SEEMLA

Final event

Brussels, Belgium
20 November 2018
Nils Rettenmaier, IFEU

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

Project coordinator
FNR

Partner
b-tu Brandenburg University of Technology Cottbus - Senftenberg
ifeu Institute for Energy and Environmental Research Heidelberg
Legambiente
Salix energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691874

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

How environmentally and socio-economically sustainable is biomass for bioenergy from marginal lands?

Project coordinator

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Who we are – What we do

IFEU - Institute for Energy and Environmental Research Heidelberg, since 1978

- Independent scientific research institute
- Organised as a private non profit company with currently about 70 employees
- Research / consulting on environmental aspects of
  - Energy (including Renewable Energy)
  - Transport
  - Waste Management
  - Life Cycle Assessment
  - Environmental Impact Assessment
  - Renewable Resources
  - Environmental Education

IFEU - Institute for Energy and Environmental Research Heidelberg, since 1978

- **Our clients (selection)**

European Union

European Environment Agency

European Commission

ETC RWM

World Bank, UNEP, FAO, etc.

THE WORLD BANK

Departments of Federal, State and Local Governments

Federal Ministry Department (Environment, Economy, Transport)

State Departments

Non-governmental Organisations

NABU

GREENPEACE

VCD Verkehrsclub Deutschland

BUND

Transport and Logistic Service Providers

DB

Deutsche Post

Seemla

Who we are – What we do

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Industrial Associations

PlasticsEurope
edana
DGfH
petcore
ACE Auto Club Europa
Verband Metallverpackungen

Organisations of Development cooperation

inWent Internationale Weiterbildung und Entwicklung gGmbH
CDG Carl Duisberg Gesellschaft e.V.
GOPA Worldwide Consultants
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Companies

PET CYCLE
Coca-Cola
DANONE
Der Grüne Punkt
Shell
SIG
BMW
Bayer
Red Bull
MVV Energie
Kimberly-Clark
P&G
Tetra Pak

Schools, Public Services, ASEW, Consumer Advice Centre

Foundations

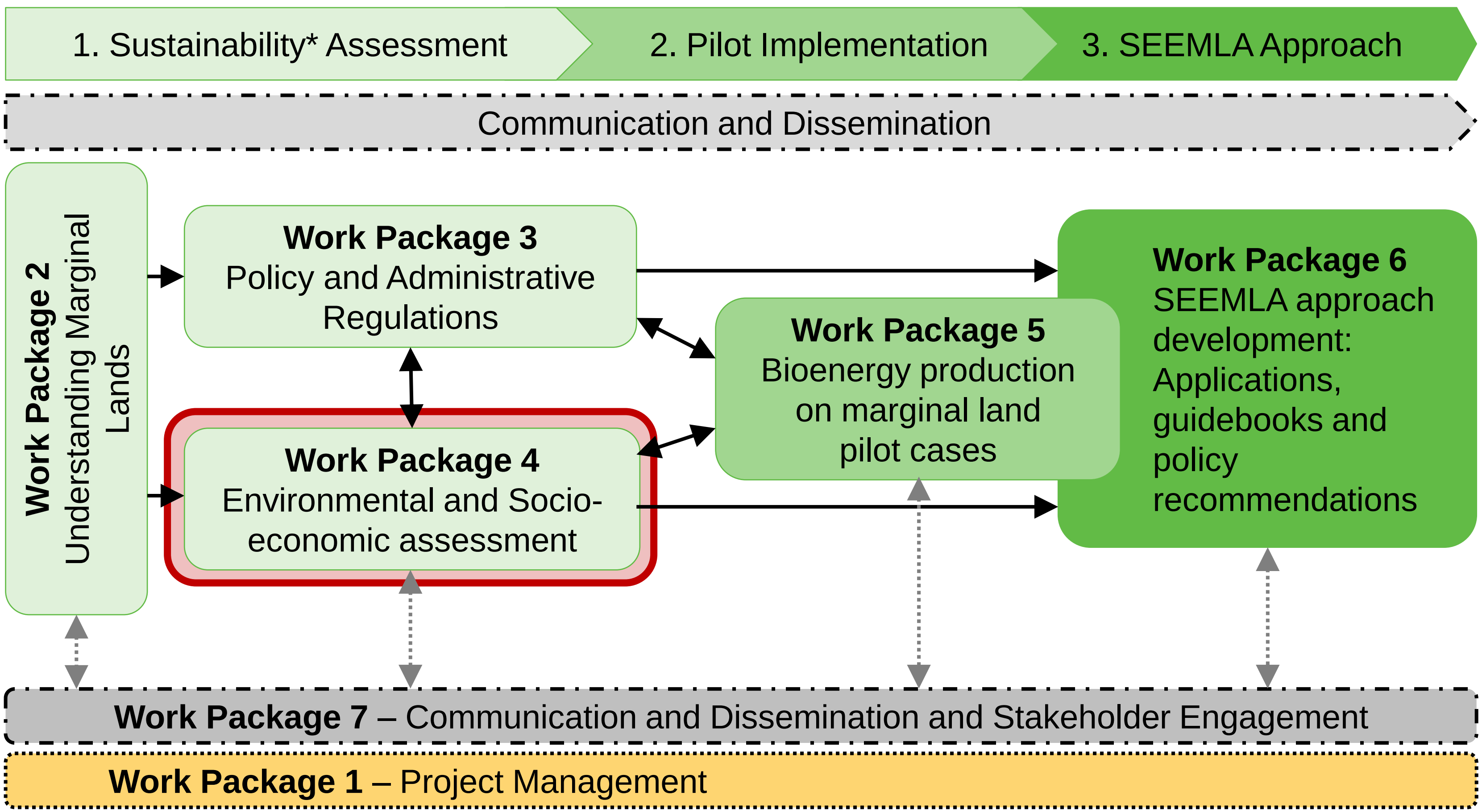
Who we are – What we do

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

Department	Head of Department
Biomass and Food	 Guido Reinhardt PhD, biologist, chemist, mathematician
Resources and Recycling Management	 Horst Fehrenbach Dipl.- biologist
Industry and Products	 Bernd Franke MSc, biologist
Mobility	 Udo Lambrecht MSc, physicist
Energy	 Lothar Eisenmann MSc, physicist  Martin Pehnt Dr. Ing. PhD physicist

Sustainability assessment in SEEMLA

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe



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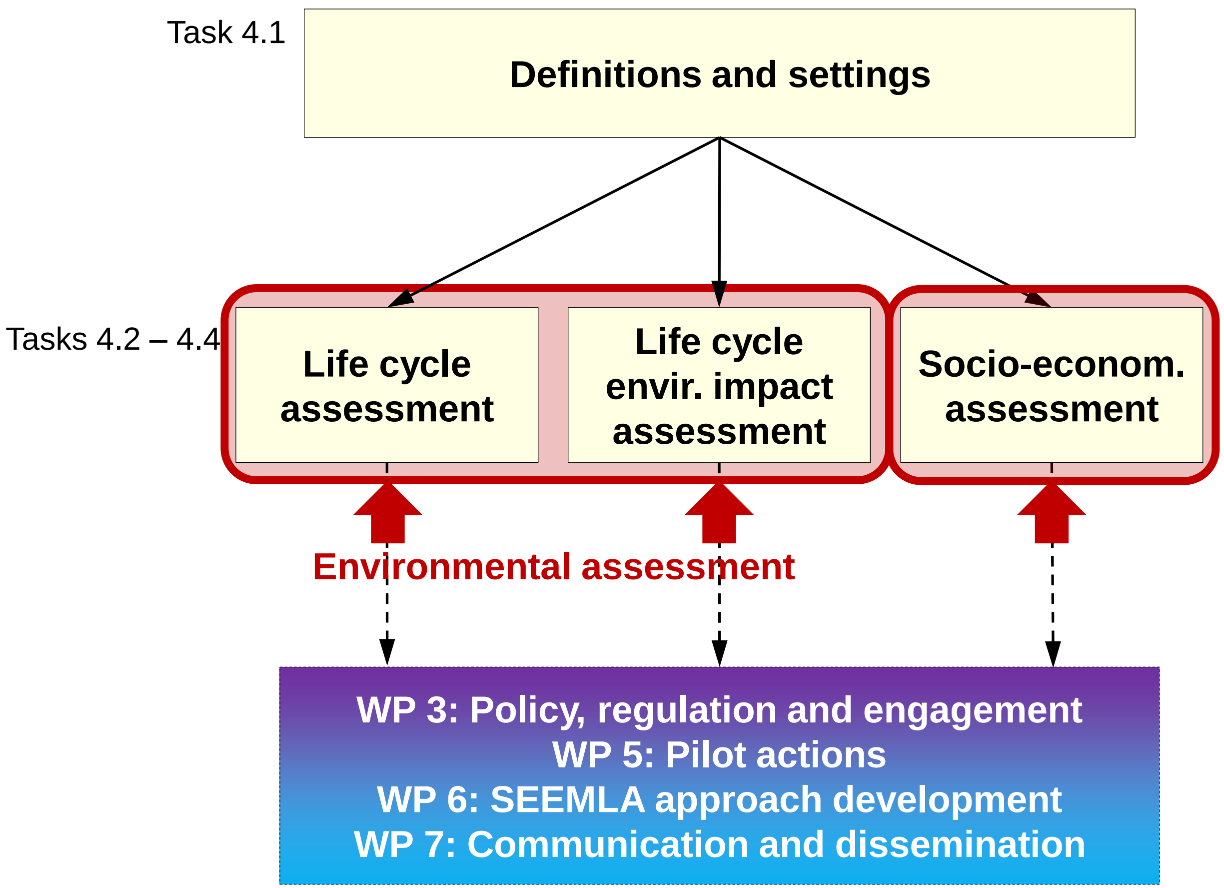

