Comparing emissions from alternative energy vectors

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LowCVP Seminar: Moving to a life-cycle assessment of vehicle emissions

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Why is LC GHG emissions an important metric?

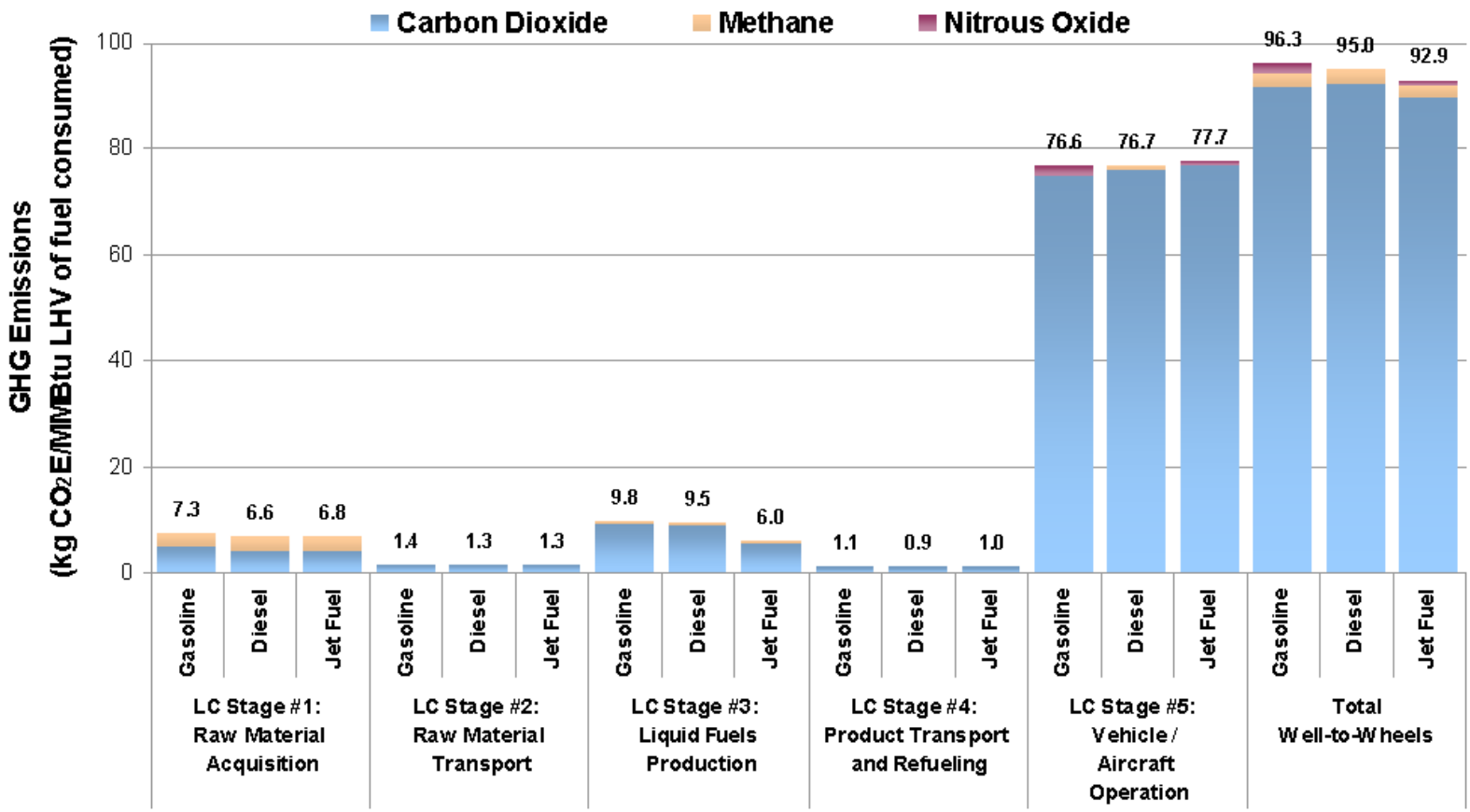
- GHG emissions reduction an important driver for alternative fuels uptake
- Accurately estimating emissions important for policy objectives and for fair comparison of chains
- Definition, methodological and data issues affect the comparison of different chains
- Different fuel chains have very different characteristics, emissions profiles across the chain (and beyond), and uncertainties

What affects LC GHG emissions estimates?

- GHG emissions considered
- Fuel chain characteristics (inc technology, operations, location, timing)
- Boundaries
- Co-products
- (Data) uncertainties

