Environmental data for hemp: Review of existing studies and new insights from nova-Institute

11th EIHA conference
Wesseling, 2014-05-21

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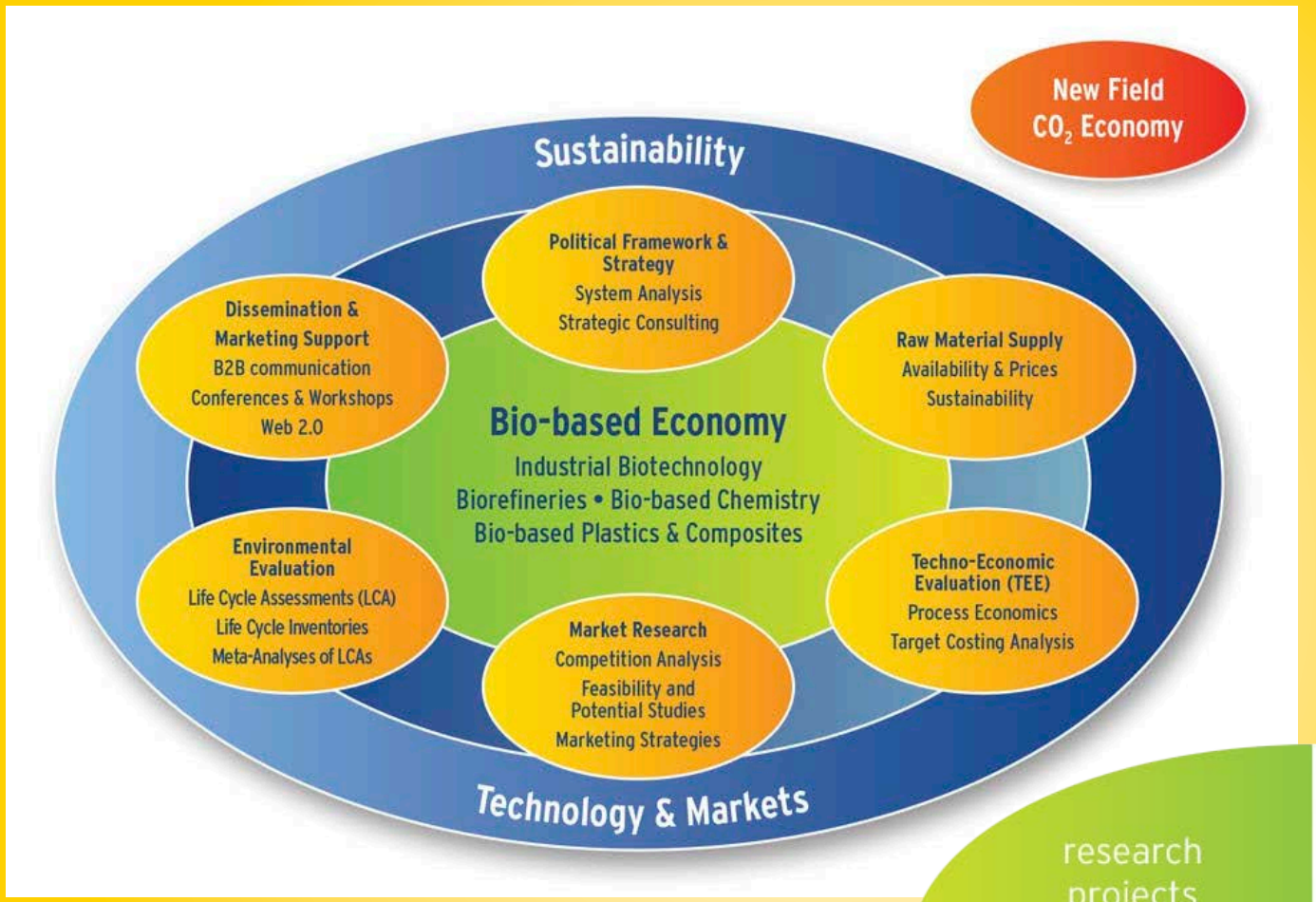
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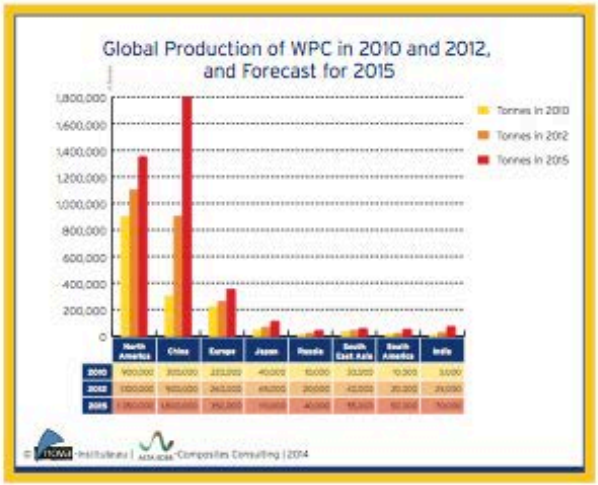
WPC/NFC Market Study 2014-03

Wood-Plastic Composites (WPC) and Natural Fibre Composites (NFC): European and Global Markets 2012 and Future Trends

Authors: Michael Carus, Dr. Asta Eder, Lara Dammer, Dr. Hans Korte, Lena Scholz, Roland Essel, Elke Breitmayer



Download this study and further nova market studies at:
www.bio-based.eu/markets

Source: Carus & Eder et al. 2014

Many of the following figures are coming from this market study

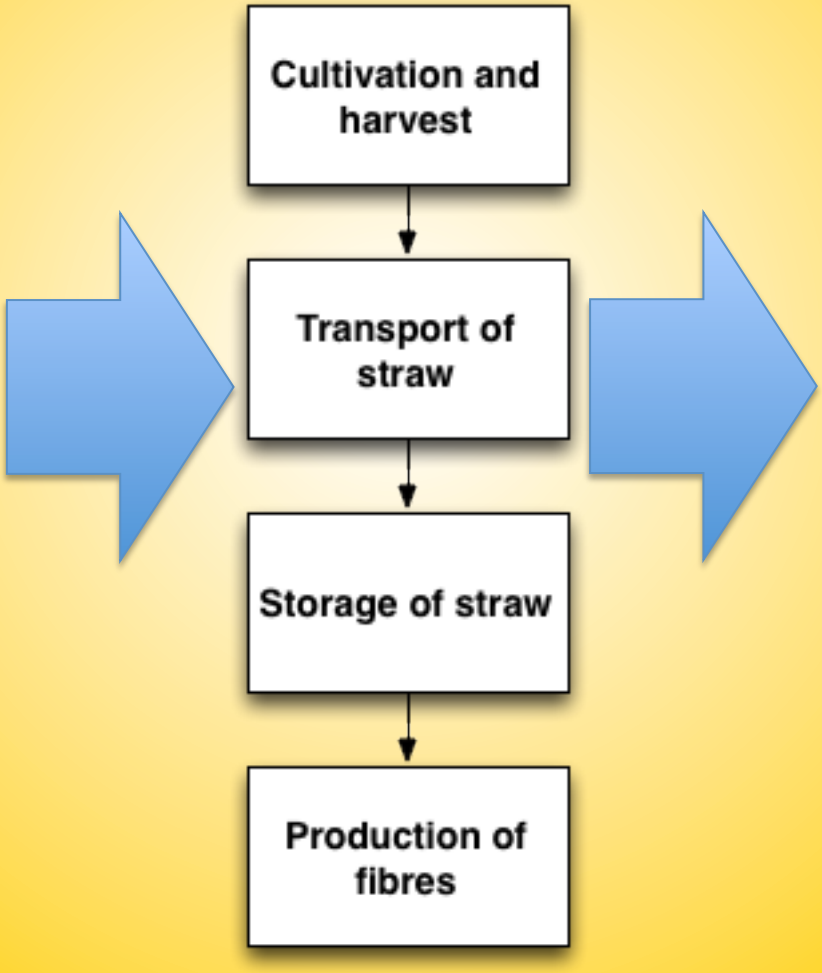
Please see www.bio-based.eu/markets

Life Cycle Assessment (LCA) on Natural Fibres

Life cycle of hemp fibre production ("cradle-to-gate")

Inputs

- Materials (fertilizer, pesticides, etc.)
- Energy flows (electricity, heat, etc.)



Outputs

- Materials (products, by-products)
- Emissions (carbon dioxide, etc.)

