



Department
for Transport



SUSTAINABILITY
THROUGH LIFE CYCLE APPROACHES

Imperial Network of Excellence in Sustainability through Life Cycle Approaches

‘Imperial Life Cycle Network’

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 www.imperial.ac.uk/life-cycle-network

 @ICL_LifeCycle

 Group: ‘Life Cycle Community UK’



Department
for Transport

Life Cycle Assessment, counterfactuals and policy making

Carly Whittaker





- ▶ Proud to kick-start the LCA Network Seminar Series



SUSTAINABILITY
THROUGH LIFE CYCLE APPROACHES

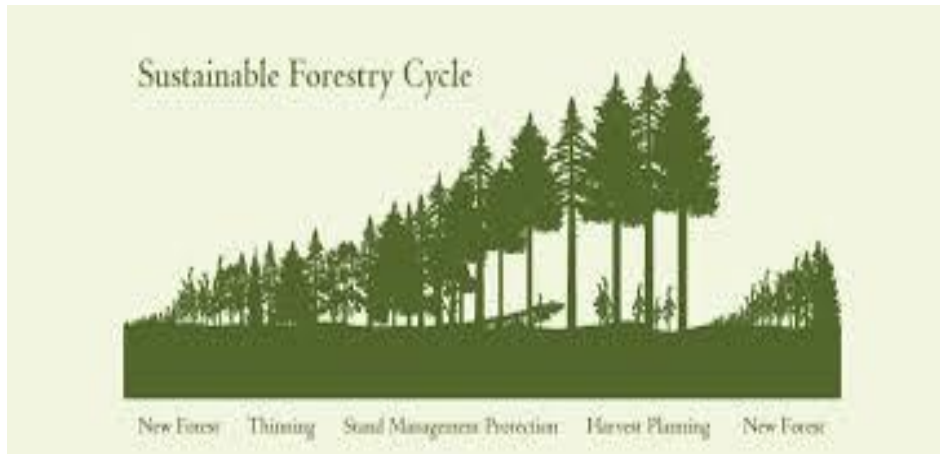




A little bit about me

- ▶ Studied at Imperial College (Biology BSc, Forestry MSc)
- ▶ Worked in Life Sciences Department in 2006
- ▶ First job examined bioenergy supply chains in the UK- using biomass for heat, power and biofuels.
- ▶ Used life cycled assessment to examine the potential that biomass had to mitigate GHG emissions







Overview of today's seminar

- ▶ Intro to the UK Policy Challenge: Reducing GHG emissions from transport
- ▶ The Renewable Transport Fuel Obligation
- ▶ How we use LCA
- ▶ Attributional LCA- regulation
- ▶ Consequential LCA- policy development
- ▶ Case study: Fuels produced from waste plastics.





UK Policy Challenge: Reducing GHG emissions from Transport

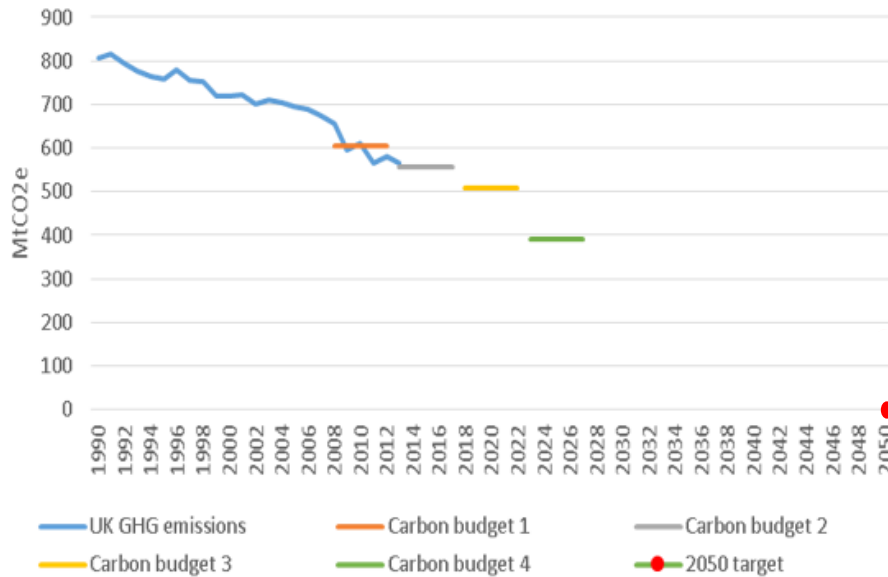




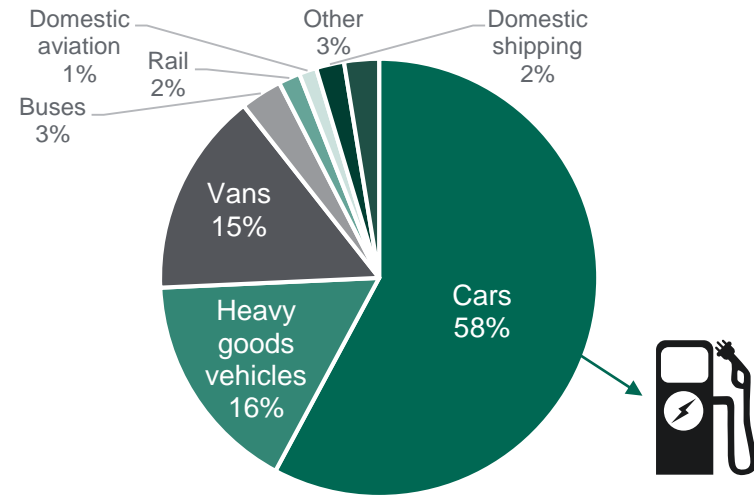
UK Policy challenge: Reducing emissions from transport