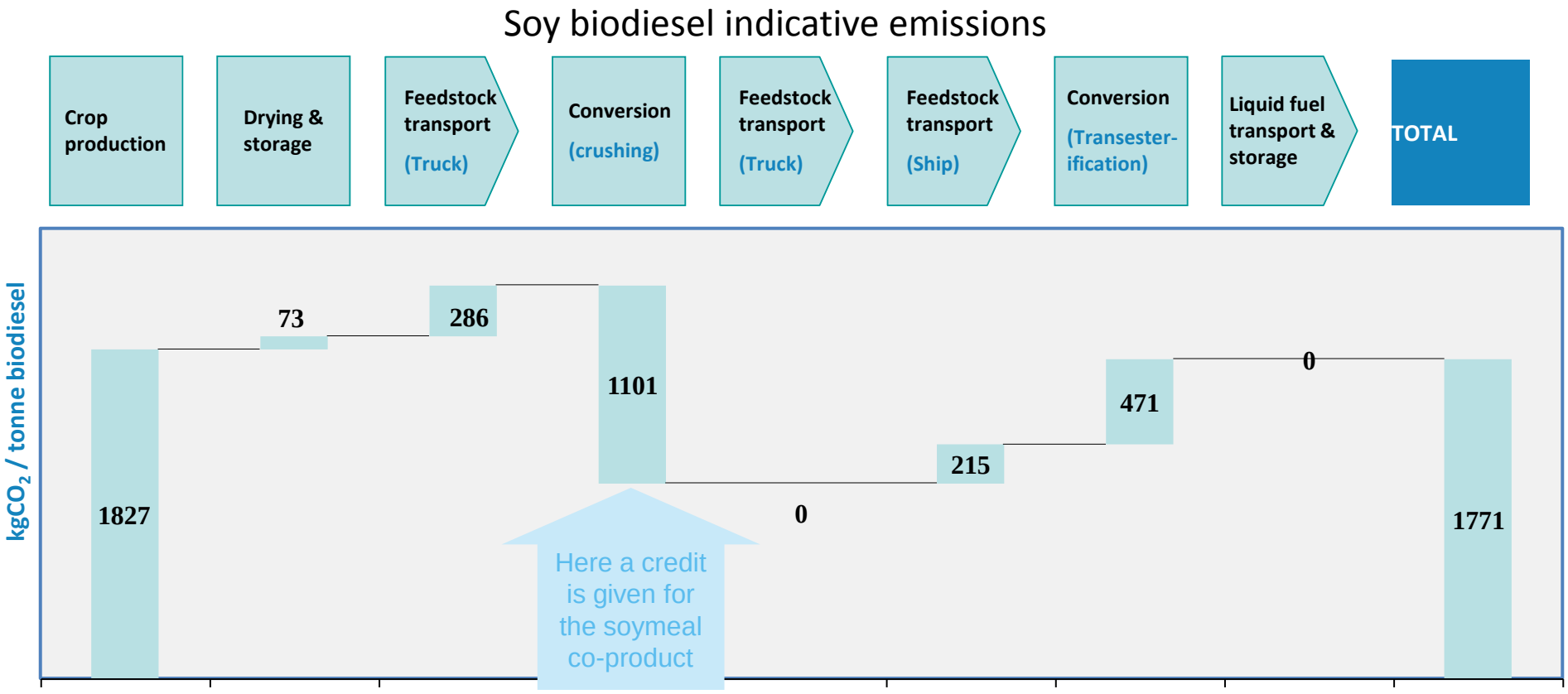
GHG emissions – what emissions and where they occur

Figure ES-3. Life Cycle GHG Emissions for Conventional Transportation Fuels in kg CO_2E per MMBtu LHV Fuel Consumed



Source: DOE-NETL (2009)

