# Biomass production for bioenergy: land-use and climate change

## Considerations for high latitudes

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# RENEWABLE ENERGY IN EUROPE

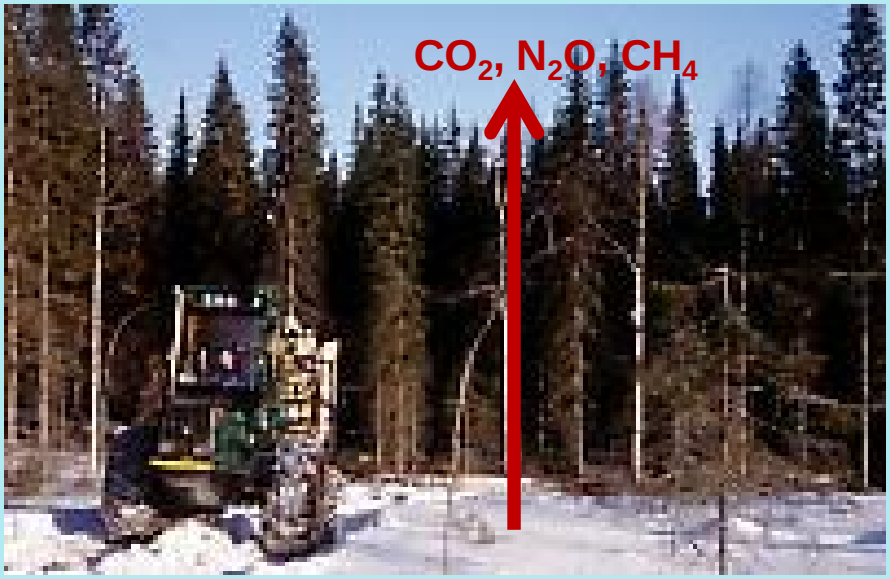
General EU target: 20 % of energy used should be based on renewable energy sources by 2020

Finland by 2020: 38 % of energy should be renewable (was 28.5 % in 2005)

Bioenergy based on forest biomass and bioenergy crops (field biomass) have an important role In the development of renewable energy

# IS BIOENERGY CLIMATICALLY NEUTRAL?

**Carbon dioxide** ← **Carbon dioxide**




Atmos. Chem. Phys. Discuss., 7, 11191–11205, 2007
www.atmos-chem-phys-discuss.net/7/11191/2007/


Atmospheric Chemistry and Physics Discussions

# $N_2O$ release from agro-biofuel production negates global warming reduction by replacing fossil fuels

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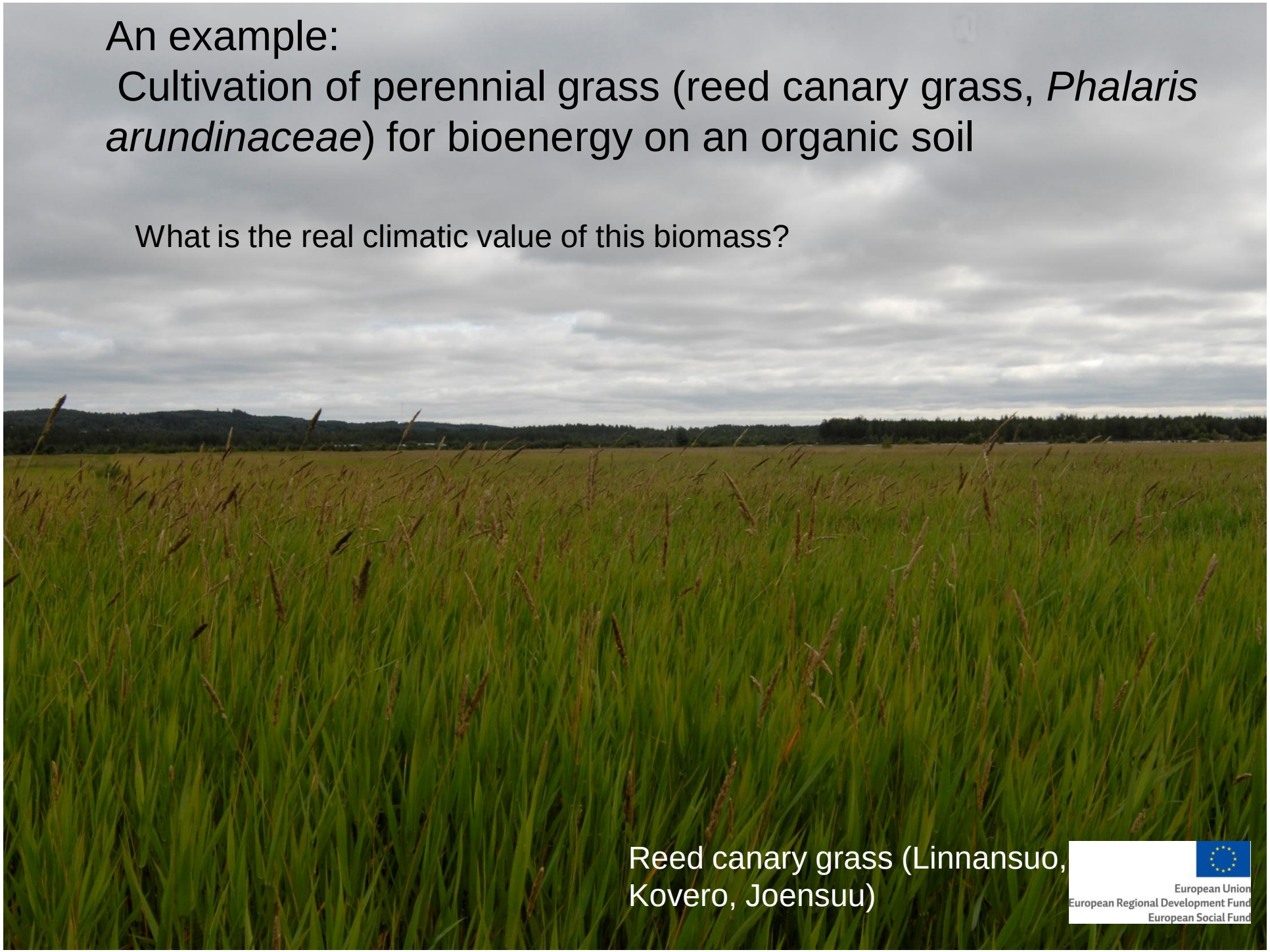
# Annual balance of greenhouse gases ($CO_2$, $CH_4$, $N_2O$) of ecosystems (with peat or mineral soils) used for agriculture or forestry in Nordic countries