UK is committed to the Net Zero by 2050- **legally binding target**

UK GHG emissions trajectory to 2050



Policy challenge is
Reducing GHG emissions
(Reducing energy demand)

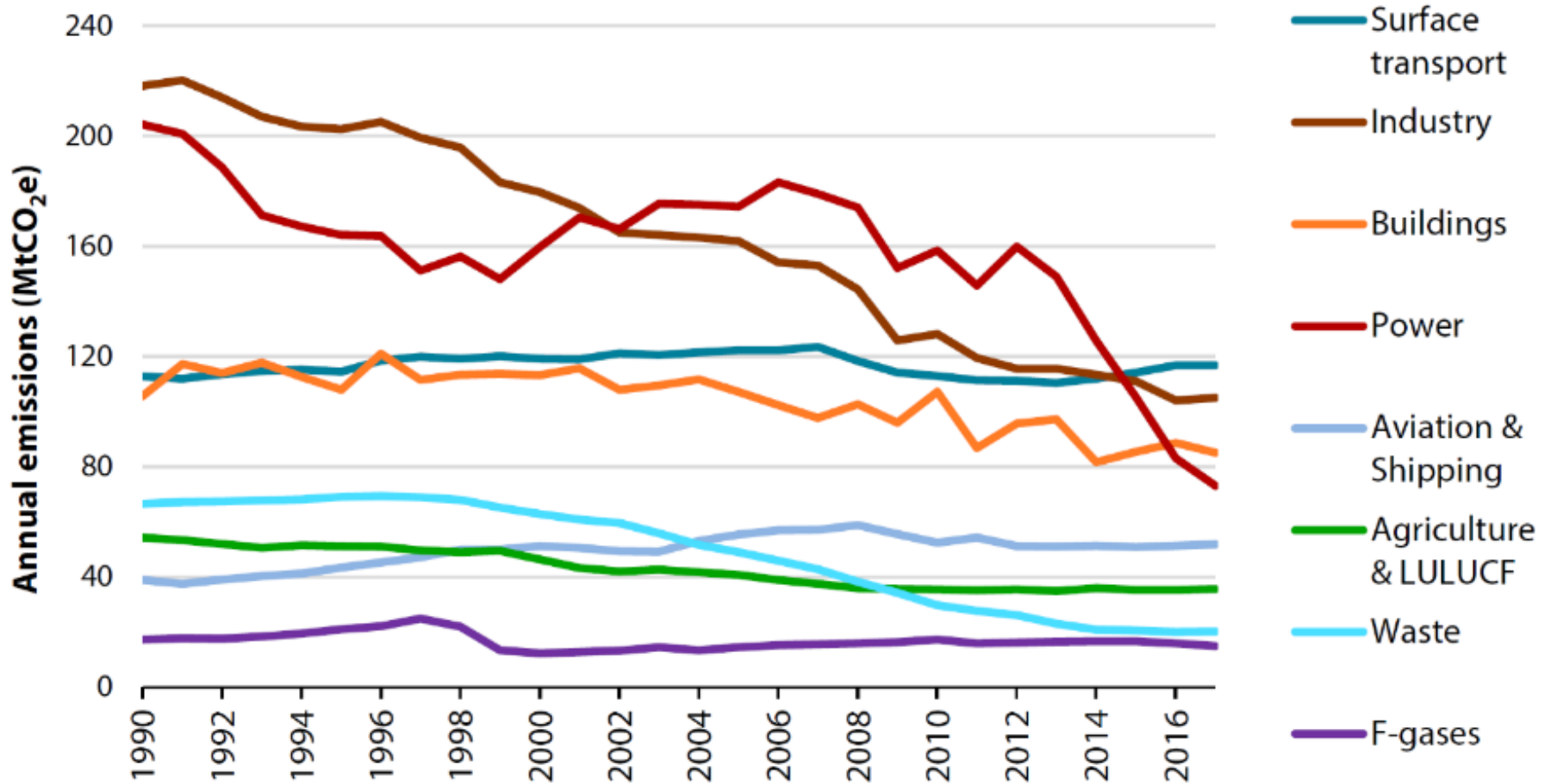


Emissions from UK transport





Transport emissions not falling



BEIS (2019) Final UK GHG emissions national statistics





The Renewable Transport Fuel Obligation





▶ Renewable Transport Fuel Obligation (RTFO)

- ▶ Has been operating since 2008. On average saves 2.5 Mt CO₂/year, and is increasing!
- ▶ Is one of the Government's main policies for reducing GHG emissions from fuel supplied for use in transport
- ▶ Rewards production of renewable transport fuels of biological and non-biological origin
- ▶ Typical feedstocks include...

