

LCA of Bio-Oils and Energy Crops

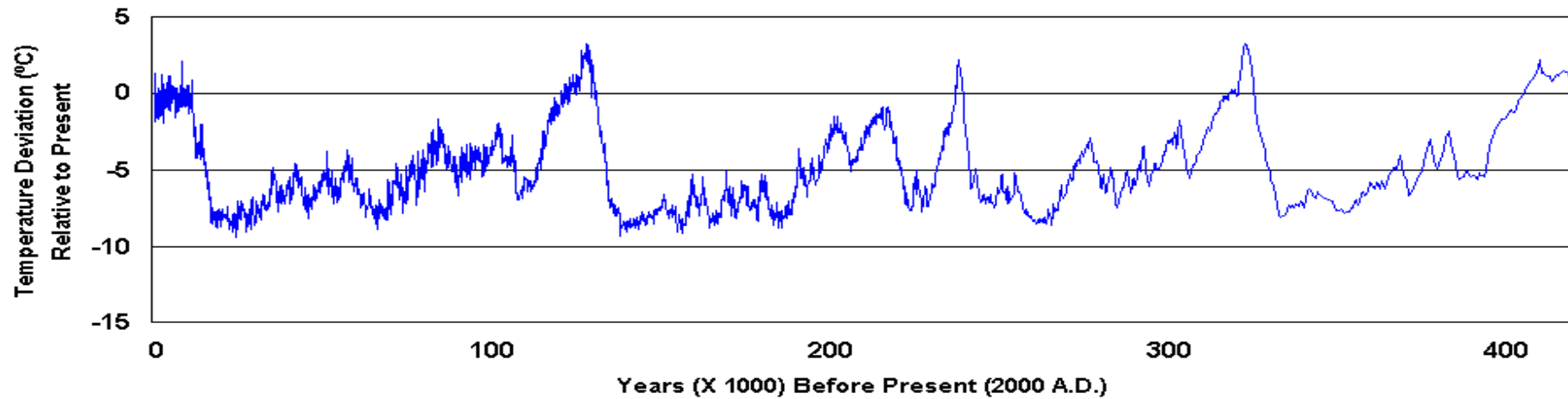
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University of Bath

Drivers for Bio-energy

- Kyoto
- Renewable Energy Targets
- Fuel Security
- RTFO (in Europe)
- Easy to use with current infrastructure and technology

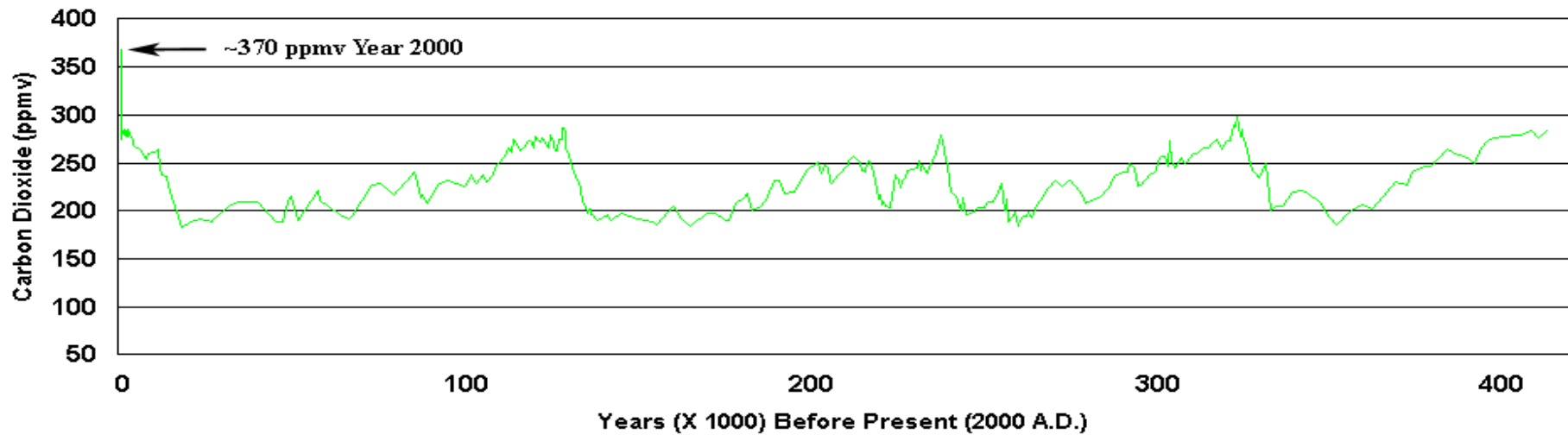
Temperature of Lower Atmosphere Last 400,000 Years

From Antarctica ice and air data



Atmospheric CO2 Concentrations Last 400,000 Years

From Antarctica Ice and air data



Source: http://www.geocraft.com/WVFossils/last_400k_yrs.html

and http://www.geocraft.com/WVFossils/last_400k_yrs.html, based on publications from Nature



Changing media coverage...

- “UK 'lacks ambition' on bioenergy”
 - BBC News, 18 September 2006
- “Bioenergy: Fuelling the food crisis?”
 - BBC News, 4 June 2008
- Secret report: biofuel caused food crisis
Internal World Bank study delivers blow to plant energy drive (Guardian, July 4th 2008)



TELL THE GOVERNMENT
TO CHOOSE THE RIGHT
BIOFUEL

OR THE
ORANG-UTAN
GETS IT

Friends of the Earth Advert : 2007



Port-au-Prince, Haiti: Residents protest against food price rises in front of UN peacekeepers in April

Borneo, Malaysia: A worker harvests palm oil

Brazil: Large fields of soy



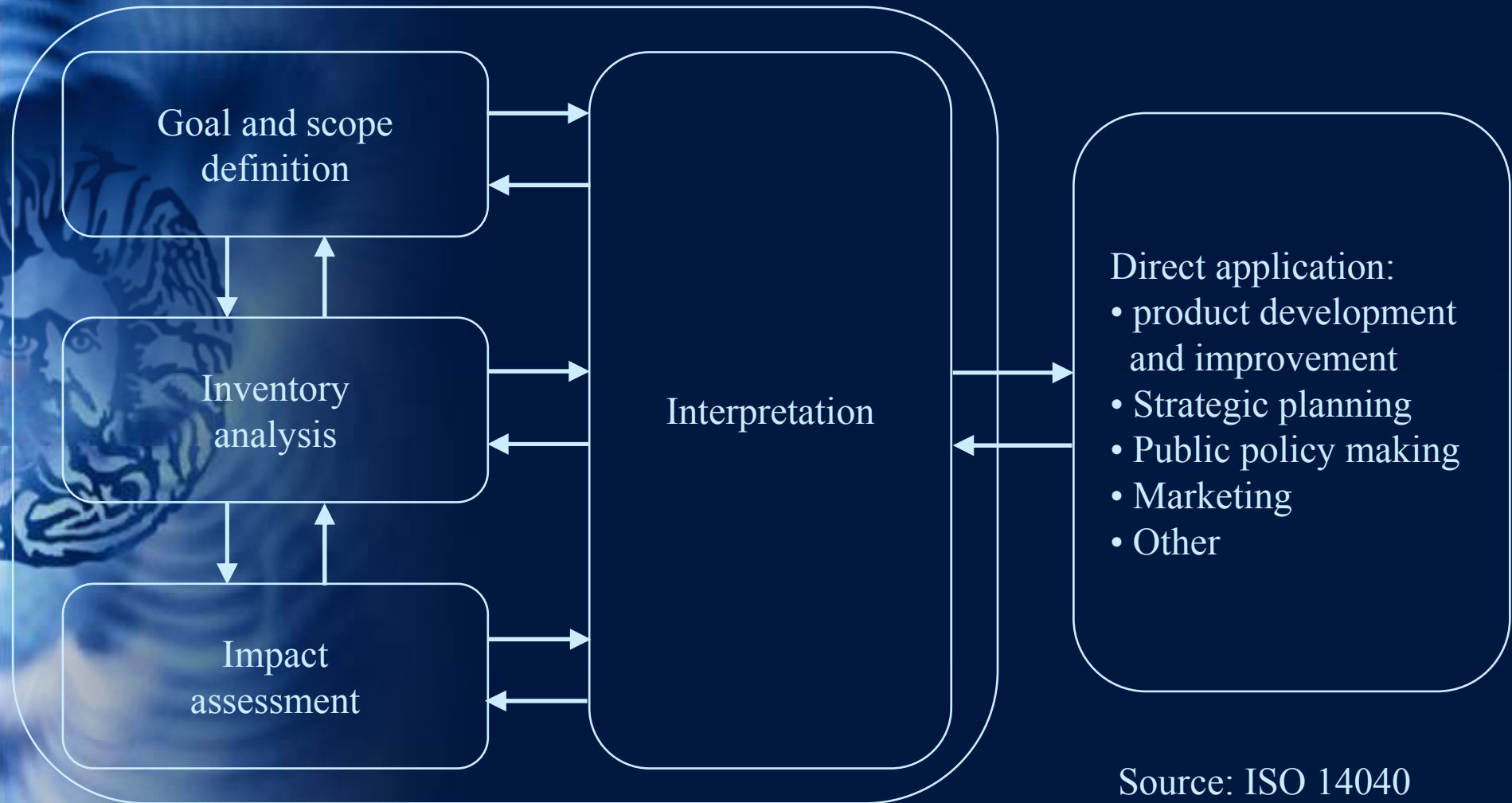
Source: www.guardian.co.uk

Can Bio-energy help?

