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Bioenergy Environmental Impact Analysis (BIAS)

Impacts of Biofuels on Greenhouse Gas Emissions

Uwe R. Fritsche
Coordinator, Energy & Climate Division
Oeko-Institut e.V. (Institute for applied Ecology), Darmstadt Office

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BIAS: Brief Overview

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- **FAO commissioned joint study from Öko-Institut, IFEU and Copernicus Institute on key environmental issues of bioenergy**
  - Develop Analytical Framework: **methods**
  - **Issues**: Life-Cycle GHG + direct and indirect LUC, air emissions & toxics, biodiversity, water, soil impacts
  - Approach: **compile** existing knowledge, use own analysis and scientific expertise
  - **Define** Data Categories and „Tool Box“
  - Application **not part** of current BIAS activities

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Biomass & Biofuels

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Biomass crops

Residues/wastes

Material Use

Energy Use

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Potential Biofuel Crops

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Biodiesel

Bioethanol

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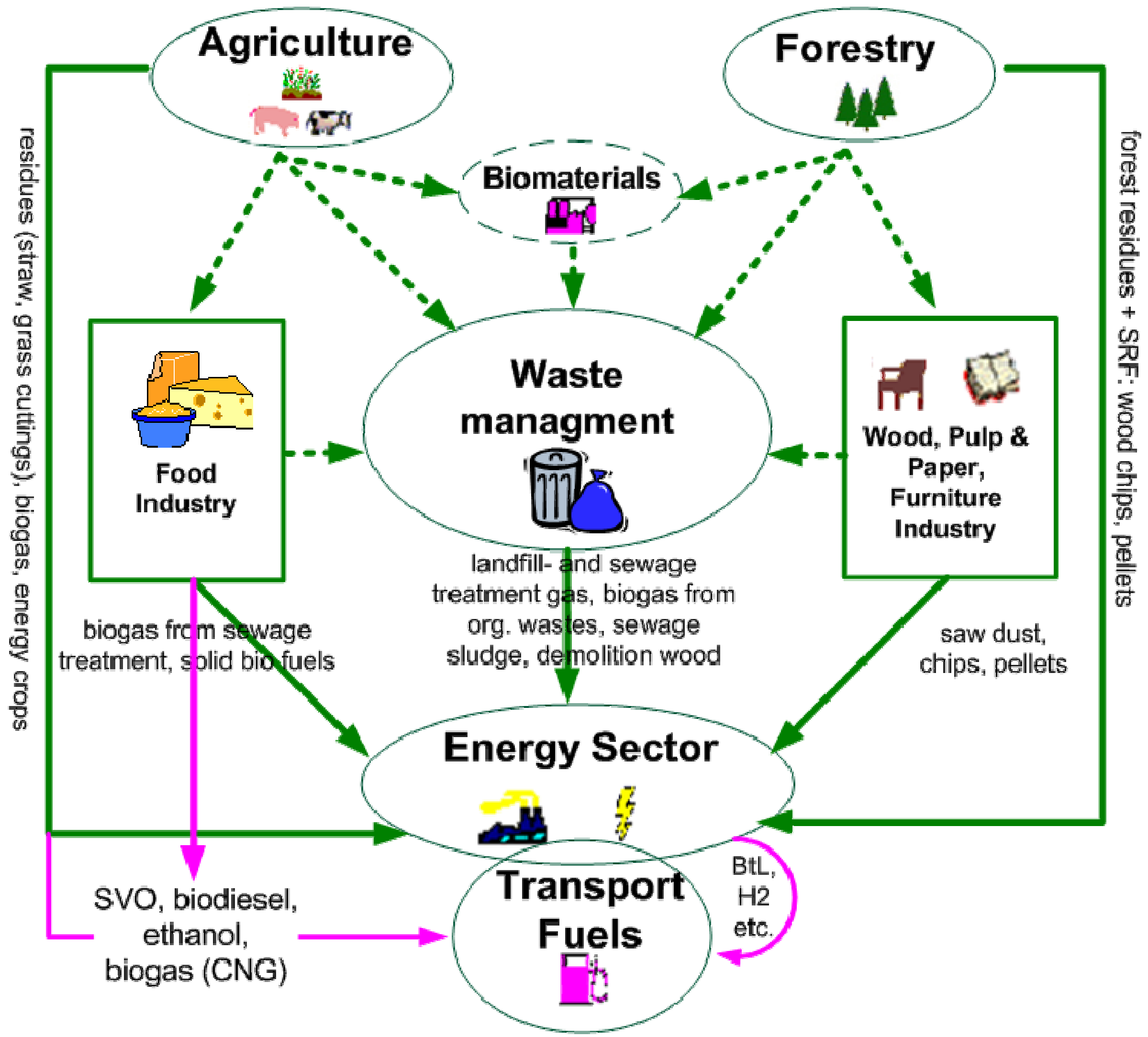
Consider all Bioenergy Flows