Used cooking oil



Wheat



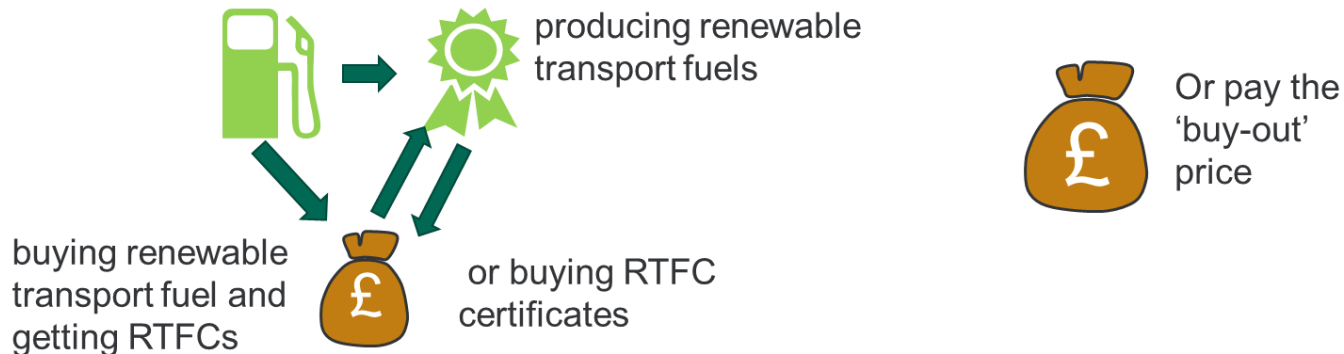
Food waste





- ▶ RTFO Order – Fuel suppliers to UK must provide a **volume** of sustainable renewable fuel, based on their overall volume of fuel they supply to road transport
- ▶ This is met by tradable Renewable Transport Fuel Certificates (**RTFCs**) that are awarded per litre/kg of renewable fuel.

Suppliers can get RTFCs by:





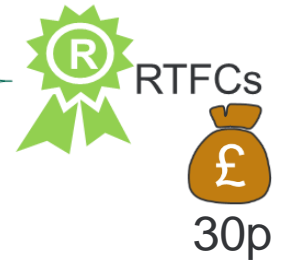
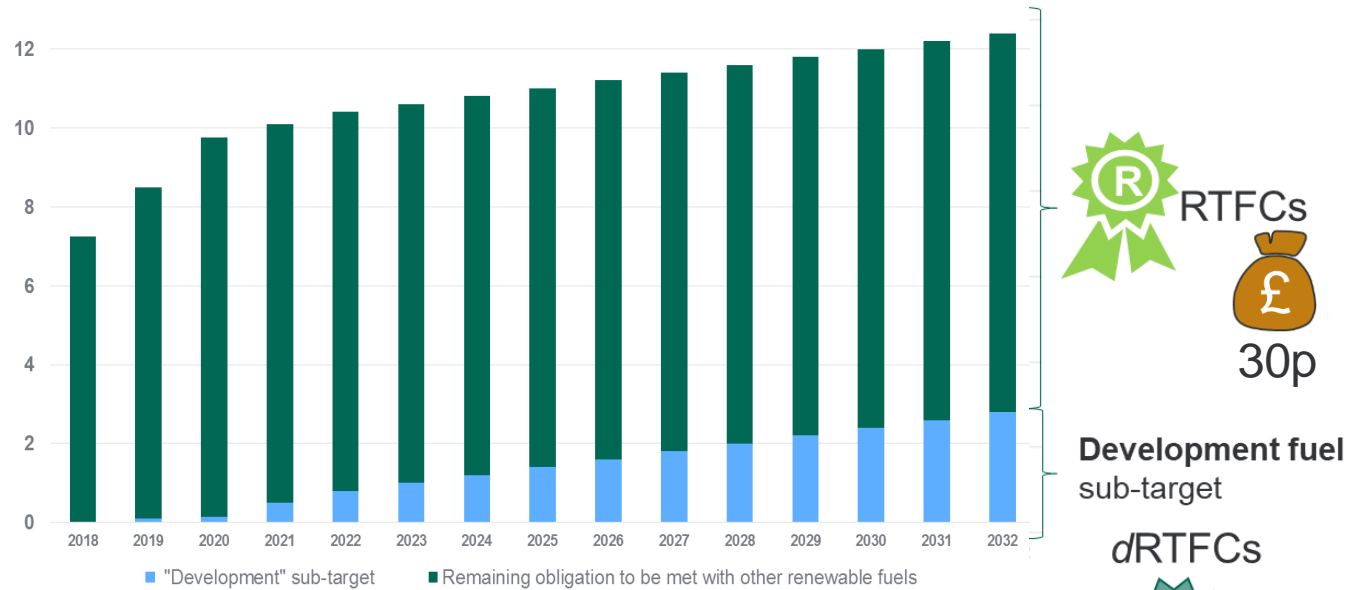
Two obligations

Main RTFO:
“Conventional”
renewable fuels

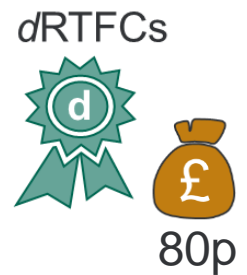
Development fuel:
Advanced renewable
fuels



RTFO obligation and development fuels sub target



Development fuel
sub-target





The RTFO Unit publishes a list of accepted and qualifying feedstocks for RTFCs, and defines:

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



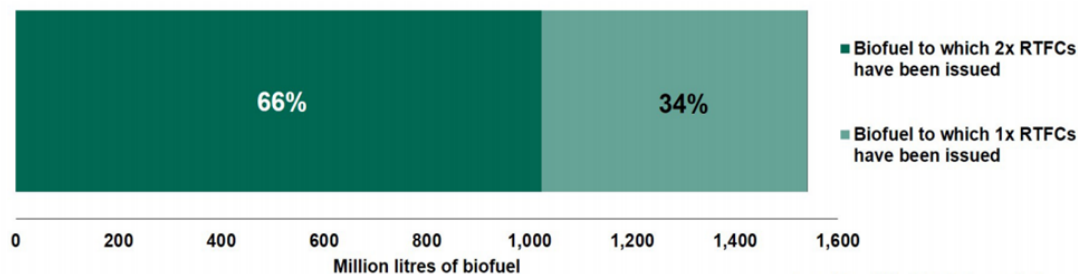
Per kg / litre

- ▶ 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



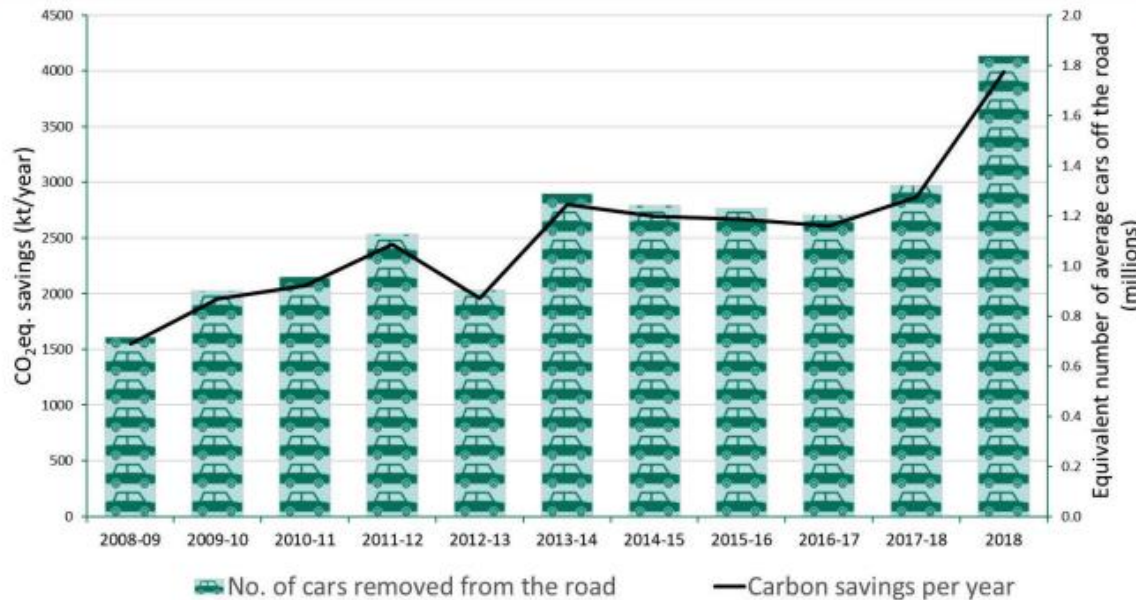
Per kg / litre





Saving GHG emissions from transport

- ▶ Renewable fuels must meet **50%** or **60%** GHG emission saving threshold
- ▶ Compared to a 'fossil fuel comparator'
- ▶ Regulate this via LCA methodology – attributional LCA
- ▶ 2018 saved approx. 4 Mt CO₂
- ▶ Equivalent to taking 1.8 million cars off the road



RTFO Annual Report 2018





How we use LCA



What is your Question?

What are the environmental impacts of producing 1 litre of bioethanol from wheat?

Spot the difference

What are the environmental impacts of producing bioethanol from wheat?

Attributional LCA

- Looks at a single unit of production
- Provides a snap shot of impacts
- Relevant to person causing emissions

Regulation

Consequential LCA

- Looks at changes in production
- Provides a 'great picture' of impacts
- Considers 'knock on' effects

Policy Analysis

The LCA studies will be done in a different way





- ▶ Provides a snap shot of impacts and provides “one answer”
- ▶ **In the RTFO:** GHG Methodology to calculate “carbon intensity” (g CO₂ eq. per MJ fuel) to test whether a renewable fuel meets the minimum GHG emission saving.

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

- ▶ Equation provided in the European Renewable Energy Directive (RED)- harmonisation in methodology across member states- and worldwide.



The RTFO: How we regulate it?

- ▶ RTFO Unit based in Hastings
- ▶ Get around 1,000-2,000 consignments of fuel per month, covering ~300-400 million litres of fuel
- ▶ Suppliers must meet GHG emission saving of 50% or 60%
- ▶ They must provide carbon intensity figure (CI) for their fuel
- ▶ Also need to declare if there are any land use changes that have occurred
- ▶ All applications must be verified by third party independent verifier
- ▶ 98% of fuel is audited by a Voluntary Scheme, who calculates the CI





RED GHG Accounting Methodology: Equation

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$





$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

E_{ec} = Emissions from extraction or cultivation of raw materials

E_l = annualised emissions from carbon stock changes caused by land-use change

E_p = emissions from processing

E_p = emissions from transport and distribution

E_u = Emissions from fuel in use (equal zero)

E_{sca} = emission saving from soil carbon accumulation via improved agricultural management

$E_{ccs/ccr}$ = emission saving from carbon capture

E_{ee} = emission saving from excess electricity from cogeneration





$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

E_{ec} = Emissions from extraction or cultivation of raw materials

E_p = emissions from processing

E_p = emissions from transport and distribution

We usually only see these ones used/reported





- ▶ Looks at consequences of changes in production on overall GHG emissions
- ▶ E.g. Indirect land use effects
 - ▶ Considers the GHG impacts of indirect land use change due to increased demands for crops for renewable fuel production.
 - ▶ Avoiding GHG emissions that occur due to waste disposal
- ▶ These are usually impacts that are directly out of the control of the supplier, but we want to encourage suppliers to choose outcomes that lead to GHG emission savings – and tailor policies accordingly





REDII and “Recycled Carbon Fuels”

- ▶ Following RED, REDII was finalised in December 2018- and introduces “recycled carbon fuels” that can contribute to the share of renewable energy in the transport sector
- ▶ **Recycled carbon fuels are transport fuels made from fossil derived wastes that are not suitable for reuse or recycling, or cannot be avoided.**
- ▶ **Therefore- there has since been increasing interest in ‘recycled carbon fuels’ by fuel developers and we have been considering if they can deliver GHG emission savings.**
- ▶ REDII is yet to set out a methodology to calculate GHG emission saving thresholds from recycled carbon fuels so we are proposing to develop our own GHG methodology





Fuels made from waste plastic?

