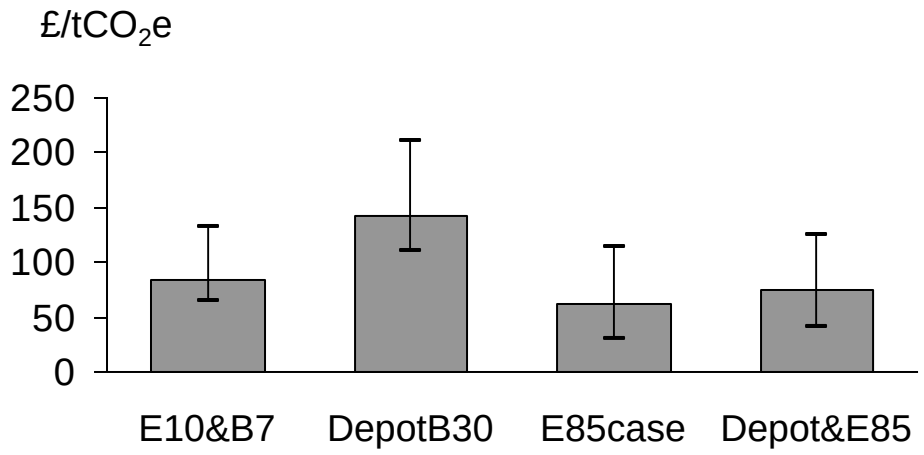


- Only Depot30 case is significantly more expensive, as it accumulates vehicle conversion costs and marginal maintenance costs.
- Cost effectiveness is sensitive to cost inputs as a high range of biofuels cost is used to capture uncertainty around future fuel costs. All scenarios are equally sensitive to cost inputs.

Cost effectiveness comparison – cost sensitivity



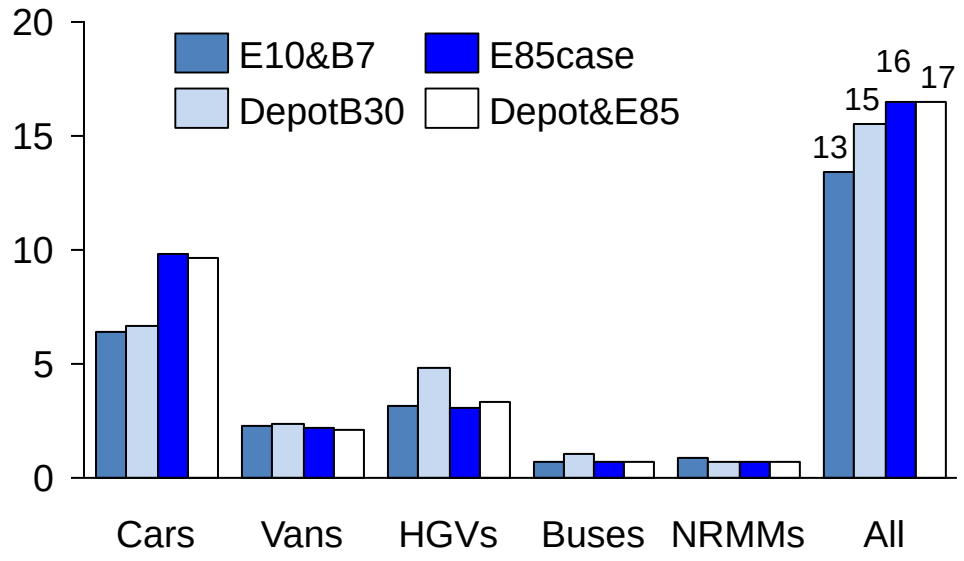
Cost effectiveness comparison – cost sensitivity



Reminder: costs captured include vehicle capital & marginal costs and energy expenditure (excl. tax).
Costs do not include cost of incentives nor potential infrastructure upgrade