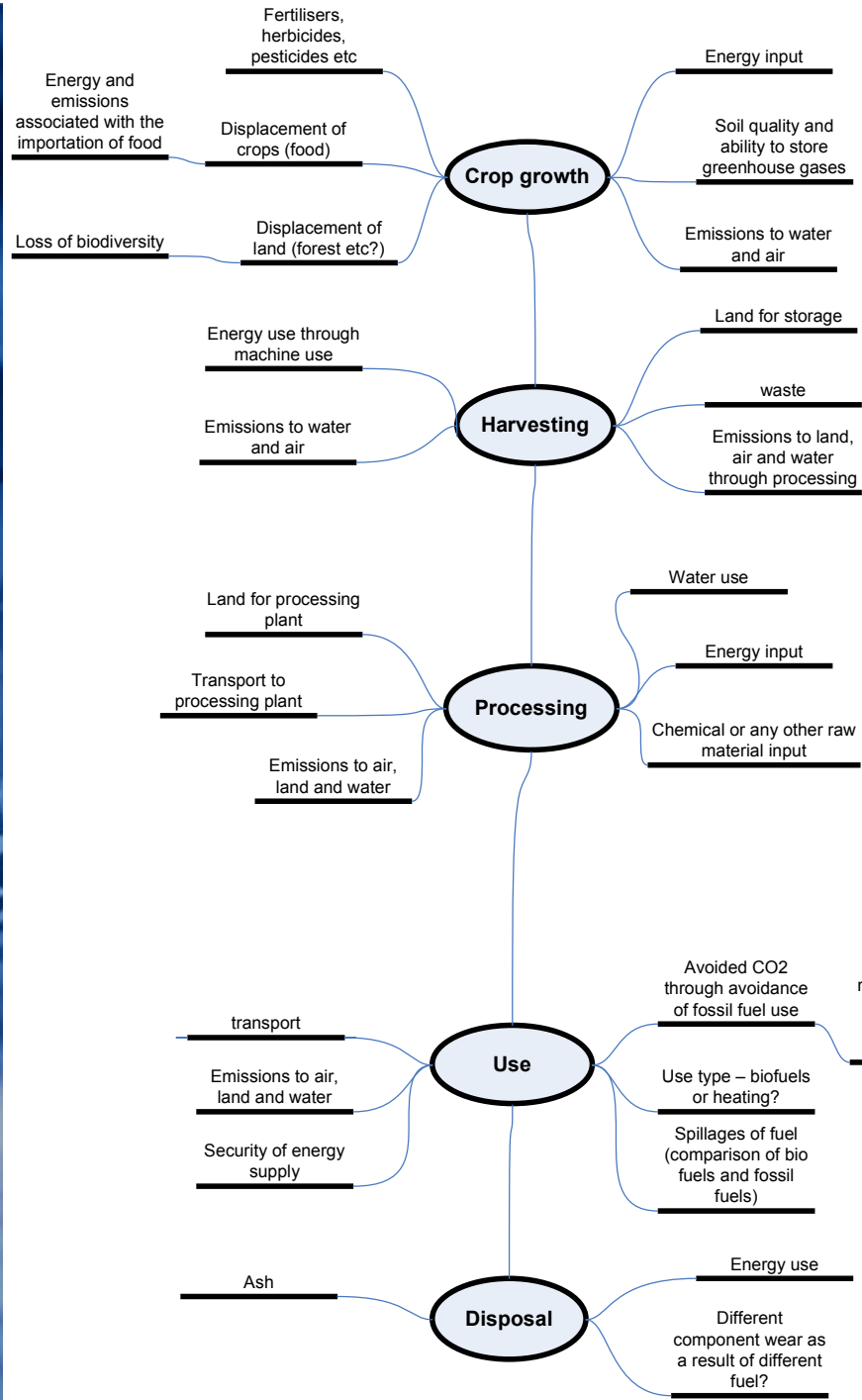
- Need to ensure we understand the impacts of decisions
- Comprehensive research on land availability, energy and water use, food importation, fertiliser use etc...
- Wider questions – which of these impacts, eg food shortages, are associated with bio-energy? Which with drought, conflict etc?
- Attributional and Consequential LCA
- Two case studies, biofuel and heat

Life Cycle Assessment Framework according to ISO 14040

Four different phases of LCA can be distinguished:



Source: ISO 14040



Biofuels from crops

Ideal Energy Crops

- high yield (maximum production of dry matter per hectare)
- low energy input to produce
- low cost
- composition with the least contaminants
- low nutrient requirements

Land Use Conflict

- Land “squeeze” becomes more prevalent as land is required for food, housing and energy
- There are bio-fuel targets, although these might be revised
- In the UK in order to meet the 5% biofuels blend in the RTFO targets approximately 10% of the total agricultural land would be required

Main Feedstocks

- Arable/Annual

- Rapeseed, wheat, maize, sugar beet, potatoes

- Herbaceous Perennials

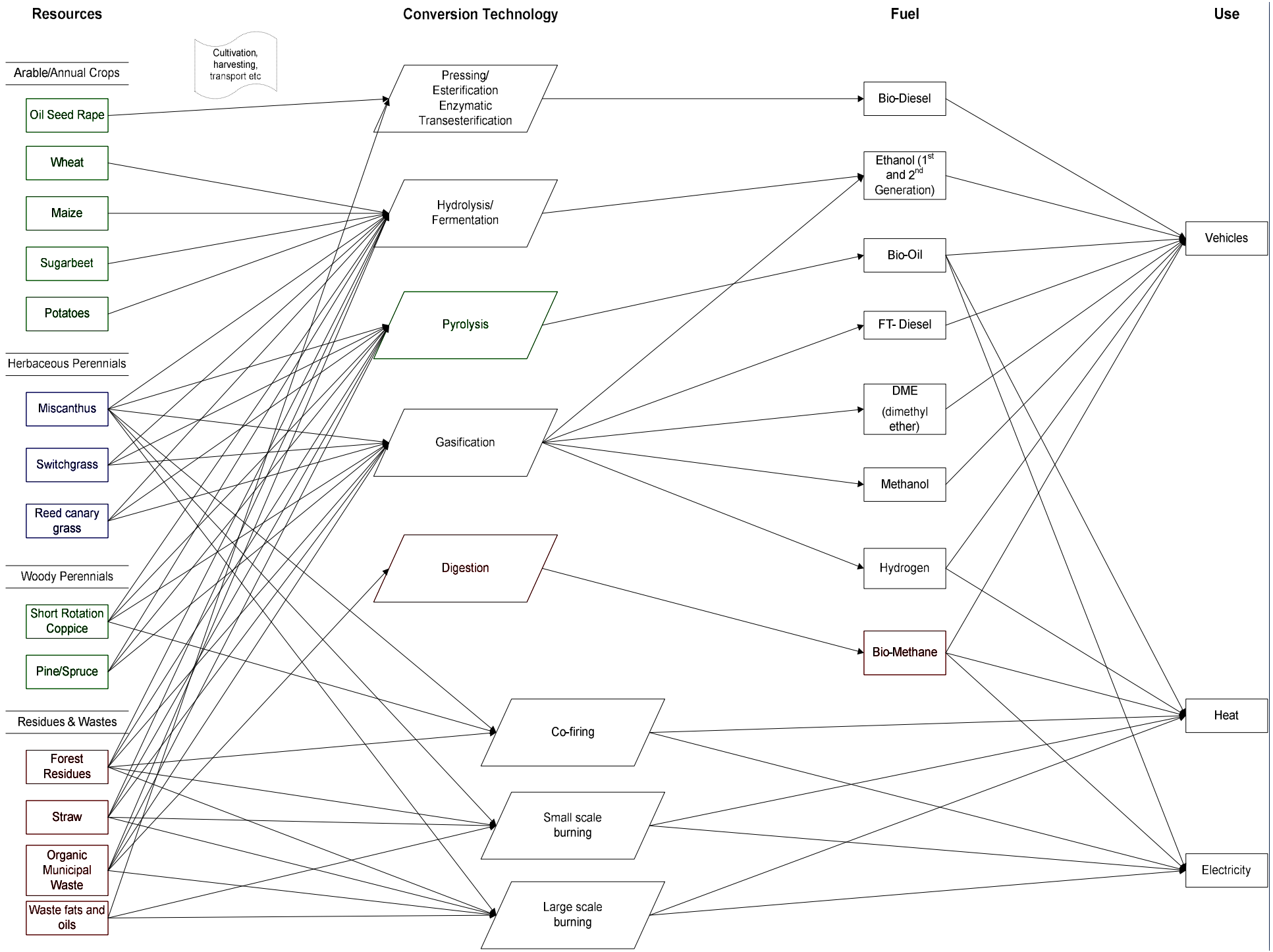
- Miscanthus, switchgrass, reed canary grass