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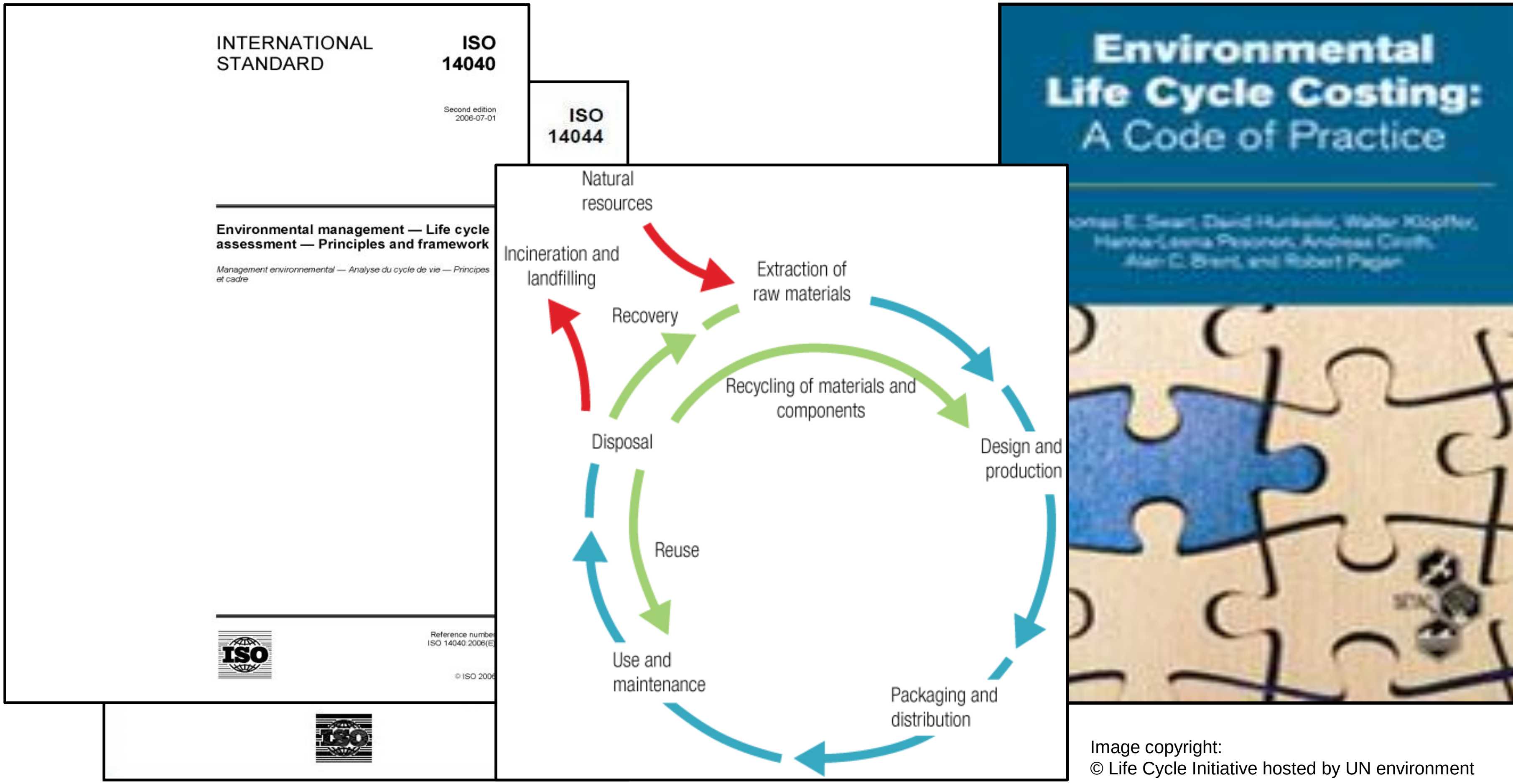
Methodology: Life cycle thinking



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Methodology: Details

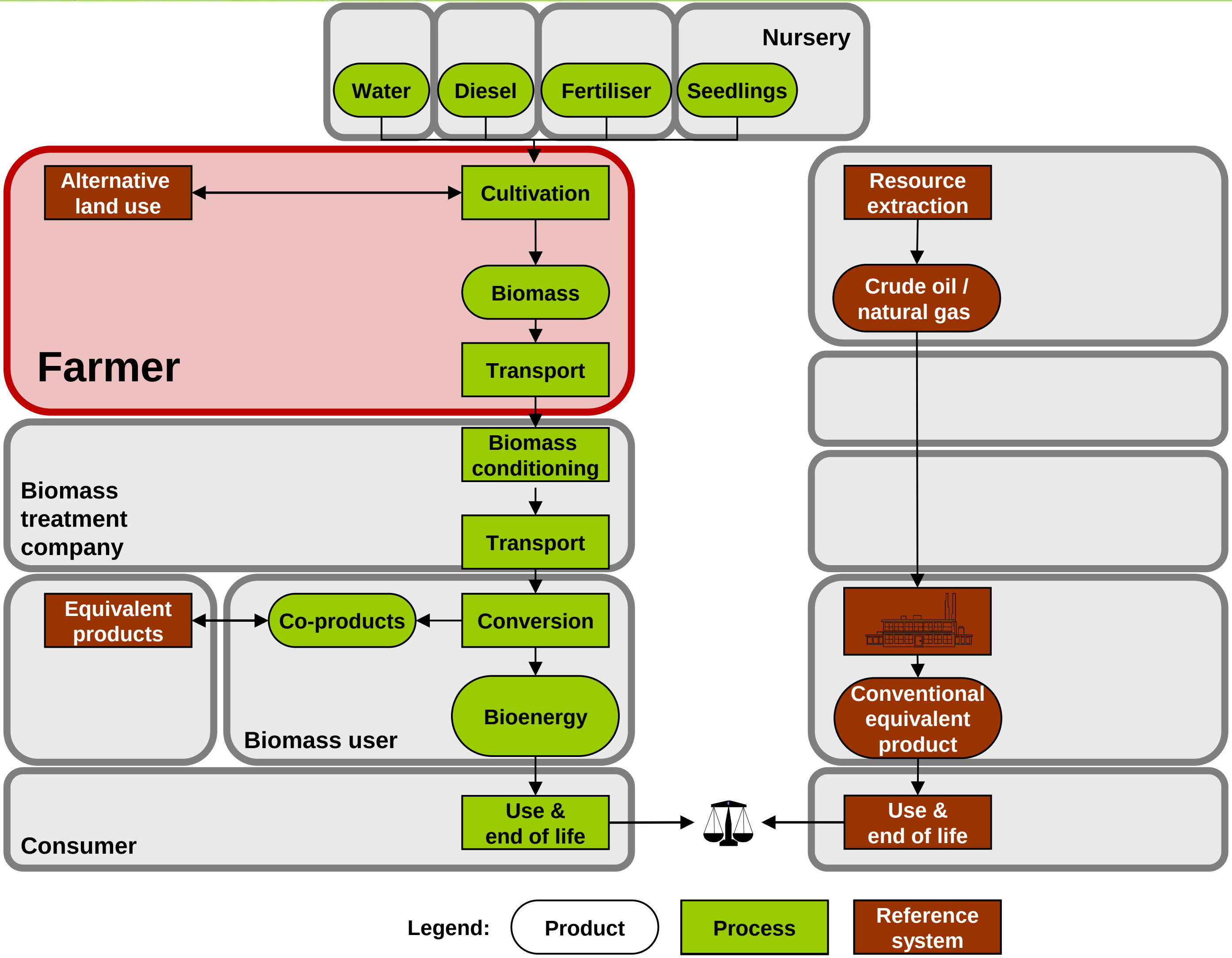
Environm. assessment

- *Screening* life cycle assessment (**LCA**) according to ISO standards 14040 & 14044
  - Generic scenarios for 2030
  - Mature technology
- Life cycle environmental impact assessment (**LC-EIA**)
  - Envir. impacts occurring at local scale (e.g. land use) not yet state-of-the-art in LCAs
  - Our approach: elements from envir. impact assessment (EIA)
- Goal: Policy information on the environmental impacts of using marginal land for the provision of bioenergy

