# Life cycle inventory modelling of biofuels for the ecoinvent database

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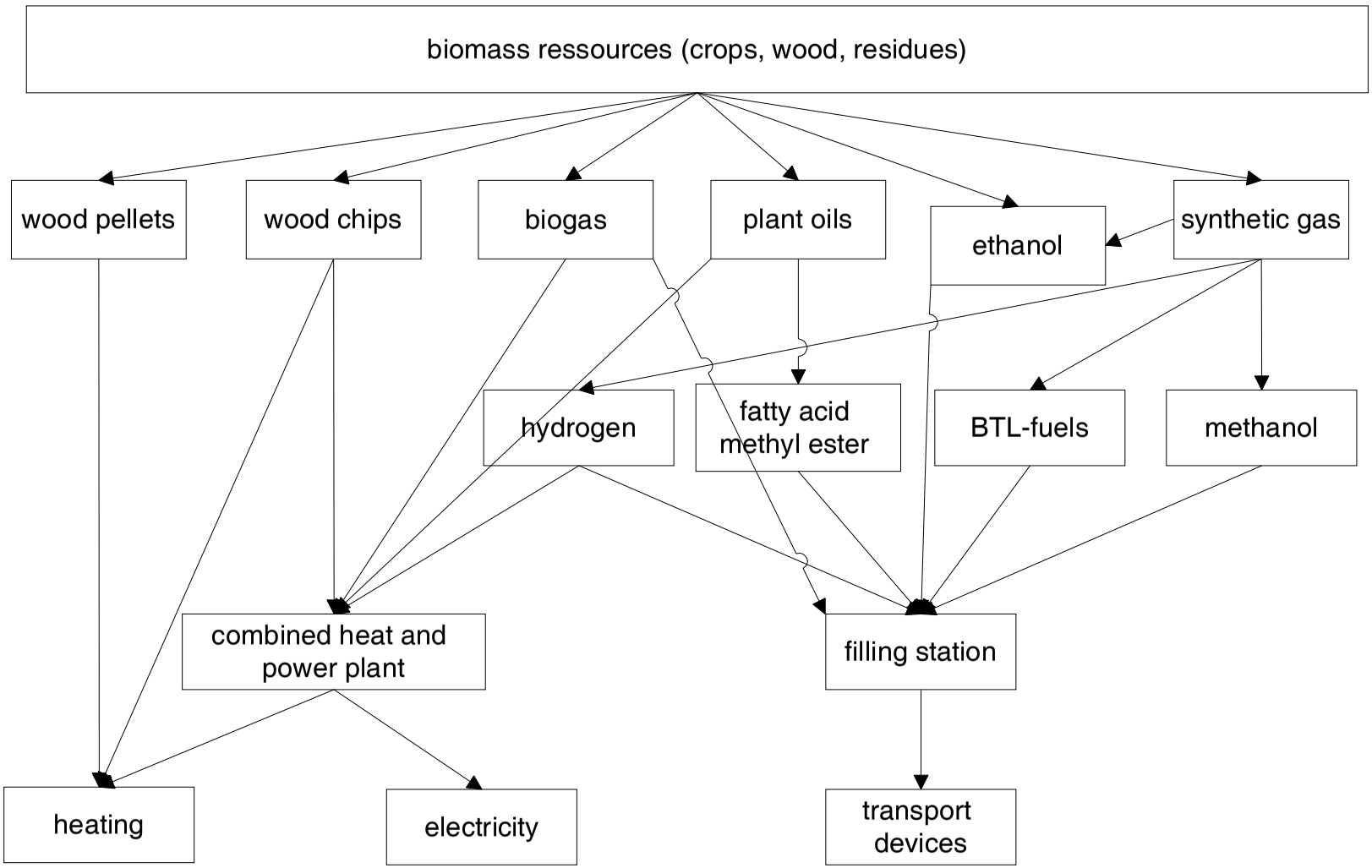
# Topics

- Goal and scope of the project “Life cycle inventories of bioenergy”
- Methodology allocation
- Specific regional problems
  - Soy beans
  - Plant oils
- Conclusions

# Problem setting for the project "LCI bioenergy"

- Diverging results for bioenergy in separate studies
- ecoinvent data v1.3 cover only a small part of bioenergy chains. No common database
- Aims to fully cover the of most important bioenergy chains
- Support for energy policy (fuel tax reductions)
- Examination for GHG reduction potential
- Investigation of several environmental aspects of "biofuels" supply chains