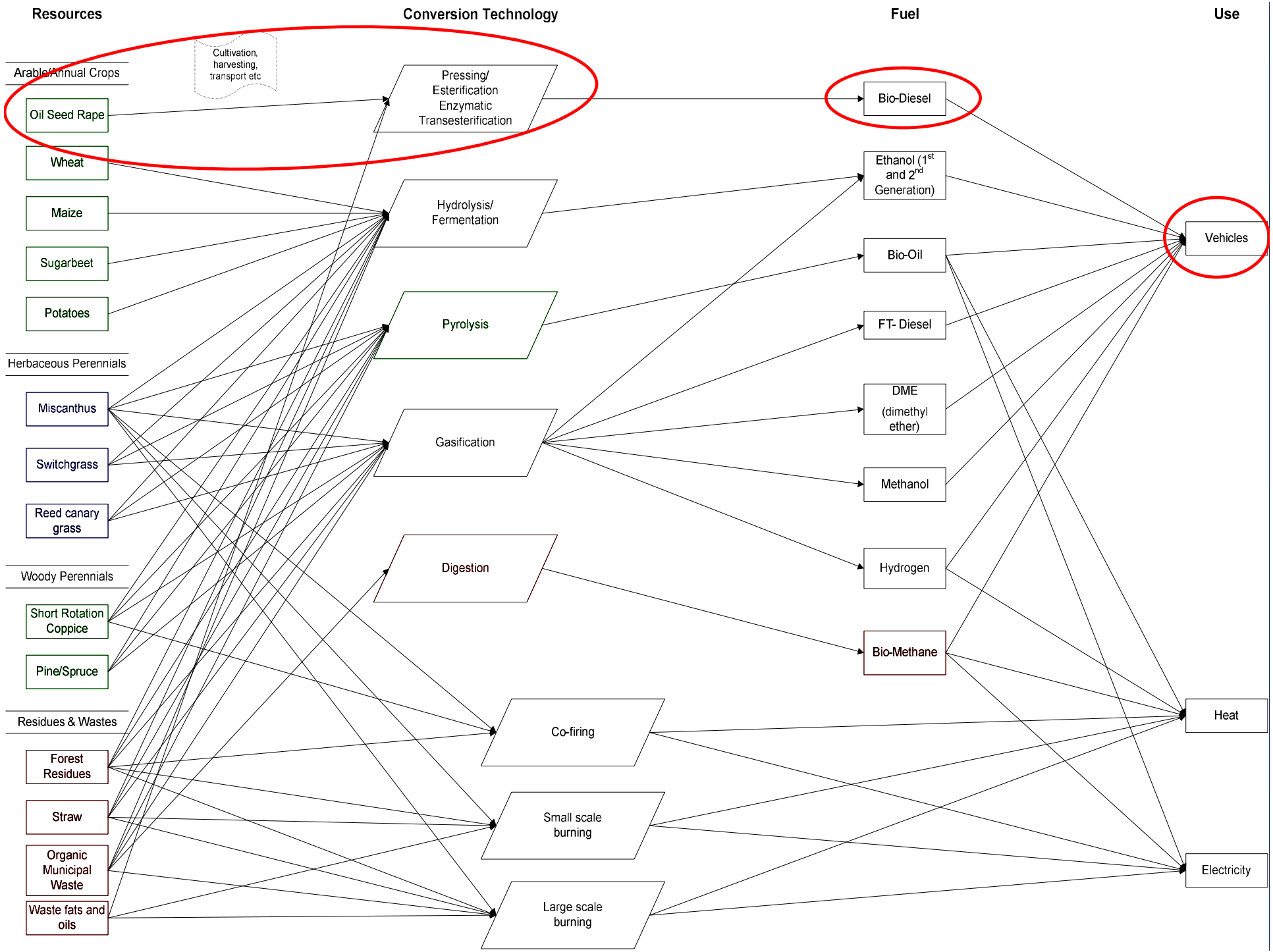
- Woody Perennials

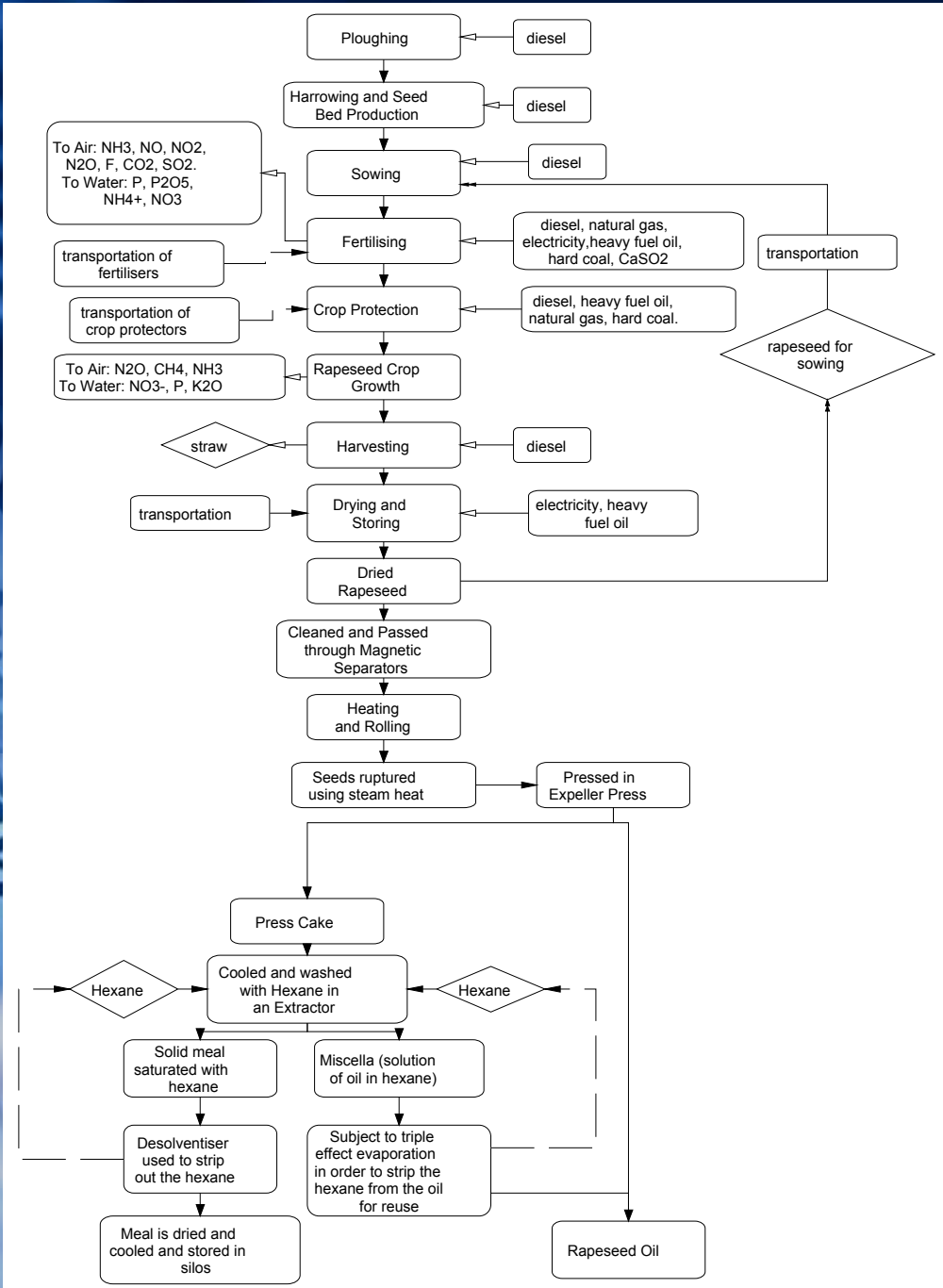
- Short rotation coppice, pine, spruce

- Residues and Wastes

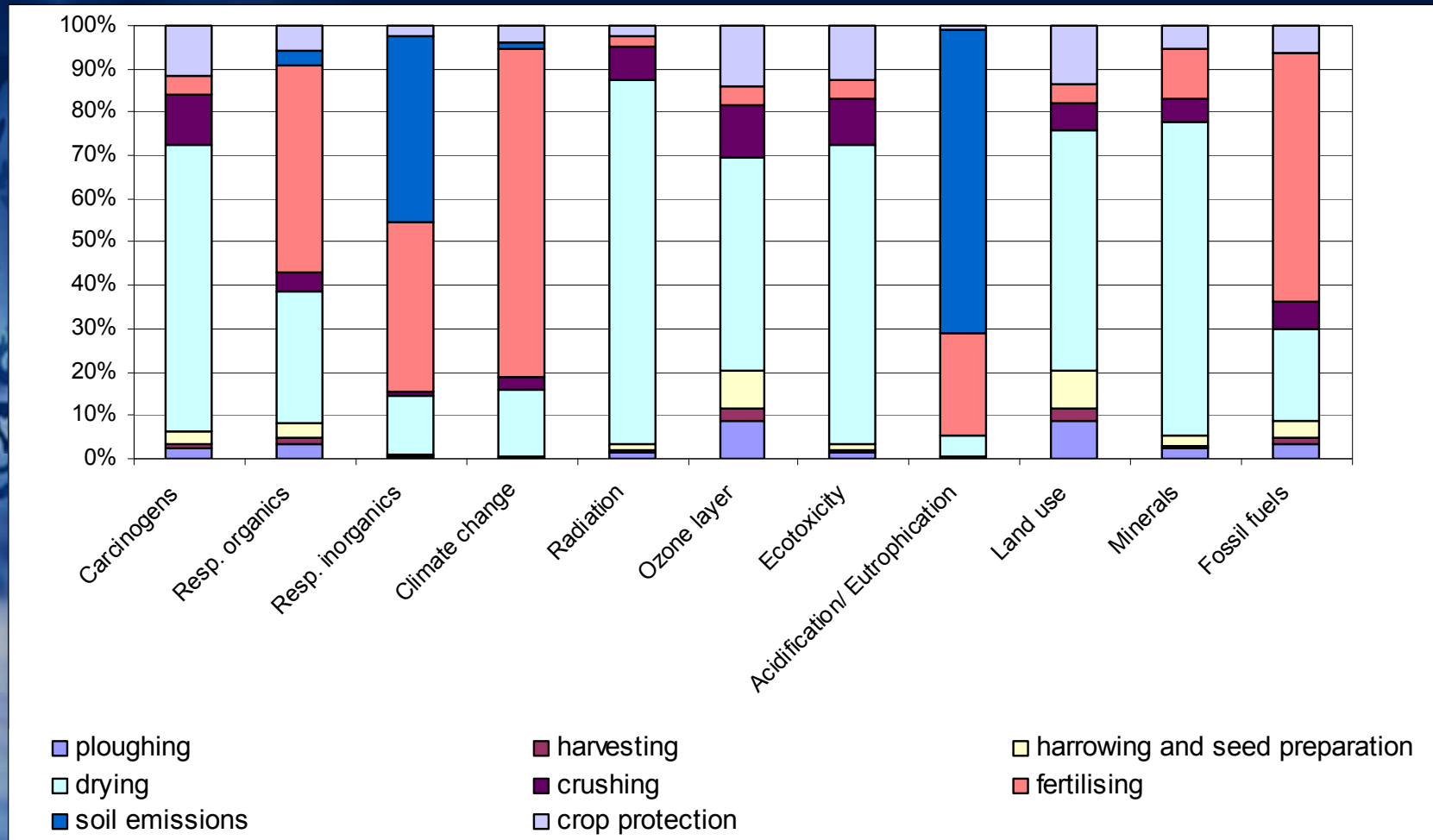
- Forest residue, straw, organic municipal waste, waste fats and oils