Socio-econ. assessment

- Life cycle costing (**LCC**) according to SETAC guidelines from the perspective of farmers
- Evaluation of generated employment
- Assessment of further relevant factors
- Goal: Policy information on the economic viability and contribution to local communities in rural areas

Methodology: Life cycle comparison



Agenda

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

1 Introduction and methodology

2 Environmental assessment:

- Key results and conclusions from LCA
- Key results and conclusions from LC-EIA
- Synopsis and recommendations

3 Socio-economic assessment:

- Key results and conclusions
- Recommendations

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LCA: Key results and conclusions I

Comparison between bioenergy and conv. energy supply

2x

- Well-known pattern of environmental impacts confirmed
  - No significant differences between standard land and marginal land
- Energy and GHG emission savings possible
  - Except in the case of large carbon stock changes due to LUC
- Tendency towards disadvantages with other envir. impacts
  - Negative effects due to N- and P-related emissions of fertilisation
- Entire life cycle and all envir. impacts to be considered
  - Avoidance of indirect land-use changes (iLUC) of central importance
  - Only land with low biomass carbon stock to be converted
  - Biomass drying expenditures must be minimised

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1x

- Results range wider than usual
  - Due to many energy crops, use options and different site qualities

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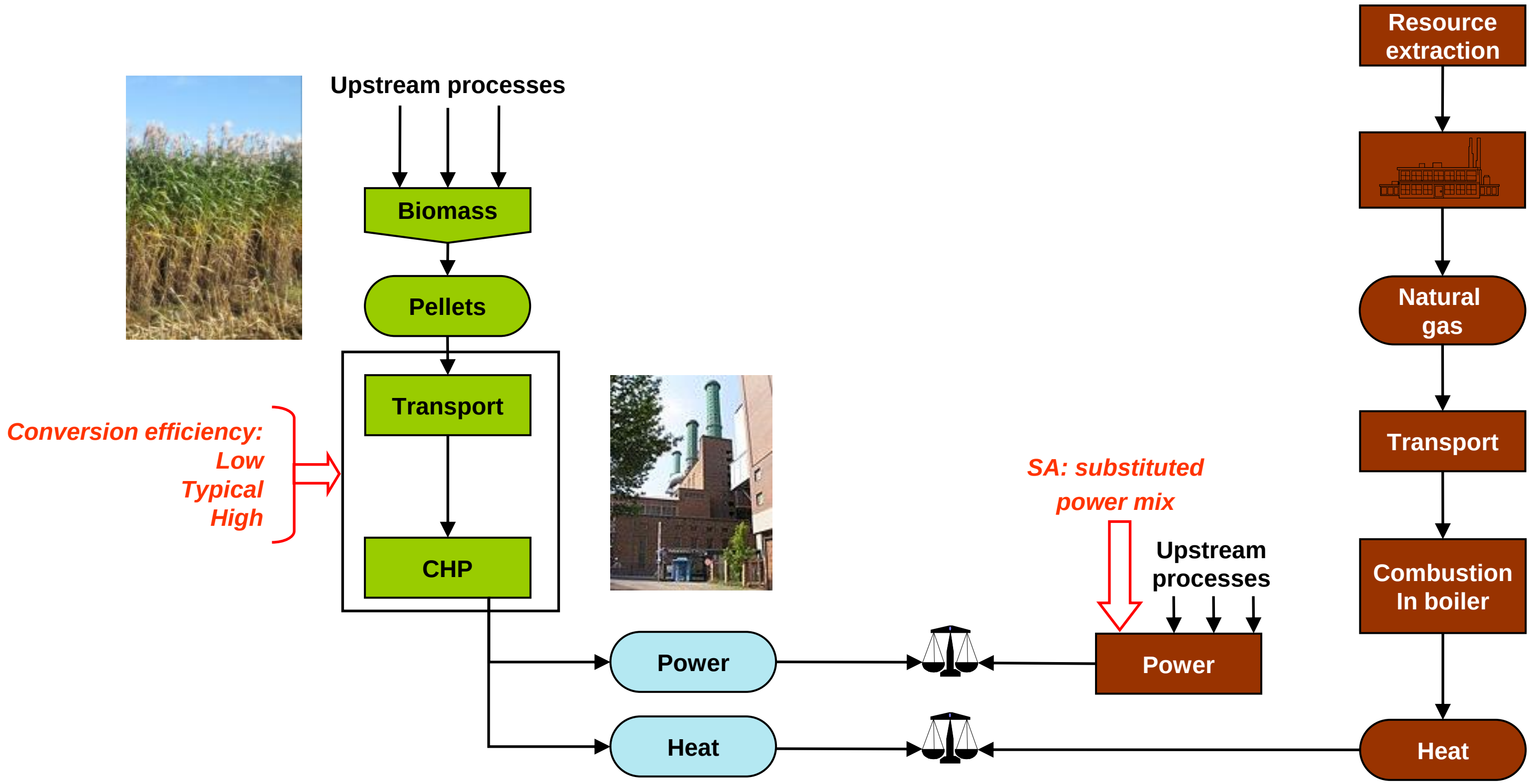
Example: Miscanthus → small CHP



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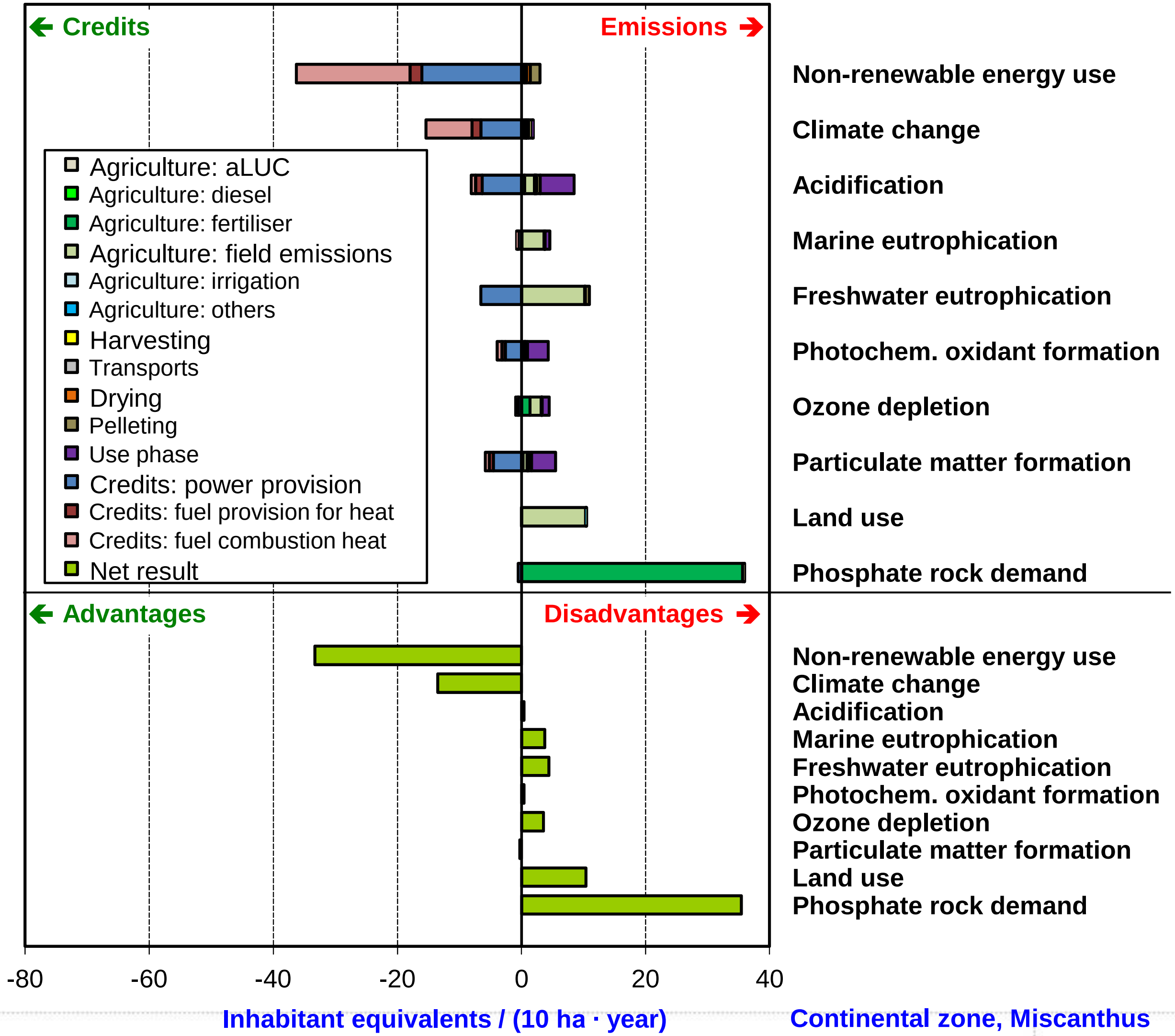
Example: All impact categories