Agricultural production stages during the crop cycle

Tillage and fertilizer application

Sowing

Harvesting technique 1

Harvesting technique 2

Haying

Baling

Comparison of fertilizer inputs

	Hemp (European field survey 2013)	Kenaf (Malaysia field survey 2013)
Nitrogen Kg N / ha	50 - 100	100 - 150
Phosphorus Kg P_2O_5 / ha	0 - 75	25 -75
Potassium Kg K_20 / ha	50 - 150	75 - 100
Sources	European field trials, literature data	LKTN standard manual (Malaysia), field trials (Italy), literature data (USA)

Comparison of pesticide and herbicide inputs

	Hemp (European field survey 2013)	Kenaf (Malaysia field survey 2013)
Glyphosate kg / ha	4*	4
Metolachlor kg / ha	0	4
Glyphosateisoprophyl amine kg / ha	0	2 – 6
Others	0	?

* Some hemp famers are using Glyphosate before sowing (roundup).

Fibre production with the total fibre line

Intake conveyor

Guillotine

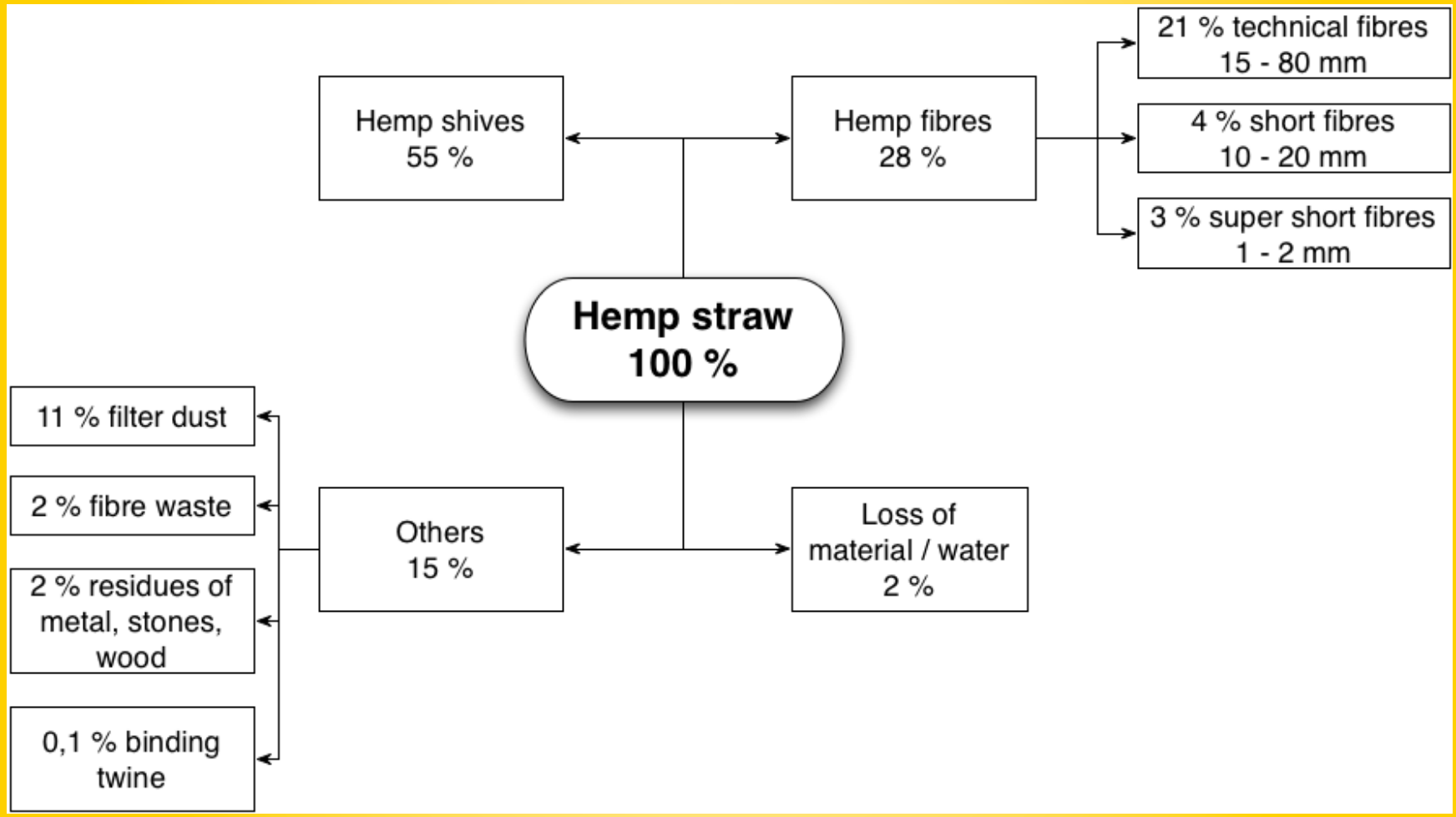
Shredder / bale opener

Hammer mill

Refiner

Fibre baling

Average material flows of hemp fibre production



Source: EIHA 2012

Energy use for fibre production

Reference	Essel (2013)	NNFCC (2010)	Carus et al. (2008)	Cherrett et al. (2005)	Munder et al. (2005)
Purpose	Fibre	Fibre	Fibre	Textiles	Fibre
Electricity use (kWh / t fibre)	310	336	130	150	20 - 50
Diesel use (l / t fibre)	1,666	-	-	-	-
Remarks	Total fibre line	Total fibre line	Decortication only	Decortication only	Decortication only

Greenhouse gas emissions

Small differences between different Natural Fibres

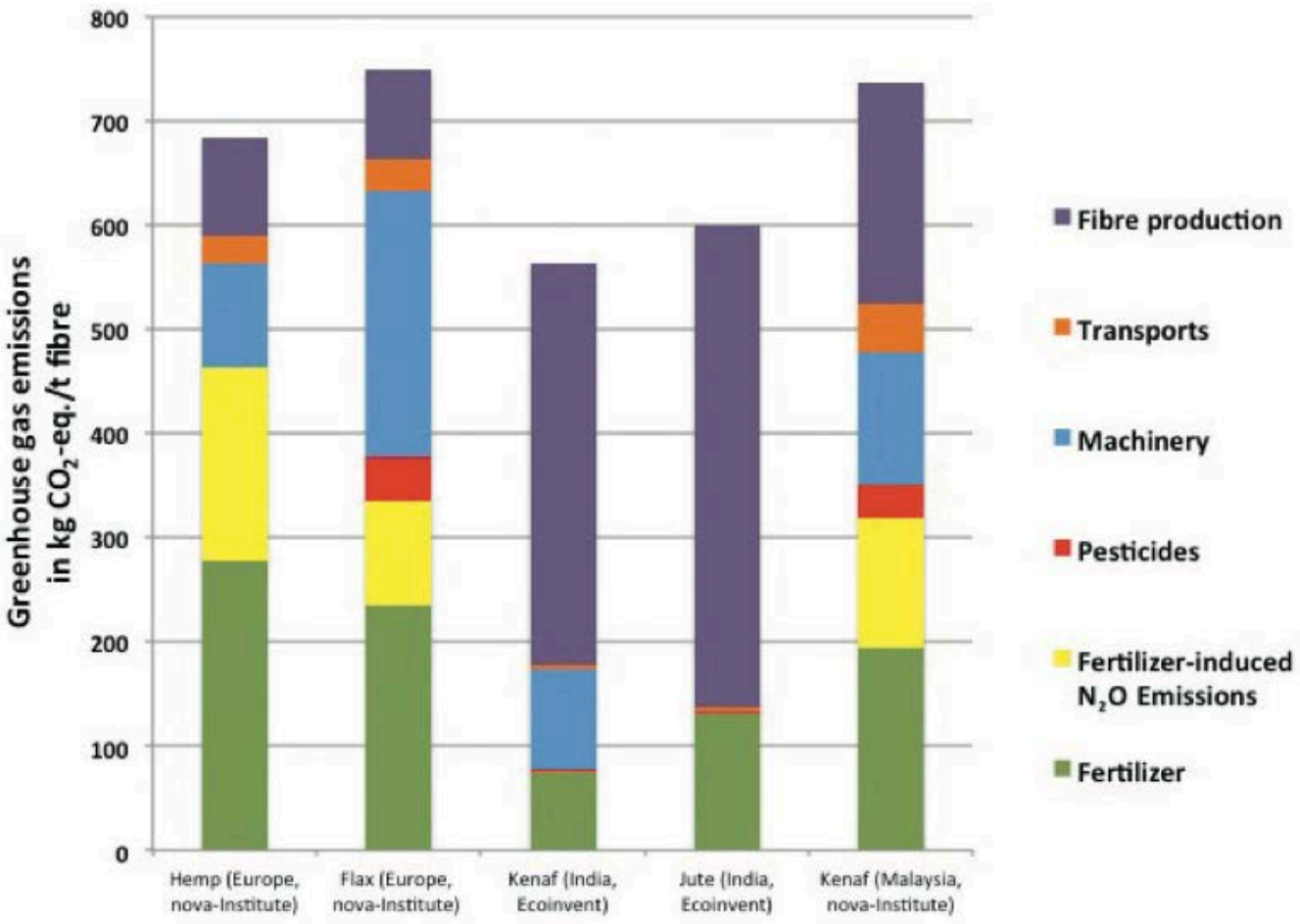


Figure 11.2: Comparison of the greenhouse gas emissions of different natural fibres (nova 2014, Ecoinvent 2010)