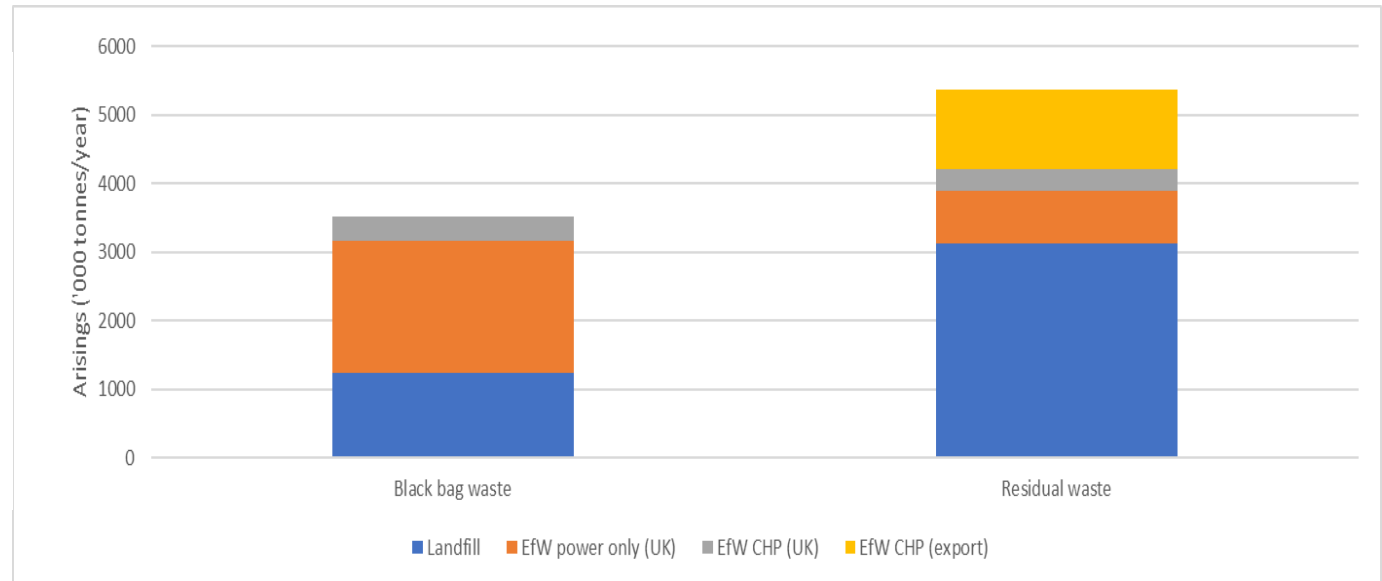


- The Government currently incentivises the use of biomass waste for fuel production.
- But a good proportion of this is heavily mixed with plastic- difficult to separate and must be disposed of together.
- E.g. contaminated food packaging, polycotton textiles, sanitary waste.
- We recognise that RCFs are not **renewable** but have explored the potential GHG emission savings that can be achieved by RCFs





How is this waste currently disposed of?



Black bag waste and residual wastes ~ 23-30 MT – **not recyclable material**

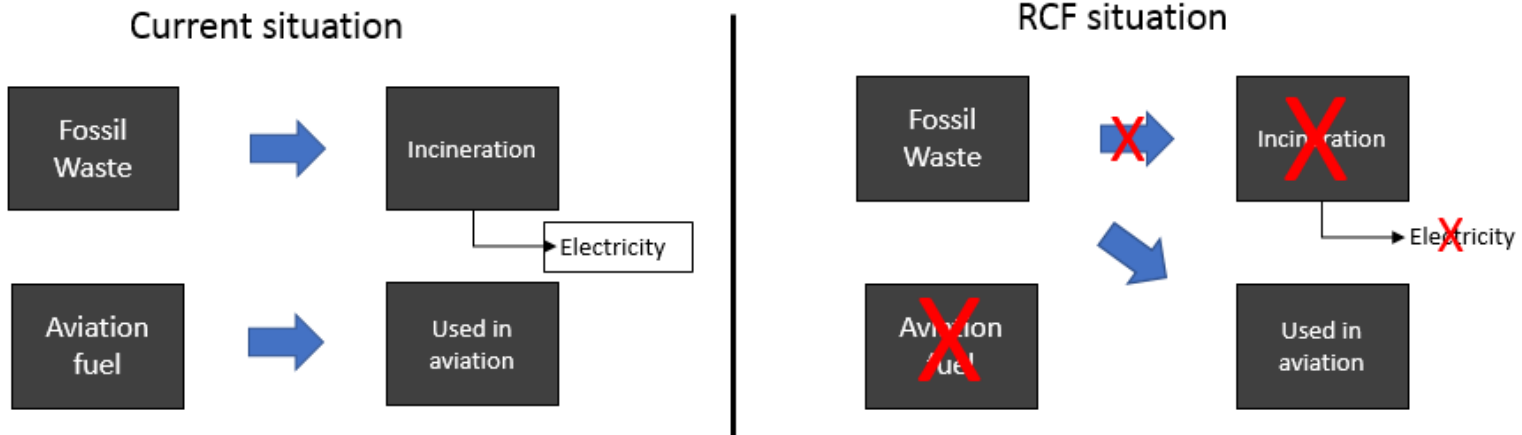
Landfill is the most common end-of-life fate (~50%)

Followed by incineration for electricity (~30%) and for electricity and heat (~20%).