| Gas (g $m^{-2}$ $yr^{-1}$) | Peat soils (agriculture) [a] | | | | Mineral soils (agriculture) [c] | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Min | Max | n | Mean | Min | Max | n |
| Net $CO_2$ exchange | 1790 | 290 | 3040 | 7 | -741 | - | - | 1 |
| $CH_4$ flux | 0.123 | -0.24 | 1.56 | 15 | -0.053 | -0.26 | 0.033 | 16 |
| $N_2O$ flux | 1.39 | 0.046 | 5.50 | 19 | 0.342 | 0.050 | 0.64 | 26 |
| **Total GWP as $CO_2$ eq.** | **2200** | | | | **-640** | | | |
| | Peat soils (forests) [b] | | | | Mineral soils (forests) [d] | | | |
| | Mean | Min | Max | n | Mean | Min | Max | n |
| Net $CO_2$ exchange | -900 | - | - | 1 | -480 | -1100 | 760 | 16 |
| $CH_4$ flux | 0.647 | -0.869 | 4.76 | 40 | -0.262 | -0.760 | -0.025 | 11 |
| $N_2O$ flux | 0.324 | >0.001 | 4.10 | 44 | 0.035 | -0.009 | 0.108 | 16 |
| **Total GWP as $CO_2$ eq.** | **-790** | | | | **-480** | | | |

# An example:

Cultivation of perennial grass (reed canary grass, *Phalaris arundinaceae*) for bioenergy on an organic soil

What is the real climatic value of this biomass?



Reed canary grass (Linnansuo, Kovero, Joensuu)