Source: Carus & Eder et al. 2014

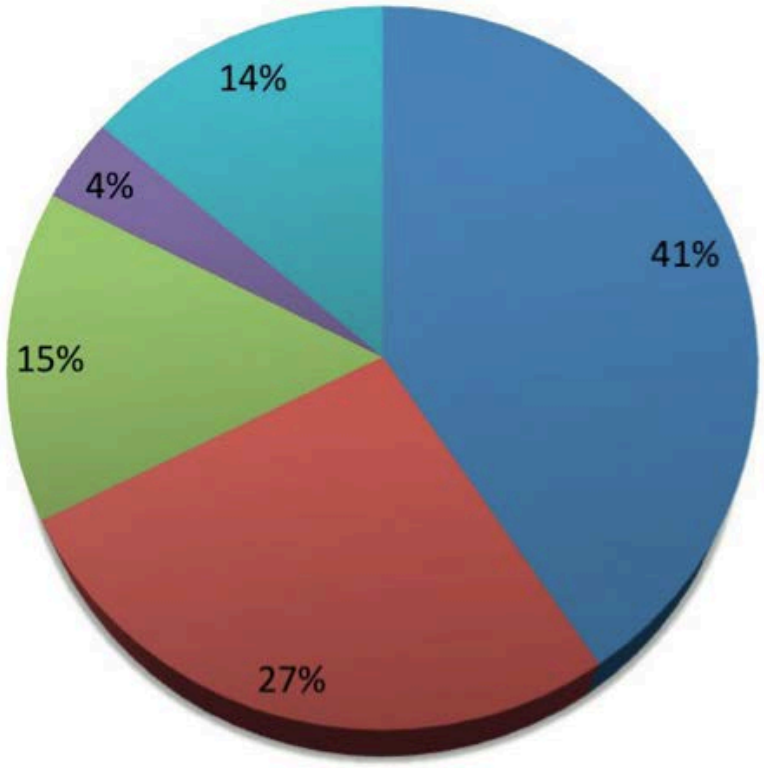
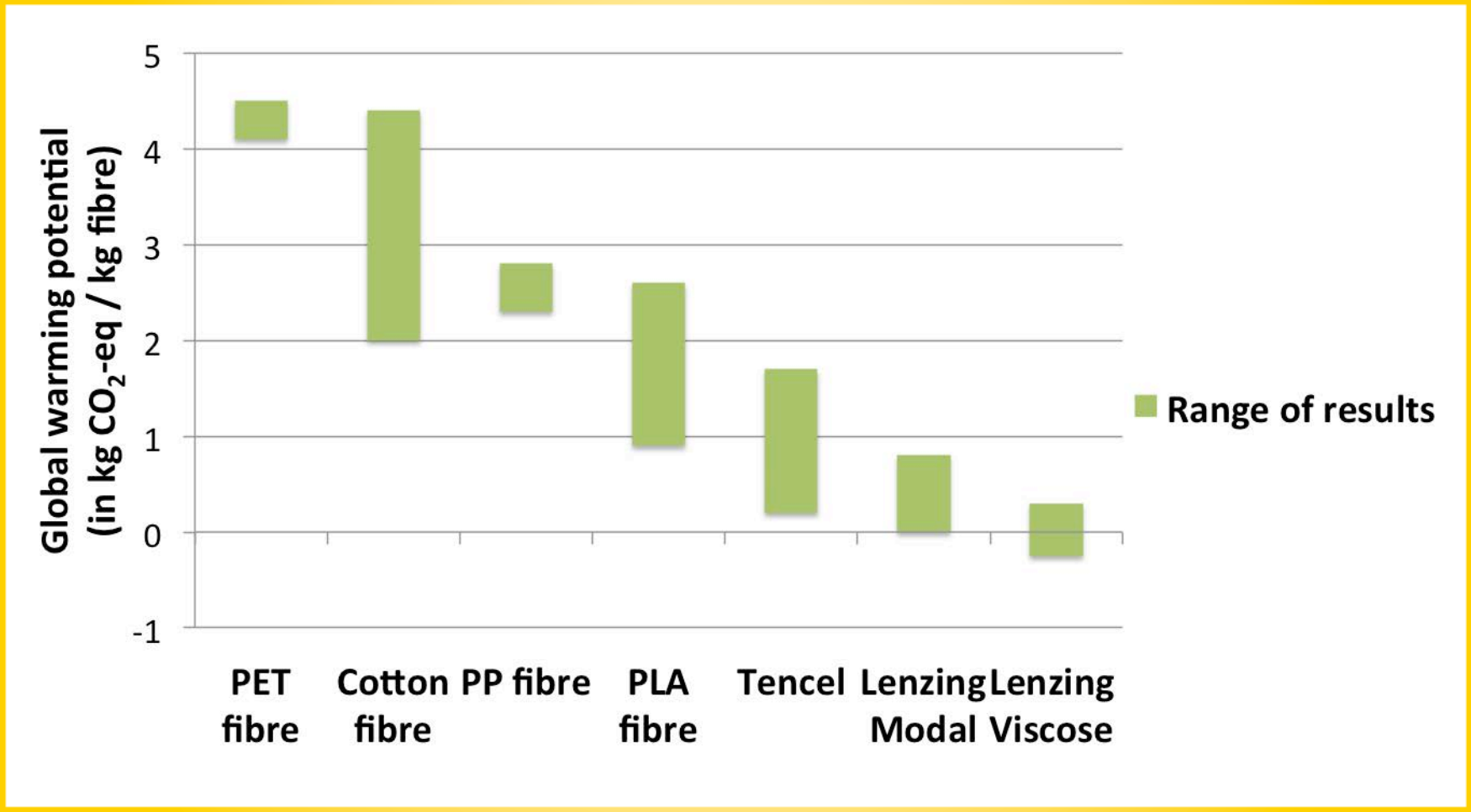


Figure 11.1: Impact of different production steps on the overall greenhouse gas emissions of hemp fibre production in Europe (Haufe & Carus 2011).