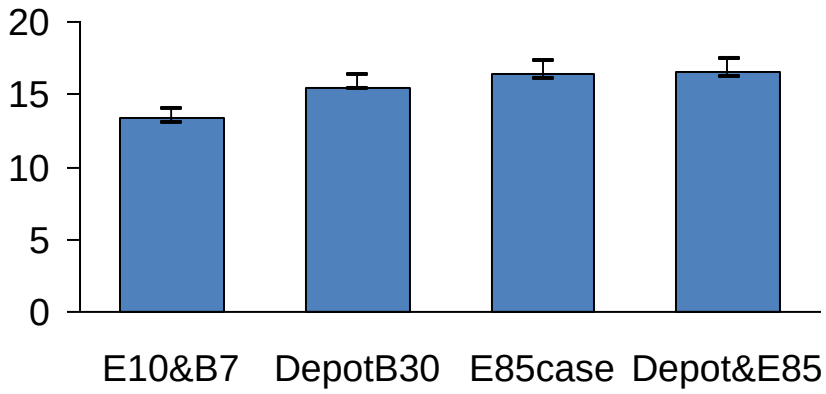
C. Comparison of scenarios: as expected the scenario with high reliance on double counting achieves lowest emission savings 4/4

Cumulative 2014-2020 WTW emission savings, $MtCO_2e$
Baseline cumulative 2014-2020 WTW emissions = 1,066 $MtCO_2e$

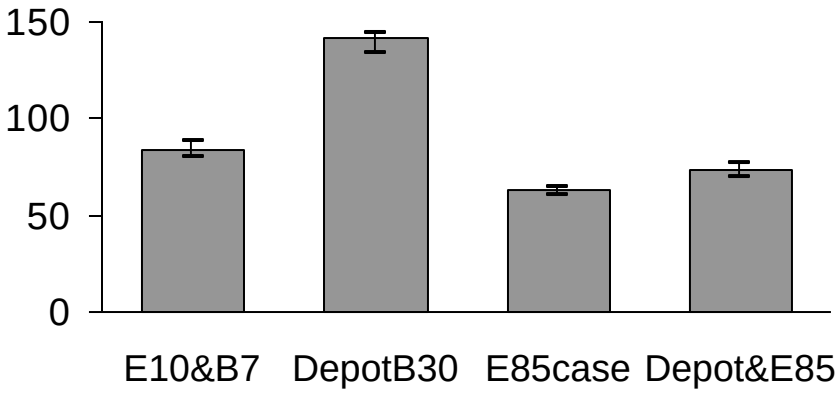


- Highest WTW savings achieved in scenarios involving E85 blends, related to cars' high contribution to WTW emissions
- Results not very sensitive to WTW saving inputs as possible range for WTW savings is limited by sustainability criteria thresholds
- Cumulative WTW savings represent 1.3%-1.6% of total cumulative WTW emissions

Cumulative 2014-2020 WTW emission savings, $MtCO_2e$



Cost effectiveness in £/tCO_2e – WTW sensitivity



D. Common challenges to the implementation of RED scenarios and emerging conclusions from industry consultation 1/4

- All scenarios face the following barriers of challenges – albeit to different degrees:
  - Supply of E2G and drop-in fuel or securing high volume of waste oils (mainly UCO today)
  - Reliance on FAME from food crop when the regulatory framework is uncertain for 2020 (e.g. share of food crop based fuels, ILUC factors) and undefined post-2020
  - Introduction of E10 at the forecourts
  - Stimulating the demand of new blends

- The DepotB30, E85 and Depot&E85 cases face extra challenges (e.g. further demand support, supply of new vehicles, infrastructure cost, use of E2G and BTL) and the **emerging conclusion from discussions with industry is that the E10&B7 case is the most probable case, despite the critical role of waste oils supply.**

- Consultation revealed a general frustration and scepticism of stakeholders, coming from:
  - Lack of UK government support for E10 and action towards meeting the target
  - Uncertain EC regulatory 2020 framework and undefined post-2020 framework
  - Inconsistent transposition of RED across Member States

  as **key enablers virtually all require government intervention and/or EC level decisions**