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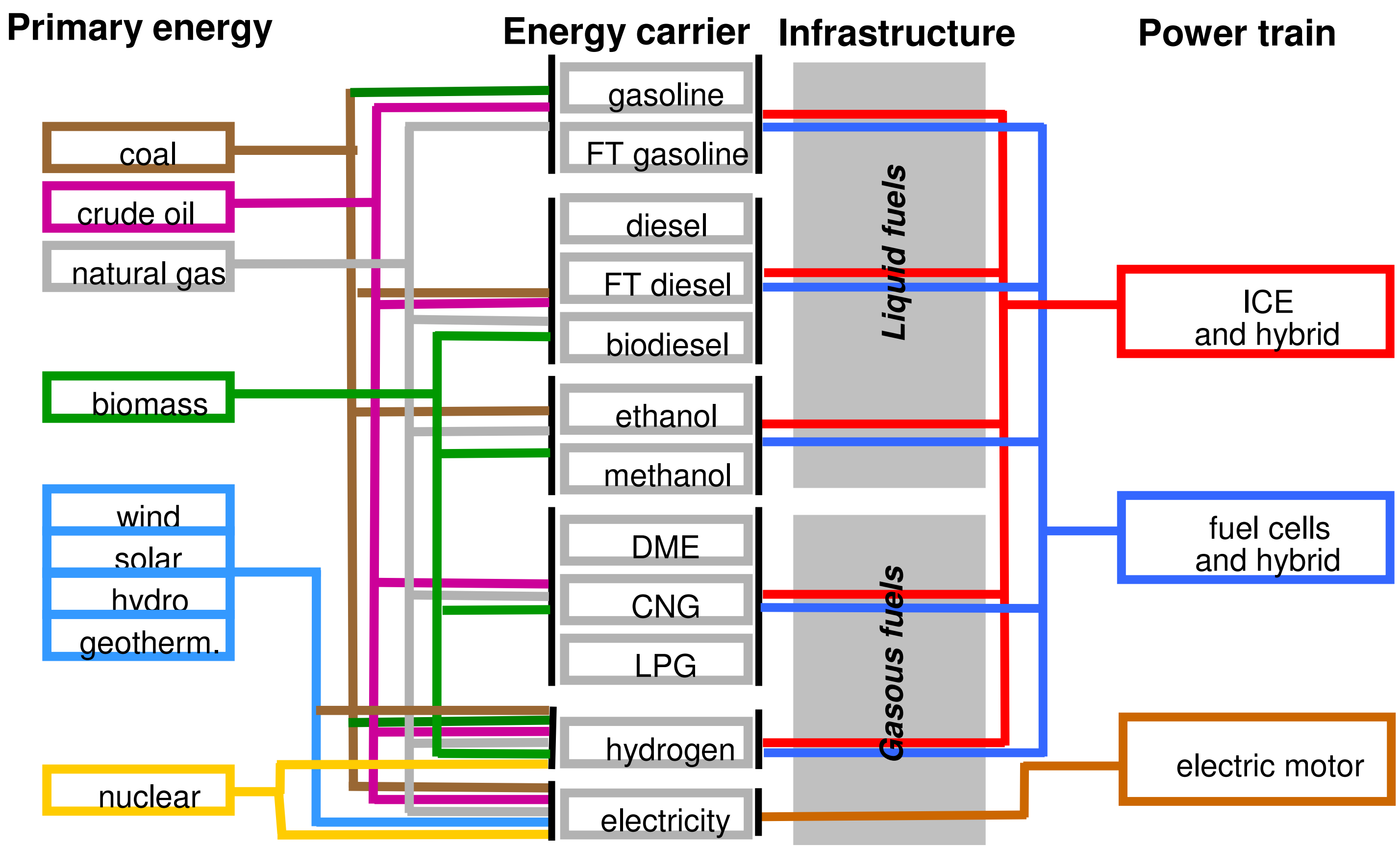