Shares of different processing steps to total GHG emissions

Source: Carus & Eder et al. 2014

Comparison with other natural and man-made fibres



Data from literature review

Source: nova 2013

Huge differences between Natural Fibres and synthetic fibres

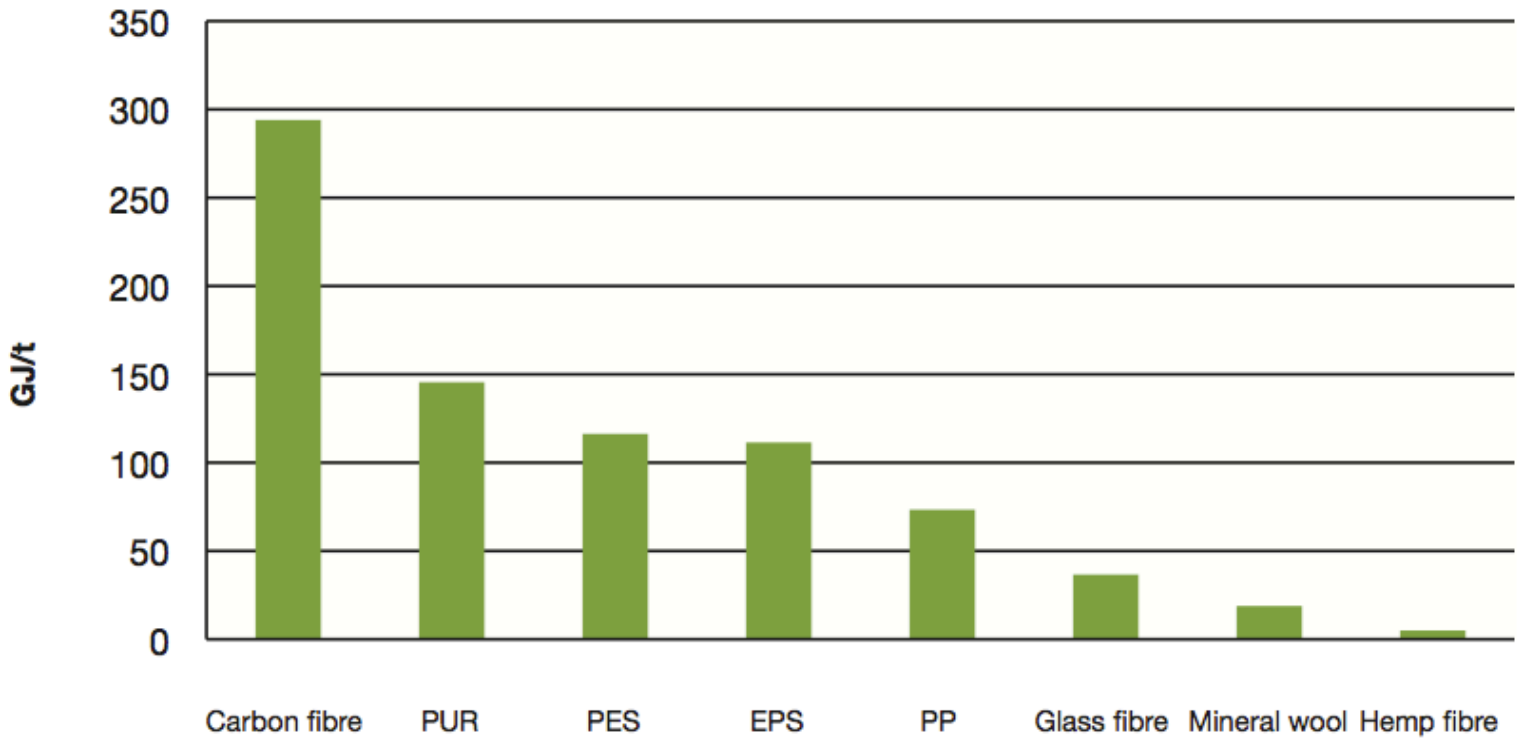


Figure 11.3: Resource depletion of different materials in gigajoules per tonne (Haufe & Carus 2011)

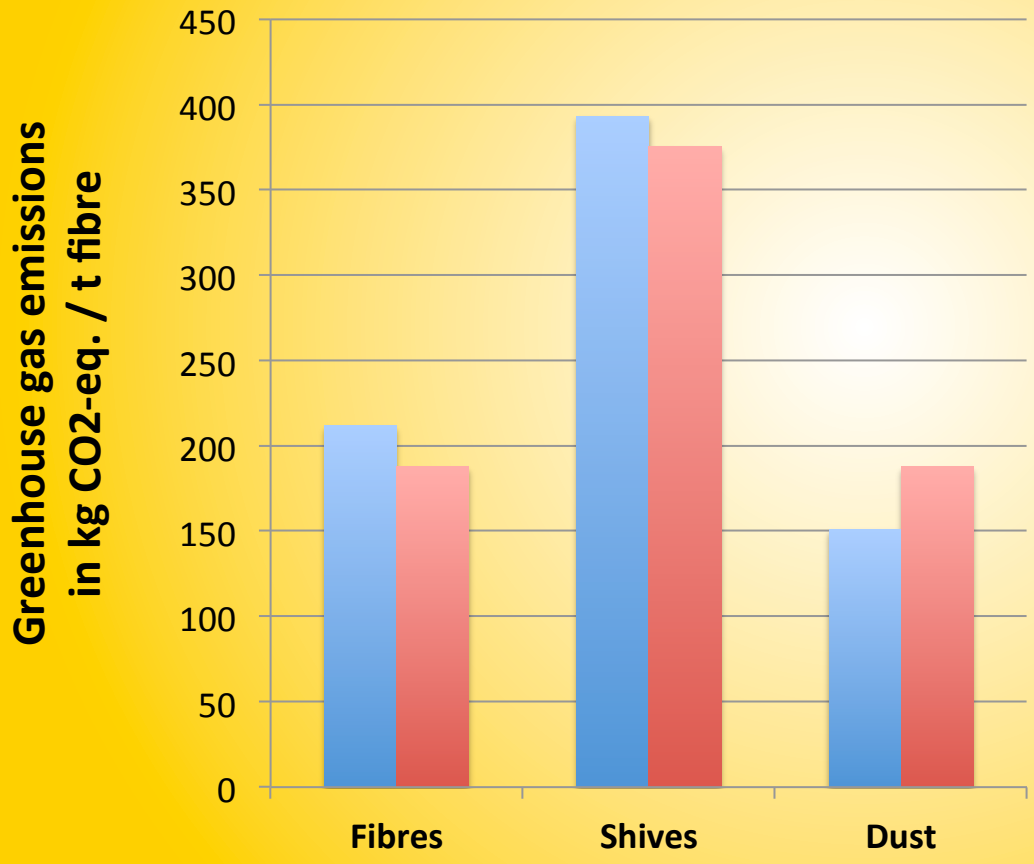
Source: Carus & Eder et al. 2014

Allocation of environmental impacts

Allocation of environmental impacts

- Hemp and flax fibre production are multi-output processes producing fibres, shives and dust (filter dust, metals stones, fibre wastes etc.)
- Allocation procedures are necessary to allocate the environmental impacts on the products and by-products by
  - mass
  - economic value
  - energy content (not useful for fibres)

Allocation by mass for hemp and flax



Product / by-product	Mass distribution (%) for hemp total fibre line
Fibres	28
Shives	52
Dust	20
TOTAL	100

Greenhouse Gas Emissions

Biocomposites & Insulation

Highest share for the epoxy resin

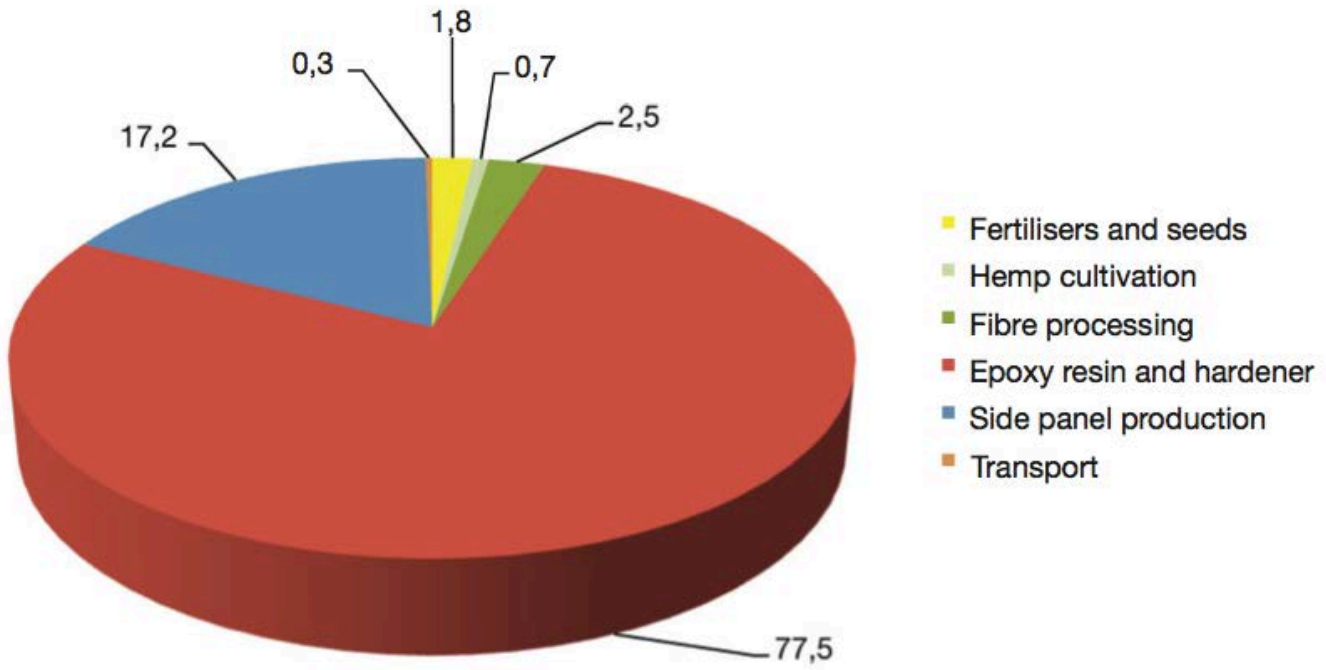
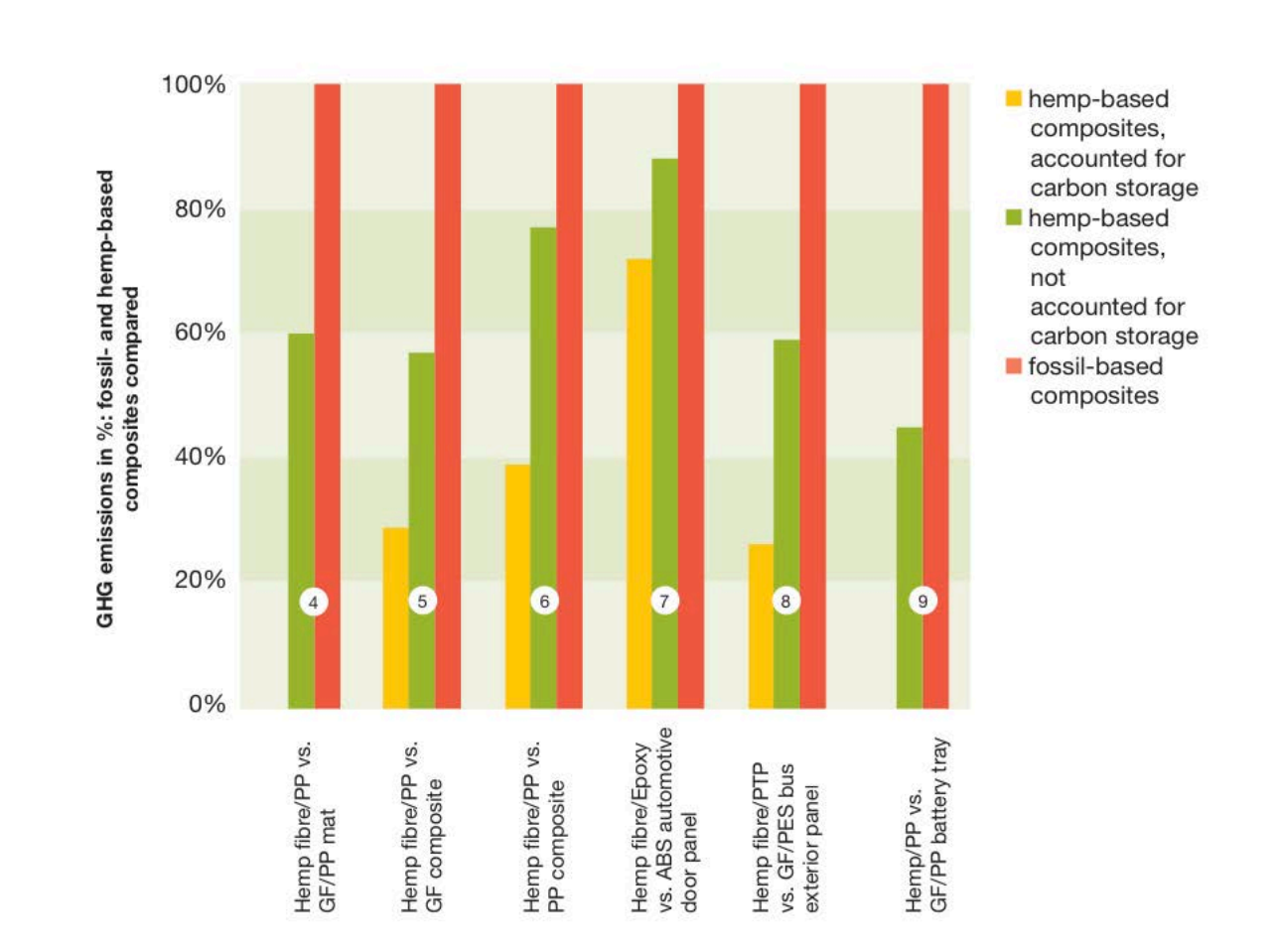