GHG emissions – what emissions and where they occur



Source: E4tech

GHG emissions – what emissions and where they occur

Effect of fugitive methane emissions on LNG

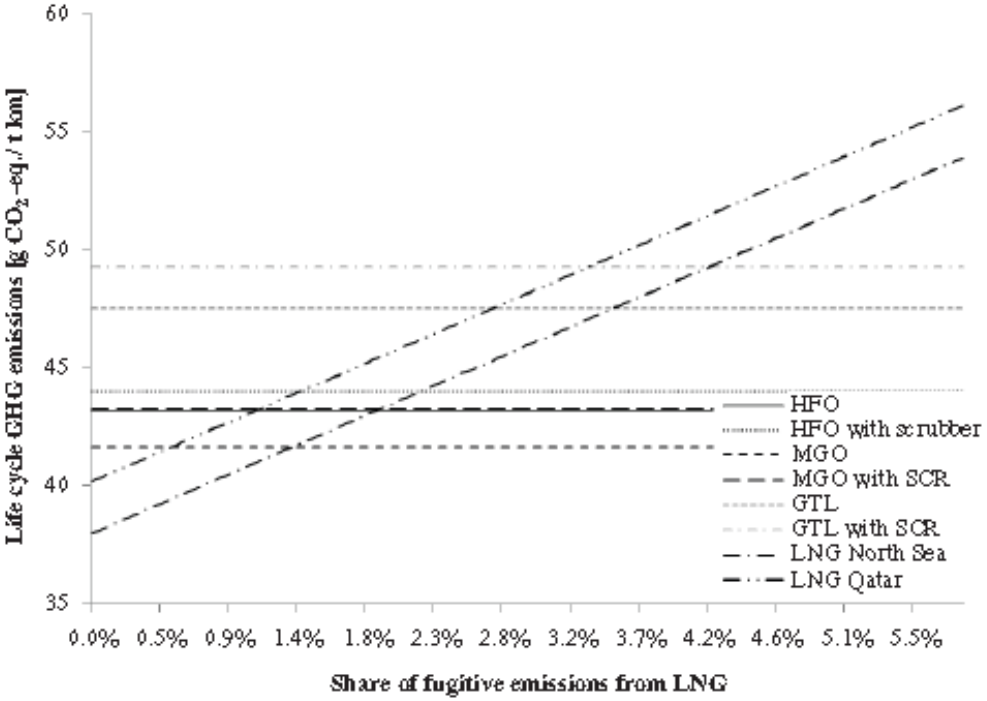
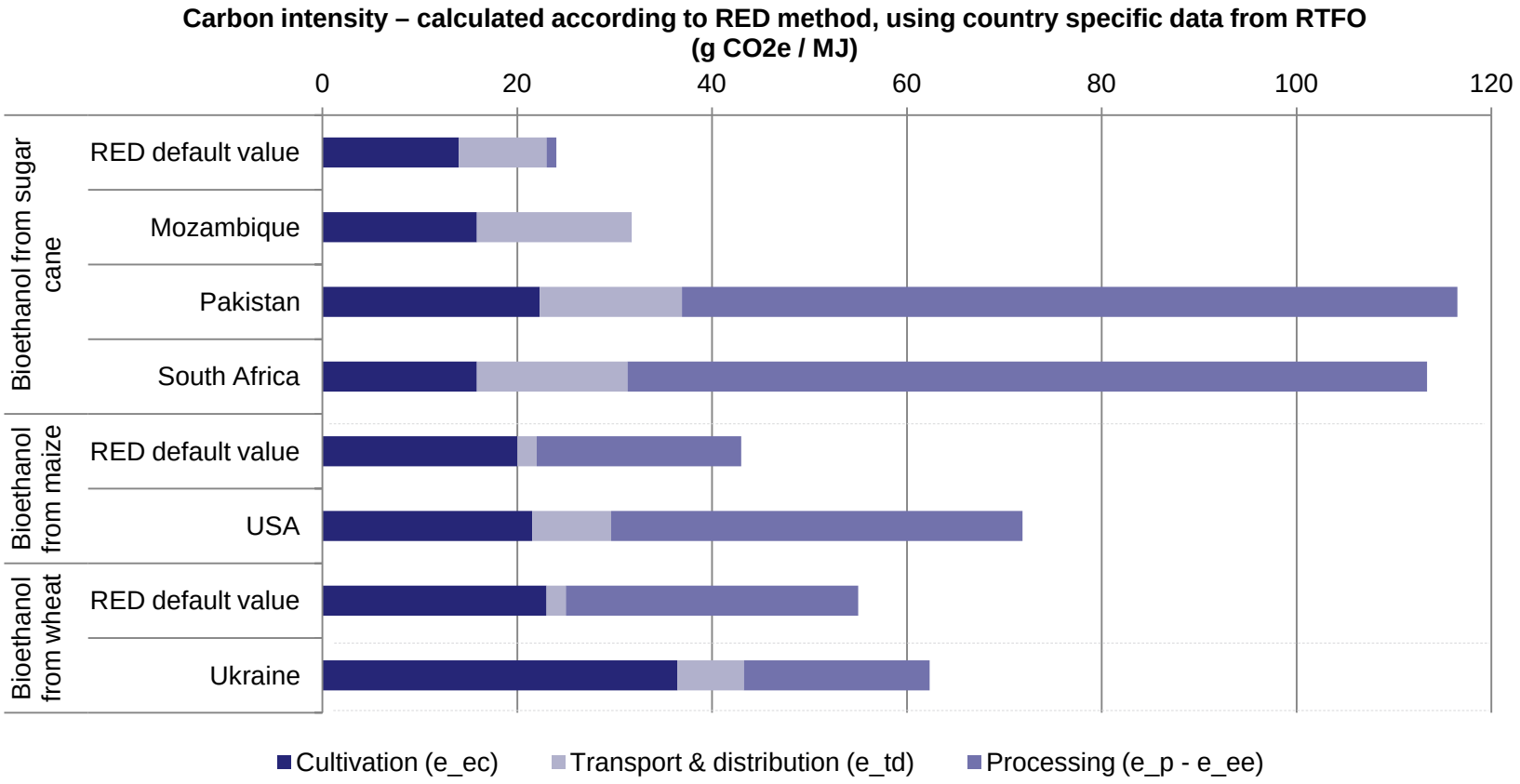


Fig. 4 Life cycle GHG emissions versus the amount of fugitive emissions of methane

Source: Bengtsson et al. (2011)