Source: **Based on WBCSD 2004**

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Greenhouse-Gas Emissions

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- **Accounting Issues**
  - Scope and data background
  - Allocation and system boundaries
  - Life-cycle analysis: full fuel-chain approach
  - GHG from direct and indirect land-use change
  - Links to EU and global GHG data and methodologies (EEA, GBEP, UNEP…)

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GEMIS Database

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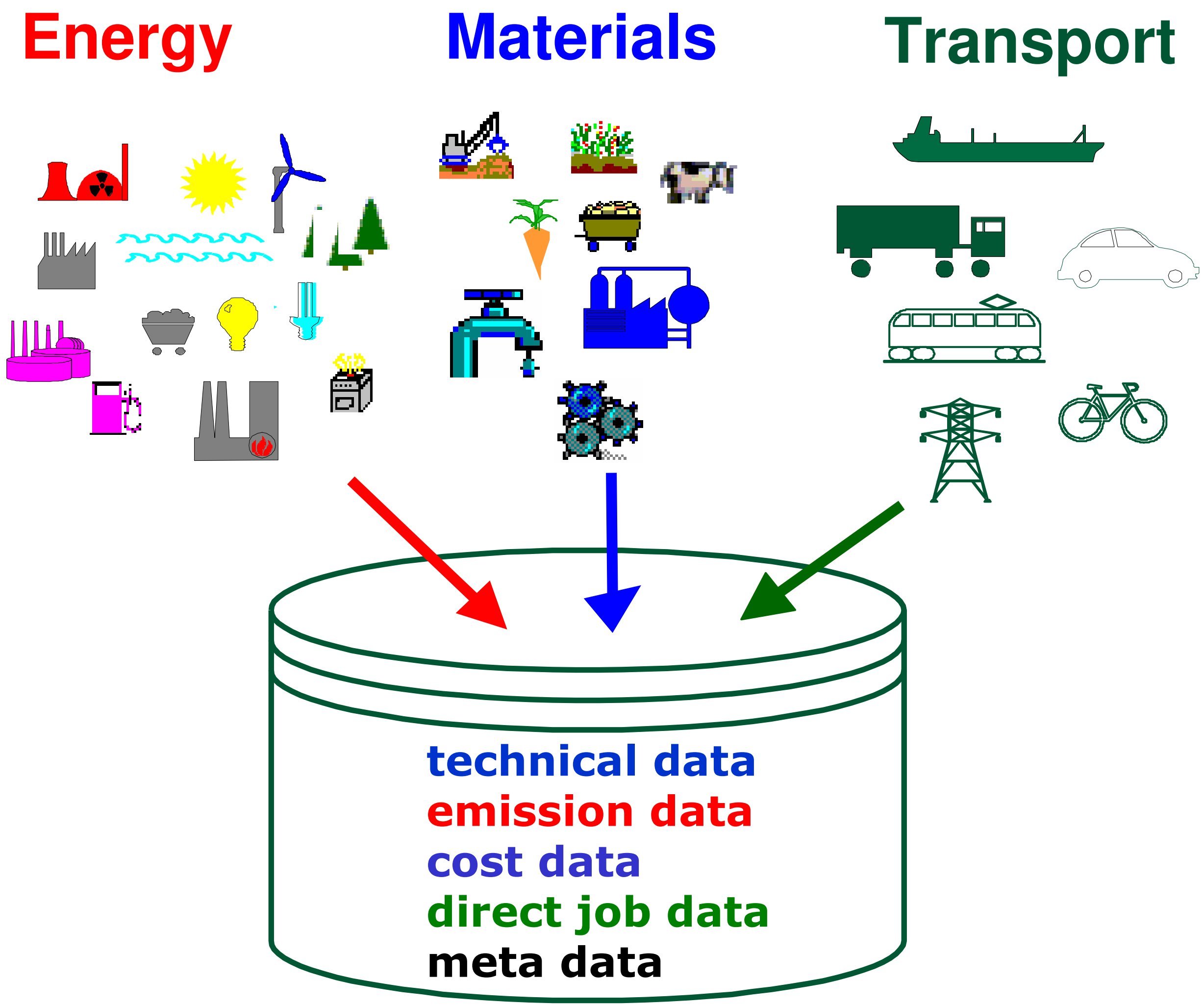