D. Comparison of common challenges: securing sustainable feedstock supply and commercialisation of new fuels 2/4

Challenge	Barriers	Enablers	Comment
Securing & using high volume of waste oil based fuel	• Non-food FAME quality • Supply competition – UK UCO production not enough • Waste oil collection systems quality and reach	• Refined biodiesel standard or use of HVO over FAME • Harmonisation of MS policies could help prevent distorting of supply share • Support collection of waste oils	• Ultimately no guarantee of supply as no control over demand from outside the EU
Supply of E2G and BTL fuel	• Production plants require high capital (typically over €100million) • Biofuel policy framework is uncertain (delayed ILUC factor decision, new accounting rules, no post 2020 strategy announced) • [E2G] Decreasing petrol demand	• Further technology innovations to improve economics and emission savings • Incentives and support for investment • Clearer regulatory and policy framework • [E2G] Transition to blend higher than E10	• Double counting mechanism not well regarded by industry: unclear for investors and not encouraging high volumes • Proposed DfT support of £25million seen as too low • Decision on ILUC factor and new accounting rules delayed until 2015
Reliance on FAME from food crop	• Not all existing production plants can be upgraded to meeting 50% threshold[1] • Investment in new plants unlikely under uncertain regulatory framework	• Relaxation of threshold for existing plants • Clearer framework for future new plants	• Clearer framework unlikely to help new plants as food crops are unlikely to be supported by EC in the long term

1 – The WTW performance of FAME can be improved through investment in efficiency technology (e.g. Combined Heat and Power) or use of better feedstock (e.g. crop using less fertiliser). Interviewed industry stakeholders however reported that not all FAME producers would be willing /able to make the investment, or access a selected crop supply at a competitive price

D. Comparison of common challenges: the 2-grade system calls for a (currently lacking) coordinated roll out of E10 3/4

- The UK gasoline distribution is a 2-grade system; it means a maximum of 2 gasoline grades using the distribution infrastructure can be offered at the forecourts. Further blends would rely on truck delivery and thus be volume limited.
- In a 2-grade system, a new blend (e.g. E10) is expected to become the main grade while the protection grade (E5) would become the premium grade. This implies the roll-out within a region / fuel distribution area will be quick, as opposed to E10 being slowly introduced alongside other blends like in France.
- This creates challenges for 'first movers', i.e. retailers taking the risk of selling E10 when the demand is not in place yet – barriers are detailed below.

Challenge	Barriers	Enablers	Comment
Introduction of E10 at the forecourts	• Most fuel retailers are non-obligated • Consumer acceptance: see below • Lack of government support (to address consumer acceptance, lack of endorsement, RTFO capped at 4.75%) • Lack of rollout coordination – 2 grade system means rollout must be quick	• Address non-obligated retailers, e.g. mandate • Coordinated roll-out • Address demand: see below • In all cases, strong role for central government and/or affiliated agency	• Consumer acceptance: refrain non obligated as well as obligated retailers
Stimulating the demand for a new blend – consumer acceptance	• End users unwilling to pay price premium for CO_2e savings • End user concern over impact on engine • End user rejecting biofuel sustainability credential	• Incentive address cost premium over lower blends, e.g. energy based taxation and preferential differential • Fuel labelling • Information communication	• Finland provides example of successful communication campaign[1]

1 – E10 was introduced in January 2011 and by December 2011 represented 51% of gasoline sales, a success partly attributed to a education and communication campaign (CE Delft and TNO, 2013)

D. Additional challenges specific to DepotB30, E85 and Depot&E85 cases

Introduction of B30 for fleet vehicles

- Demand:
  - No tax differential or incentive in place at the moment making the adoption of biodiesel cost effective for users – only a marginal number of users will pay a premium for cost savings. Past support program (20p/l fuel duty rebate in 2002-2010) yielded less than 10% uptake of biodiesel fuel among commercial fuel sales[1].
  - Beyond costs, there are consumer acceptance issues (fuel quality and sustainability credential)
- Supply of vehicles:
  - EURO 6 specification hard to meet for wide range of biodiesel blends – OEMs unlikely to optimise and certify for one blend type. CEN fuel standard in development for B30
- Distribution*: dedicated channels required or additional cleaning procedure to avoid contamination.
- Storage*: conversion to compatible materials required. Impact on low usage storage unknown.