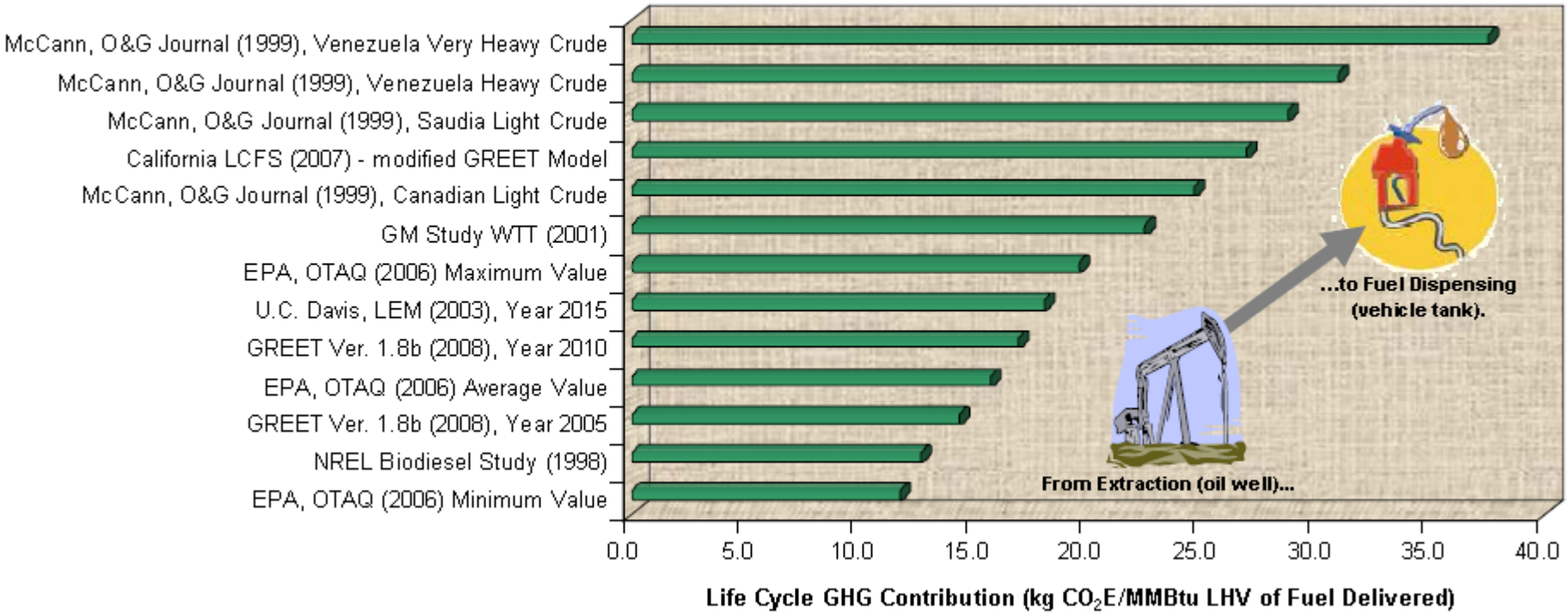
Fuel chain characteristics – effect of location and practices



Source: E4tech

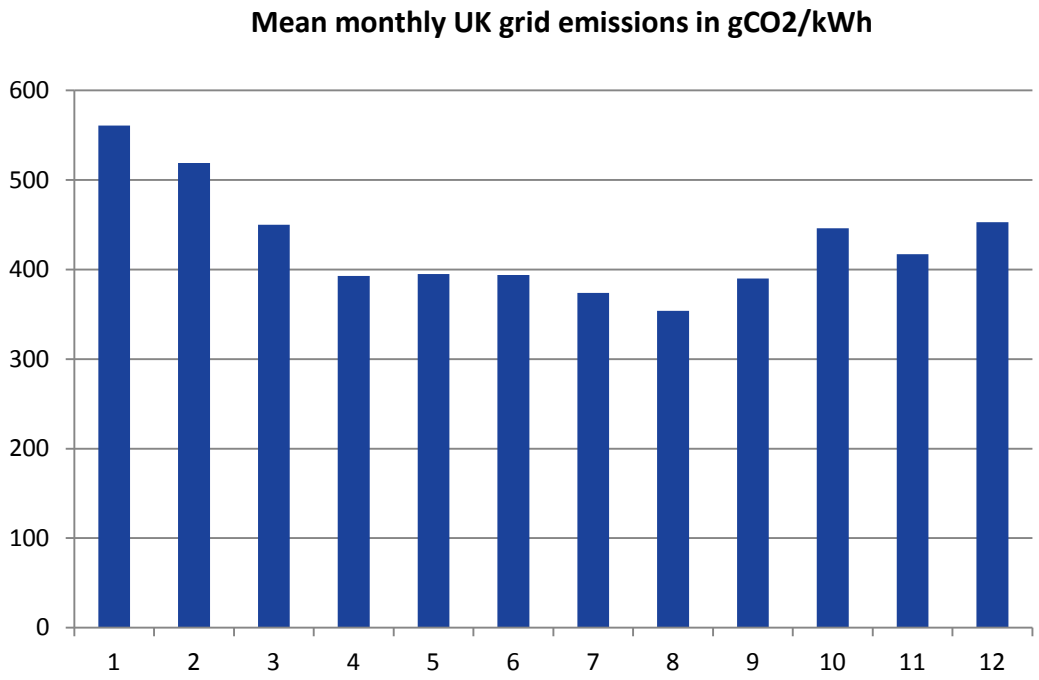
Fuel chain characteristics – effect of location and practices

Figure ES-4. Comparison of Diesel Fuel Greenhouse Gas Profiles from Various Studies