freely available at www.gemis.de

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Life-Cycle GHG Balances

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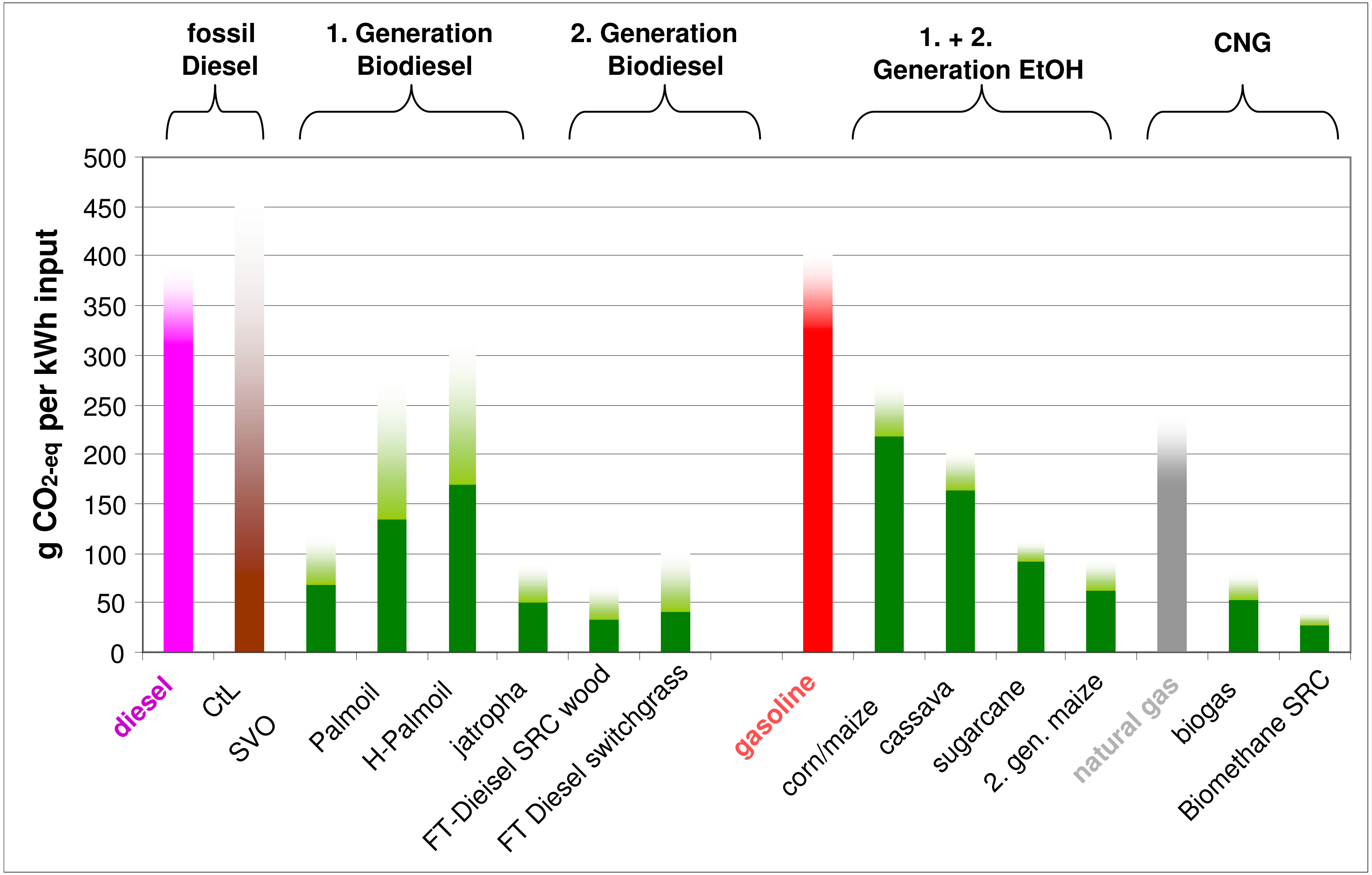

Data include by-product credits, but **no land-use change** (GEMIS 4.4)