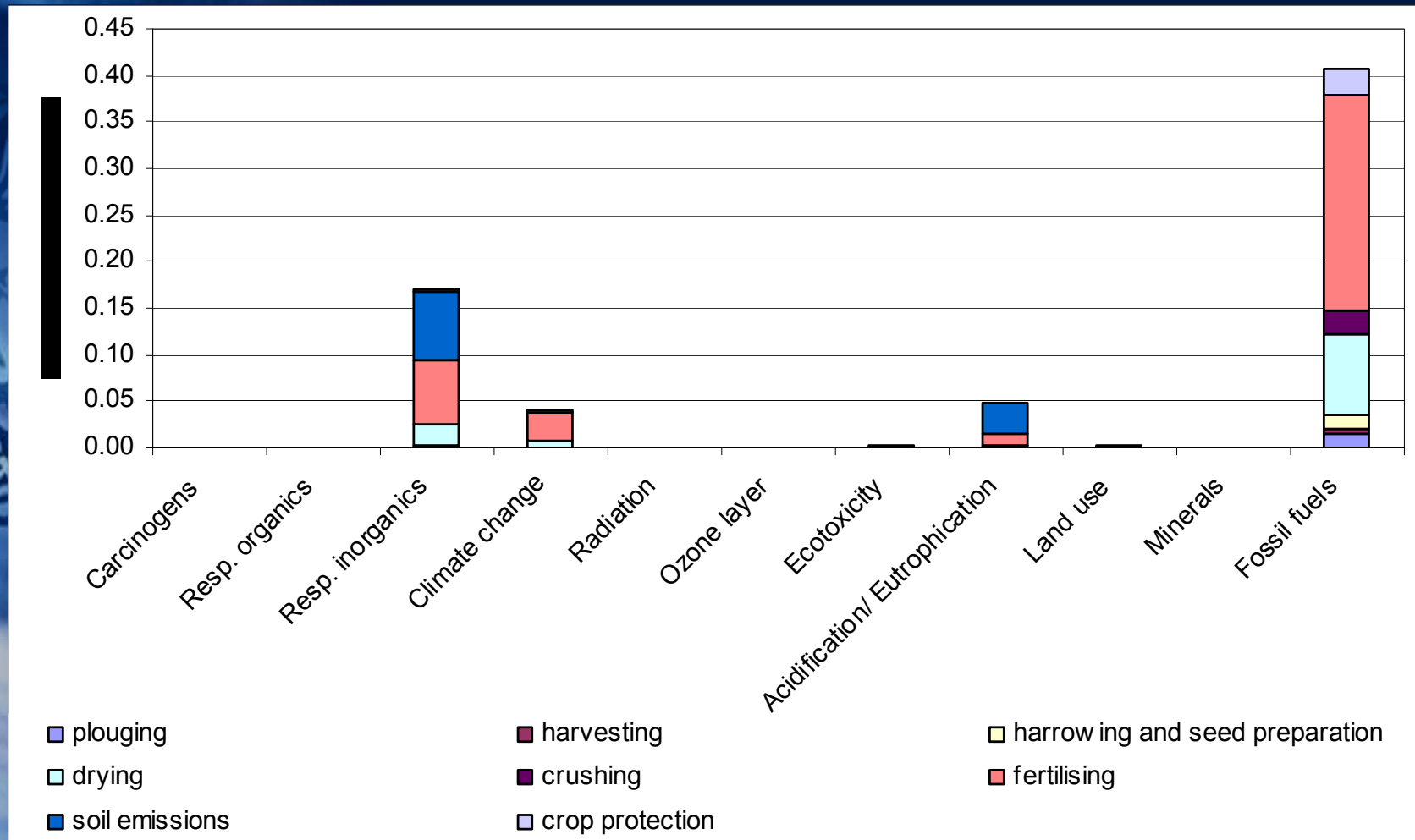




Characterised Data for Rapeseed Production

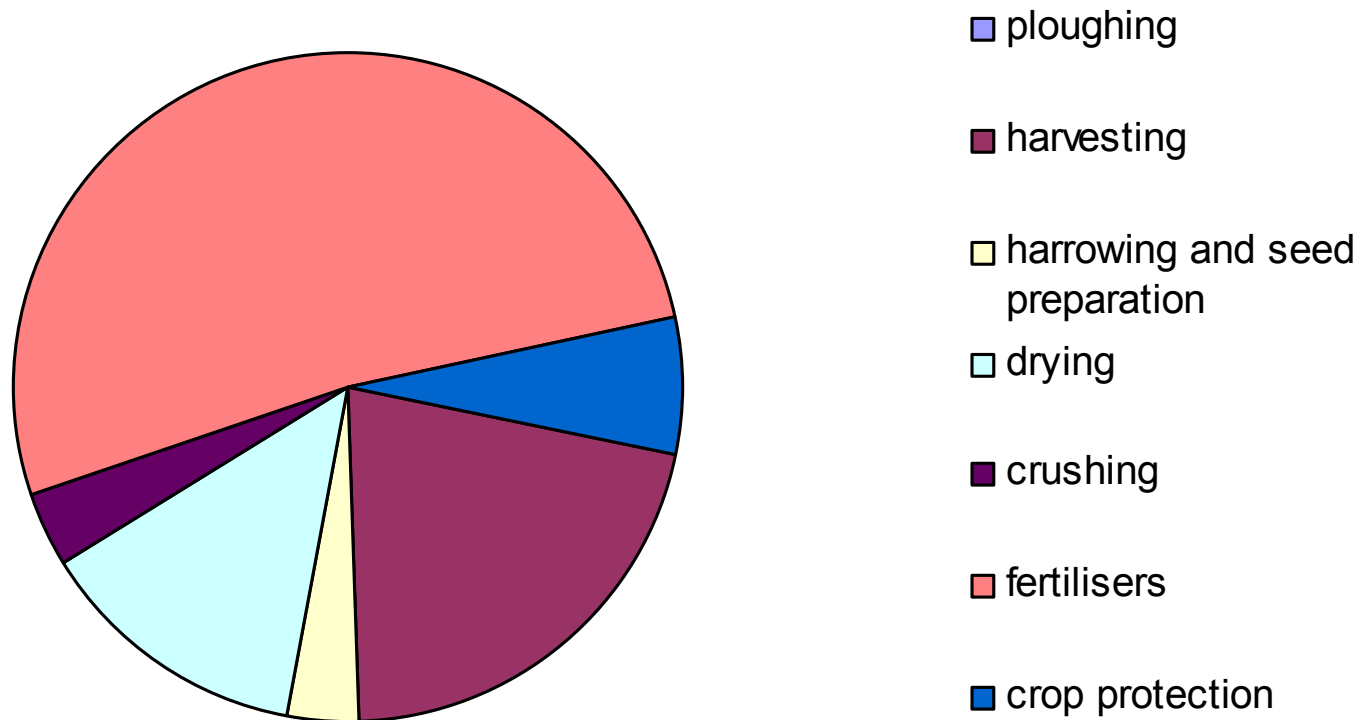


Normalised Data for Rapeseed Production



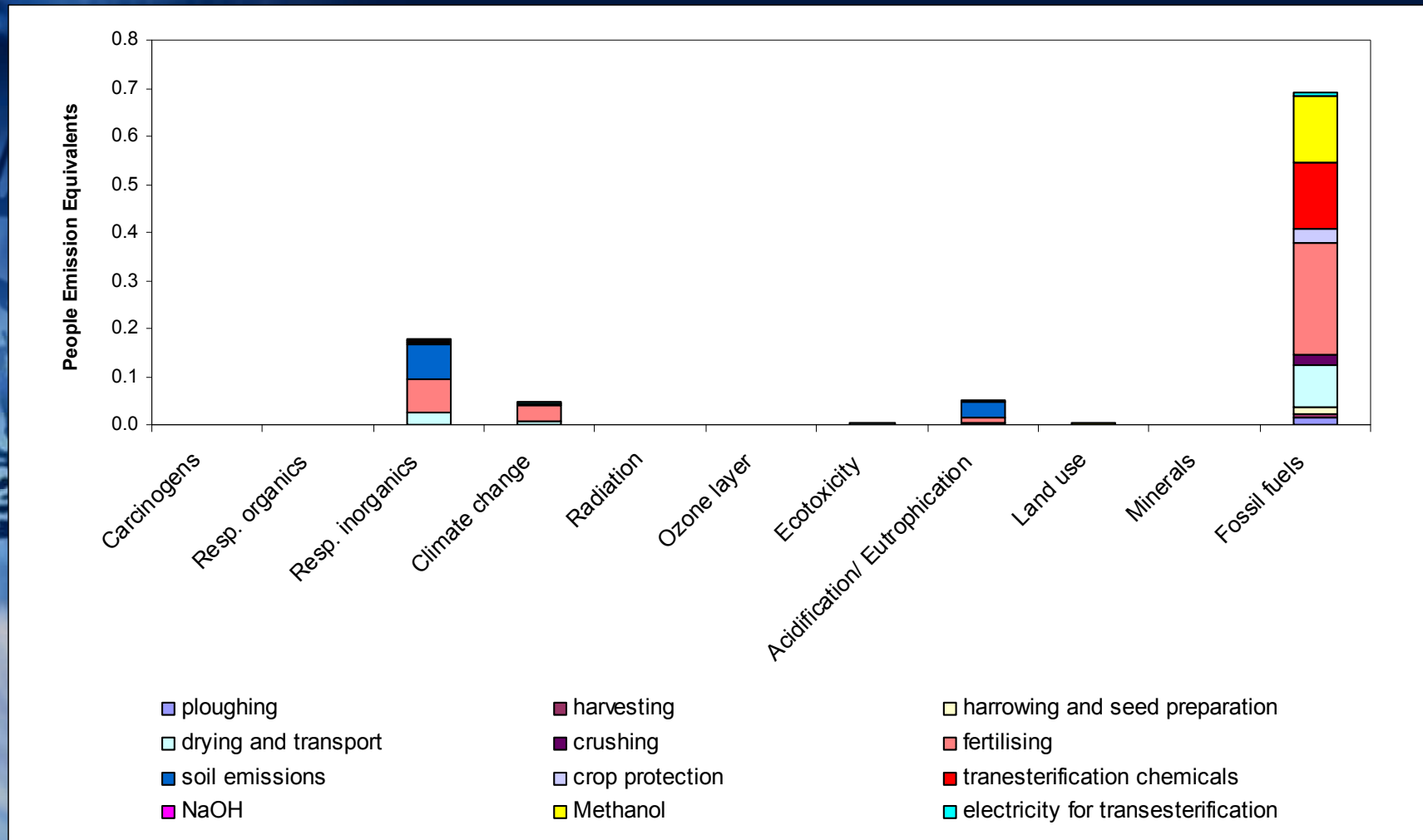
Water Use in Crude Rape Oil Production

water used in crude rape oil production



Total Water Consumption = 510m³ per hectare of rapeseed (produces 1188kg crude oil)

Normalised Data for rapeseed based bio-diesel



Net Energy of rapeseed based biodiesel

- Energy Content (ERSU, Strathclyde):
 - Diesel ~ 37.9 MJ/L.
 - Biodiesel ~ 35.6 MJ/L.
- Embodied energy of bio-diesel is calculated to be 29.75MJ/L