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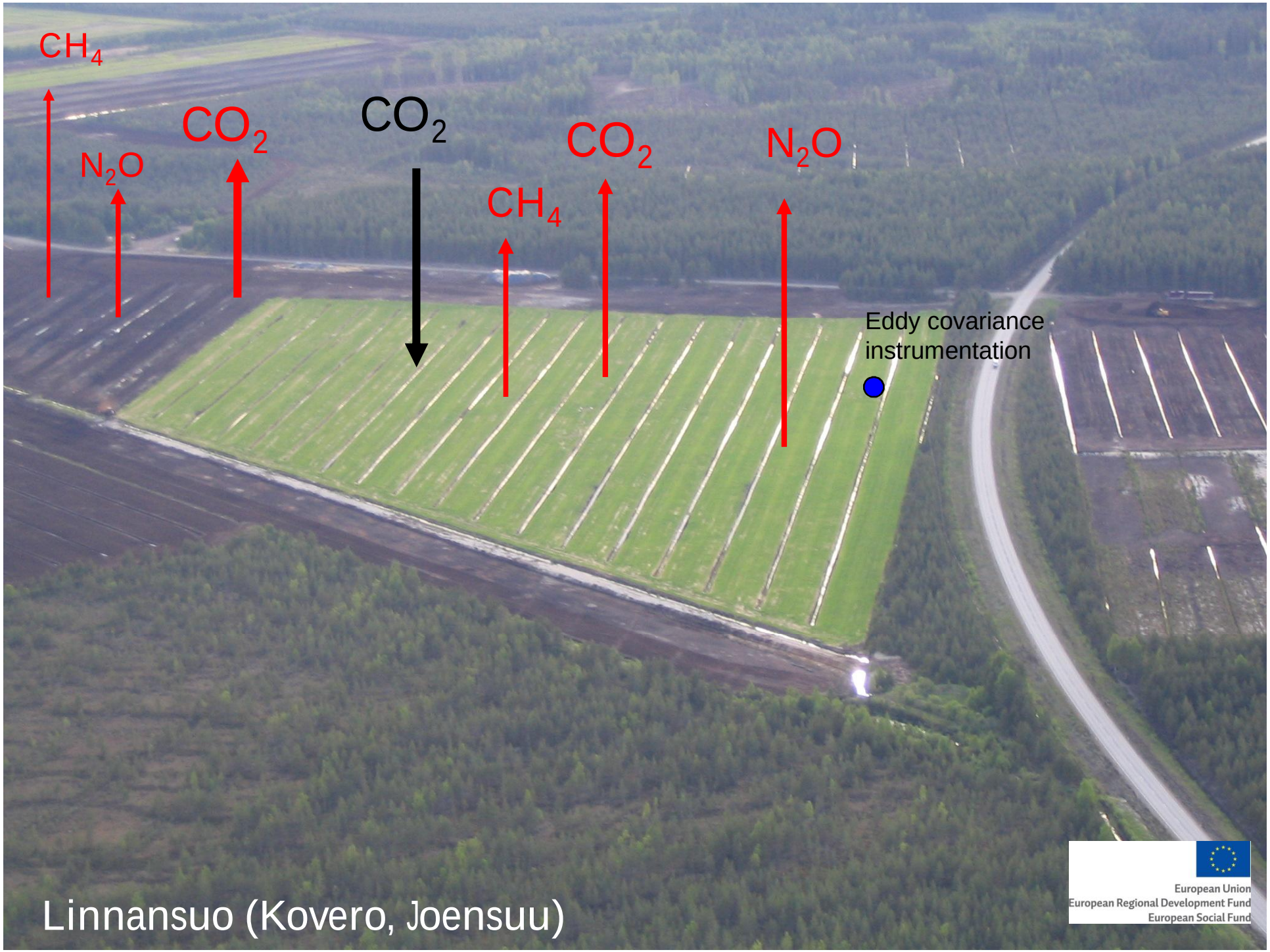
$CH_4$
$N_2O$
$CO_2$
$CO_2$
$CH_4$
$CO_2$
$N_2O$
Eddy covariance instrumentation
Linnansuo (Kovero, Joensuu)
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$CO_2$ balance has been measured in 2004-2007 by eddy covariance method and $N_2O$/$CH_4$ emissions by chamber techniques

