Accounting for biogenic NMVOC emissions in LCA

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Outline of the situation

- Isoprene and terpenes are emitted from photosynthesizing leaves of plant species
- Major contributor to global annual biogenic VOC emissions
  - 450 Mio. tonnes carbon in isoprene per year
  - 1'200 Mio. tonnes carbon in biogenic volatile organic compounds
- Contributes to formation of ozone (summer smog)
- Not accounted for in LCA so far

Goal of this presentation

- Investigate the relevance of biogenic NMVOC in the context of renewable fuels
- LCA of production pathways of biomass-to-liquid fuels (BTL or so called “second generation”)
- Biomass resources straw, short-rotation wood and miscanthus
- Full life cycle including also NMVOC emissions of fuel production and use

NMVOC emissions in different studies (kg/ha/year)

Pollutant	Plant	Range	Mean
Isoprene	Poplar	189-1600	476
Monoterpene	Swiss forest	Factor 5	29
VOC	Swiss agriculture	-	4
VOC	Swiss grasslands	-	3.6
NMVOC	German area	5-25	-

- Measurements as microgram isoprene per gram of dry matter leaves per hour
- Large range in literature
- Dependent on plant species, season, climate (activity of the plant), etc.

Calculation of emissions

- Leaf weight (kg/ha)
- Emission factors (kg/kg leaf/h)
- Biomass yields (tonnes / ha)
- Country specific correction factors depending on irradiation, sunshine hours, temperature

- Richardson S. (2002) Atmospheric Emission Inventory Guidebook. Third Edition. CORINAIR: The Core Inventory of Air Emissions in Europe, EEA: European Environment Agency
- Sanderson M. G. (2002) Emission of Isoprene, Monoterpenes, Ethene and Propene by Vegetation.

Life cycle inventory

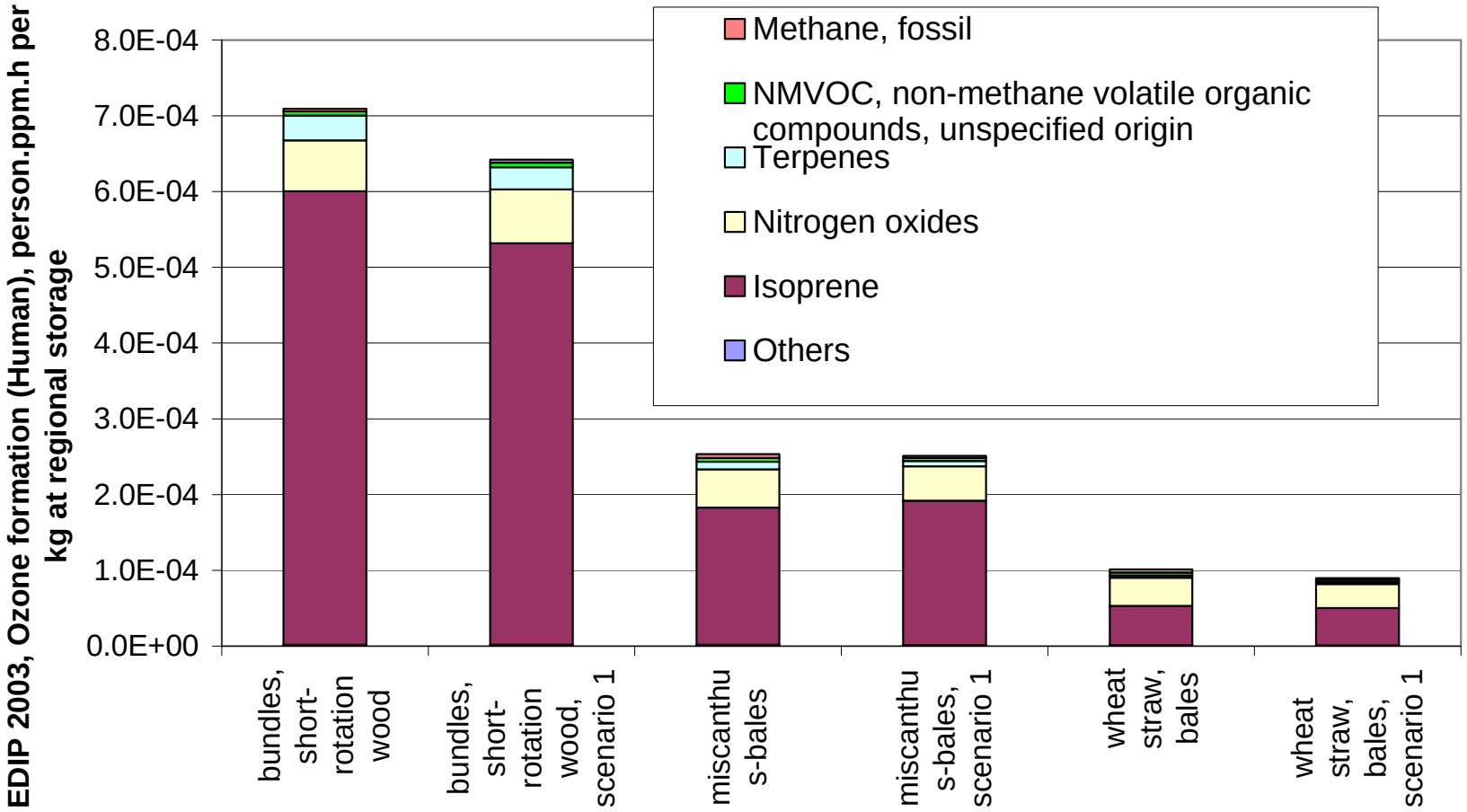
	leaf weight (kg/ha)	biomass harvest (kg dry matter/ha/period)	Isoprene (kg/kg leaf/h)	other NMVOC (kg/kg leaf/h)	Isoprene (kg/ha/a)	Monoterpene (kg/ha/a)
Willow-Salix	1500	176'844	3.40E-05	1.70E-06	53.1	2.7
Miscanthus	1250	15'547	1.60E-05	8.00E-07	21.6	1.1
Wheat	1250	8'618	1.60E-05	8.00E-07	20.1	1.0