Introduction of E85 at forecourts

- Demand:
  - Beyond fuel demand, vehicle demand must be incentivised
- Supply of vehicles:
  - OEMs already make FlexFuel Vehicles (FFVs) but unclear how easy it is to bring to UK market. EC CO_2 regulation does not reward OEMs for FFVs anymore.
  - Risk of FFVs being refuelled with E5/E10, giving sub-optimal fuel consumption and lower emission savings
- Distribution*: only 2 petrol grades available, E85 will stay niche to 2020 (supply by road from refinery)
- Poor post-2020 prospect for E85 considering petrol/diesel unbalance and unlikely status of grade fuel: barrier for refuelling infrastructure investment and OEMs effort to supply

1 – Source: UKPIA

*Associated cost not included in cost effectiveness calculation

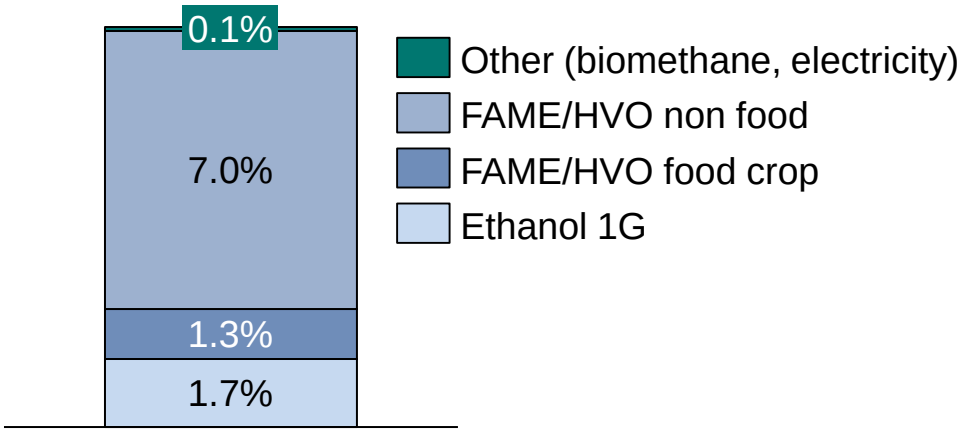
E. Decision on recommended RED scenario to be taken forward: the E10&B7 approach is the recommended strategy for the UK 1/2

- When comparing the four RED scenarios in terms of cost effectiveness, sensitivity to double counting rules, reliance on commercialisation of new fuels, reliance on FAME/HVO made from food crop, and implementation challenges, **the E10&B7 case emerges as the best approach.**
- The E10&B7scenario achieves less cumulative WTW emission savings over 2013-2020 than the other scenarios (c. 3Mt or 20% difference with E85case), due to its higher use of double counting fuel. However its overall much reduced implementation challenges, notably around investment in infrastructure upgrade and new vehicle introduction, make the E10&B7 case the most plausible pathway for the UK to meet the RED transport target, with the lowest risk of 'lock in' with fuel blends not desirable or sustainable in the long term.
- Industry stakeholders also believe the E10&B7 is the most realistic approach.

Criteria (slide number for quantitative values)	**E10&B7**	**DepotB30**	**E85 case**	**Depot&E85**
WTW emission saved (slide 33)				
£/tCO_2e and £/GJ (slide 32)				
Sensitivity to double counting changes (slide 31)				
Reliance on waste oils supply (slide 27)				
Reliance on high volumes of BTL and/or E2G (slide 30)				
Reliance on FAME/HVO from food crop (slide 30)				
Requires support for new vehicles and/or new blend adoption				
Requires transformation/upgrade of distribution infrastructure				
Overall industry preference				