- ▶ Compared the GHG emissions from changing how fossil wastes are currently disposed



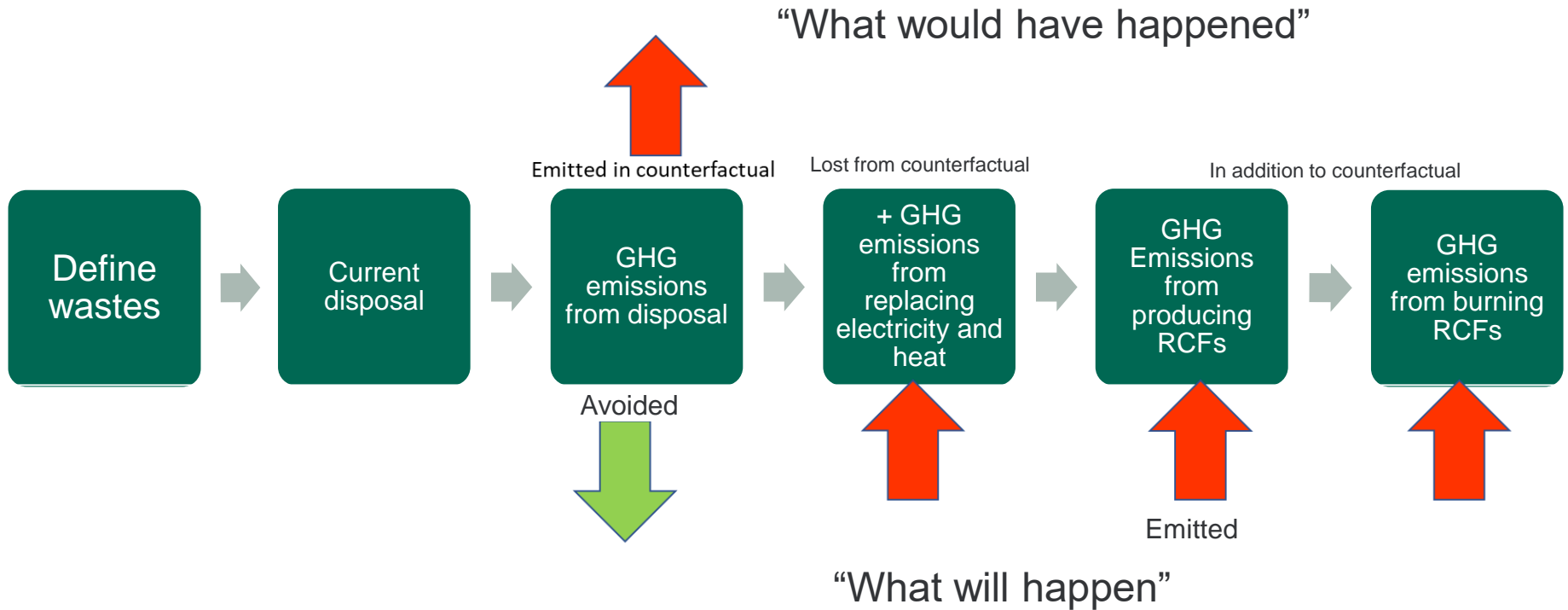
X = avoided GHG emission





Calculating the GHG emission savings

- ▶ Calculates GHG emissions from





The GHG emissions from disposal

- Landfill – negligible for fossil component – not for biological waste however
- Energy from waste (EfW) GHG emissions from **combusting** the waste to generate heat or power
- These emissions are avoided in the RCF scenario- but that also means there is a penalty in the RCF scenario



PENALTY!

Landfill	EfW (power)	EfW (CHP)	Export CHP	Gases only: Coke ovens
No replacement	Grid average electricity (2024 projected)	Grid average electricity and natural gas	Grid average electricity in country and natural gas	Natural gas





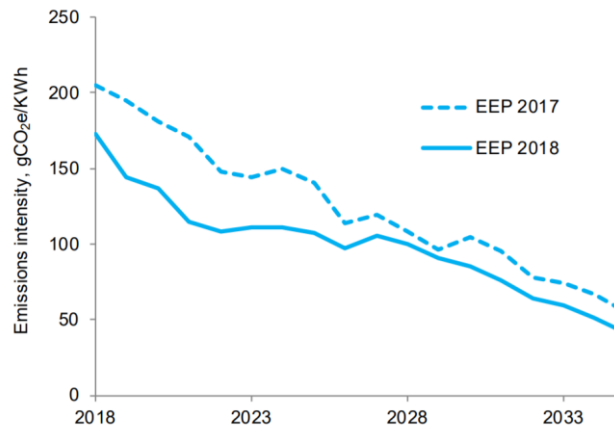
The GHG emissions from replacing electricity and heat

➤ The heat and electricity needs to be replaced... but what with?