- Emissions dependent on factors like species, climate, irradiation
- 3 types of biomass
- No differentiation concerning production patterns as e.g. organic production or yields

Life cycle impact assessment

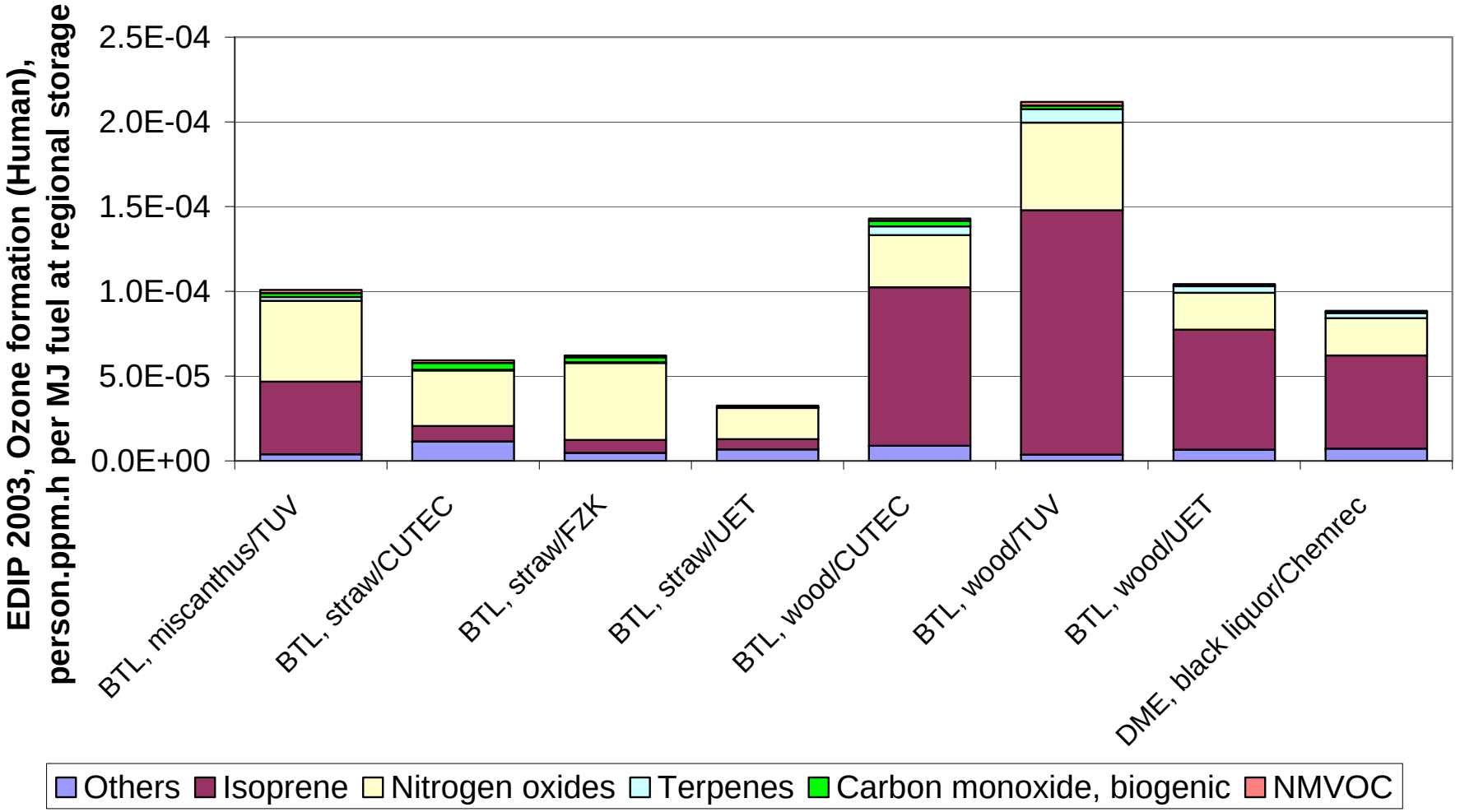
- Exclusion of biogenic NMVOC in the original study because of uncertainties
- Sensitivity analysis with different methods shows some similarities
- CML 2001 does not provide factors for unspecified NMVOC
- For this presentation we use EDIP 2003, ozone formation (human) which accounts for several substances