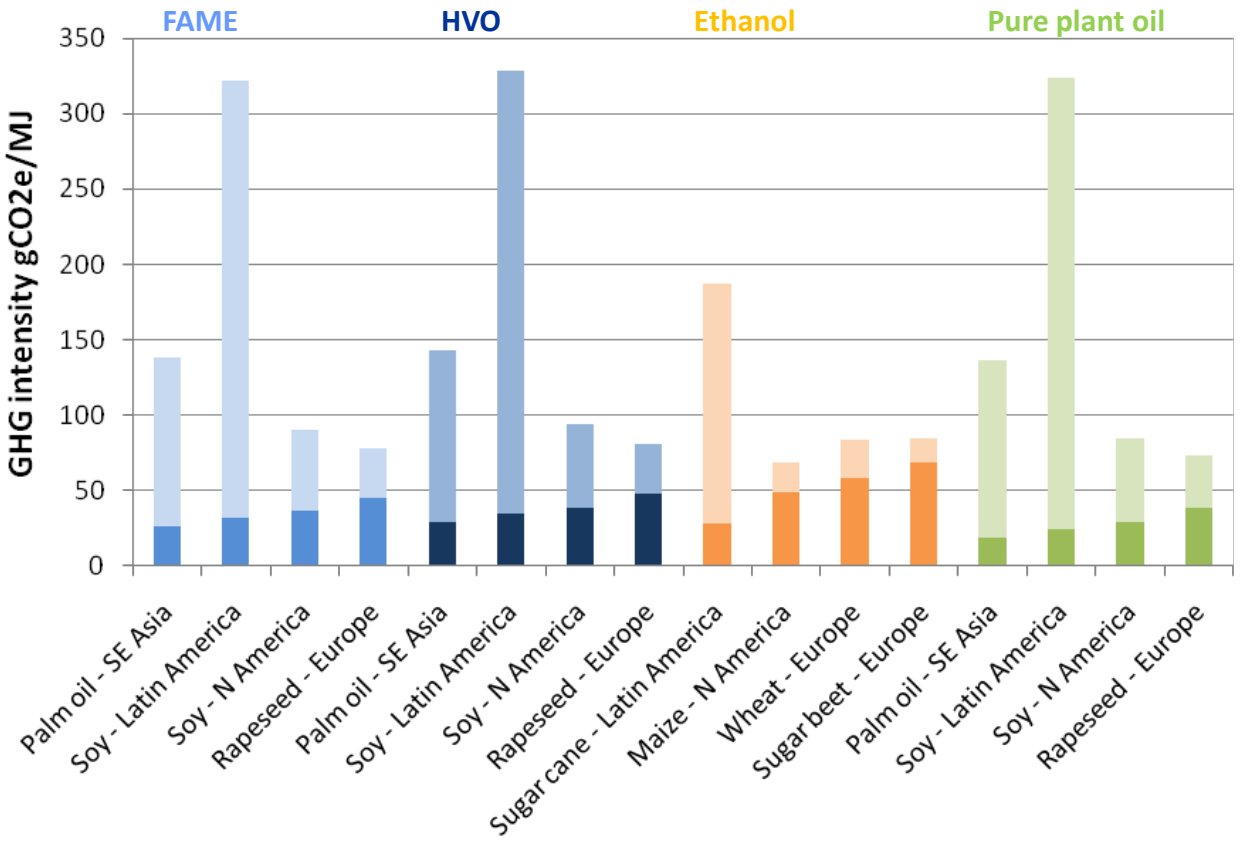
Source: DOE-NETL (2009)

Fuel chain characteristics – effect of location and practices



Source: http://www.earth.org.uk/note-on-UK-grid-CO2-intensity-variations.html

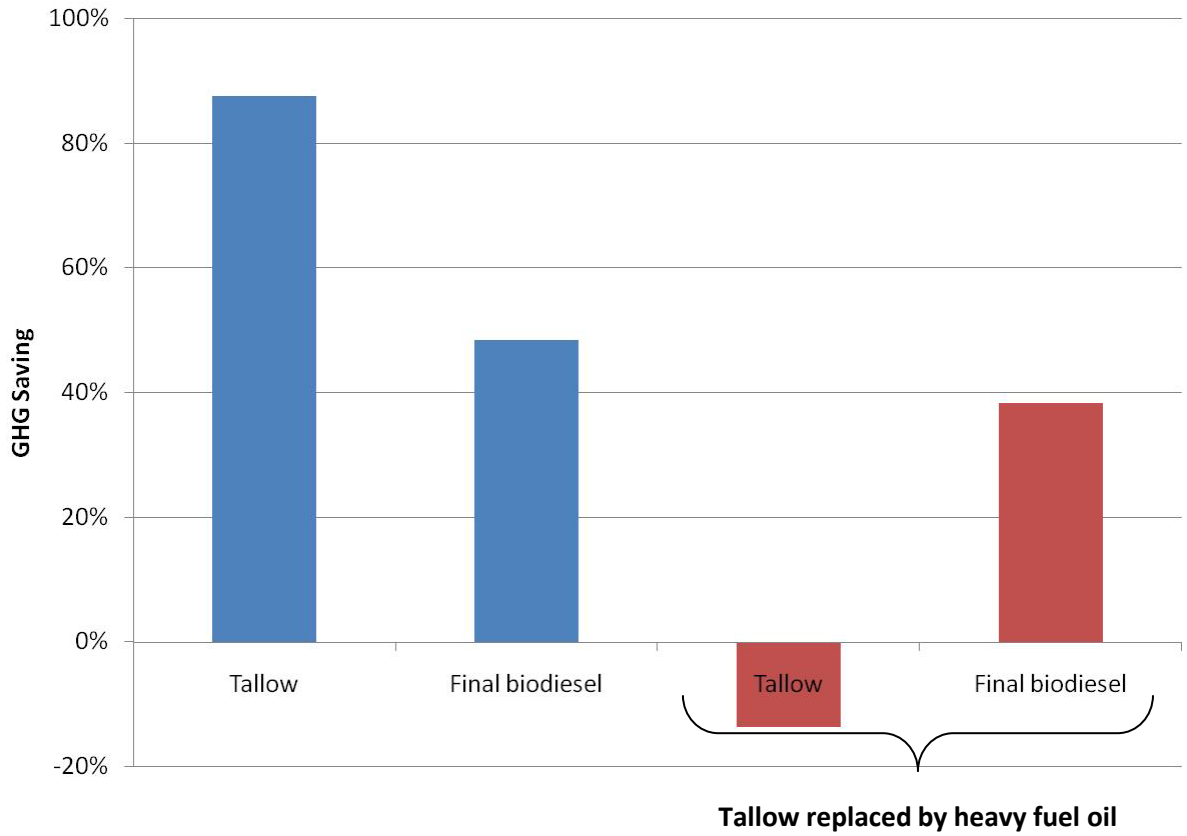
Boundaries – effect of land use change on biofuels