Performance of Biofuels

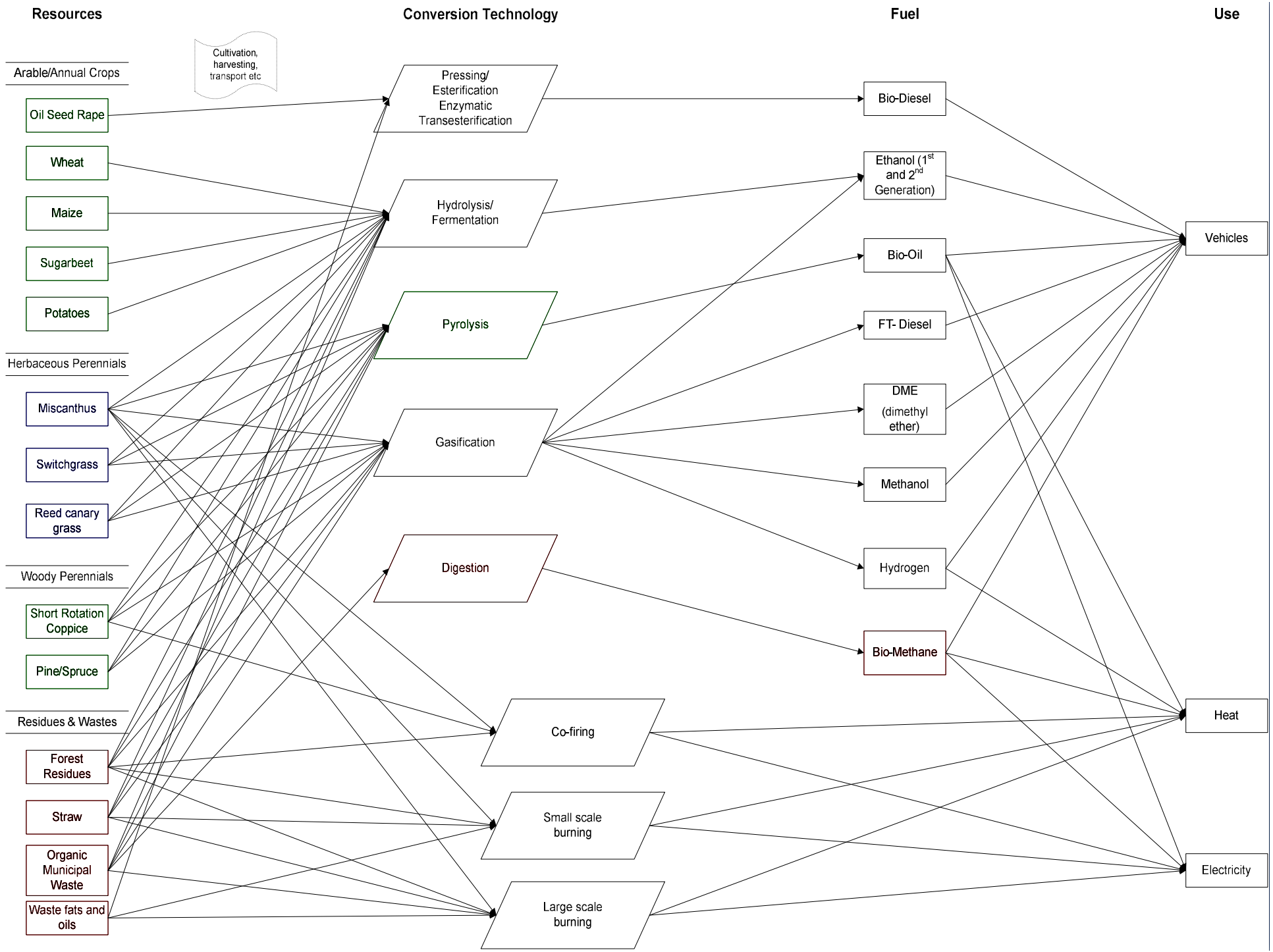
■ Biodiesel

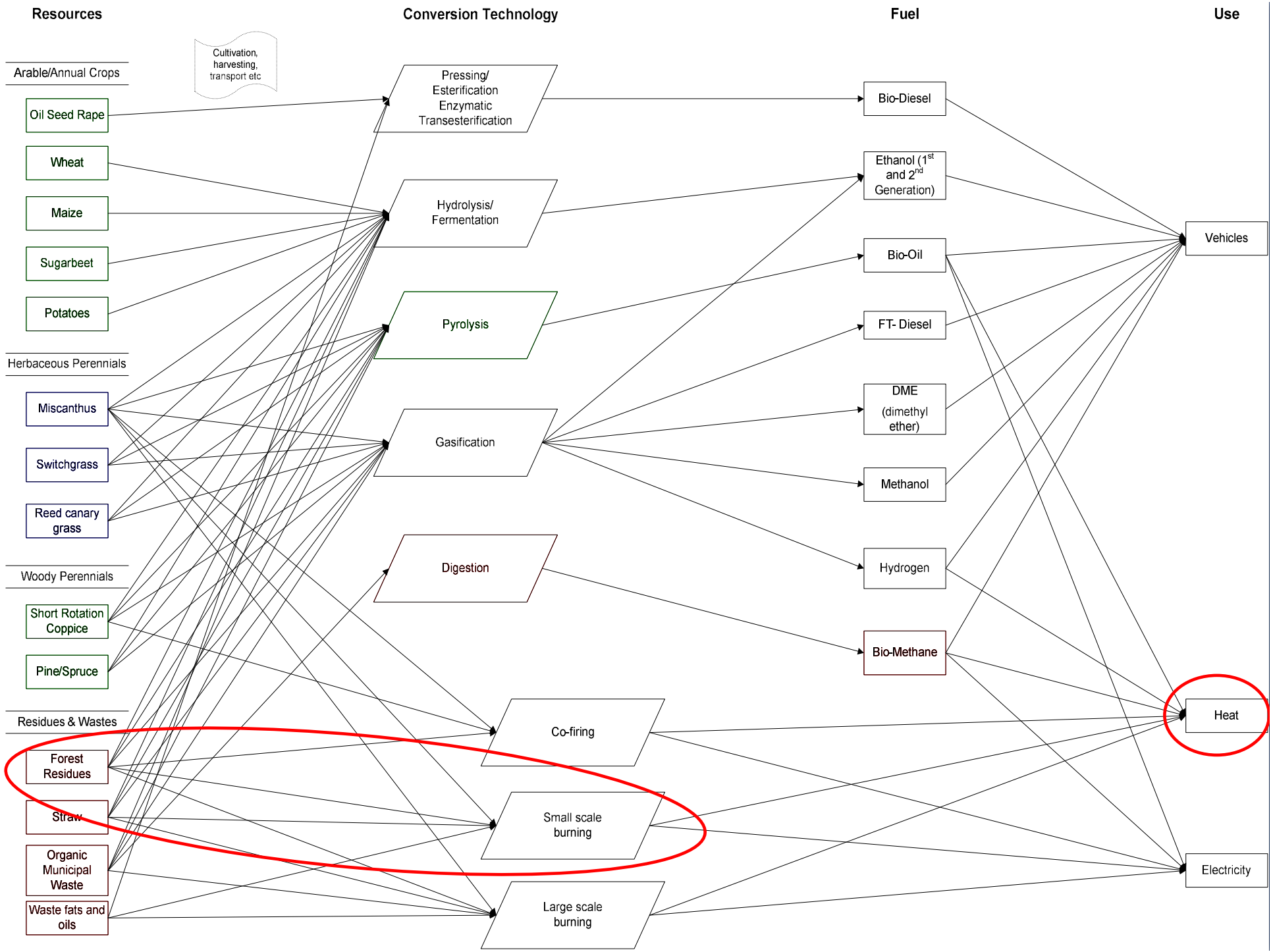
- At blends lower than 20% there is an increase in efficiency and improved fuel economy without an impact on performance
- Specific fuel consumption is higher for engines using high blends of biodiesel
- Problem with thickening at high blends due to higher viscosity



2nd generation biofuels

- Energy produced from lignocellulosic material
- More energy obtained per hectare
- Technology still in development