➤ Also need to think how this may change over time



Landfill	EfW (power)	EfW (CHP)	Export CHP	Heat only (cement kilns)	Export cement kiln (EU av. Mix)	Gases only: Coke ovens
No replacement	Grid average electricity	Grid average electricity and natural gas	Grid average electricity in country and natural gas	Cement kiln mix (coal, natural gas, biomass)		Natural gas



https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794590/updated-energy-and-emissions-projections-2018.pdf





- ▶ GHG Emissions from producing RCFs
 - ▶ Are there any opportunities to capture carbon during the processing stages?
 - ▶ Gasification technologies produce a pure CO₂ stream from the gasifier that could be captured.

- ▶ Unlike biofuels, CO₂ emissions from burning RCFs are accounted for
 - ▶ This is fossil CO₂



CO₂
↑





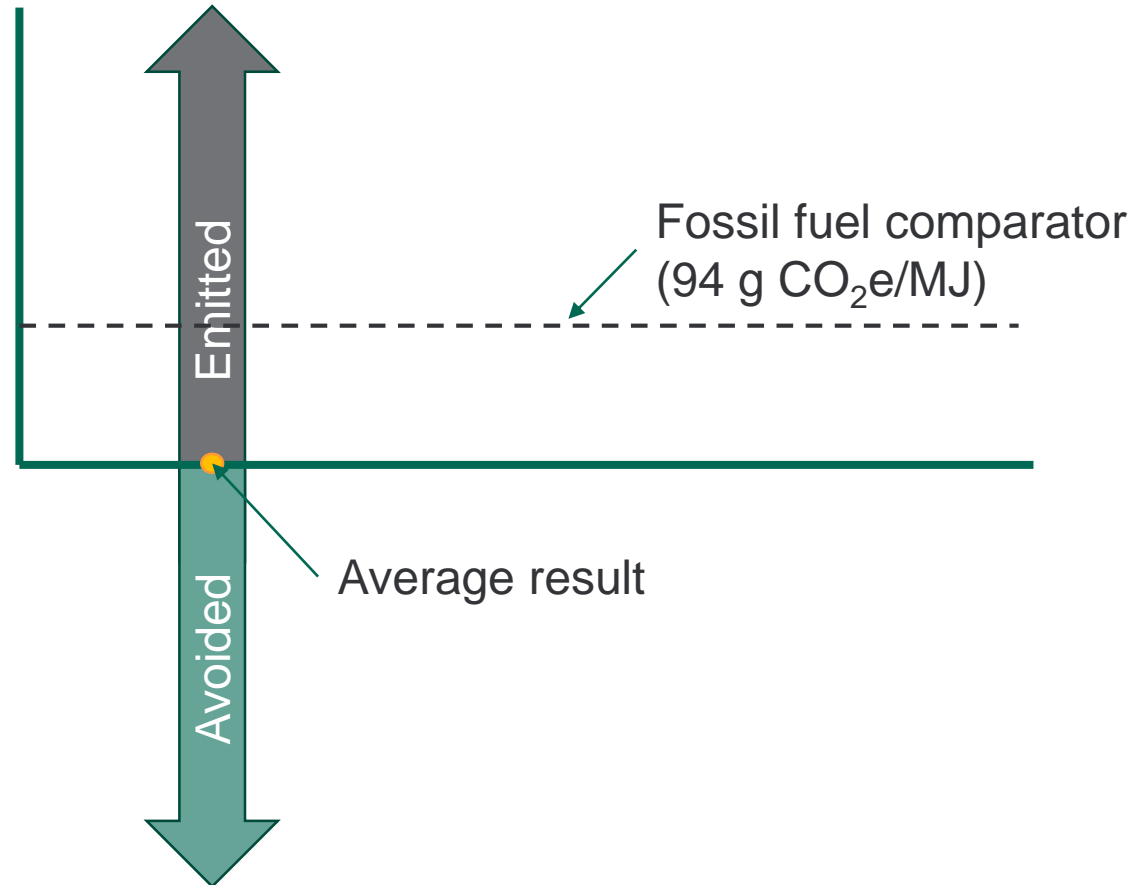
Emitted when we make RCF

- Combustion emissions
- Processing emissions
- Energy 'penalty'