Source: E4tech

The bottom portion of each bar is the default value with no land use change
The top portion shows the emissions from land use change

Boundaries – effect of market substitution effects



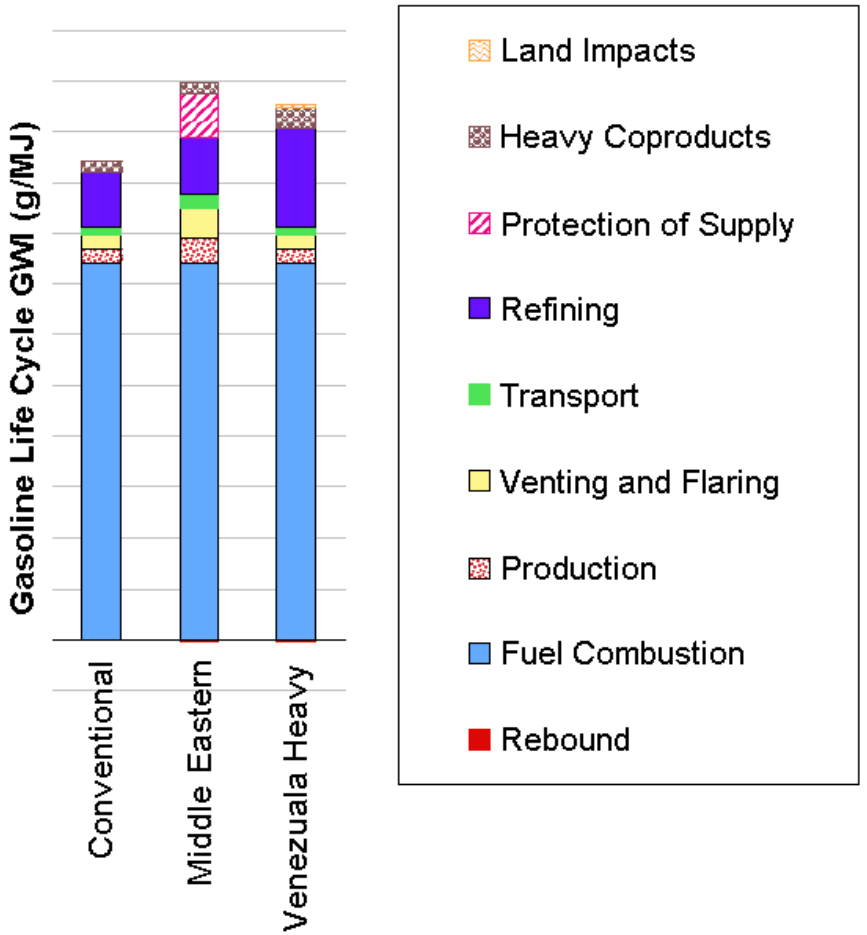
Source: E4tech

Boundaries – effect of additional direct and indirect effects on petroleum fuel production