# Resources, conversion techniques and "bioenergy" products investigated



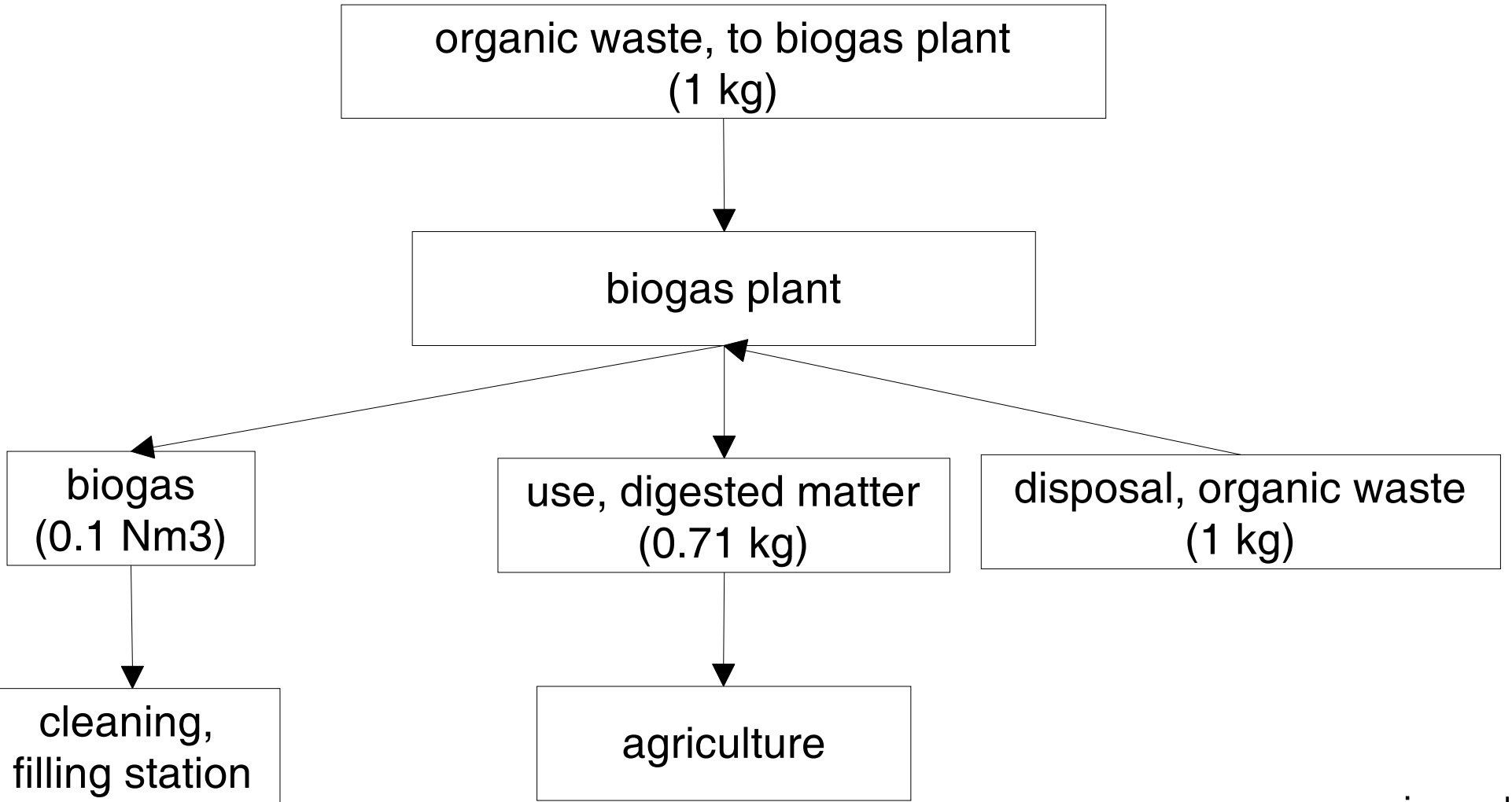
# Goal and Scope

- Time frame 2005 or new future technologies
- Investigation from well to Swiss wheel
- Products from multi-output processes are investigated with allocation factors that can be varied by the data user
- All direct co-products are included in the analysis
- Consistent investigation of energy, food and material products from biomass
- Clear differentiation of fossil and organic carbon
- Publication with ecoinvent data v2.0 late 2007 (www.ecoinvent.org)