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GHG from Land-Use Change

		C-Stock (t C/ha)		$t\ CO_2/ha$	Farming	Emission
Plantation	**Previous use**	**soil**	**above gr.**	**total**	**lifetime (a)**	**$t\ CO_2/ha*a$**
Wheat	Set-aside	-11	0	-40	20	2,0
Wheat	Temperate grassland	-11	0	-40	20	2,0
Wheat	Temperate forest	-23	-35	-213	20	10,6
Sugar beet	Set-aside	-11	0	-40	20	2,0
Sugar beet	Temperate grassland	-11	0	-40	20	2,0
Sugar beet	Temperate forest	-23	-35	-213	20	10,6
Sugar cane	Tropical moist rain forest	-31	-120	-553	20	27,7
Maize	Set-aside	-11	0	-40	20	2,0
Maize	Temperate grassland	-11	0	-40	20	2,0
Maize	Temperate forest	-23	-35	-213	20	10,6
Palm oil	Tropical moist rain forest	-4	-57	-224	20	11,2
Rapeseed	Set-aside	-11	0	-40	20	2,0
Rapeseed	Temperate grassland	-11	0	-40	20	2,0
Rapeseed	Temperate forest	-23	-35	-213	20	10,6
Soy bean	Tropical moist rain forest	-31	-120	-554	20	27,7

<u>Assumptions of LUC from the UK (LowCVP 2007)</u>

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GHG Balance incl. direct LUC

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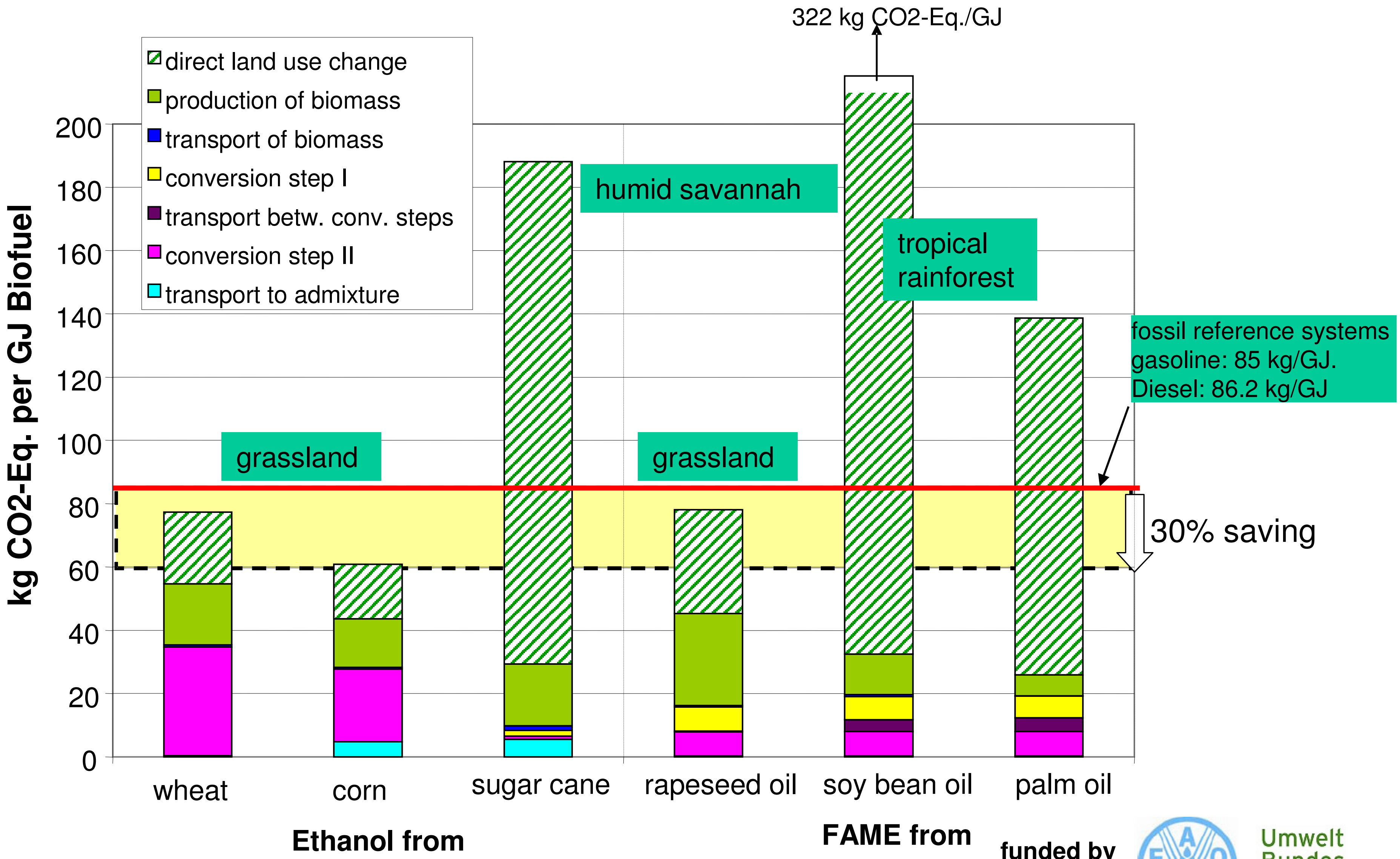

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"Leakage" from Biofuels?