Life Cycle GHG Emissions for Gasoline

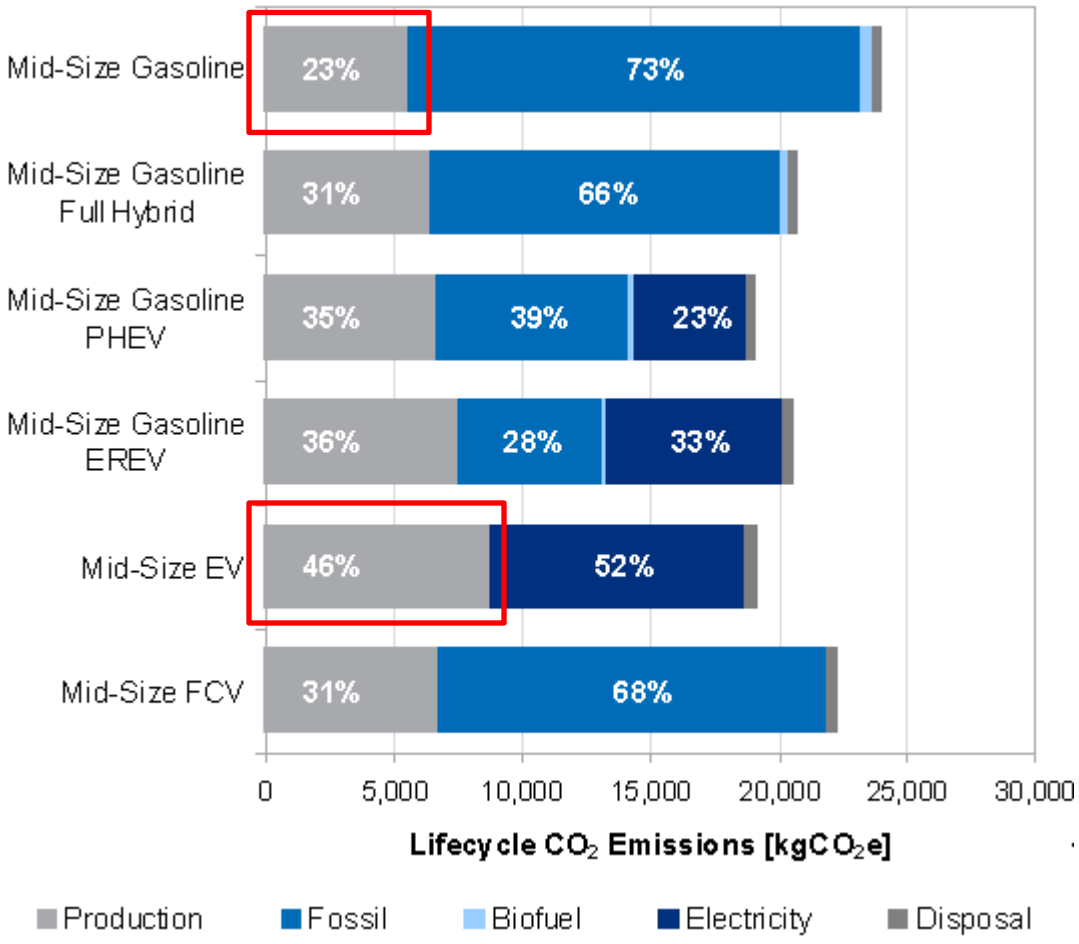
Direct + Indirect

Vehicle + Fuel Cycle



Source: S Unnasch (2009)

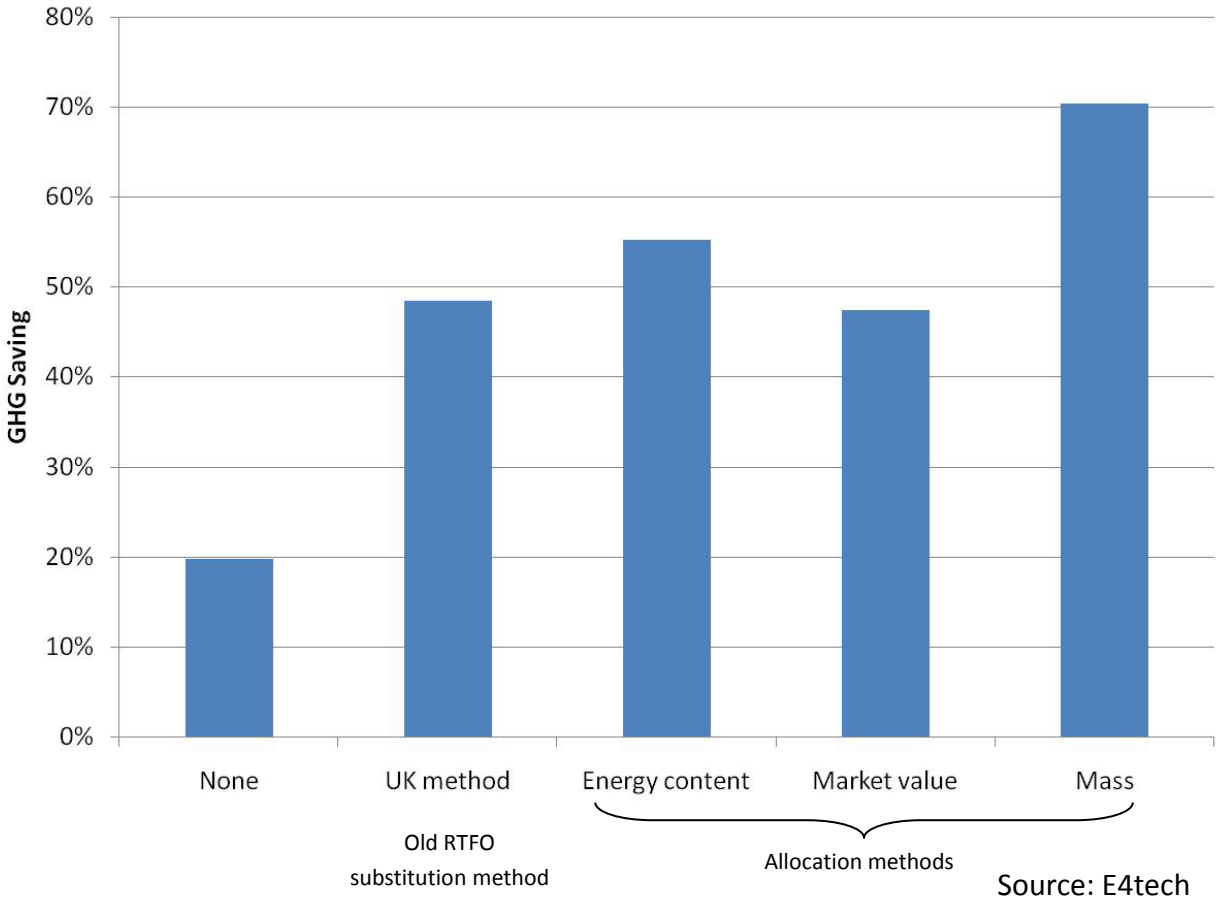
Boundaries – effect of embedded emissions