Figure 11.4: Cradle-to-gate energy use of hemp fibre/epoxy door panels for the automotive industry. Data is given in percentage (Haufe & Carus 2011)

Source: Carus & Eder et al. 2014

GHG emissions in % for the production of fossil-based and natural fibres-based composites: Impressive results!



Source: Carus & Eder et al. 2014

How to compare biofuels with hemp biocomposites?

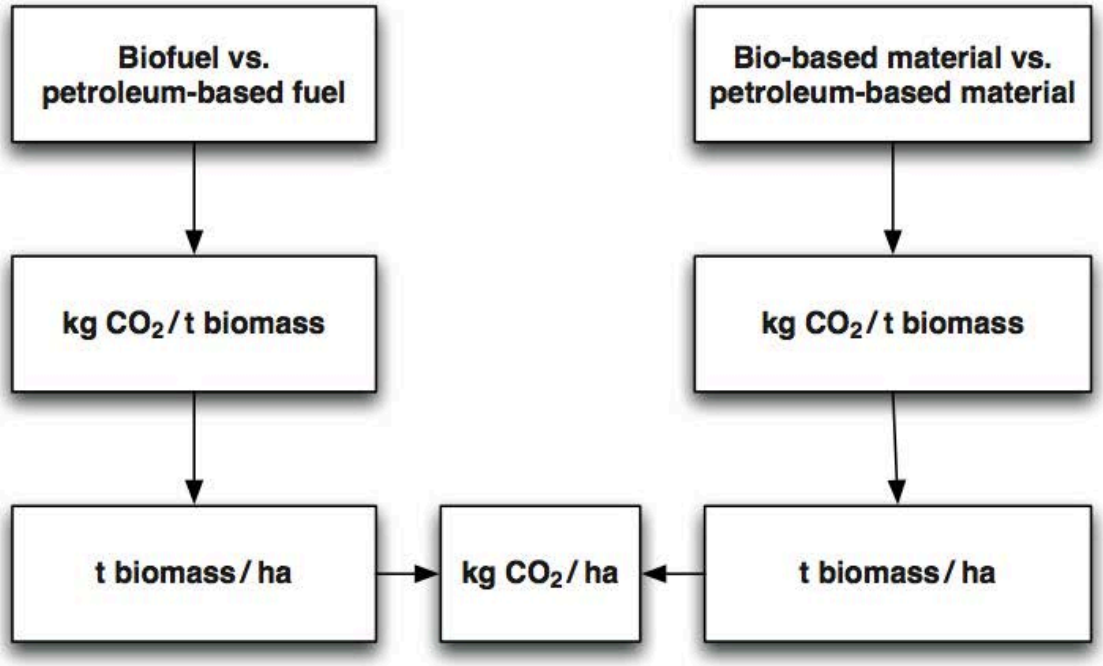
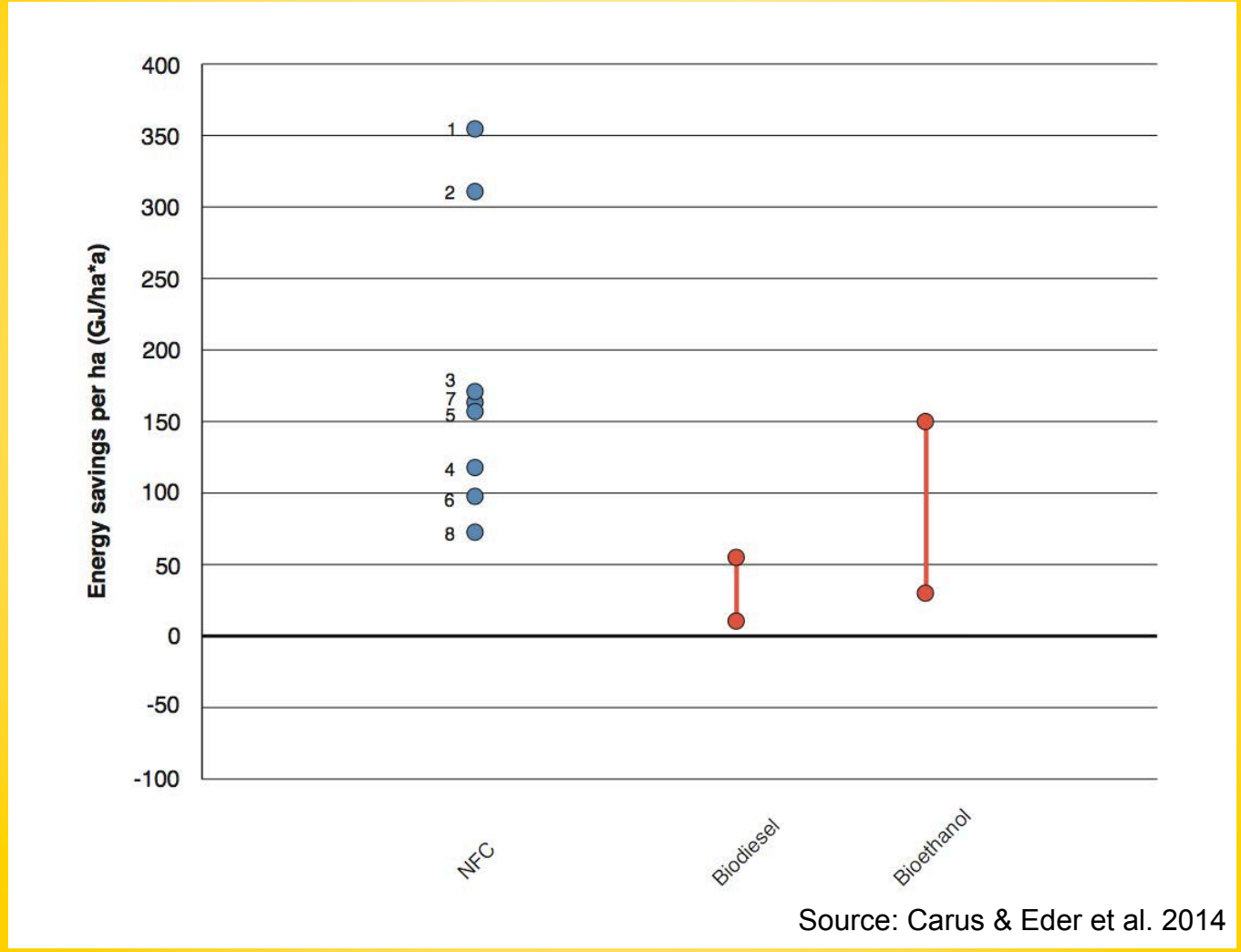


Figure 11.6: Example illustration of the methodology used (nova 2014)

Source: Carus & Eder et al. 2014

Hemp Fibre Composites can be better than Biodiesel and Bioethanol!