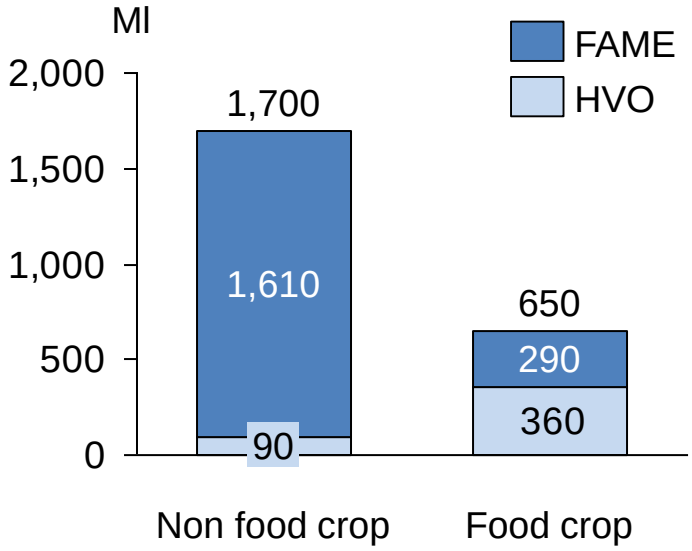
E. Decision on recommended RED scenario to be taken forward: summary of fuel contributions 2/2

Contribution to RED target in 2020 – E10&B7 case



- The recommended trajectory implies:
  - c. 1,300 Ml of E1G (or slightly less if some double counting E2G is also supplied)
  - c. 650 Ml of FAME/HVO from food crop
  - c. 1,700 Ml of FAME/HVO from double counting fuels (expected to be mostly UCO), or less if BTL is also supplied
  - 4,600 t of biomethane

Biodiesel volumes required to achieve RED target and potential HVO contribution – E10&B7 case



- Under the projection of 15 PJ (~450 Ml) of HVO available for the UK road transport sector, up to 20% of the FAME/HVO required to meet the RED target could be HVO:
  - up to 5% of the fuel made from non food crops
  - up to 55% of the fuel made from food crops
- Despite modest projected values of HVO from non food feedstock for 2020, a higher contribution for the longer term could help to minimise the risks associated with the traceability, security of supply and technical issues associated to FAME non food[1]

1- At the moment FAME from non food feedstock is produced mainly from UCO and tallow, whereas HVO processes are characterised by a greater feedstock flexibility

1. Introduction
2. Scope and approach
3. Fuel pathways
4. RED scenarios
5. **Recommendations**
6. References and Acronyms

Recommendations for the UK to meet the RED transport target

- From considerations such as cost effectiveness, sensitivity to double counting rules, reliance on commercialisation of new fuels, reliance on FAME made from food crops, and implementation challenges, the emerging recommendation for the UK to reach the RED target is to pursue the **E10 & B7 approach**, namely:
  - Roll out E10 and increase the biodiesel blending up to the existing B7 specification
  - Maximise the use of double counting fuels that do not use food crop feedstock; this implies a high reliance on Used Cooking Oil and other waste oils, as fuels based on other feedstock will still be in limited supply by 2020
- Despite the limited role of drop-in fuels for the 2020 target, a supporting framework should be put in place, as they offer a better prospect to decrease emissions, and could make up for supply shortfall of waste oils feedstock and displace FAME based on food crops over time
- Some of these actions can be taken by UK actors (e.g. the introduction of E10), while other enablers require actions at European level, such as reaching a final decision on the sustainability criteria and accounting rules to bring the regulatory clarity currently lacking for investment in new biofuels
- An overarching issue for the industry players that are meant to implement the changes required to reach the RED target is the inconsistent transposition of the RED across Member States. The UK should therefore communicate its chosen strategy, in order to give the EC the opportunity to consider actions that could harmonise policies across the EU
- The next slides discuss the actions or next steps required to implement the recommendations for the UK to achieve 10% of renewable energy in road transport

The successful introduction of E10 at UK forecourts will require a dedicated programme and actions from government and industry

- While the RTFO incentivises fuel suppliers to blend ethanol in gasoline, this is not sufficient for the introduction of E10, as the RTFO is capped at 4.75%vol blend and the non obligated fuel retailers (>60% of retail operators, with supermarkets selling c.40% of retail petrol and diesel) have no incentive to propose a product that might not be in demand.