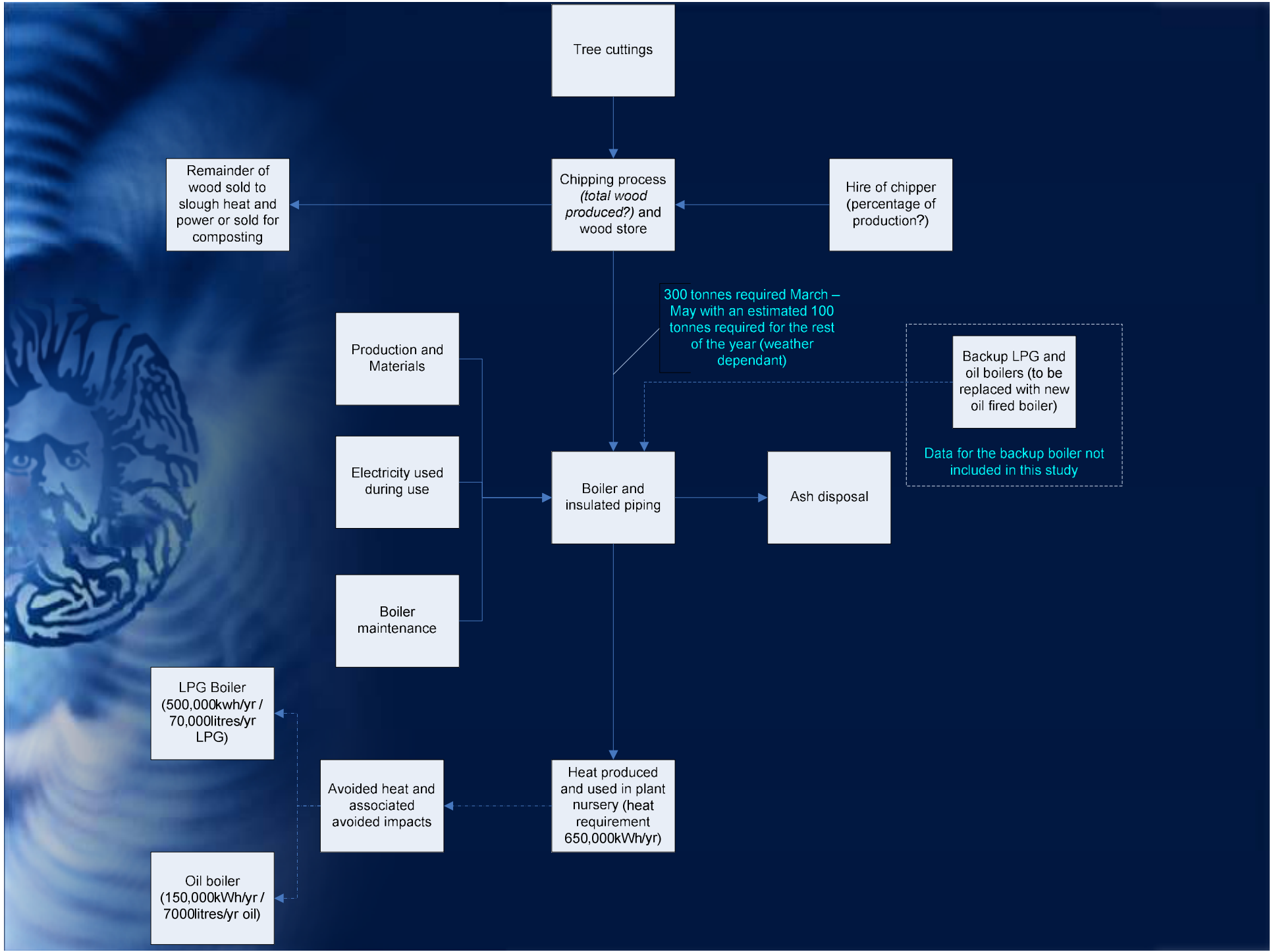




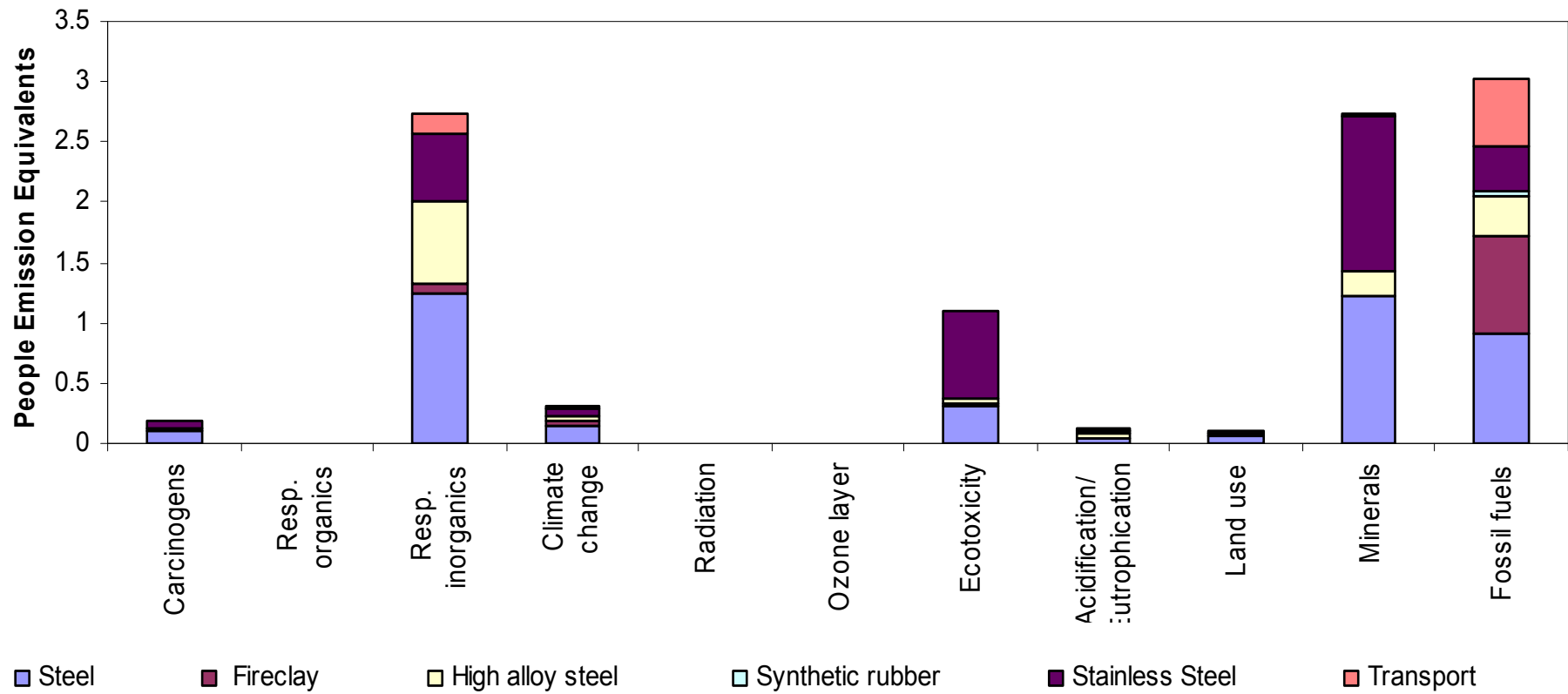
The boiler has been estimated to save over 100 tonnes of CO2 each year