# Allocation

- Multi-output processes are stored in the database – BEFORE allocation
- Input- and output-specific allocation factors, i.e. individual allocation factor allowed per pollutant and input
- Allocation executed after import of dataset into database
  -> calculation of allocated unit processes
  -> matrix becomes invertible
- NO system expansion,
  NO credits
- Cut-off applied for outputs without economic value and wastes for recycling

# Allocation: Example Biogas

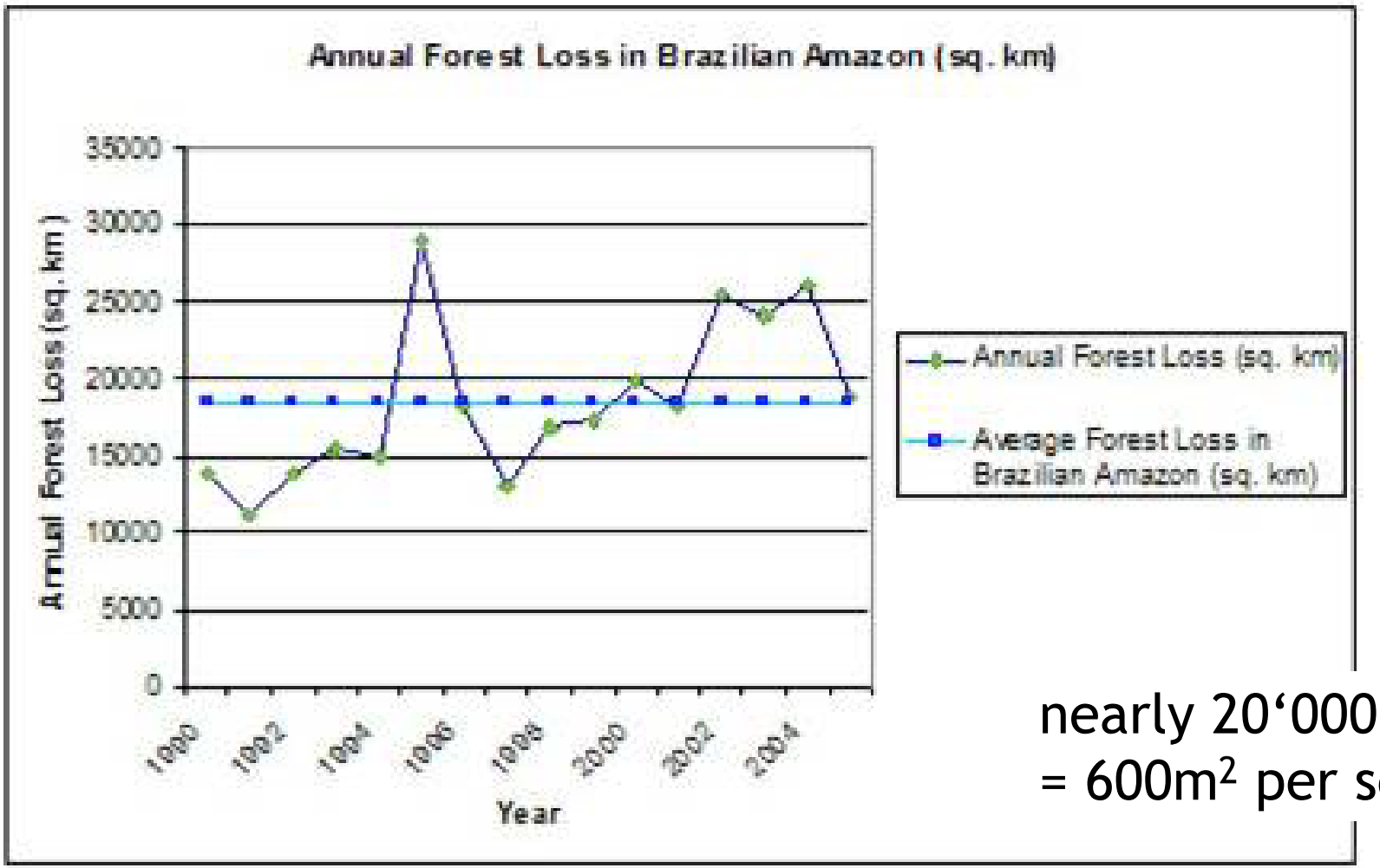


# Soybean production

# Increase of agricultural area

This area was cleared by soybean farmers in Novo Progreso. Brazilian Government figures show that the rate of clearing has increased.