Source: Carus & Eder et al. 2014

Detailed LCA data for insulation material

Final LCA background report

LCA:TIM project

LCA: Ten Insulation Materials

"Het opstellen van regels, het uitvoeren van levenscyclusanalyses inclusief dataverzameling en het geven van beleidsaanbevelingen m.b.t. vijf niet-hernieuwbare (glaswol, rotswol, PUR, EPS, XPS) en vijf hernieuwbare (schapenwol, papiervlokken, vlasisolatie, houtvezelisolatie, hennepisolatie) thermische isolatiematerialen voor spouwmuren"
(Bestek met nummer: DG5/PP/DDL/11032)

Task 2 - Life cycle assessment of thermal insulation materials for walls in the Belgian building context

Good results for Thermohanf

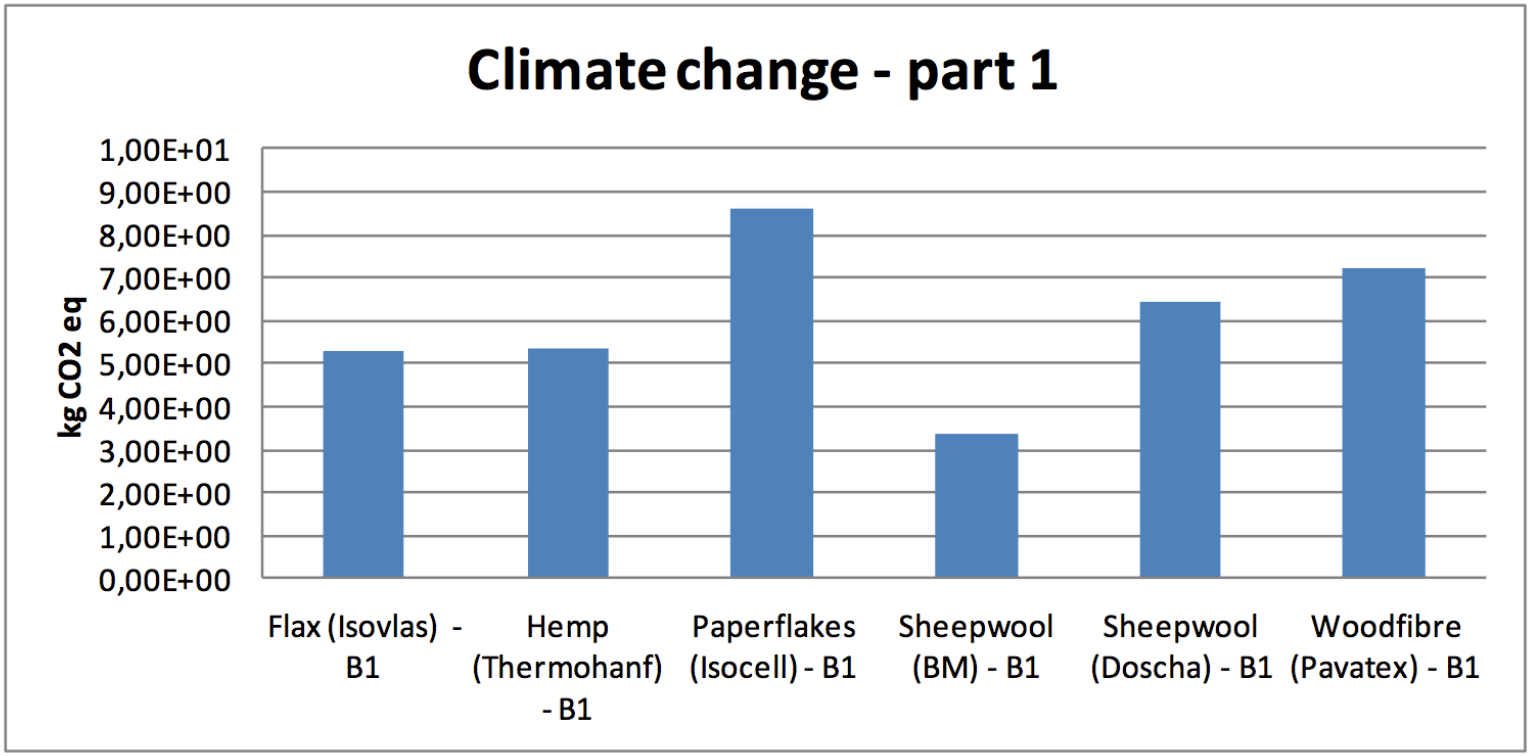


Figure 22: Comparison of results from part 1 in the impact category Climate change (amounts necessary to insulate wall type B1 to a U-value of 0,24 W/m^2.K)

MultiHemp

http://www.multihemp.eu

Home Project Overview Research Partners Contact us

FP7 – MultiHemp – Multipurpose hemp for industrial bioproducts and biomass

In the frame of multi-hemp, the partners will use cutting-edge genomic approaches to achieve rapid targeted improvements in hemp productivity and raw material quality for end-user requirements, whilst also advancing scientific understanding of gene-to-trait relationships in this crop.

This work will be combined with innovations in agronomy, harvesting and processing methods to generate sustainable products from improved varieties.

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nova-Institute together with the project leader **Università Cattolica del Sacro Cuore**
(www.unicatt.it, contact: Stefano Amaducci, email: multihemp@unicatt.it)

will perform the **most comprehensive LCA on Hemp ever**:

- from different cultivation scenarios (region, soil, climate)
- via different harvesting and processing technologies
- to different final products such as insulation material.

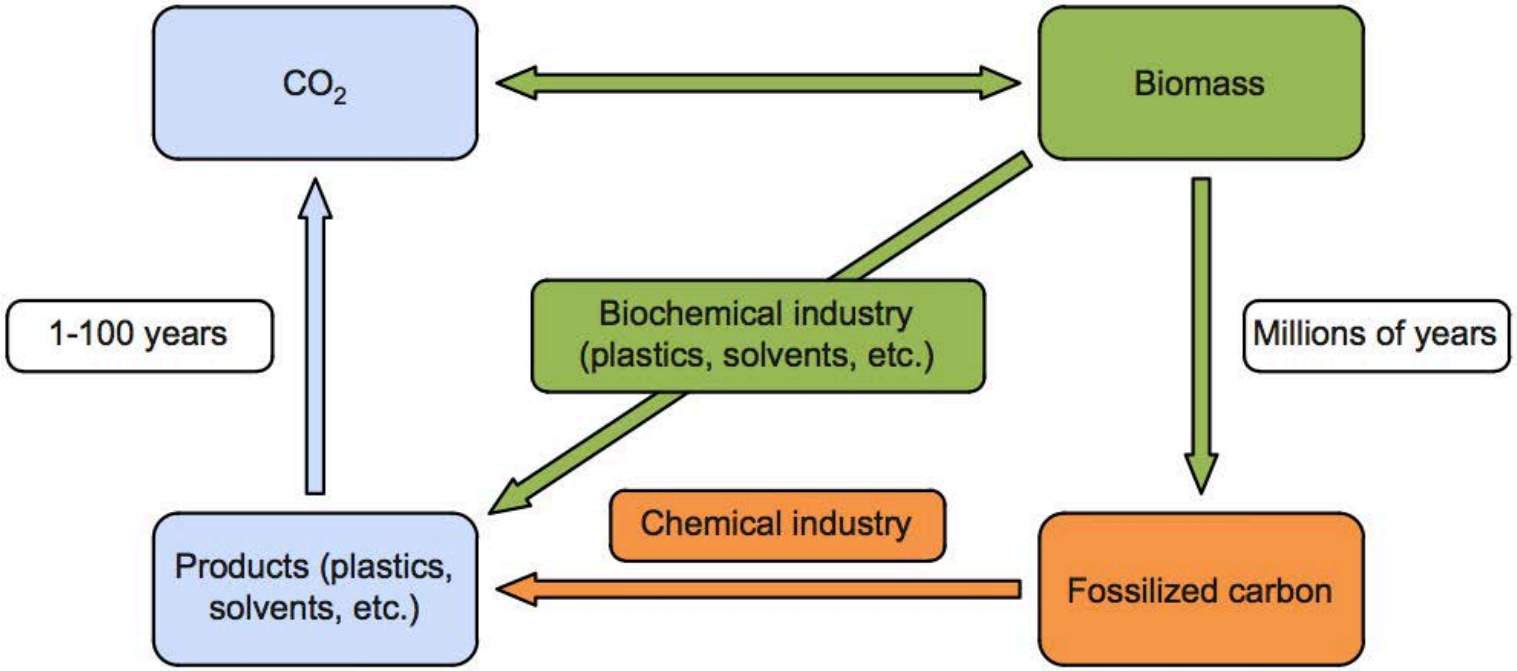
First results will be available in early 2015.

email: roland.essel@nova-institut.de

Storage of biogenic carbon

Kohlenstoffspeicherung („Carbon storage“)

Figure 1 **Carbon cycle of bio-based and fossil-based products**



NOTE This figure is adapted from Narayan (2001) [5].