Source: IFEU 2018

→ Pattern confirmed; *entire* life cycle & *all* impacts to be considered

Life cycle assessment: Results

Example: Influence of site quality

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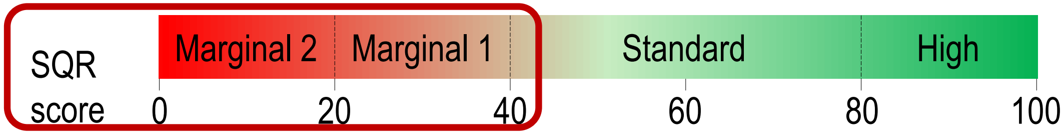
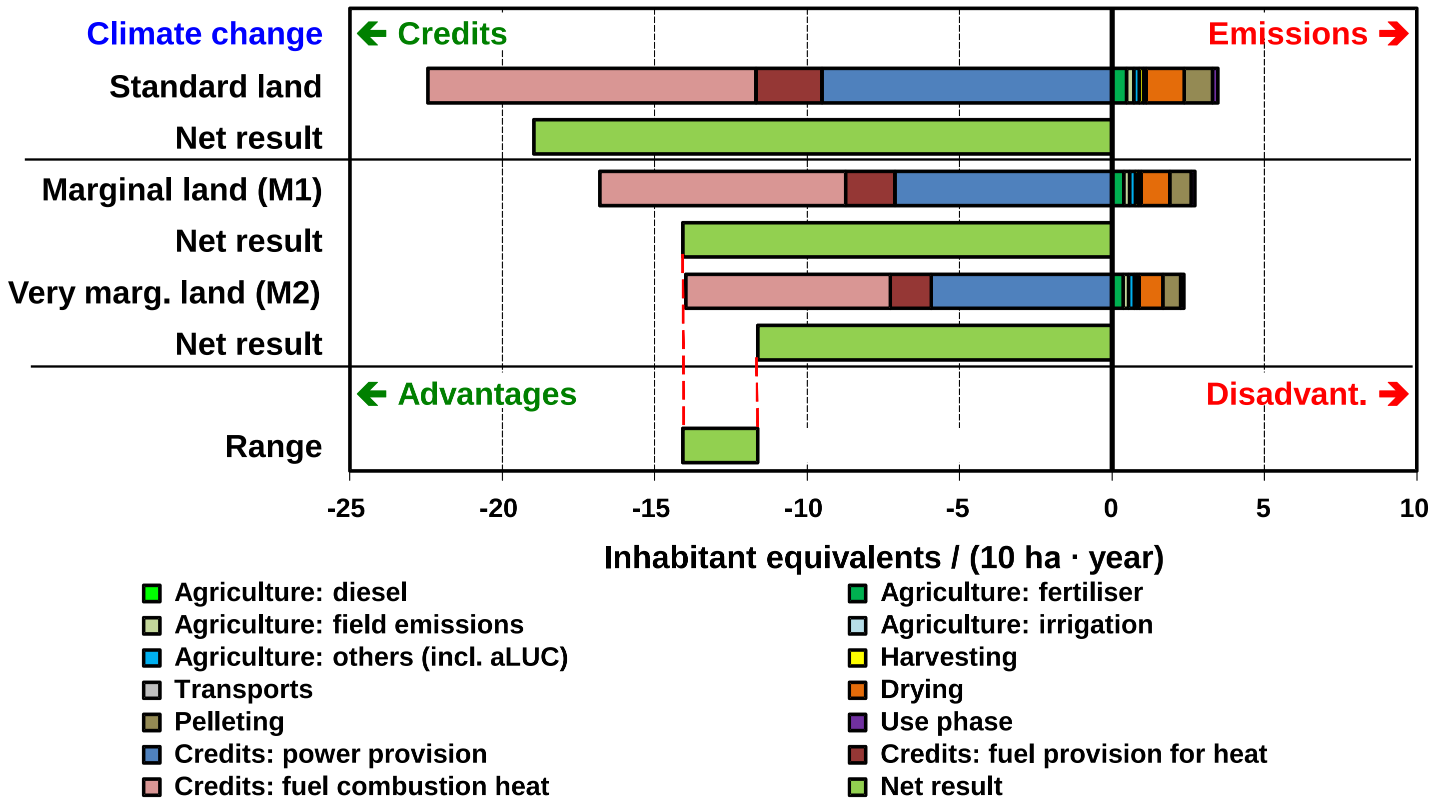
SEEMLA definition of 'marginal'





Source: IFEU 2018

→ Results dependent on site quality

LCA: Key results and conclusions II

Comparison of bioenergy paths with each other

- Environmental advantages and disadvantages increase with increasing site quality
  - Greater energy and GHG emission savings on less marginal land
  - Discussion: Coarse resolution (2 classes only); lower SQR limit

2x

- Woody biomass is partly better than herbaceous biomass
  - Perennial grasses: greater energy and GHG emission savings but also greater disadvantages
  - Woody biomass: hardly any disadvantages + greater P use efficiency

© IFEU

2x

- Stationary use for electricity & heat generation beats biofuels
  - Combined heat & power generation currently better than 2G ethanol

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1x

- Photovoltaics tend to be much more environmentally friendly than bioenergy
  - Bioenergy competes with other renewables, e.g. ground-mounted PV, which result in significantly greater energy and GHG emission savings
    → an option for very marginal land?!

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Investigated lignocellulosic crops

Lignocellulosic crops	Woody	Trees	 Black locust	 Black pine	 Calabrian pine
		SRC	 Black locust	 Poplar	 Willow
	Herbaceous	Grasses	 Miscanthus	 Switchgrass	 Giant reed