# Annual forest loss in Brazilian Amazon




nearly 20‘000km$^2$
= 600m$^2$ per second

http://rainforests.mongabay.com/amazon/deforestation_calculations.html
http://sitemaker.umich.edu/section2group3/results_and_discussion

# Clear cutting of primary forests

- Agricultural area is increased by clear cutting
- Land transformation leads to $CO_2$ emissions
- Burning of residues with further emissions
- Loss of biodiversity
- $CO_2$ from land transformation accounts for about 90% of Brazil $CO_2$ emissions
- Particles from residue burning are an important problem in South-East Asia

# Principle of investigation

- What is the increase in agricultural area for the production in the reference year?
- What is emitted per $m^2$ of clear cut land?
- Allocation of emissions between wood and stubbed land
- Stubbed land is the main driver
- New elementary flow „$CO_2$, land transformation“ as used by IPCC for different possibilities of analysis

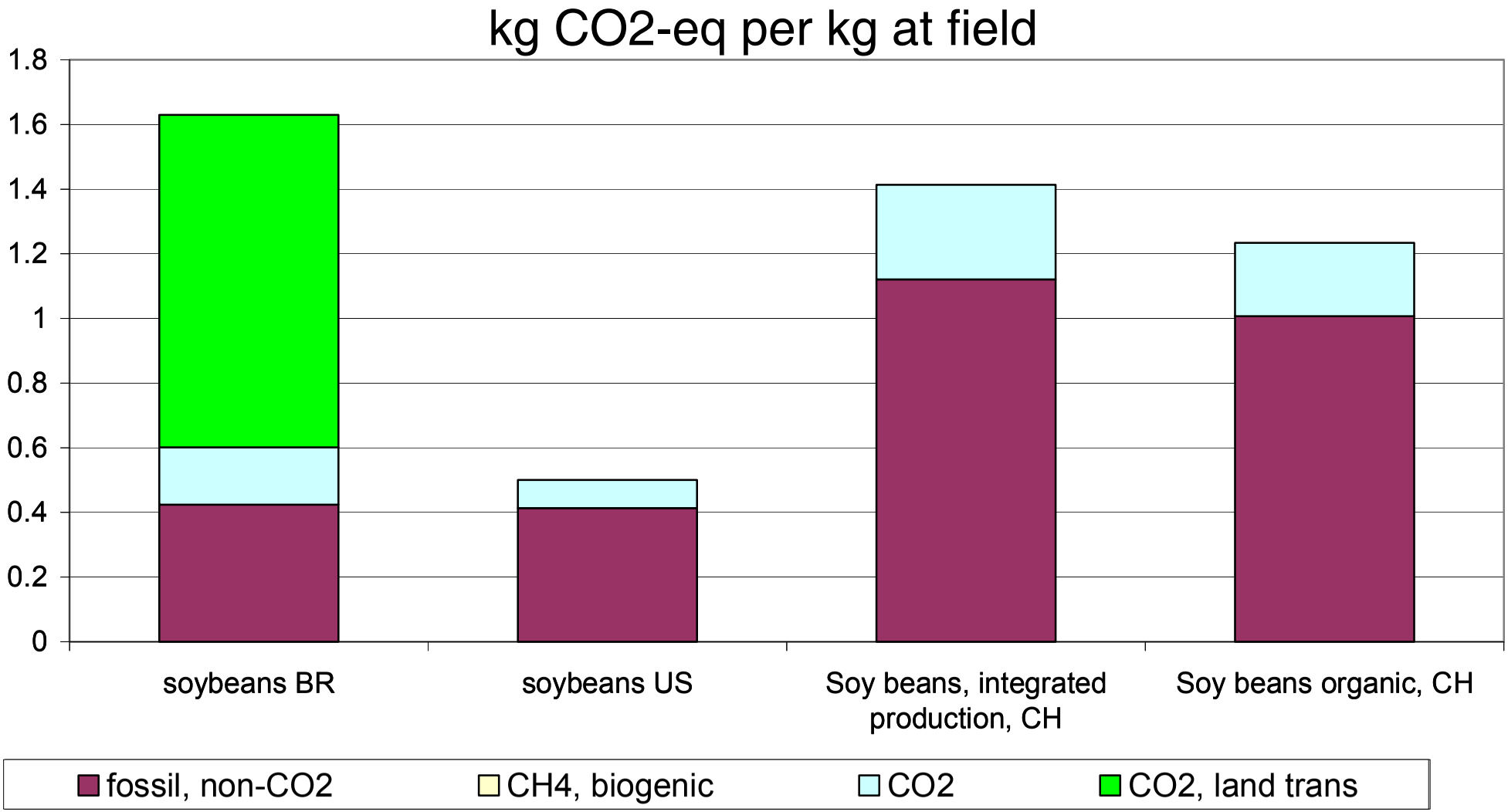
# Inventory Clear Cutting

| Name | Location | InfrastructureProcess | Unit | clear-cutting, primary forest | round wood, primary forest, clear-cutting, at forest road | provision, stubbed land |
|---|---|---|---|---|---|---|
| Location | | | | BR | BR | BR |
| InfrastructureProcess | | | | 0 | 0 | 0 |
| Unit | | | | ha | m3 | m2 |
| round wood, primary forest, clear-cutting, at forest road | BR | 0 | m3 | 5.21E+1 | 100 | - |
| provision, stubbed land | BR | 0 | m2 | 1.00E+4 | - | 100 |
| Wood, primary forest, standing | - | - | m3 | 1.82E+2 | 29 | 71 |
| Transformation, from tropical rain forest | - | - | m2 | 1.00E+4 | - | 100 |
| Transformation, to forest, intensive, clear-cutting | - | - | m2 | 1.00E+4 | - | 100 |
| power sawing, without catalytic converter | RER | 0 | h | 1.24E+1 | 100 | - |
| Carbon dioxide, land transformation | - | - | kg | 1.20E+5 | - | 100 |
| Carbon monoxide, fossil | - | - | kg | 7.84E+3 | - | 100 |
| Methane, fossil | - | - | kg | 5.14E+2 | - | 100 |