Source: Ricardo (2011)

Co-products – effect of attributing emissions or credits

Example of biodiesel produced from a mix of vegetable oils and animal fat



Source: E4tech

Co-products – effect of attributing emissions or credits

Influence of different allocation methods at refineries

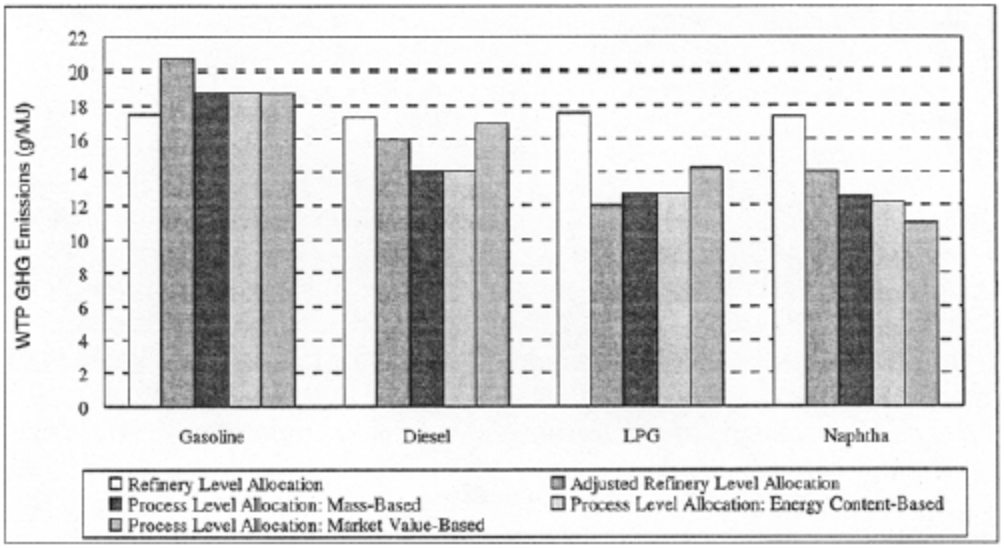


Fig. 4: Well-to-pump greenhouse emissions for fuel production: grams per mj of fuel available at fuel pump

Source: Wang et al. (2004)

(Data) Uncertainty

Example of uncertainties associated with ILUC

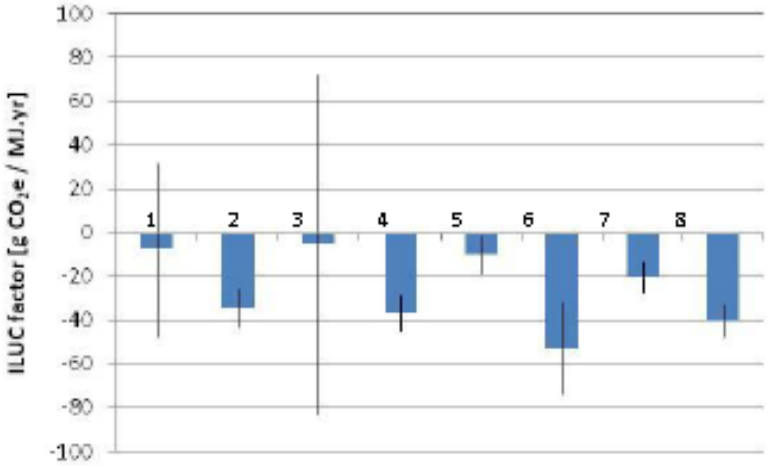


Figure 29. Indirect land use change impacts for the different scenarios modelled for wheat bioethanol.

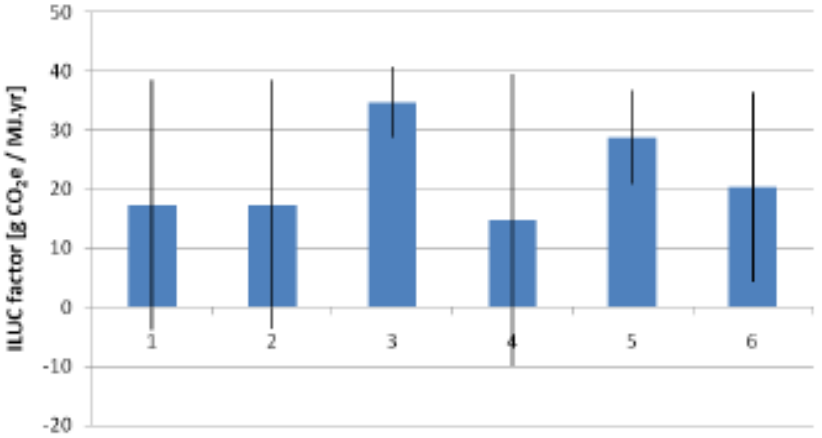


Figure 15. Indirect land use change impacts for the different scenarios modelled for oilseed rape biodiesel.

Source: E4tech (2010)

How can LC GHG emissions comparisons evolve?

- Harmonisation of definitions, methods and data
- Research and understanding to inform LCA
- Practicality for integration into policy making
- Flexibility for evolution with changing systems