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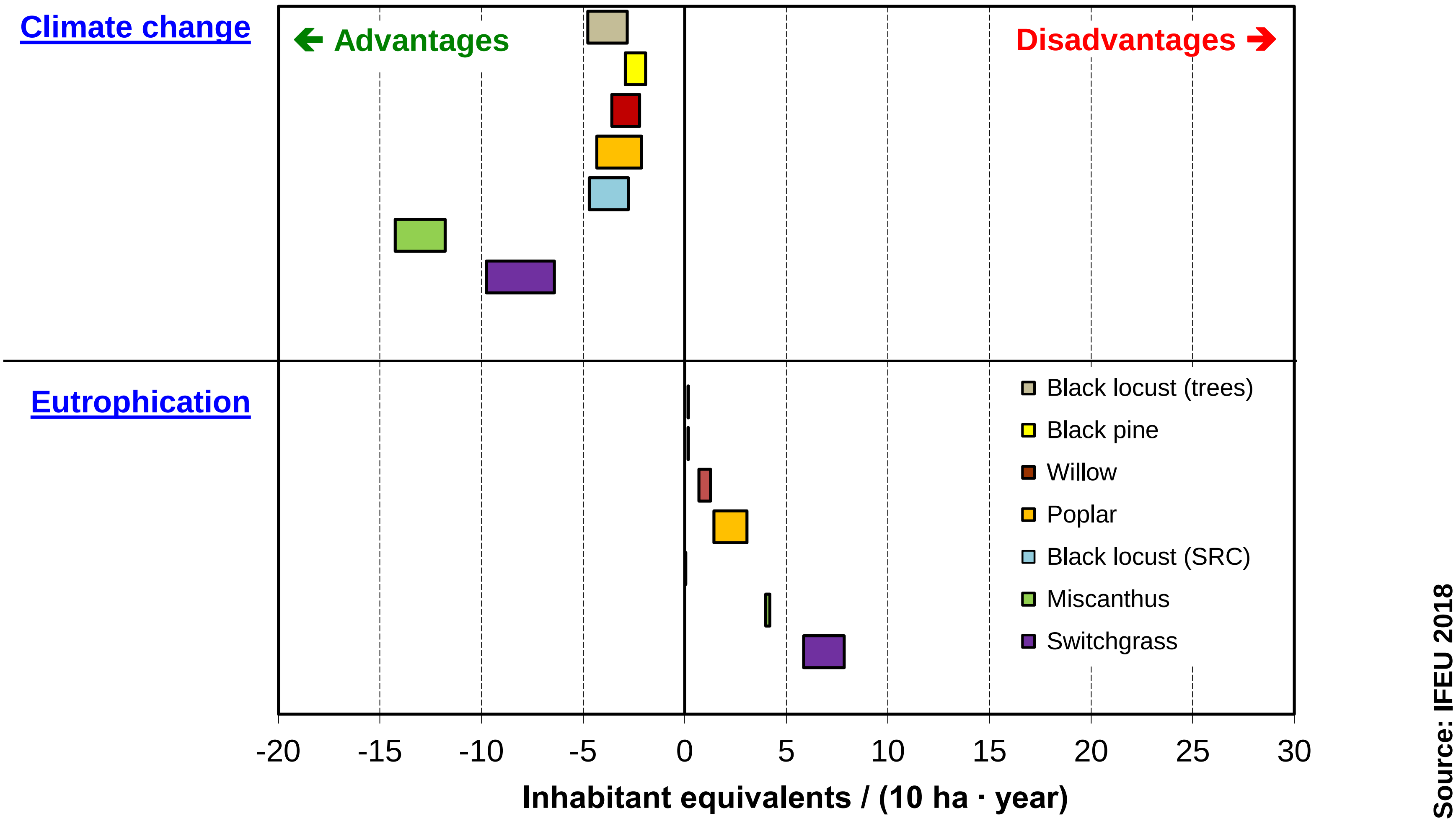
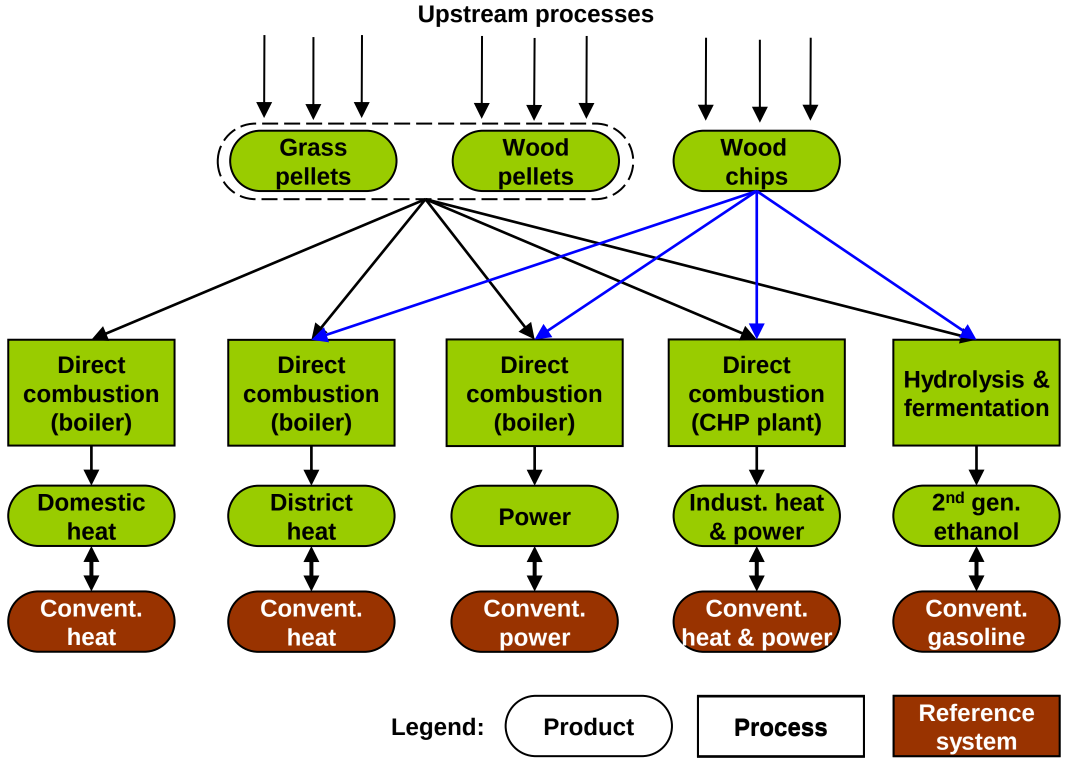
Lignocellulosic crops in comparison



→ Crops qualitatively similar, but quantitative differences

Investigated biomass use options



Source: IFEU 2018

Life cycle assessment: Results

Biomass use options in comparison

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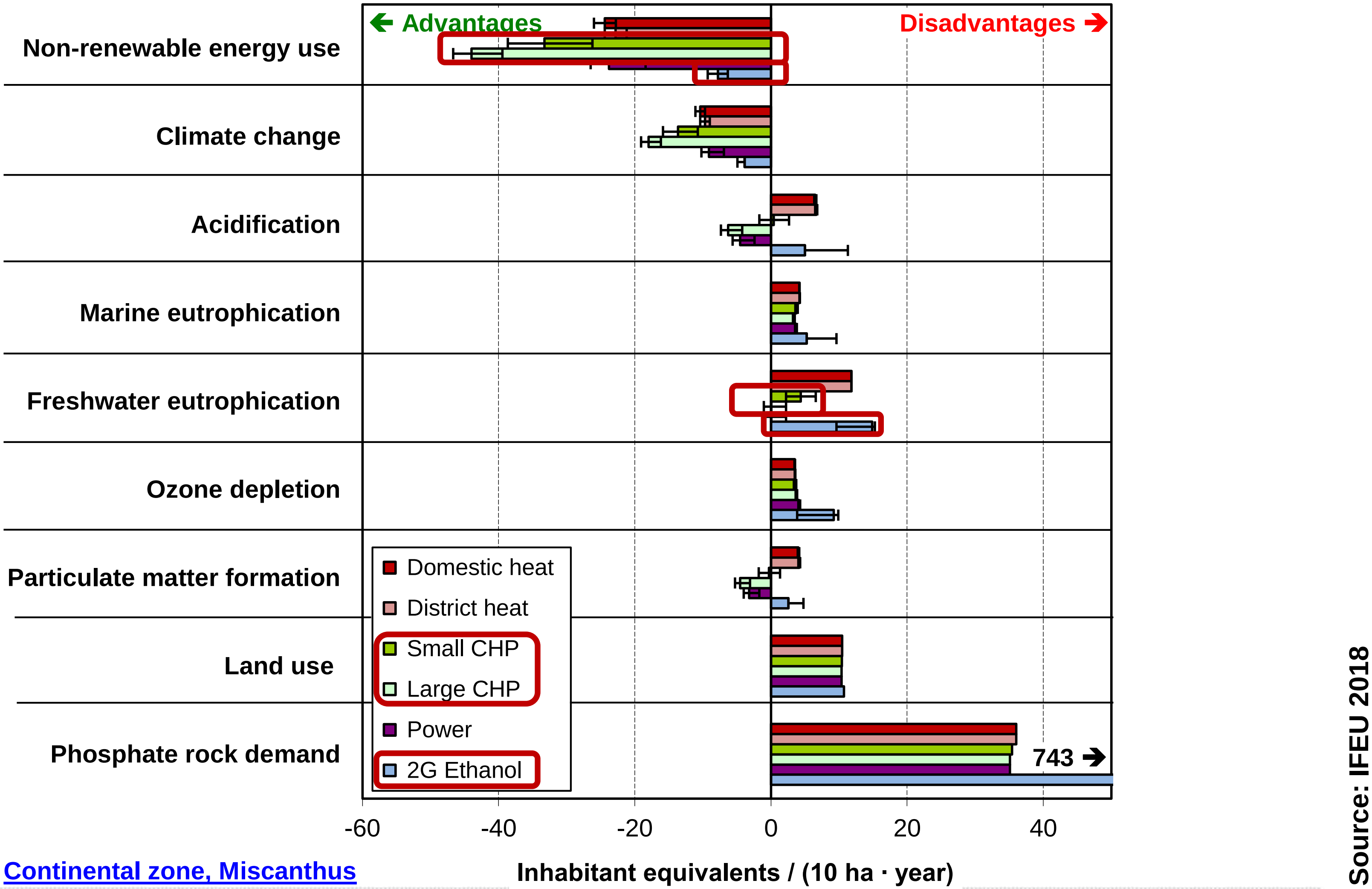