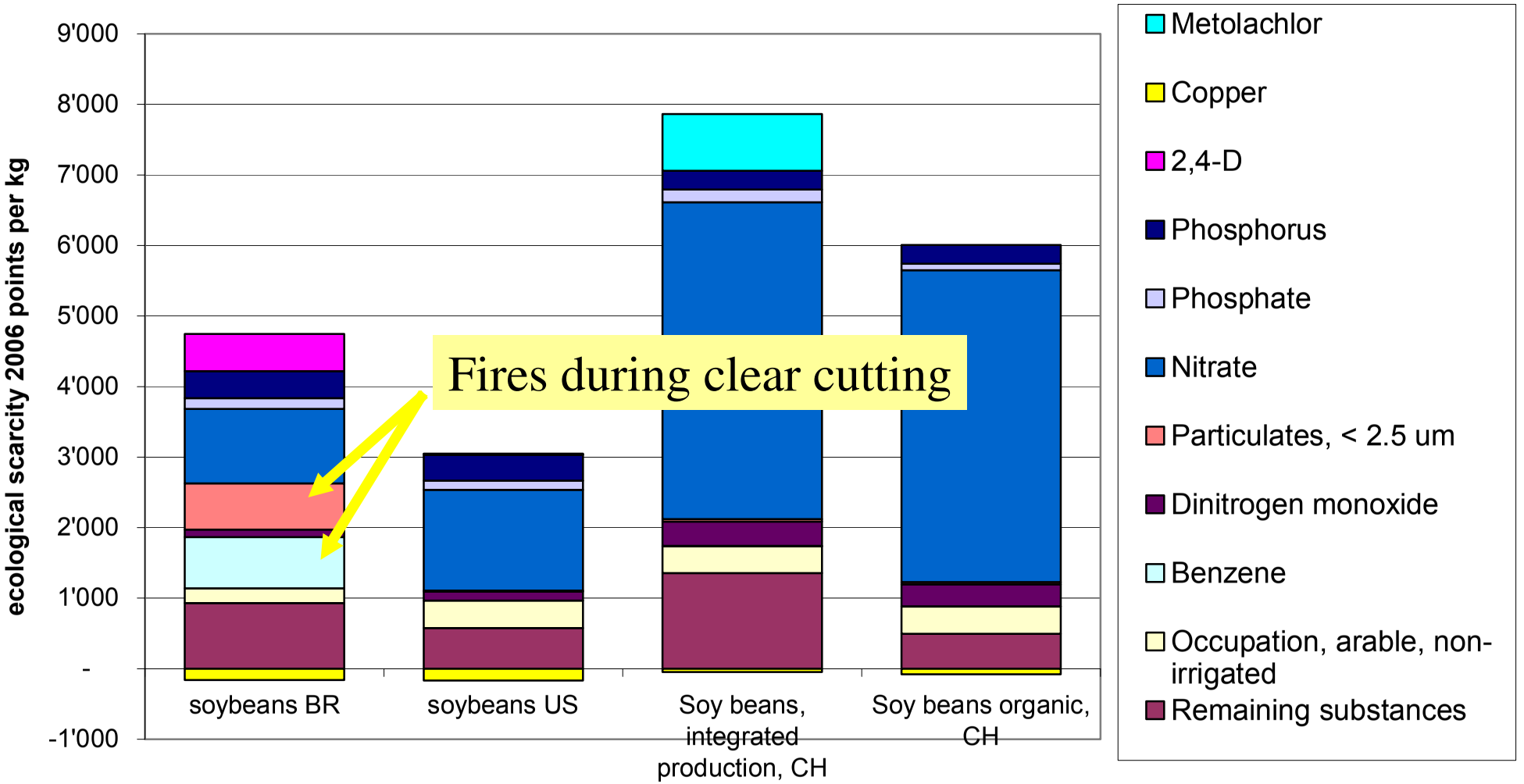
# Inventory agricultural product

| Name | Location | Unit | soybeans, at farm |
|---|---|---|---|
| Location | | | BR |
| InfrastructureProcess | | | 0 |
| Unit | | | kg |
| Occupation, arable, non-irrigated | | m2a | 1.97E+0 |
| Transformation, to arable, non-irrigated | | m2 | 3.93E+0 |
| Transformation, from forest, intensive, clear-cutting | | m2 | 6.22E-2 |
| Transformation, from arable, non-irrigated | | m2 | 3.77E+0 |
| Transformation, from shrub land, sclerophyllous | | m2 | 1.03E-1 |
| provision, stubbed land | BR | m2 | 6.22E-2 |