Ozone formation of biomass production



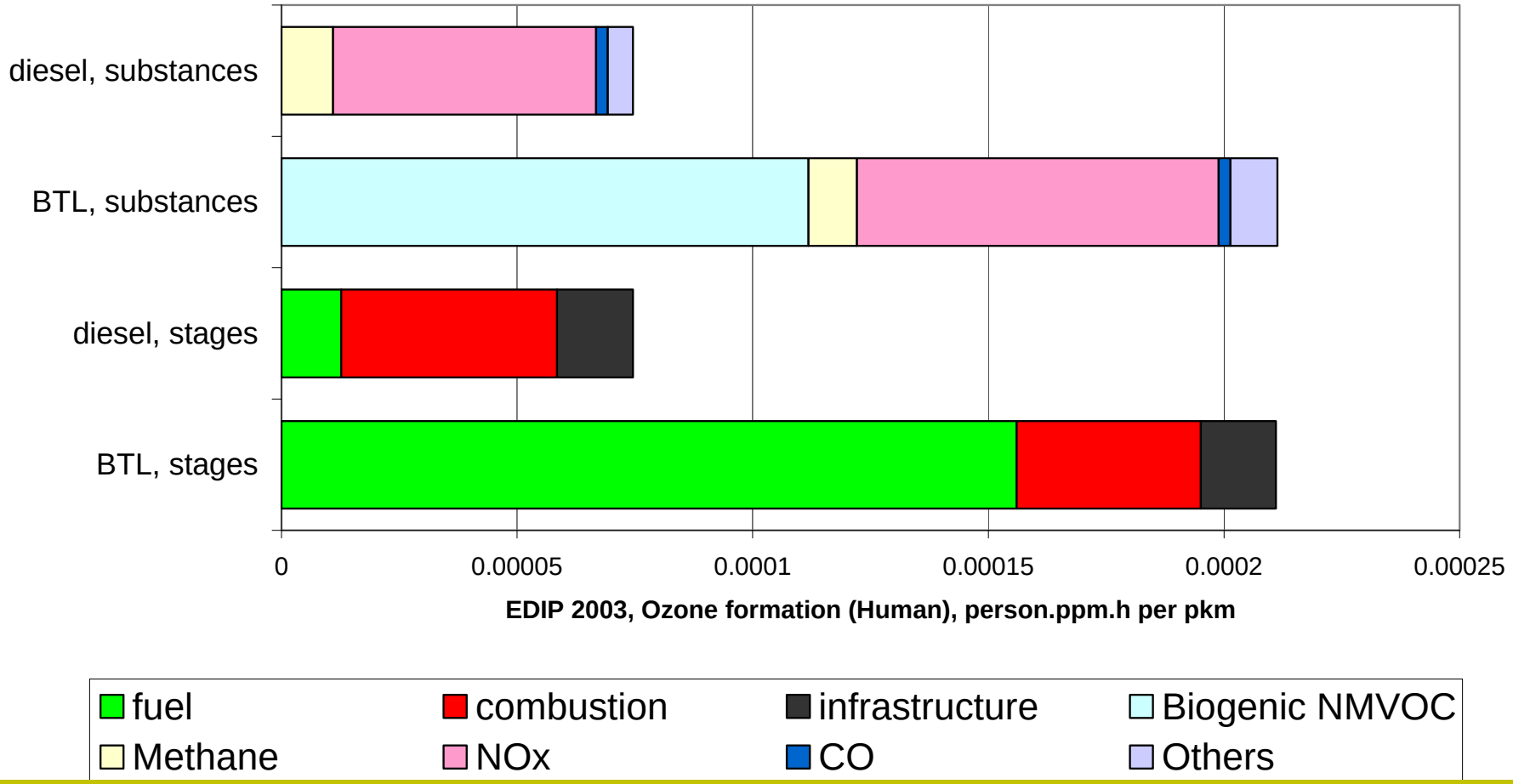
- Isoprene accounts for an important part of emissions
- Large differences between types of biomass