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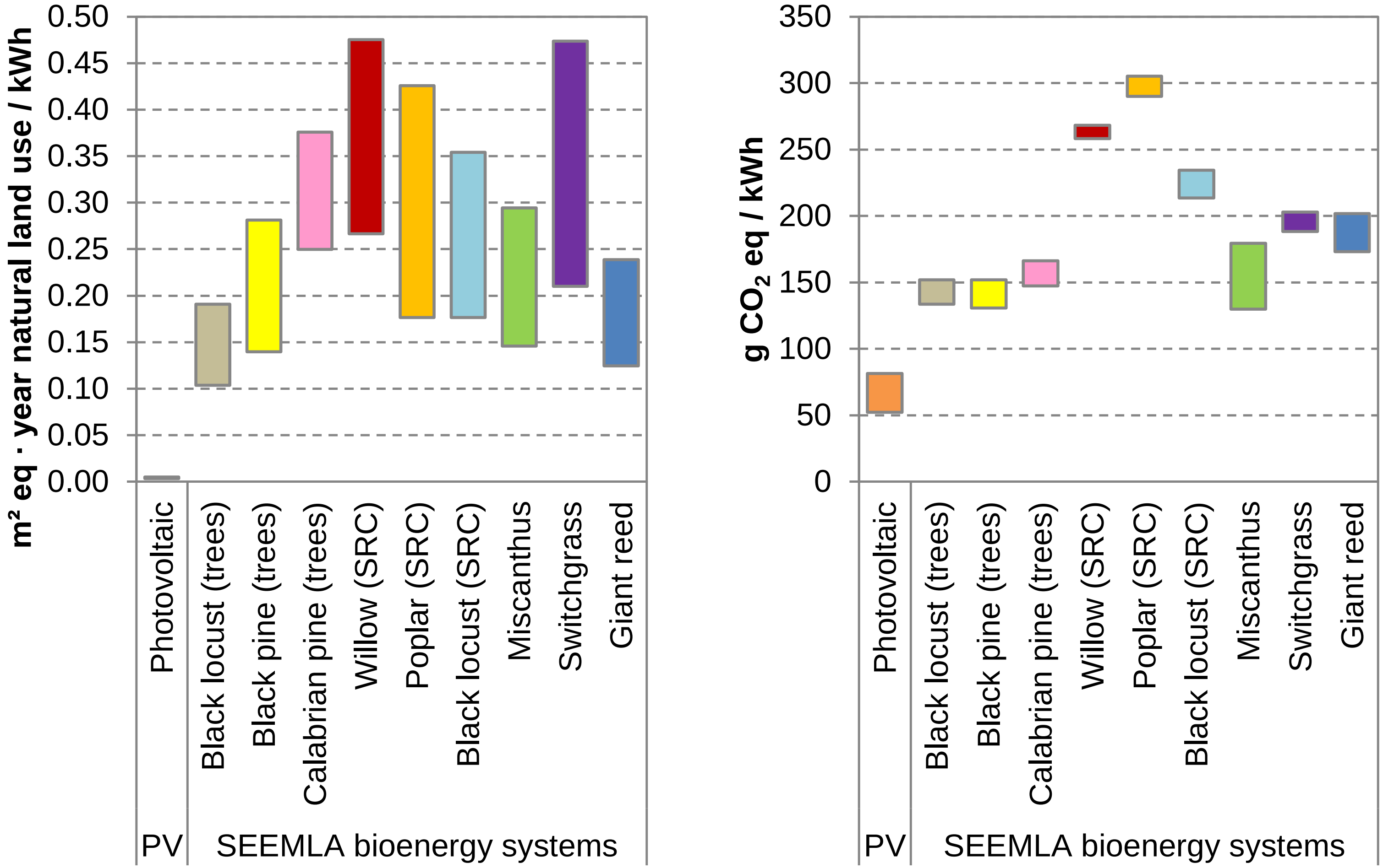
→ Stationary use beats biofuels (as long as coal power plays a role)

Excursus: Photovoltaic systems



Source: IFEU 2018

➔ PV: lower land use footprint and less GHG emissions per kWh

LC-EIA: Key results and conclusions I

- High land footprint of bioenergy, especially on marginal areas
  - Land use for bioenergy >> land use for conventional energy (per MJ)
  - Land use on marginal land > land use on standard land (per MJ)

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- Grasses require less land than SRC or trees, but this is more strongly affected
  - Higher intensity and frequency of agricultural activities, but positive effect of higher area yield of perennial grasses predominates.
  - Importance of harvest time

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2x

- Predominantly neutral effects on soil and water
  - In comparison to idle land, effects on soil are neutral or even positive
  - Miscanthus, willow or giant reed may reduce groundwater recharge
- Individual consideration of impacts on fauna, flora, biodiversity and landscape necessary
  - Effects on flora and biodiversity are highly location-dependent
  - Conversion of species-rich grassland very negative for biodiversity
  - Impacts to be assessed on individual basis (incl. neighbouring areas)

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Example: Miscanthus

Risks associated with Miscanthus (vs. idle land)

Type of risk	Affected environmental factors								
	Soil	Ground water	Surface water	Plants / Biotopes	Animals	Climate / Air	Land-scape	Human health & recreation	Bio-diversity
Soil erosion	neutral[1]		neutral[1]						
Soil compaction	neutral	neutral		neutral	neutral				neutral
Loss of soil organic matter	neutral / pos. / neg.			neutral	neutral				neutral
Soil chemistry / fertiliser	neutral	neutral / negative[2]	neutral						
Eutrophi-cation	neutral[1]	neutral[1] / negative[2]	neutral[1]	neutral[1]	neutral[1]				neutral[1]
Nutrient leaching		neutral / negative[2]							
Water demand		neutral / negative[3]		neutral / negative[3]	neutral / negative[3]				neutral / negative[3]
Weed control / pesticides		neutral[1]	neutral[1]	neutral[1]	neutral[1]				neutral[1]
Loss of land-scape elements				negative / positive[4]	negative / positive[4]	negative / positive[4]	negative / positive[4]	negative / positive[4]	negative / positive[4]
Loss of habitat types				negative / positive[4]	negative / positive[4]				negative / positive[4]
Loss of species				neutral / negative	neutral / negative				neutral / negative

➔ **Issues: high water demand & potential invasiveness**

Lignocellulosic crops in comparison

Risks associated with all investigated crops (vs. idle land)

Type of risk	Perennial crop / feedstock				
	Black pine / Calabrian pine	Black locust (tree)	Willow / poplar / black locust (SRC)	Miscanthus / switchgrass	Giant reed
Soil erosion	A	A	B	B	B
Soil compaction	A	A	A	B	B
Loss of soil organic matter	B	B	B	B	B
Soil chemistry / fertiliser	A	A	B	B / C	C
Eutrophication	A	A	A / B	B / C	C
Nutrient leaching	A	A	A / B	B / C	C
Water demand	B	B	C	D	D
Weed control / pesticides	A	A	B	B	B
Loss of land-scape elements	C	C	C	C	C
Loss of habitat types	C	D*	C / D*	C	C
Loss of species	C	D*	C / D*	C	C

➔ Trees pose the least risks, followed by short rotation coppice

LC-EIA: Key results and conclusions II

- Photovoltaics (PV) tend to be more compatible with nature conservation than bioenergy
  - Land footprint of PV electricity << electricity from biomass
  - Ecological added value (compared to bioenergy) if well-managed

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- Biodiversity at risk due to (further) intensification of land use
  - Marginal land is often the last retreat for species that already suffer from the intensive agricultural use of standard land
  - Broad public discussion needed as to which proportion of marginal land should be reserved for which purpose → land allocation plans

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- Guidelines for environmentally compatible cultivation of energy crops on sensitive sites are necessary
  - Marginal land often has special site conditions which often imply a high nature conservation value
  - 'Good farming practice' is not sufficient, at least not for sensitive sites

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Synopsis and recommendations I

Synopsis

- LCA and LC-EIA complement each other well.
- Energy and GHG emissions can be saved, however, at the cost of other negative environmental impacts and a high risk of biodiversity loss.
  - Priority on biodiversity protection. GHG emissions savings secondary.
- No general ‘certificate of compliance’ can be issued for bio-energy from marginal land from an environmental viewpoint.
- Financial incentives will be needed. This offers possibilities to consider sustainability aspects in support programmes

Recommendations

- Previous non-utilisation of land is most important. Low land quality is only a secondary criterion.
  - Only in this way indirect land-use changes (iLUC) can be avoided.