# Soybean greenhouse gasses

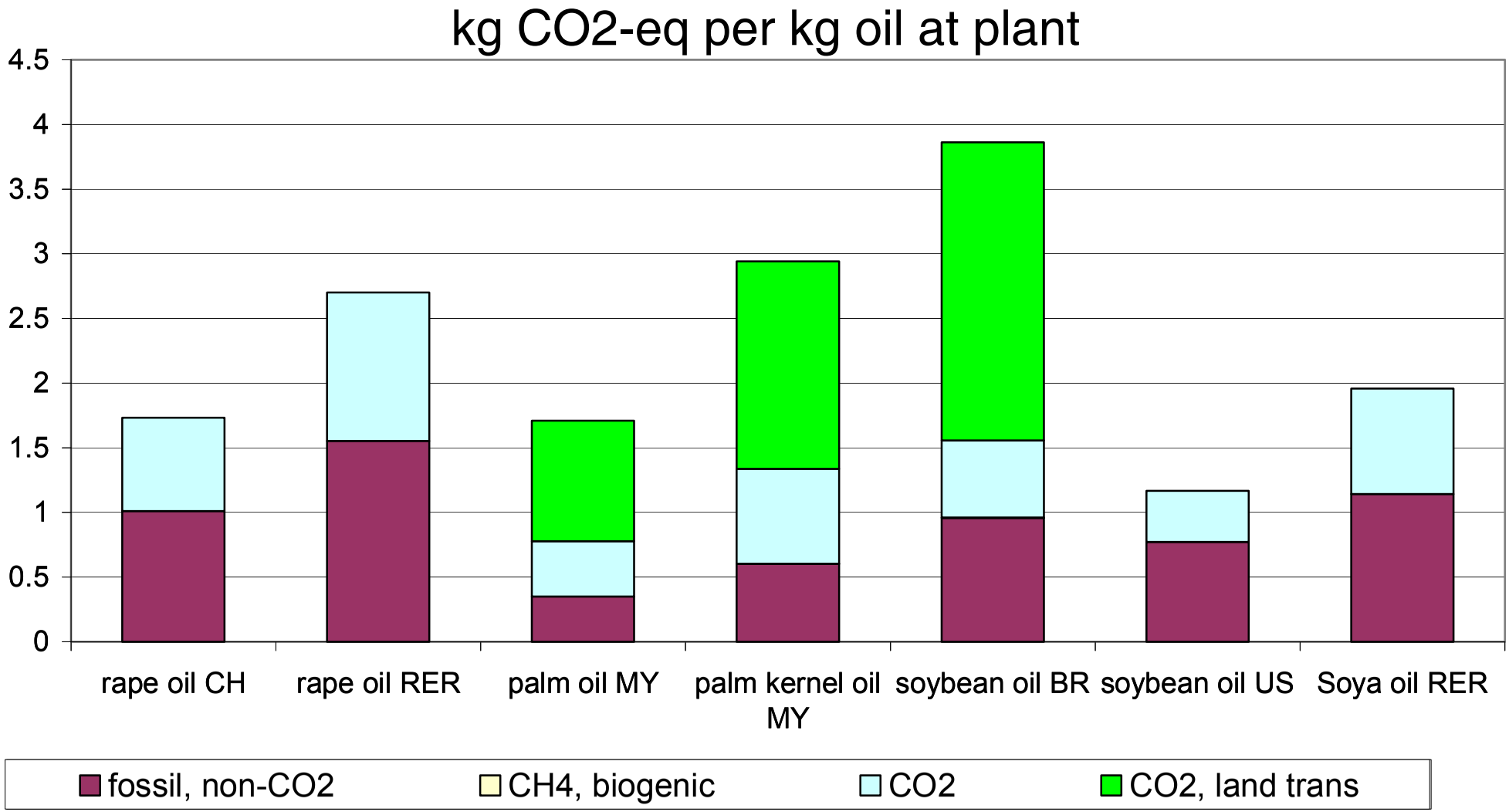


# Soybean (ecological scarcity 2006)




- **Important differences in environmental profile**

# Plant oil production



# Conclusions

- Products show environmental “Achilles’ tendon” in different areas
  => Focus of investigation depends on product analysed
- “Biofuels” example:
  - burning of residues
  - $CO_2$ emissions due to land transformation
  => acknowledge and model regional differences
- ecoinvent data provide the necessary information

# Thanks to participating organisations

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  - Chudacoff Oekoscience, Zürich
  - Doka Ökobilanzen
  - ENERS Energy Concept, Lausanne
  - INFRAS, Bern
  - Swiss Federal Institute of Technology Zürich (ETHZ)
- ecoinvent manager: Rolf Frischknecht, ecoinvent Centre
- Project leader: Niels Jungbluth, ESU-services Ltd.


# Swiss Centre for Life Cycle Inventories

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agroscope
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Research for Agriculture and Nature