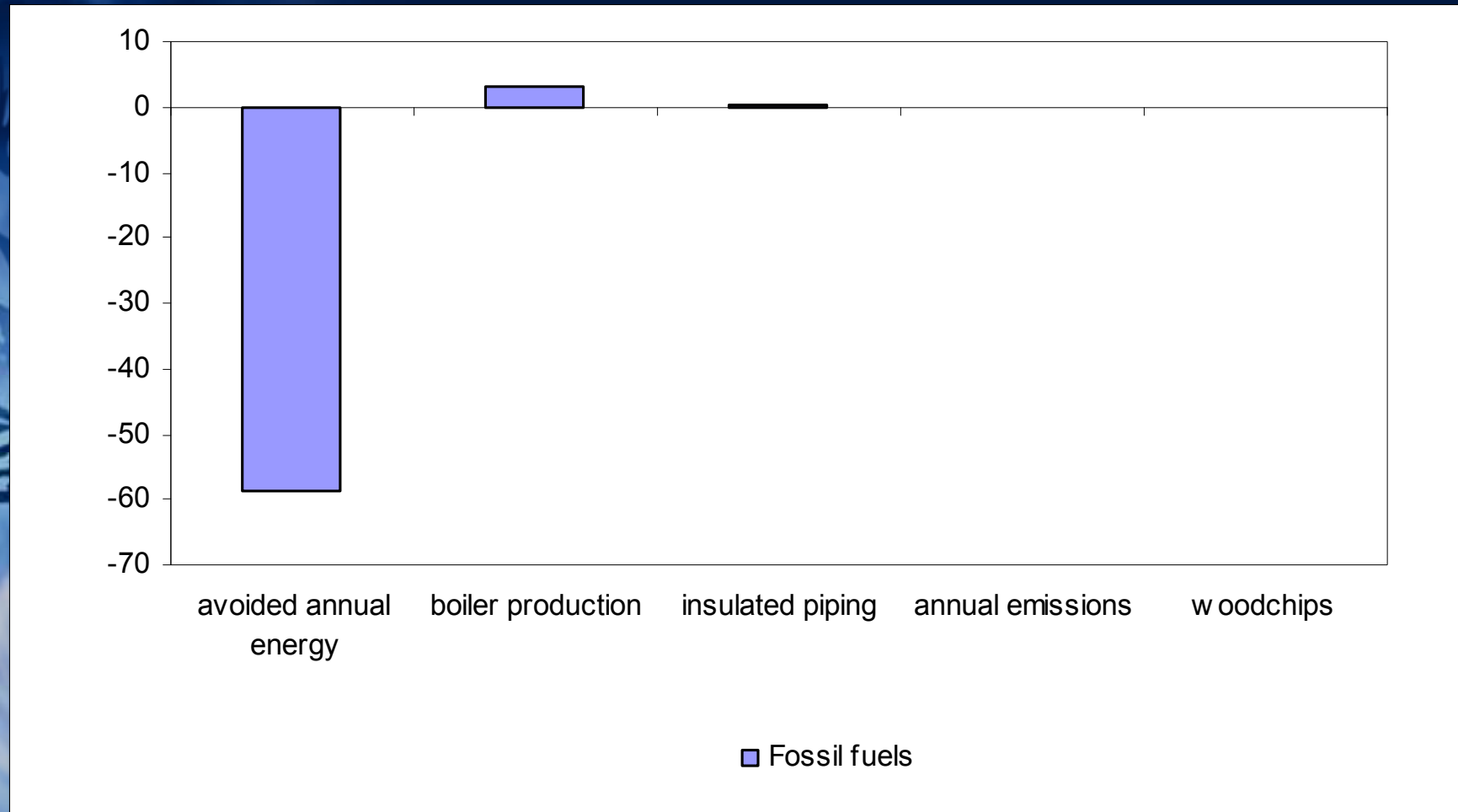




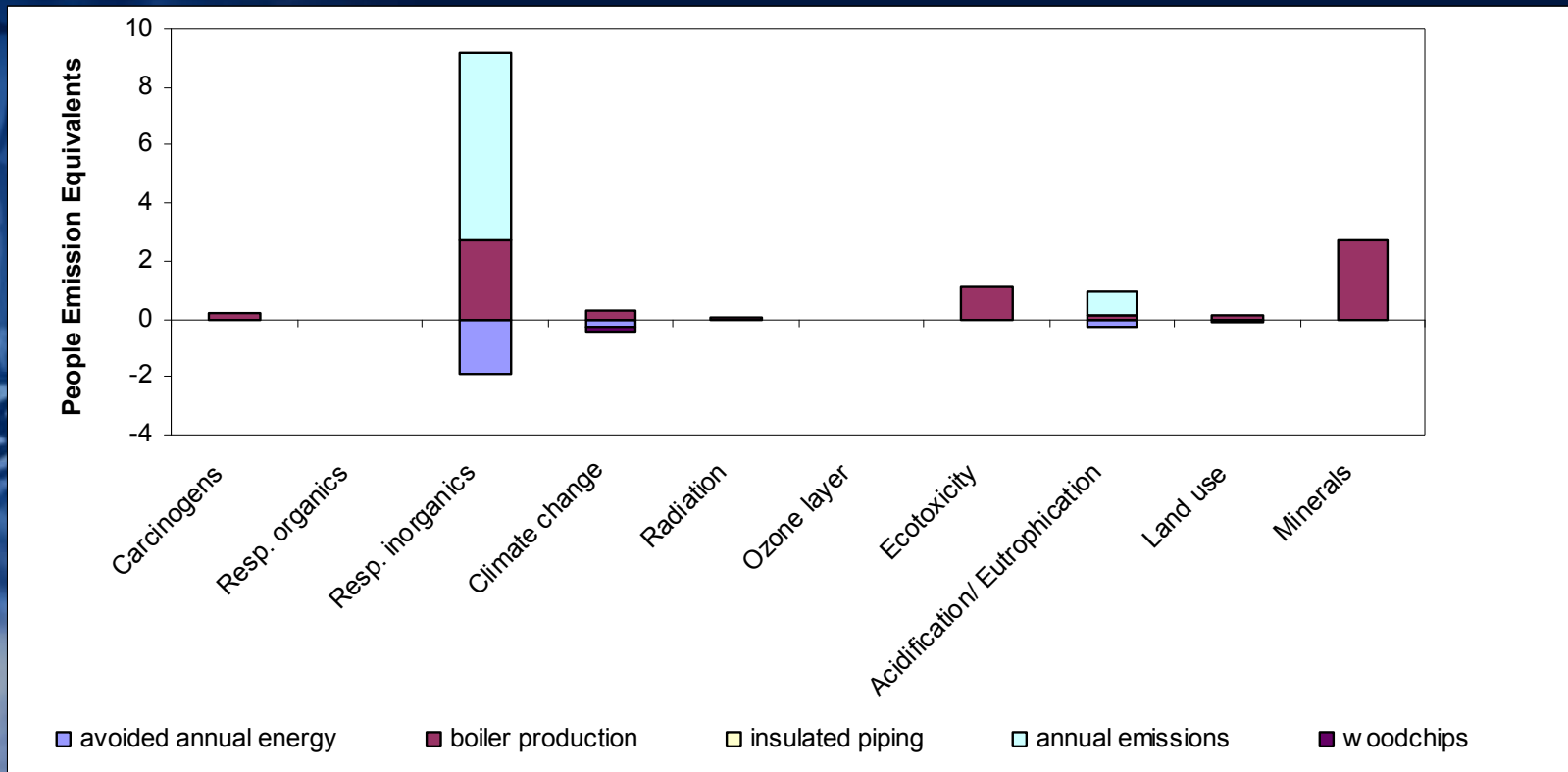
Normalised Boiler Production



Fossil fuel use and avoidance in a small biomass boiler

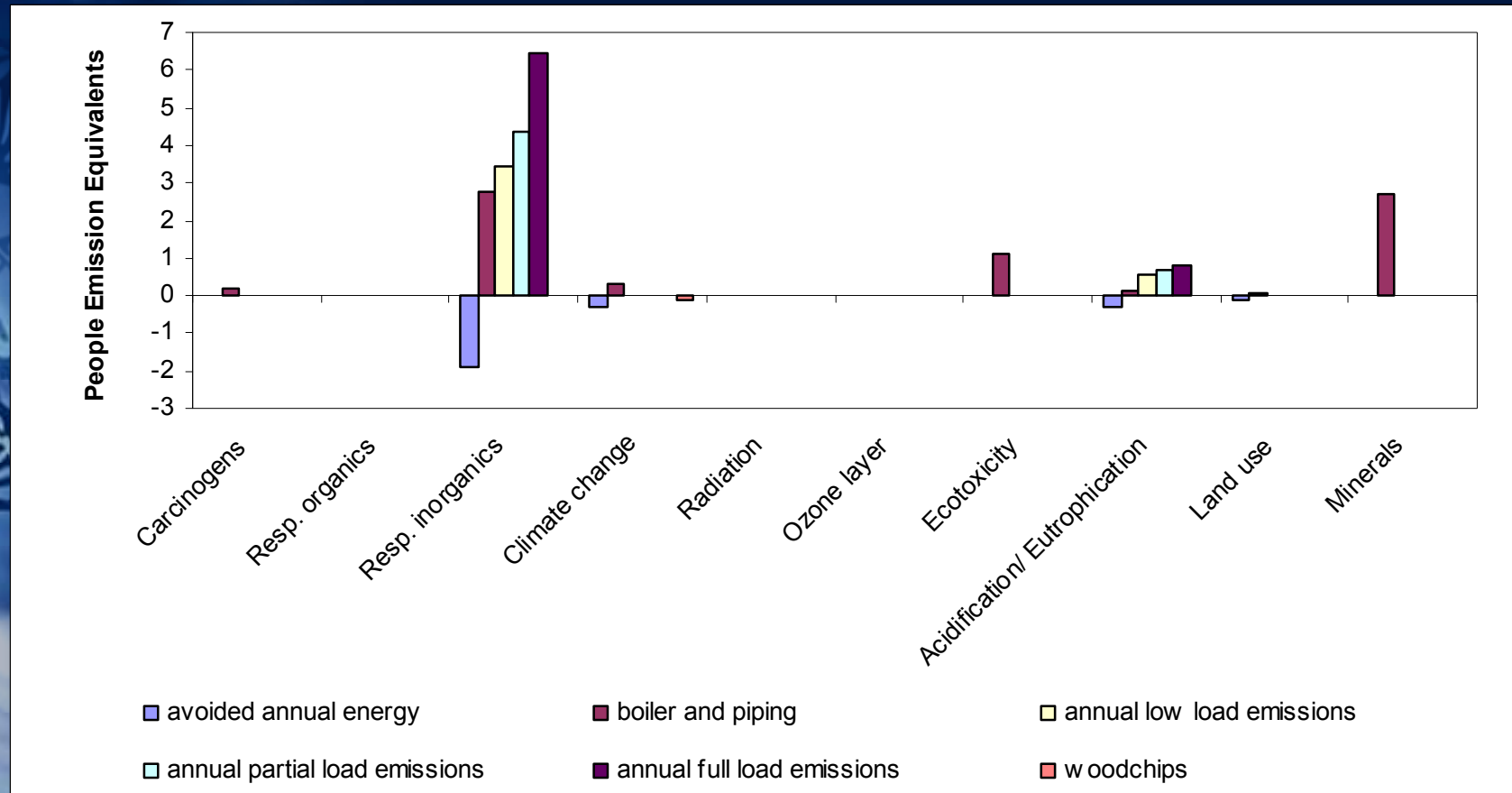


Normalised data for a small woodchip biomass boiler



Respiratory inorganics - effects resulting from winter smog caused by emissions of dust, sulphur and nitrogen oxides to air.


Normalised data for the boiler with differing loading ratings



Using other impact assessments the impact of winter and summer smog is negligible

Concluding Remarks

- Need to understand the wider implications
- Everything has some negative impact
- Bio-energy could be used to help meet renewable energy and carbon reduction targets
- This is not a new concept



“I foresee the time when industry shall no longer denude the forests which require generations to mature, nor use up the mines which were ages in the making, but shall draw its raw material largely from the annual products of the fields,” he declared.

“I am convinced that we shall be able to get out of the yearly crops most of the basic materials which we now get from forest and mine. We shall grow annually many if not most of the substances needed in manufacturing.

“When that day comes, and it is surely on the way, the farmer will not lack a market and the worker will not lack a job. More people will live in the country. The present unnatural condition will be naturally balanced again. Chemistry will reunite agriculture and industry. They were allowed to get too far apart and the world has suffered by the separation.”

Henry Ford (1863 – 1947)

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