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Partner

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Synopsis and recommendations II

- Land worthy of protection should be excluded
  - Land with high carbon stock and peatland
  - Land with high biodiversity value, e.g. highly biodiverse grasslands
  - Land under agri-environmental programmes in the past 10 years
  - High nature value farmland (HNV)
- Stationary use for electricity & heat generation beats bio-fuels, but other renewables (e.g. PV) should be considered
- Guidelines for environmentally compatible cultivation of energy crops on sensitive sites are necessary
  - 'Good farming practice' is insufficient, at least not for sensitive sites
  - Lessons learnt from the evaluation of pilot cases could be helpful
- Land allocation plans at EU, national or regional level + biomass use concepts + stakeholder involvement
- Research funding should be continued
  - New varieties, loss-reducing cultivation systems, biomass composition
- Farmers' competencies need to be built up
  - Harvest time, varieties and cultivation systems, yield security

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Conclusions

Bioenergy from marginal land is more expensive than from standard land and can involve higher risks

- Even on standard arable land, cultivation of perennial crops is unattractive without financial incentives
- Lower land rents can only partially compensate for this

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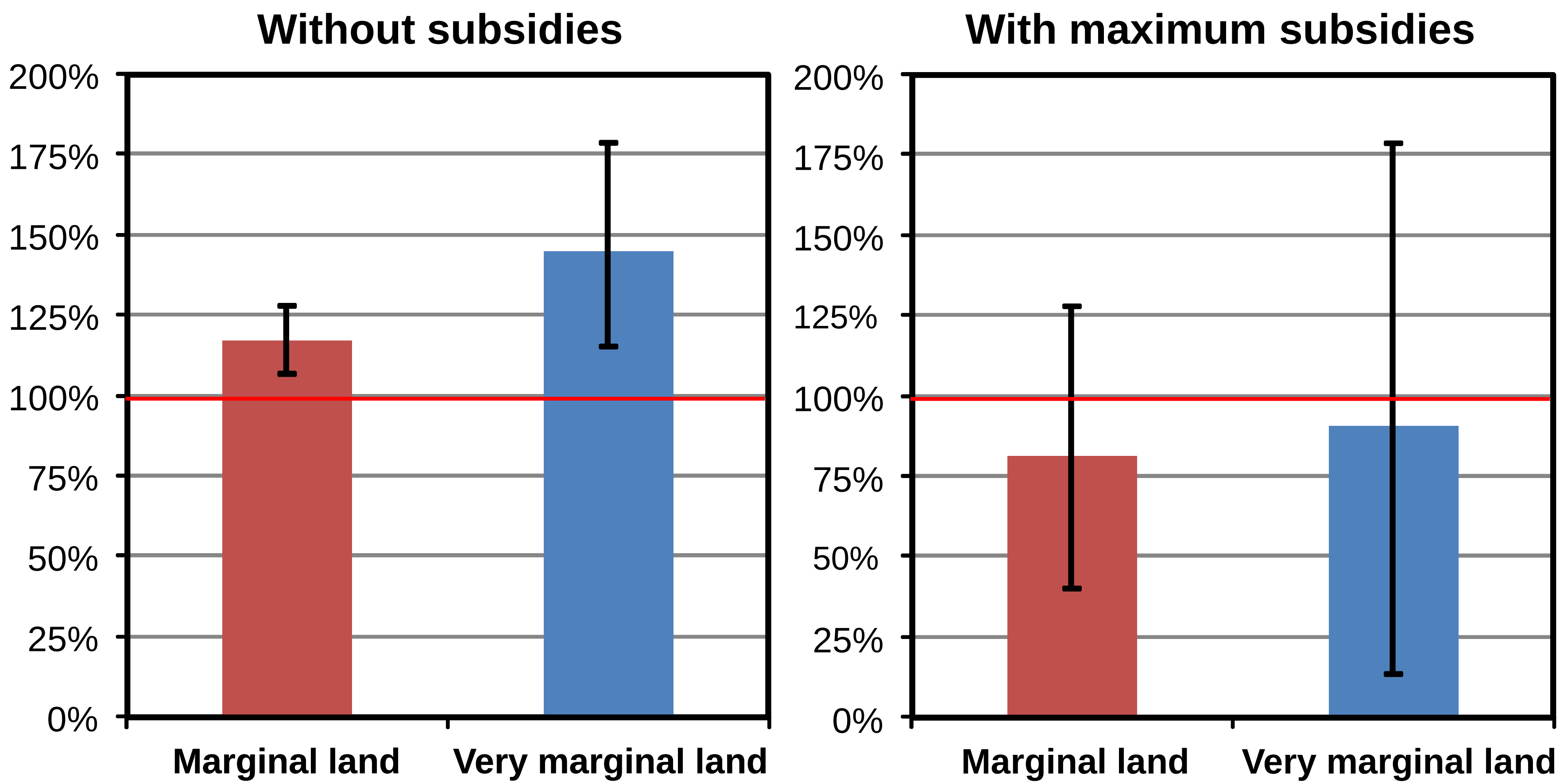
Comparison to standard land

Biomass production costs in relation to standard land



- ➔ **Maximum additional subsidies for areas with natural constraints (ANC) in the current CAP are more than sufficient**
- ➔ **Differentiated financial incentives needed**

Conclusions

Bioenergy from marginal land is more expensive than from standard land and can involve higher risks

- Even on standard arable land, cultivation of perennial crops is unattractive without financial incentives
- Lower land rents can only partially compensate for this

Necessity of financial incentives

- Cultivation of perennial crops on marginal land not profitable outside niches
- Additional incentives e.g. as foreseen for areas with natural constraints (ANC) in the CAP

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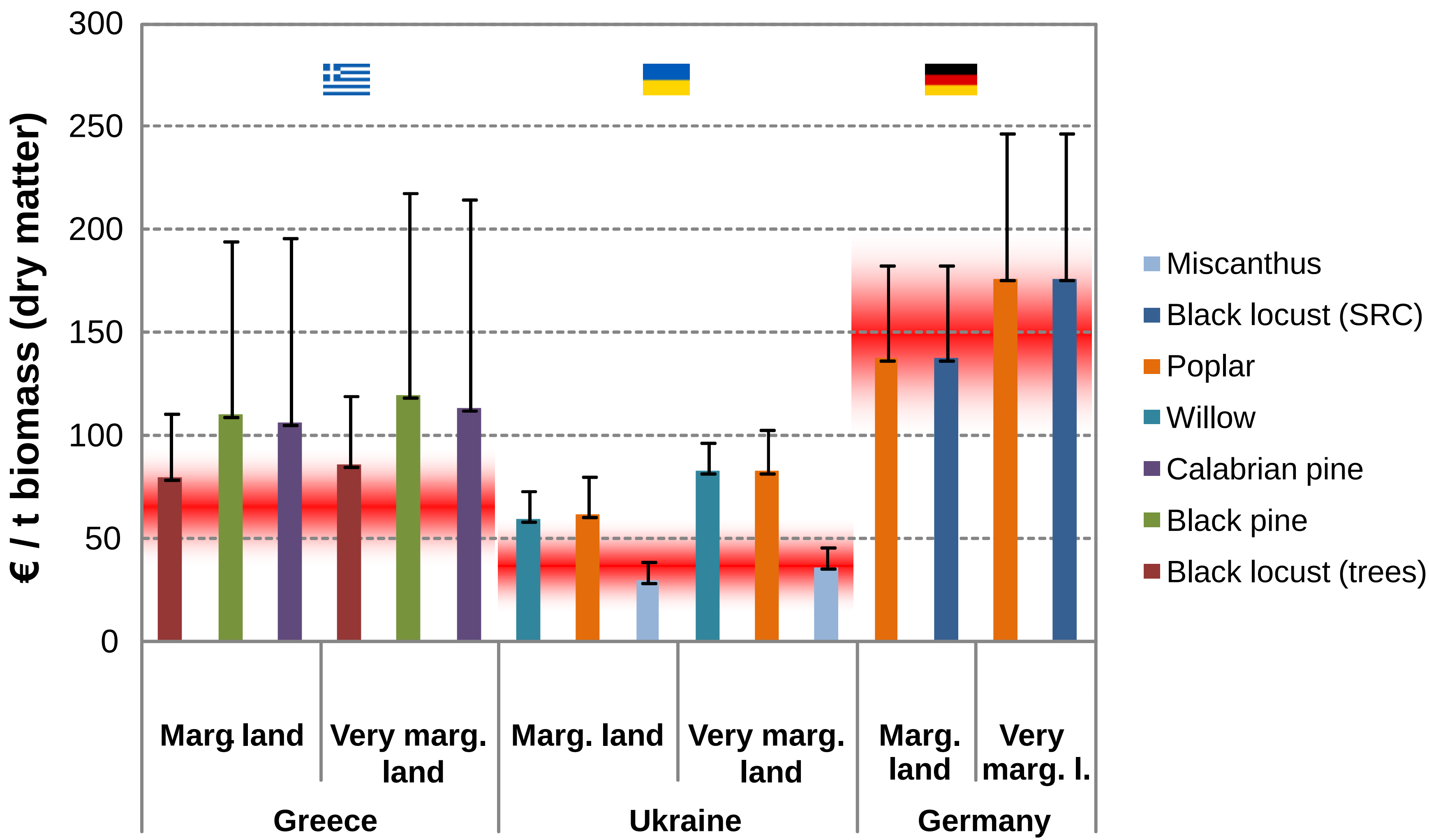
Profitability