# Sugar production of sugar cane

agriculture



Harvest manual/ machinery



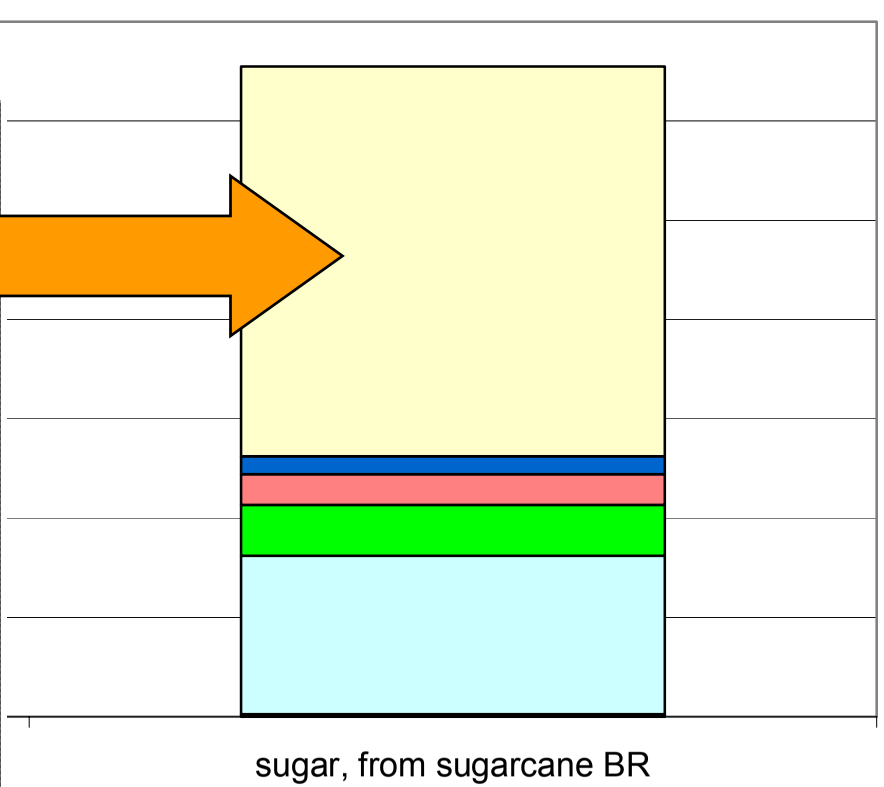
Sugar /Ethanol production



ESU-services
fair consulting in sustainability

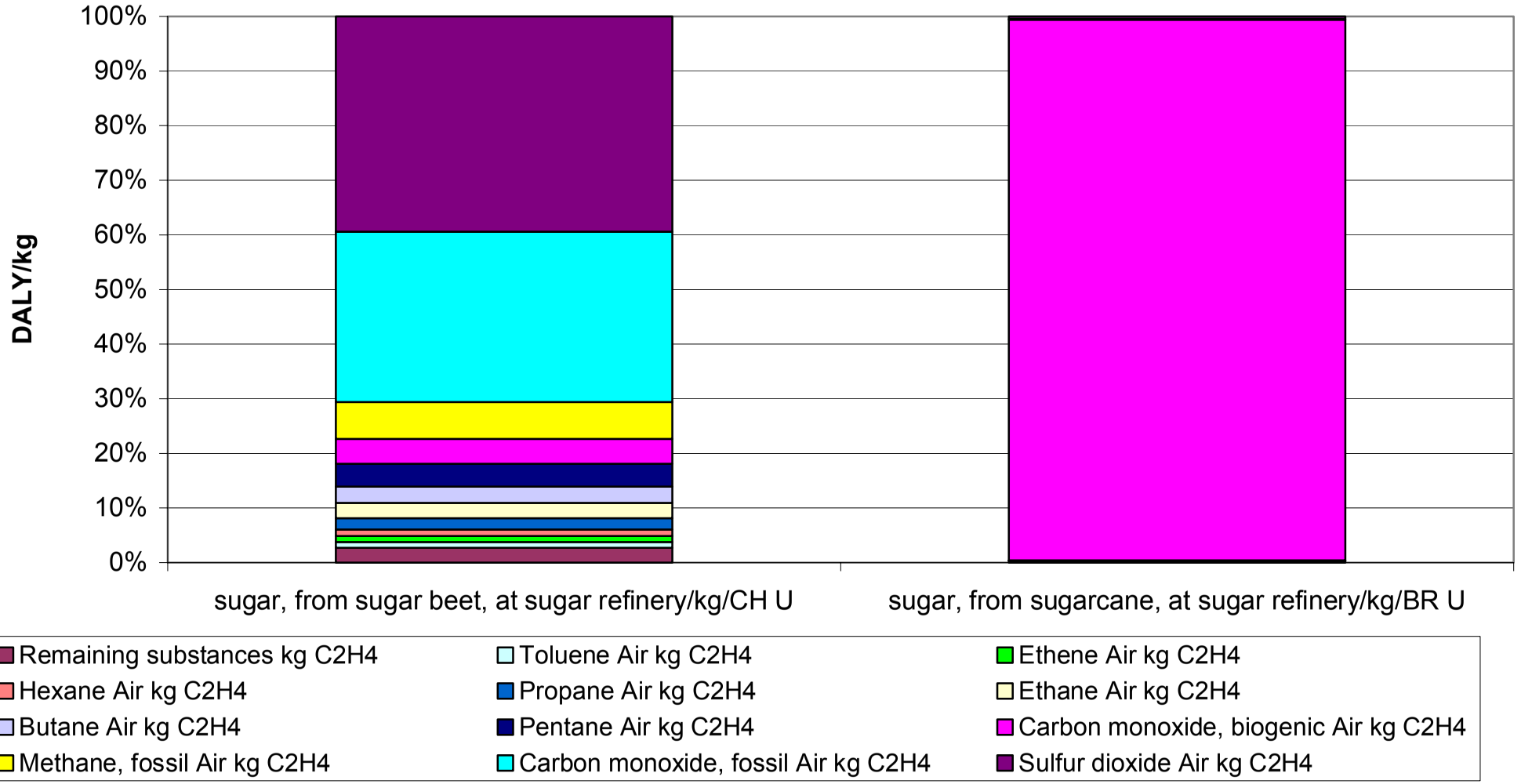
# Sugar production

Figure 2 - The pre-harvesting burn in sugar cane field to eliminate most of the trash.




- **Respiratory effects, inorganic,Eco-indicator 99, (H,A) due to burning of residues**

# Sugar production




- **Respiratory effects, organic, Eco-indicator 99, (H,A) due to burning of residues**