How much biogenic carbon is stored in hemp fibre?

- **1 kg hemp fibre contains:**

Component	Mass distribution (kg)	Carbon content (%)	Embedded carbon (kg)
Cellulose	0.650	40	0.260
Hemicellulose	0.150	40	0.060
Lignin	0.100	60	0.060
Water	0.100	0	0
TOTAL	**1.000**	**100**	**0.380**

→ **38 % of the fibre mass is "embedded carbon"**

→ **380 g biogenic carbon is stored in each kilogram of hemp fibre**

How much CO_2 is stored in 1 kg hemp fibre?

Oxidation of carbon

1 mole carbon + O_2 = 1 mole CO_2

Conversion factor: $\frac{44 \text{ g/mole}}{12 \text{ g/mole}} = 3.666$

with

- **1 mole carbon dioxide (CO_2) = 44 g/mole**
- **1 mole carbon = 12 g/mole**
- **1 mole oxygen = 16 g/mole**

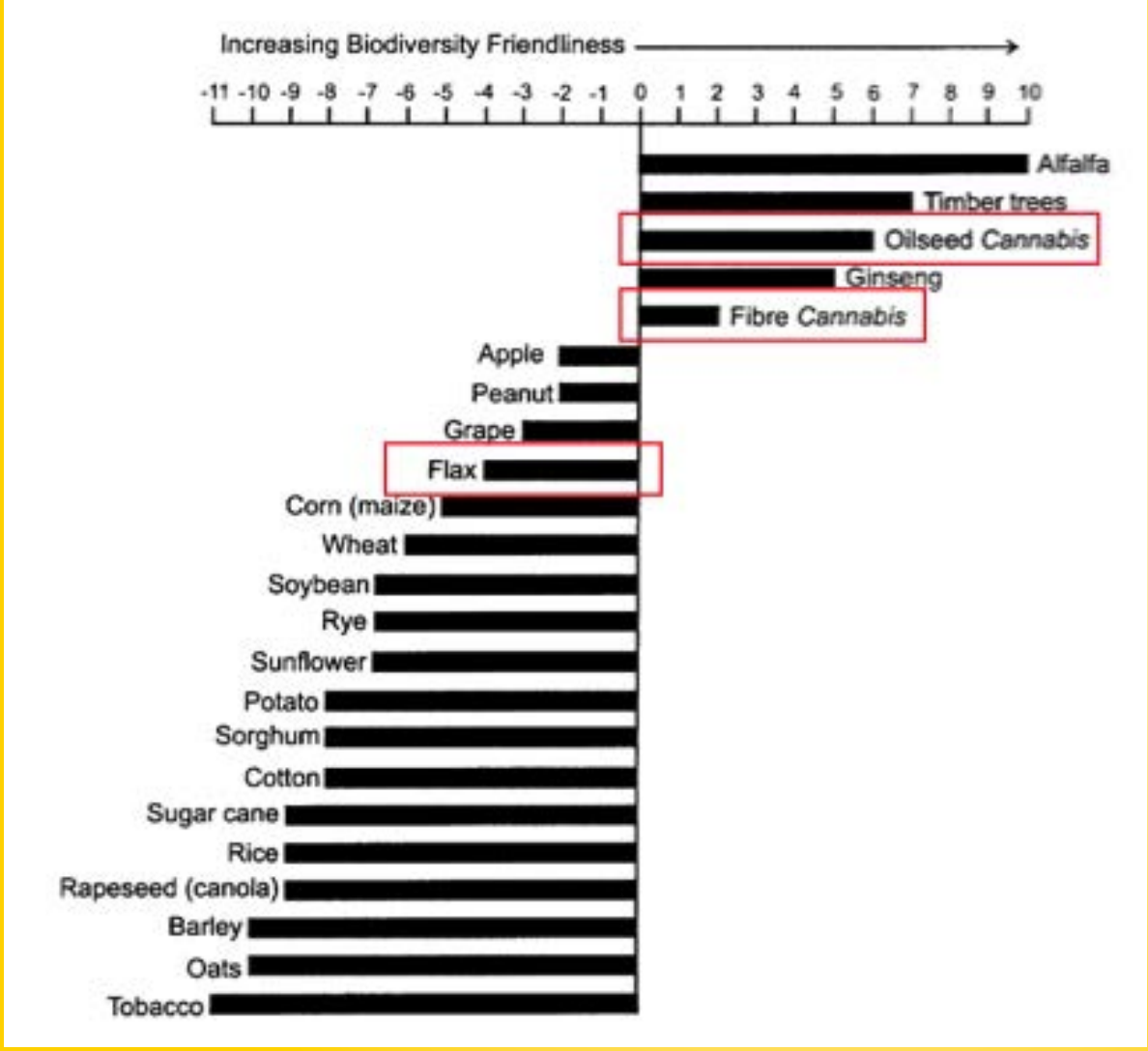
Therefore, we calculate

0.380 kg C * 3.666 = 1.393 kg CO_2

→ **1.393 kg carbon dioxide is stored per kg hemp fibre**

Biodiversity

Agro-biodiversity of different crops



In times of increasing monocultures, hemp is an enrichment to agro-biodiversity.

Source: Montford & Small 1999

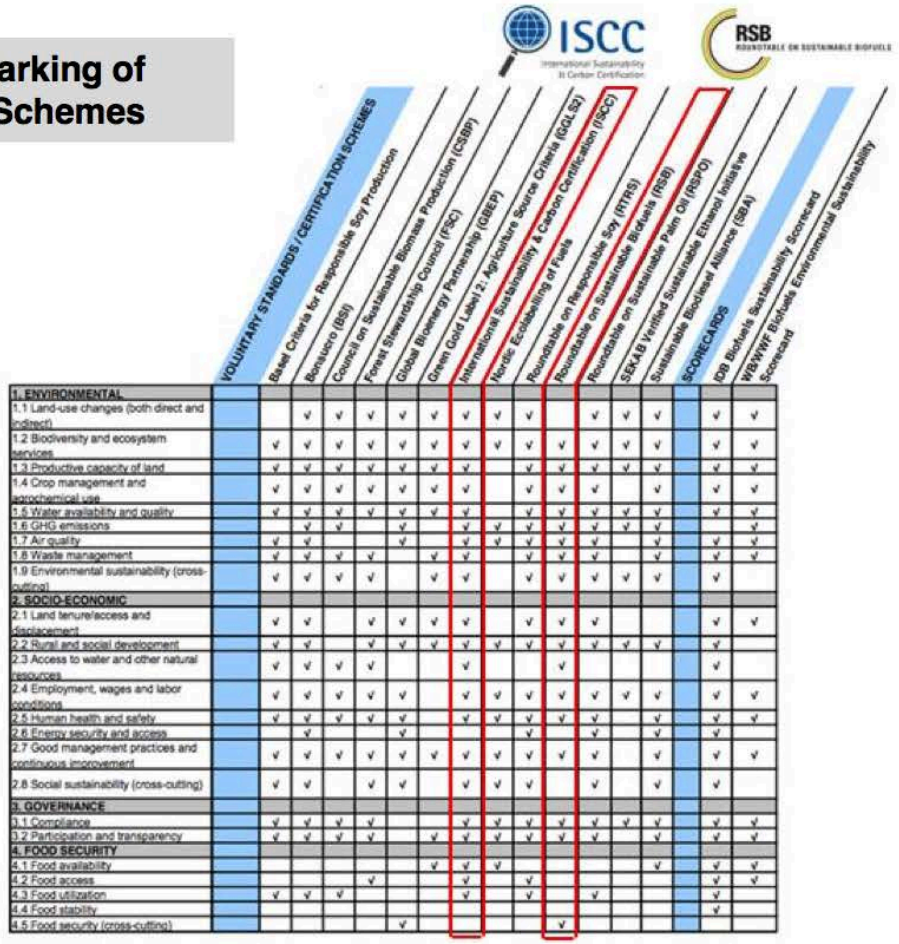
Sustainability Certification

The best way to prove the sustainability of your feedstock

ISCC plus and RSB for bio-based Materials

ISCC goes beyond the sustainability requirements of the regulatory framework of the RED