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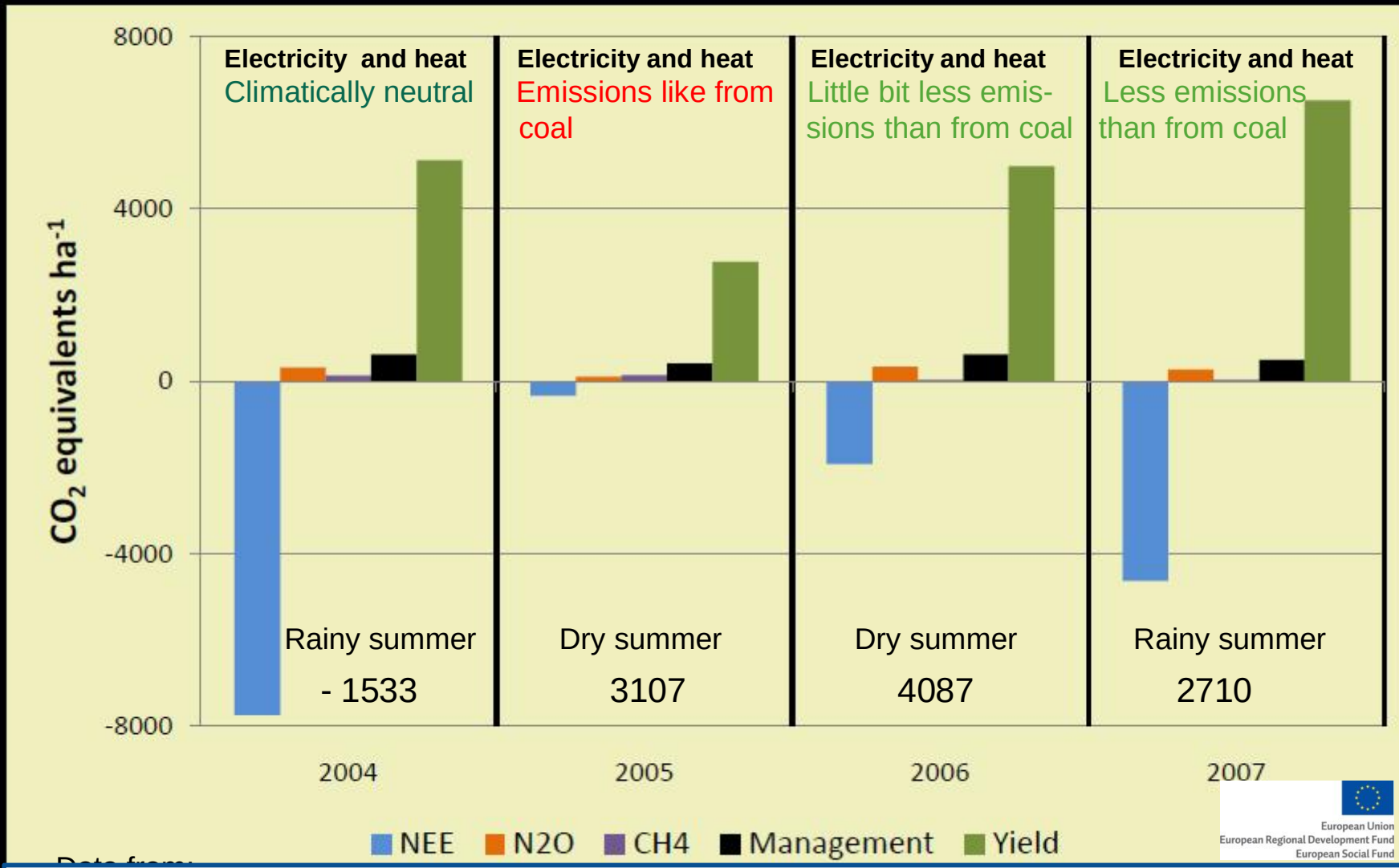
# Components of the reed canary grass life cycle analysis (LCA)




Shurpali et al. 2009. Life cycle analysis (LCA) of a bioenergy crop cultivation on organic soil (manuscript)
Shurpali et al. 2009. Cultivation of a perennial grass for bioenergy on a boreal organic soil – carbon sink or source? Global Change Biology Bioenergy, doi:10.1111/j.1757-1707.2009.01003x
Hyvönen et al. 2009- Fluxes of nitrous oxide and methane on an abandoned peat extraction site: Effect of reed canary grass cultivation Bioresource Technology 100: 4723-4730.

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# What is needed to evaluate how bioenergy reduces the atmospheric greenhouse gas load from energy production

- Just to know the amount of carbon in harvested biomass is not enough

- The gas balance of the whole production chain has to be analyzed (life-cycle)

- The chain starts with the production of biomass (forest biomass , agro-biofuels). The basic question is: What are the real greenhouse gas balances of sites used for biomass production?

  - *We have to know the $CO_2$ exchange between the atmosphere and vegetation + soil. The carbon reservoir of soil can remain constant, decrease or increase. If the cultivation increases the decomposition of soil organic matter, the site can act as a source of $CO_2$ even carbon is bound to biomass.*

  - *What are the emissions of $N_2O$ and $CH_4$?*

- *Climatic impact of bioenergy varies between years depending on the weather conditions which affect annual gas balances and crop yield*

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# KANTIVA

## Themes and WP's

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Research Center at University of Kuopio
for multidisciplinary studies of bioenergy

Issues concerning production and use of bioenergy:

| THEMES | WORKPACKAGES |
|---|---|
| Energy utilisation of biomasses & cleaning technologies of combustion emissions | Clean biomasses |
| | Waste |
| Climate effects | GHG balances in the field and forest biomass production areas |
| | Hydrocarbon emissions from biomass production and use |
| | Fine particle emissions from the use of bioenergy and their climatic effects |
| Health effects | Development of PM sampling techniques for biomass combustion |
| | Health effects from exposure to emissions from wood combustion |
| | Development of toxicity testing methods for biomass PM |
| | Occupational risks and safety |
| Environmental and health risk analysis & regional modelling | Regional modelling |
| | Climate and health risk analyses |

Leverage from the EU 2007–2013