- The recommended actions to facilitate the introduction of E10 are:
  1. **Support the uptake of E10 among fuel suppliers and retailers**
     - Establish a biofuel pathway to at least 2020, e.g. raise the RTFO blend cap, clarify what feedstocks are supported in the long term
     - Incentivise non-obligated retailers, e.g. mandate adoption for large retailers
  2. **Stimulate the consumer demand and acceptance**
     - **Establish an information campaign**, including harmonised fuel labelling[1], that makes customers aware of changes in biofuels, clarify compatibility aspects as well as biofuel sustainability benefits. Finland provides an example of a successful campaign and roll-out
     - **Make E10 a commercial proposition**, e.g. through changes in fuel duty taxation, to be based on energy rather than in volume terms or/and preferential differential taxation
  3. **Organise a coordinated rollout of the blend** to minimise the risk of pioneer retailers bringing the blend to the market

- Stakeholders that can deliver these actions are the government (or affiliated agency) and the fuel suppliers & retailers. Vehicles OEMs also have a role to play in the communication campaign on vehicle compatibility.

1 – Fuel labelling is already defined in the British Standard

Increasing the biodiesel blend to the 7% limit will require safeguards around fuel quality and both UK and EU action to secure waste oils supply

- As diesel vehicles are already compatible with B7*, increasing the blend level of biodiesel up to 7% presents less barriers than introduction E10. It does however require incentives for the fuel supply chain and ironing out concerns regarding fuel quality reported by some industry stakeholders.
- The recommended actions to reach 7% blending in diesel and maximise the use of UCO & other waste oils are:

1. Support the uptake of B7 among fuel suppliers and retailers

- ► Establish a biofuel pathway to at least 2020, e.g. raise the RTFO blend cap, clarify what feedstocks are supported in the long term
- ► Elaborate refined biodiesel standards that ensure an appropriate quality level of FAME made from UCO/waste oils, that does not compromise engine behaviour under winter conditions, e.g. by updating BS EN14214 standard. Revision of the diesel standard (BS EN590) could also be required, e.g. for cold flow properties. The case of NRMM might require special consideration*.

2. Improve the security of a sustainable supply of UCO and other waste feedstock

A consolidated supply chain needs to be developed that secures the 2020 UK levels of non-food FAME/HVO, expected to be highly reliant on imports. Enabling actions:

- ► Maximise the collection of traceable waste oils at EU level
- ► Continue take action to mitigate the risks of fraud, through the establishment of a traceability framework that ensures the verification of the supply chain[1]
- ► Harmonise MS policies to prevent the distortion of the supply share of waste fuels within the EU

The overall need for biodiesel could be decreased (by a modest amount, c. 55Ml) by limiting the obligated volumes to transport fuels (the current obligated volume includes non-transport gas oil[2]).

* NRMMs fleet and related fuel storage are not compatible with B7.

1- A chain of custody already needs to be in place in order for biofuels to receive RTFCs and the Year 6 RTFO guidance part 2 points to the establishment of further traceability procedure for double counted feedstock. 2 – See Appendix B

Supporting the commercialisation of new biofuels will require actions both at UK and EU level

- To support the investment in new production capacity of new fuels (E2G, drop-in fuels), the recommended actions are:

  - At EU level

    Provide short-term **certainty in the regulatory framework** towards 2020 (clarifying the position around ILUC factors, accounting rules and introduction of sub-targets if relevant), as well as long term certainty, by defining a post-2020 framework.

  - At UK level

    Attract investment in commercial-scale biofuel plants (E2G, drop-in fuels).

    This will require an assessment of efficient mechanisms that bring the most clarity to investors.

    Consulted stakeholders commented loan guarantees proved efficient in the US, that the £25million grant offered in the UK was too low and that double counting for RTFCs was not as clear as setting volume targets

1. Introduction
2. Scope and approach
3. Fuel pathways
4. RED scenarios
5. Recommendations
6. **References and Acronyms**

References (1/2)