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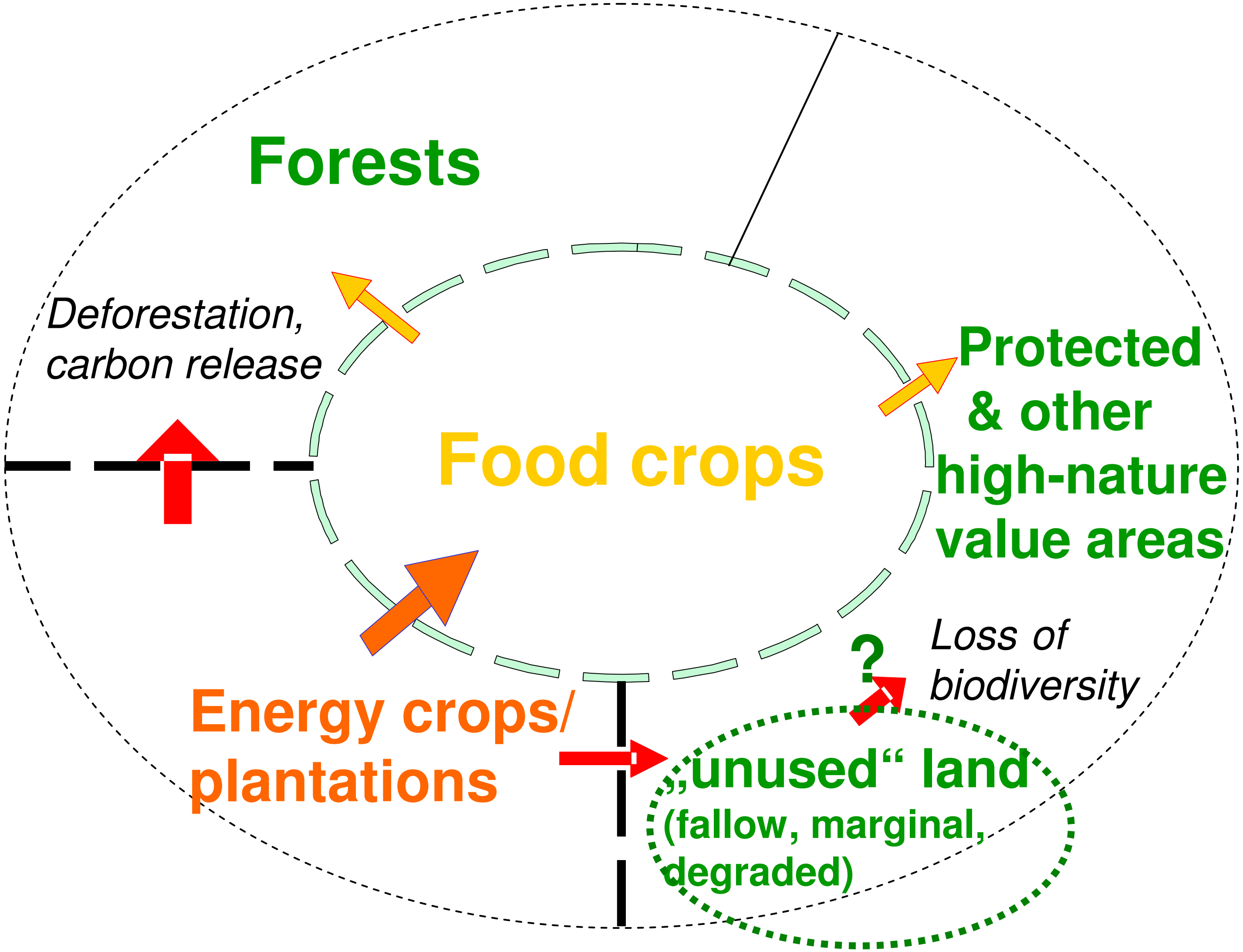