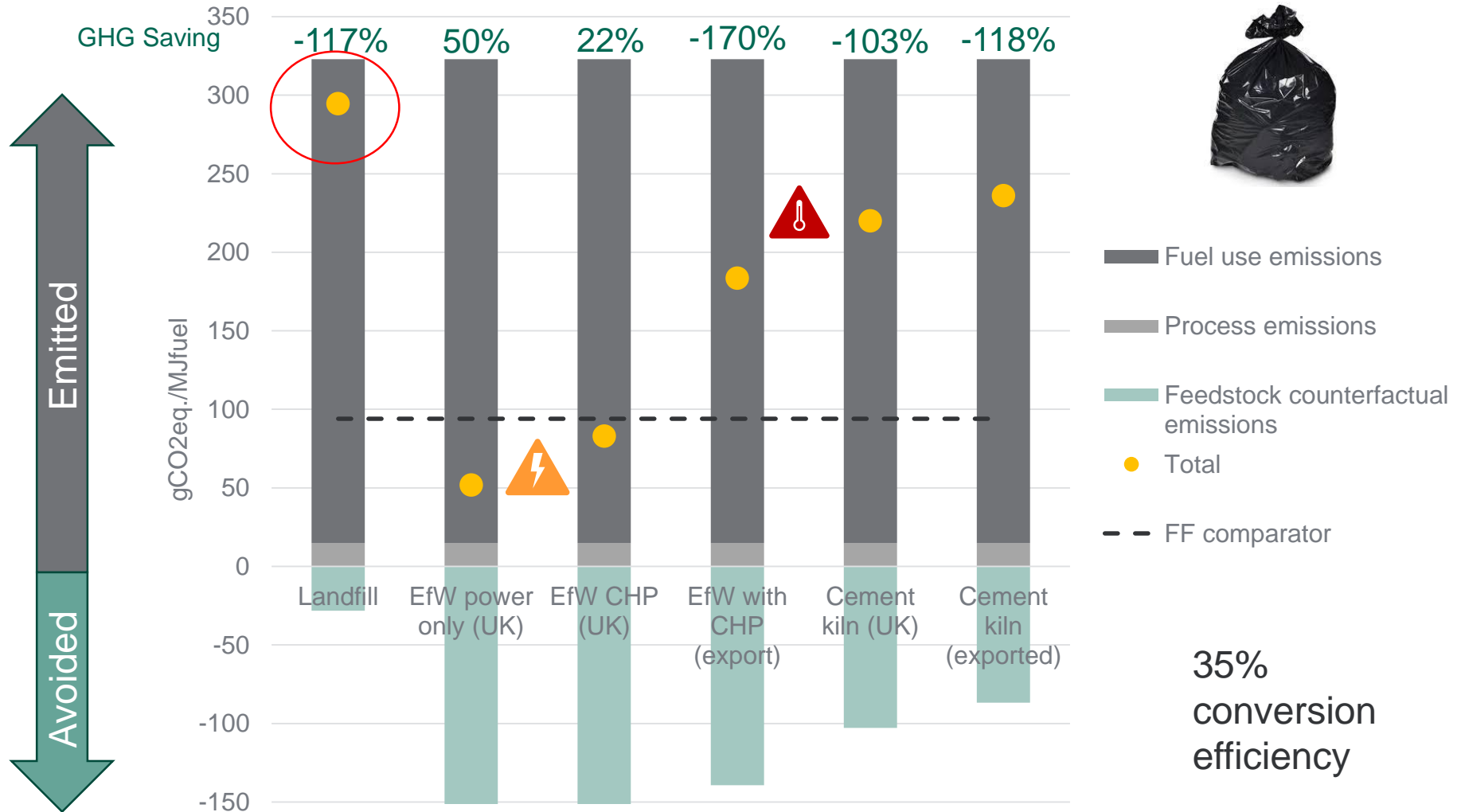
Avoided when we make RCF

- Emissions from
incineration





The counterfactual affects the results



35% conversion efficiency





- ▶ Is landfill an appropriate comparison system for RCF feedstocks?
 - ▶ UK: Targets to reduce waste to landfill
 - ▶ **Landfill not an option we should compare against**
- ▶ Does it act as a carbon store?
 - ▶ There is a considerable biological component of the waste would degrade and be emitted as **methane**.
 - ▶ Could remodel RCF study to include biogenic methane
 - ▶ But we know that it's good to divert biomass from landfill
- ▶ ***Change of question:*** If material is diverted from landfill- where should it go?





If material is diverted from landfill- where should it go?

- ▶ Our research suggests RCFs are “next best” option compared to landfill
 - ▶ If the RCF plant is more efficient than an incinerator
 - ▶ If burning waste is higher GHG than the grid average electricity
 - ▶ If the feedstock is mixed with biomass- all the better.
 - ▶ **Can use these criteria to build the GHG assessment methodology**





- ▶ What is the risk that the policy objective will not be met?
- ▶ The policy objective is to reduce GHG emissions (from transport).
- ▶ Need to test the risks against the results of the LCA model
- ▶ **“Pre-Mortem” Questions to determine impact on GHG emissions**
 - ▶ What different types of RCF could there be?
 - do they have the same counterfactual?
 - What if we supported all RCF at the same level?
 - ▶ Where do the savings occur? What happens when we import RCFs from abroad?
 - ▶ How do we stop recyclable material getting in?
- ▶ **Test the model and find options that mitigate risk by:**
 - ▶ Adding specific feedstock criteria
 - ▶ Not allowing double counting of savings
 - ▶ Setting appropriate financial support



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- ▶ UK is committed to the Net Zero by 2050- challenge to find more options for mitigating GHG emissions where possible
- ▶ The RTFO mitigates on average 2.5 Mt CO₂ eq./year and this due to increase over time with increasing targets
- ▶ The RTFO uses (a)LCA to regulate the GHG emissions savings of renewable transport fuels- only supporting those that meet the minimum criteria
- ▶ Policy development requires a consequential LCA modelling to understand the GHG impacts of new policies
- ▶ The (c)LCA model can be tested to assess the risk of the policy not meeting the objectives, and the policy can be tailored accordingly.





- ▶ We're going to be consulting on this policy later this year.
 - ▶ Will include changes on
 - E10
 - Sustainability criteria
 - Changes to how we support hydrogen
 - RCFs

- ▶ **REDII and EU Exit?**

- ▶ Any questions or follow up conversations contact me on carly.whittaker@dft.gov.uk

- ▶ **Happy to take questions now from the LCA experts!**

- ▶ Links to reports
- ▶ 2018 Study <https://www.e4tech.com/resources/129-low-carbon-fossil-fuels-sustainability-risks-and-accounting-methodology.php>
- ▶ 2019 Study <https://www.gov.uk/government/publications/greenhouse-gas-emissions-created-by-producing-fuels-from-fossil-wastes-and-residues>





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