Ozone formation of fuel production



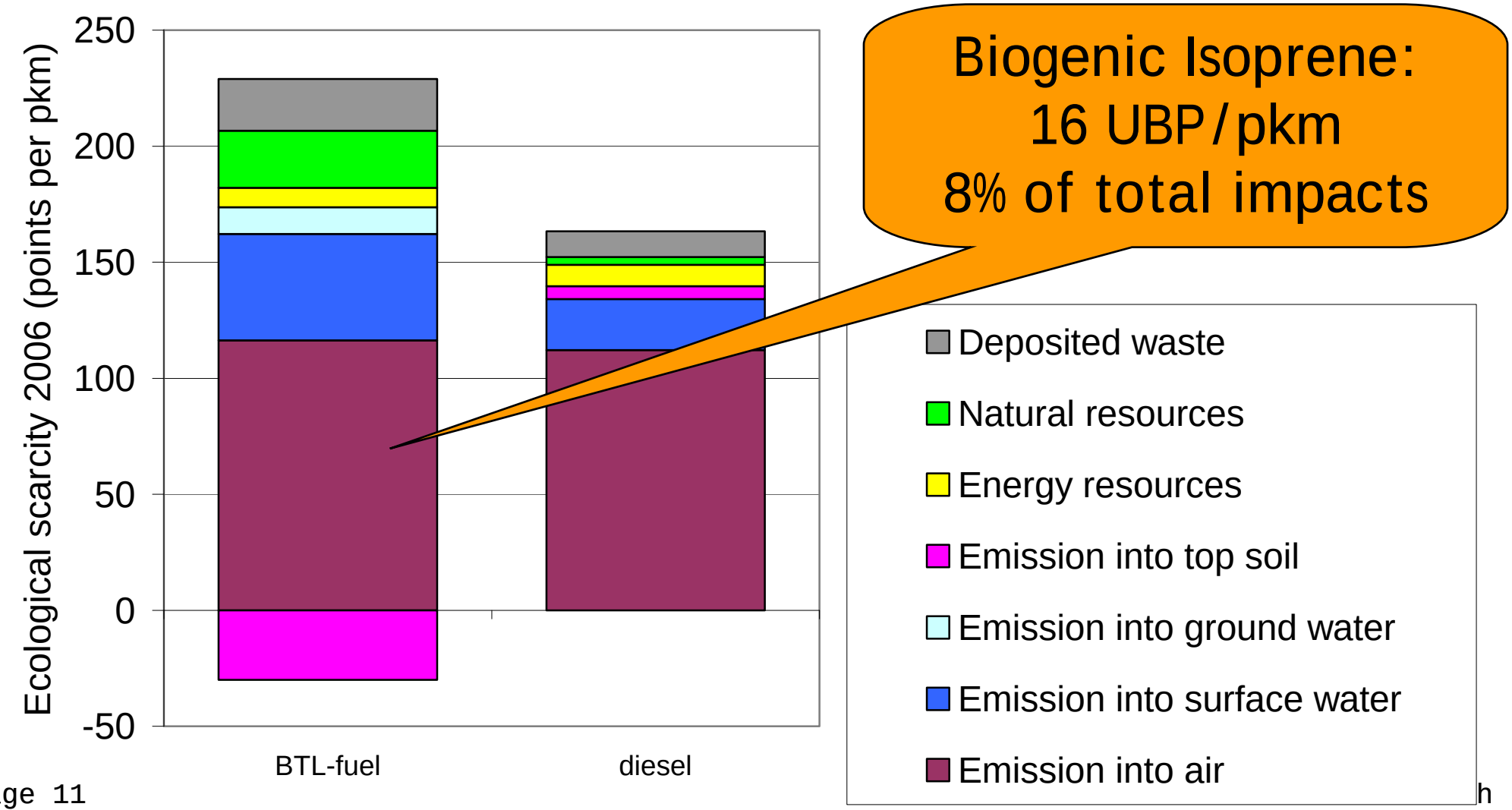
- Other emissions e.g. from NOx from stack emissions get more relevant

Using best BTL-fuel from short-rotation wood compared to diesel



- Combustion emissions lower, but fuel production due to biomass higher
- 50% of emissions are biogenic NMVOC

Total environmental impacts



Conclusions

- NMVOC emissions from growing plants contribute substantially to the photochemical smog indicator and to total environmental impacts
- Emissions of biogenic NMVOC can outweigh other improvements in the life cycle of renewables
- Uncertainties concerning differences between species, regions, natural conditions, etc. exist

Conclusions (2)

- Biomass resources with low NMVOC emissions should be a criterion in LCA of renewables
- Grassland and agriculture seem to be more favourable than forestry, especially conifers
- Further emissions arising due to cutting and harvesting are so far not considered

Discussion

- Zero emissions are not possible as long as biomass is growing
- Comparison with non-biomass products difficult because we cannot remove biomass from all land areas
- Should we only account for a change compared to a reference state?

Literature

- Life cycle inventory of producing BTL-fuels including data for the biogenic NMVOC emissions are published in EcoSpold format in a European project (www.esu-services.ch/renew.htm)
- Sanderson M. G. (2002) Emission of Isoprene, Monoterpenes, Ethene and Propene by Vegetation. Hadley Centre technical note 40, retrieved from: www.metoffice.com/research/hadleycentre/pubs/HCTN/HCTN_40.pdf
- Richardson S. (2002) Atmospheric Emission Inventory Guidebook. Third Edition. CORINAIR: The Core Inventory of Air Emissions in Europe, EEA: European Environment Agency, Copenhagen, DK, retrieved from: http://reports.eea.eu.int/EMEPCORINAIR3/en/tab_content_RLR