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Source: based on Girard (GEF-STAP Biofuels Workshop, New Delhi 2005)

Leakage: Indirect LUC

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- Leakage = unintentional side-effect(s)
- Biocropping may cause shift of current land-use (e.g., soy, wheat…) to **other** areas; **indirect** land-use **cannot be „traced back“** to project
- Carbon release from indirect land-use change impact **may offset** GHG benefits from biofuels (depending on time horizon)
- Shift of land-use may impact high-nature-value areas

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GHG from indirect LUC

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- **Displacement is a generic problem arising from restricted system boundaries**
  - Accounting problem of partial analysis („just“ biofuels, no explicite modelling of agro + forestry sectors)
  - All incremental land-uses imply indirect effects
- **Analytical <u>and</u> political implications**
  - Analysis: which displacement when & where?
  - Policy: which instruments? Partial certification schemes do not help, but have „spill-over“ effects

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GHG from indirect LUC: risk adder

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Accounting for CO_2 from indirect LUC using the "risk adder" for the GHG balance of biofuels*

	kg CO_{2eq}/GJ with a risk adder level:			relative to fossil diesel/gasoline		
biofuel route, life-cycle	**max**	**med**	**min**	**max**	**med**	**min**
Rapeseed to RME, EU	117	89	60	**38%**	**4%**	-30%
palmoil to PME, Indonesia, rain forest	180	142	103	**112%**	**67%**	**21%**
palmoil to PME, Brazil, tropical	199	154	110	**135%**	**82%**	**29%**
sugarcane to EtOH, Brazil, tropical	60	48	37	-30%	-43%	-56%
maize to EtOH, USA	89	73	57	**5%**	-14%	-33%
maize to EtOH, EU	69	60	50	-19%	-30%	-41%
SRC/SG to BtL, EU	52	37	23	-39%	-56%	-73%
SRC/SG to BtL, Brazil, tropical	59	42	25	-30%	-50%	-70%
SRC/SG to BtL, Brazil, steppe	73	52	30	-14%	-39%	-64%

bold red = **no** GHG reduction!

*= By-product allocation using lower heating value
risk adder is zero for residues/wastes and for biocrops from unused/degraded lands

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GHG from indirect LUC: risk adder

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EtOH sugarcane

Direct LUC:

A conservative: conversion of savannah

B real: conversion of soy cropping

indirect LUC:

C risk sdder (only for B)

D: total

PME Palmoil

Direct LUC:

A conservative: conversion trop. rain forest

B real: conversion of degraded land

indirect LUC:

C no risk adder

D: total

RME

Direct LUC:

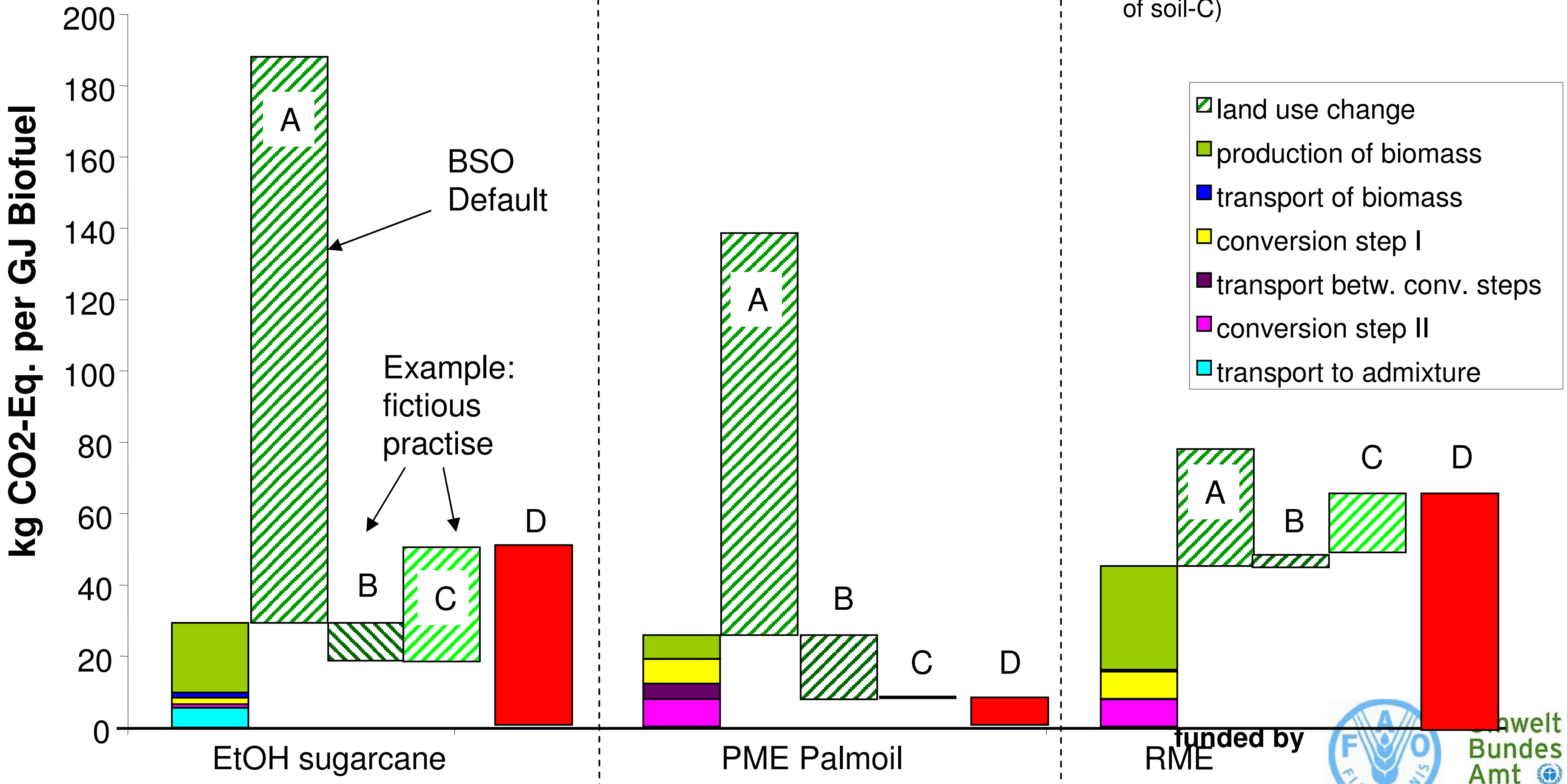
A conservative: conversion of pasture

B real: conversion of wheat crops (small reduction of soil-C)

indirect LUC:

C risk adder (only for B)

D: total



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GHG from indirect LUC: US Data

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Direct Emissions*	Gasoline	Midwest Corn Ethanol	CA Ultra Low Sulfur Diesel**	Canola Biodiesel**	Renewable Diesel** (Palm)
g/MJ	94	88	93	32	21
Indirect emissions by fuel and type of LUC* **	Corn ethanol - CRP	Corn ethanol – tropical forest	Sugarcane ethanol – tropical forest	Canola biodiesel – tropical forest	Palm diesel– tropical forest
g/MJ	140	**540**	289	1031	197
Uncertainty: corn ethanol – tropical forest	20-yr, low emission factor	20-yr, mid emission factor	20-yr, high emission factor	100-yr, low emission factor	100-yr, high emission factor
g/MJ	420	540	826	84	165

*(California Alternative Fuels Plan, CEC-600-2007-004-REV)

** No adjustment for drivetrain efficiency

*** See posted spreadsheet. Assumes 20 year amortization period, among other things.

Source: Presentation of Prof. Michael O'Hare. University of California, Berkely at the CARB LCFS Working Group 3 meeting, Sacramento, CA, January 17, 2008 based on data from Alex Farell (see http://www.arb.ca.gov/fuels/lcfs/lcfs.htm)

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Conclusions (1)

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- GHG emissions become key issue in biofuels trade
- Ccertification needed up from 2009/2010 for EU market access; will become linked to CDM
- GHG emissions must include direct land-use changes, and indirect land-use GHG emissions can be high, need „risk hedging"
- GHG limits for biofuels also reduce (but not avoid) risk of negative biodiversity impacts

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Conclusions (2)

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- So far, only few developing countries deal with life-cycle GHG emissions of biofuels (AR, BR, TH…)
- FAO should actively support countries in dealing with GHG accounting, and related certification; cooperation with UNEP needed, work with GBEP GHG Task Force
- Biogas/biomethane have low GHG profile, but often ignored → need more attention

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Biomethane: local & global

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Biomethane from compressed biogas in New Delhi, India

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Information & Contact

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www.oeko.de/service/bio

contact: u.fritsche@oeko.de

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