- AEA, Biofuels Modes Project 3, for the DfT, 2011
- AEA, Assessment of the existing UK infrastructure capacity and vehicle fleet capability for the use of biofuels, for the DfT, 2011
- CE Delft and TNO, Bringing biofuels on the market. Options to increase EU biofuels volumes beyond the current blending limits, 2013
- DECC, DfT and Defra, UK Bioenergy Strategy, 2012
- DECC, DECC Updated Energy & Emissions Projections, October 2012
- DECC, DECC/HM Treasure Green Book Appraisal guidance, September 2013
- DfT, RTFO annual reports, 2008-2013
- DfT, Impact Assessment: Motor Fuel Composition and Content Regulations – Extension of petrol protection grade requirement, 2013
- ECN, Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States, 2011
- Ecofys, Low ILUC potential of wastes and residues for biofuels, 2013
- ECF, Wasted, Europe's untapped resource. An assessment of advanced biofuels from wastes & residues, 2014
- ECUK, Transport data tables, DECC, 2013
- Element Energy, The role of biofuels beyond 2020, for BP, 2013
- Element Energy, Influences on the Low Carbon Car Market 2020–2030, for LowCVP, 2011

References (2/2)

- E4tech, An harmonised Auto-Fuel biofuel roadmap for the EU to 2030, 2013
- Irena, Production of bio-methanol. Technology Brief, 2013
- Jesper Brauer, Master of Science thesis, When will hybrid technologies dominate the heavy-duty vehicle market? Forecasting Using Innovation Diffusion Models, 2011
- JEC - Joint Research Centre-EUCAR-CONCAWE collaboration, Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context, version 4, 2013
- JRC/EUCAR/CONCAWE, EU renewable energy targets in 2020: analysis of scenarios for transport, 2011
- Littlewood et al., 2013. Importance of policy support and feedstock prices on economic feasibility of bioethanol production from wheat straw in the UK. Renewable and Sustainable Energy Reviews 17 (2013) 291–300
- NNFCC, Market Review: Biofuels, Issue 19, October 2013
- Marvel et al., 2012. Economic Optimization of a Lignocellulosic Biomass-to-Ethanol Supply Chain. Chemical Engineering Science 67(2012) 68–79
- Patterson et al., 2011. An evaluation of the policy and techno-economic factors affecting the potential for biogas upgrading for transport fuel use in the UK. Energy Policy 39 (2011) 1806–1816
- Ricardo-AEA, A review of the efficiency and cost assumptions for road transport vehicles to 2050, for the Committee on Climate Change, 2012
- TTR, Evaluating the opportunities for high blend liquid and gaseous biofuel penetration in the UK, for the LowCVP, 2009
- TTR, Biomethane for Transport - HGV cost modelling, for the LowCVP, 2011

Acronyms 1/2

AFV	Alternative Fuel Vehicle
BEV	Battery Electric Vehicle
BTL	Biomass To Liquid
CBG	Compressed Biomethane Gas
CCC	Committee on Climate Change
CEN	European Committee for Standardization
CNG	Compressed Natural Gas
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EC	European Commission
ECUK	Energy Consumption in the UK
EP	European Parliament
EV	Electric Vehicle
E1G	First Generation Ethanol, see slide 12
E2G	Second Generation Ethanol, see slide 12
FAME	Fatty Acid Methyl Ester
FCEV	Fuel Cell Electric Vehicle
FIT	Feed-in-Tariff
FQD	Fuel Quality Directive
FT	Fischer-Tropsch
FV	Flexi Fuel Vehicle
GHG	Green House Gas
HGV	Heavy Goods Vehicles
HVO	Hydrotreated Vegetable Oil
IA	Impact Assessment
ICE	Internal Combustion Engine
ISCC	International Sustainability and Carbon Certification
LGV	Light Goods Vehicles
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEP	Member of European Parliament
MS	Member State
NNFCC	National Non-Food Crops Centre
NRMM	Non Road Mobile Machinery
OEM	Original Equipment Manufacturer
PHEV	Plug-in Hybrid Electric Vehicle
RAC	Royal Automobile Club (Foundation)
REA	Renewable Energy Association

Acronyms 2/2

RED	Renewable Energy Directive
REEV	Range Extended Electric Vehicle
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
ROW	Rest of the World
RTFC	Renewable Transport Fuel Certificate
RTFO	Renewable Transport Fuel Obligation
SG	Steering Group
SMMT	Society for Motor Manufacturers and Traders
UCO	Used Cooking Oil
UK	United Kingdom
UKPIA	UK Petroleum Industry Association
WTW	Well To Wheel