FAO Benchmarking of Certification Schemes



VOLUNTARY STANDARDS / CERTIFICATION SCHEMES	Basel Criteria for Responsible Soy Production	Bonsucro (BSI)	Council on Sustainable Biomass Production (CSBP)	Forest Stewardship Council (FSC)	Global Bioenergy Partnership (GBEP)	Green Gold Label 2: Agriculture Source Criteria (GGL S2)	International Sustainability & Carbon Certification (ISCC)	Nordic Ecolabelling of Fuels	Roundtable on Responsible Soy (RTRS)	Roundtable on Sustainable Biofuels (RSB)	Roundtable on Sustainable Palm Oil (RSPO)	SEKAB Verified Sustainable Ethanol Initiative	Sustainable Biodiesel Alliance (SBA)	SCORECARDS	IDB Biofuels Sustainability Scorecard	WBG/WWF Biofuels Environmental Sustainability Scorecard
1. ENVIRONMENTAL																
1.1 Land-use changes (both direct and indirect)		√	√	√	√	√	√	√		√	√	√			√	√
1.2 Biodiversity and ecosystem services	√	√	√	√	√	√	√	√	√	√	√	√			√	√
1.3 Productive capacity of land	√	√	√	√	√	√	√		√	√	√	√			√	√
1.4 Crop management and agrochemical use	√	√	√	√	√	√	√		√	√	√		√		√	√
1.5 Water availability and quality	√	√	√	√	√	√	√		√	√	√	√	√		√	√
1.6 GHG emissions		√	√		√		√	√	√	√	√	√	√			√
1.7 Air quality	√	√			√		√	√	√	√	√		√		√	√
1.8 Waste management	√	√	√	√		√	√		√	√			√		√	√
1.9 Environmental sustainability (cross-cutting)	√	√	√	√		√	√		√	√	√	√	√		√	
2. SOCIO-ECONOMIC																
2.1 Land tenure/access and displacement	√	√		√	√	√	√		√	√	√				√	√
2.2 Rural and social development	√	√		√	√	√	√	√	√	√	√	√	√		√	
2.3 Access to water and other natural resources	√	√	√	√			√			√					√	
2.4 Employment, wages and labor conditions	√	√	√	√	√		√	√	√	√	√	√	√		√	√
2.5 Human health and safety	√	√	√	√	√		√	√	√	√	√		√		√	√
2.6 Energy security and access		√			√				√		√		√		√	
2.7 Good management practices and continuous improvement	√	√	√	√	√	√	√	√	√	√	√		√		√	√
2.8 Social sustainability (cross-cutting)	√	√		√	√		√	√	√		√		√		√	
3. GOVERNANCE																
3.1 Compliance	√	√	√	√	√		√	√	√	√	√	√	√		√	√
3.2 Participation and transparency	√	√	√	√		√	√	√	√	√	√		√		√	√
4. FOOD SECURITY																
4.1 Food availability						√	√	√					√		√	√
4.2 Food access				√			√		√						√	√
4.3 Food utilization	√	√	√				√		√		√				√	
4.4 Food stability							√		√						√	
4.5 Food security (cross-cutting)					√					√						

Source: FAO, 2011

ISCC
International Sustainability & Carbon Certification

ISCC is a non profit organisation steered by an association – open to new members

ISCC PLUS certificates are listed on the ISCC website – 35 certificates have been issued by now with more to come

full-text search: ISCC PLUS | search details | page 4

identificator	certificate holder	certified as	in put	add-ons	product cat.	issued	valid until	issued by	map	certificate	audit report
ISCC-PLUS-Cert-81729102	Cargill, Incorporated, Blair, Nebraska, United States	FG, corn wet mill, lactic acid plant	Corn	-	BIOP	17.12.2012	16.12.2013	PCU			
ISCC-PLUS-Cert-1998405	NatureWorks LLC, Blair, United States	OT	Lactic acid	-	BIOP	29.05.2013	28.05.2014	PCU			
ISCC-PLUS-Cert-81950801	Absolute Energy, LLC, St. Ansgar, IA, United States	EP	Corn	-	FEED	15.05.2013	14.05.2014	PCU			
ISCC-PLUS-Cert-10012010	Oleaginosa Moreno Hermanos S.A.C.I.F. y A., Daireaux, Buenos Aires, Argentina	OM	Soybean, Sunflower	-	FEED	12.12.2012	09.12.2013	SGS			
ISCC-PLUS-Cert-81842603	Braskem S.A., Triunfo, Rio Grande do Sul, Brazil	OT	Sugar cane	-	BIOP	01.12.2012	30.11.2013	PCU			
ISCC-PLUS-Cert-81842603	Braskem S.A., Triunfo, Rio Grande do Sul, Brazil	OT	Sugar cane	-	BIOP	01.12.2012	30.11.2013	PCU			

ISCC
International Sustainability & Carbon Certification

English

ISCC System
What is the ISCC System?

Certification Process
How can I get a certificate?

Certificate Holders
Who holds an ISCC certificate?

Stakeholders
ISCC Association

ISCC PLUS - Introduction

ISCC PLUS allows an efficient extension of sustainability certification on sectors like food, feed or technical/chemical and bioenergy applications

ISCC PLUS is a certification system for food and feed products as well as for technical/chemical applications (e.g. bioplastics) and applications in the bioenergy sector (e.g. solid biomass). On February 8, 2012 the scheme was initially introduced at the second ISCC Global Sustainability Conference and the General Assembly in Brussels. Several pilot projects and a two months public consultation including members of ISCC and other interested parties have contributed to the final ISCC PLUS scheme.

Parties, who would like to get ISCC PLUS certified, need to fulfill the ISCC PLUS core requirements (e.g. the sustainability requirements for the production of biomass or traceability requirements). The core requirements concerning the sustainability of biomass production are harmonized with the requirements of ISCC EU and ISCC DE.

RSB ROUNDTABLE ON SUSTAINABLE BIOMATERIALS

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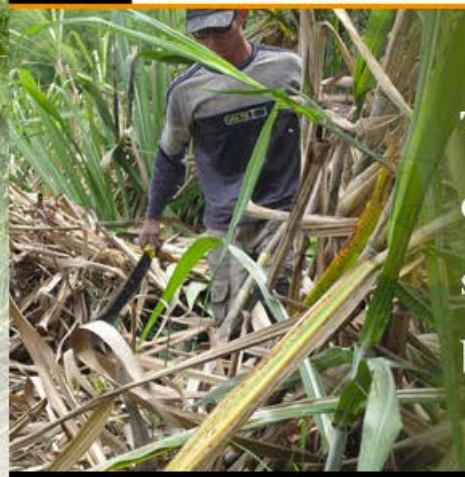

The global standard and certification scheme for sustainable production of biomaterials and biofuels.

The RSB is supported by

WWF

See who else supports the RSB

The Roundtable on Sustainable Biomaterials (RSB) is an international multi-stakeholder initiative that brings together farmers, companies, non-governmental organizations, experts, governments, and inter-governmental agencies concerned with ensuring the sustainability of biomass and biomaterial production and processing.

News

28 April 2014: Call for Public Comment for Certification Applicant: JC Chemical Co. Ltd.

14 April 2014: RSB is looking for an intern

28 March 2014: RSB Hosts Successful Event at WBM

Environmental criteria

- Greenhouse gas emissions
- Air quality
- Quality and quantity of Water
- Soil quality, productivity, erosion
- Biodiversity
- Protection areas
- Energy & Material efficiency
- Use of renewable & non-renewable resources
- Waste management

Social criteria

- Labour rights
- Working conditions
- Living conditions
- Land use rights
- Water use rights
- Local development

Economic criteria

- Fair business practices

CEN TC 411 draft on sustainability criteria for bio-based products (2014)

Easy for European Hemp
Difficult for Kenaf or Jute from Bangladesh or India

Finally

nova-Institute will publish this year a leaflet on:

Carbon Footprint and Sustainability of different Natural Fibres for Biocomposites, study will provide data for the automotive industry

1) Natural Fibres in comparison
2) Carbon Footprint from Cultivation to the natural fibre
3) Carbon Footprint for transport, further processing to the final non-woven (precursor of the biocomposites)
4) Sustainability Certification

Thank you for your attention!

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