Biomass production costs without interest, taxes and subsidies



➔ Costs already *without* interest and taxes mostly above price range

Conclusions

Bioenergy from marginal land is more expensive than from standard land and can involve higher risks

- Even on standard arable land, cultivation of perennial crops is unattractive without financial incentives
- Lower land rents can only partially compensate for this

Risk minimisation necessary, examples:

- Building up experience
- Compensation for extreme weather events
- Investment subsidies rather than incentives in sales prices
- Harvest of woody crops can be postponed depending on market situation

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Conclusions

Large differences between cropping systems, countries and even sites

- Different cost drivers: e.g. costs for machinery, seedlings or land rent can vary significantly
- Different risks: marginal sites are subject to very different biophysical constraints

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2x

Advantageous social effects

- *Additional* jobs
- More added value
- Development of new qualifications
- Precondition: long term profitability
- Strengthening local actors can avoid side effects:
  - Benefits not for rural areas
  - Displacement of extensive users and important ecosystems

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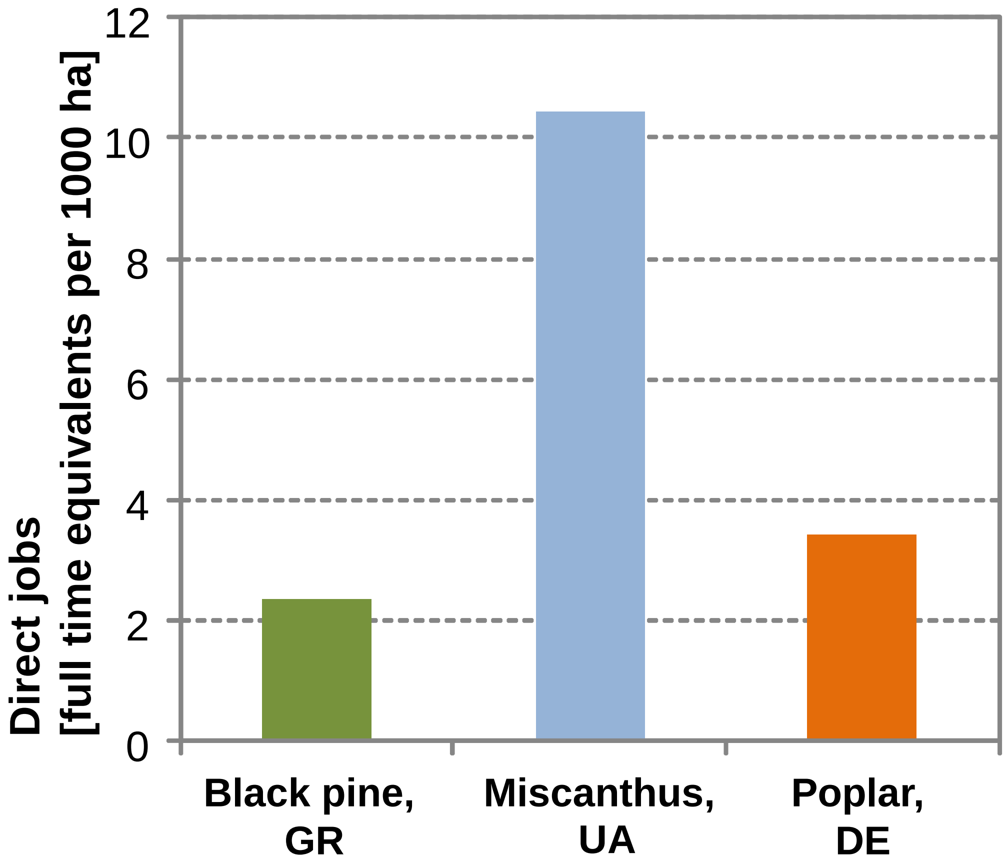
Employment



- ➔ *Additional* direct jobs and new expertise are generated
- ➔ Further indirect and induced jobs highly depend on conditions
- ➔ Similar order of magnitude to be expected

Contribution to rural economy

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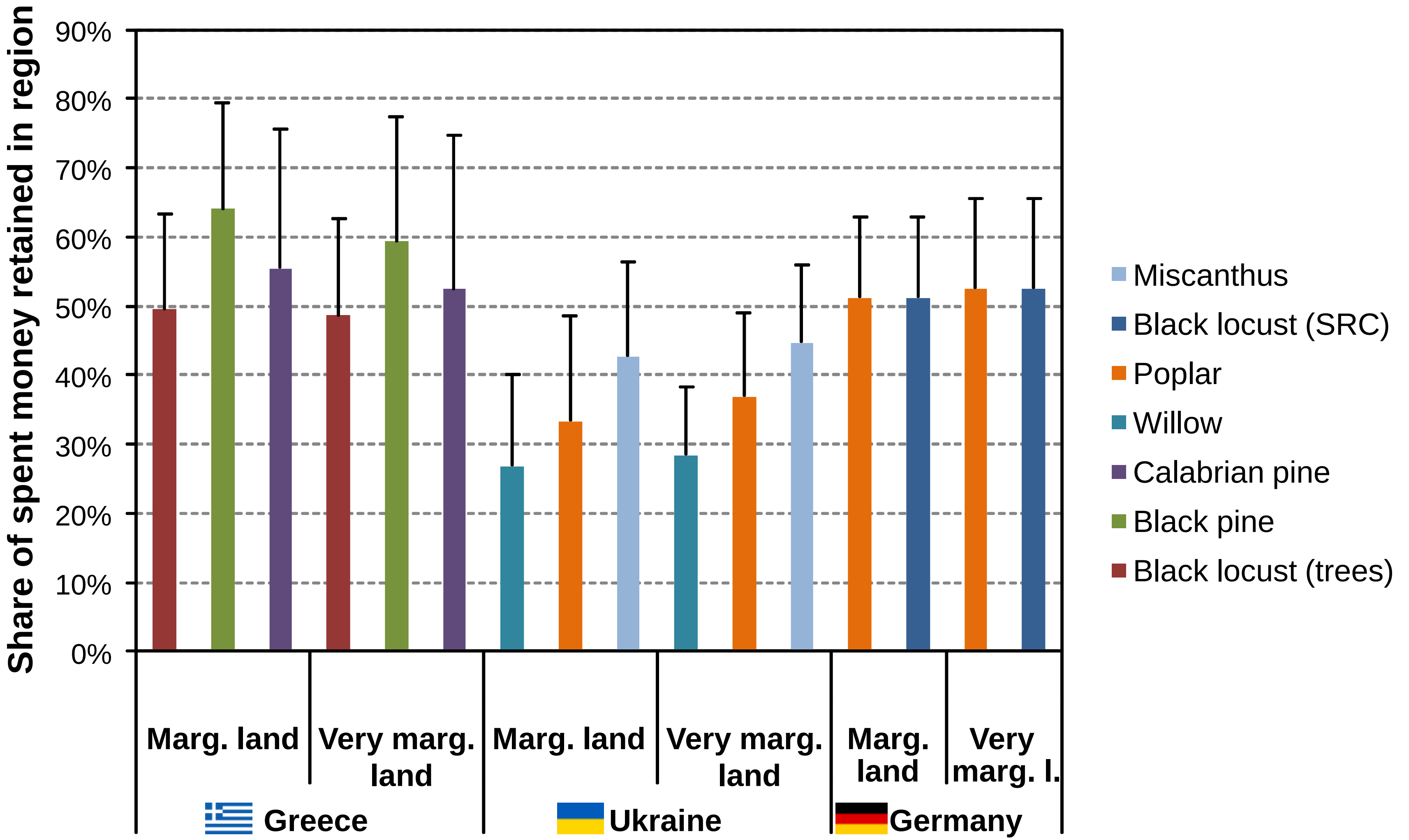

➔ **About half of the inputs can be sourced locally**

Recommendations

- Introduce incentives if expansion of bioenergy from marginal land is desired by society.
- Examine alternatives for overall sustainability.
  - Example: Photovoltaics provides more regenerative energy per area at expectedly lower costs.
- Design differentiated and long-term incentives.
  - Differentiation: Conditions and profitability vary greatly
  - Long term: lower costs, higher socio-economic benefits
- Base support programmes on sound calculations.
- Take long-term socio-economic impacts into account.
  - Public funds are used
  - Minimise environmental impacts to avoid danger for society
  - Take into account where the added value is generated

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Further reading | Coming out soon…

Rettenmaier, N., Schmehl, M., Gärtner, S., Reinhardt, G. (2018): **Final report on environmental assessment**.


Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

SEEMLA

Sustainable exploitation of biomass for bioenergy

from marginal lands in Europe

SEEMLA Project Grant Agreement no. 691874

Final report on environmental assessment

covering LCA & LC-EIA

Heidelberg, October 31st, 2018

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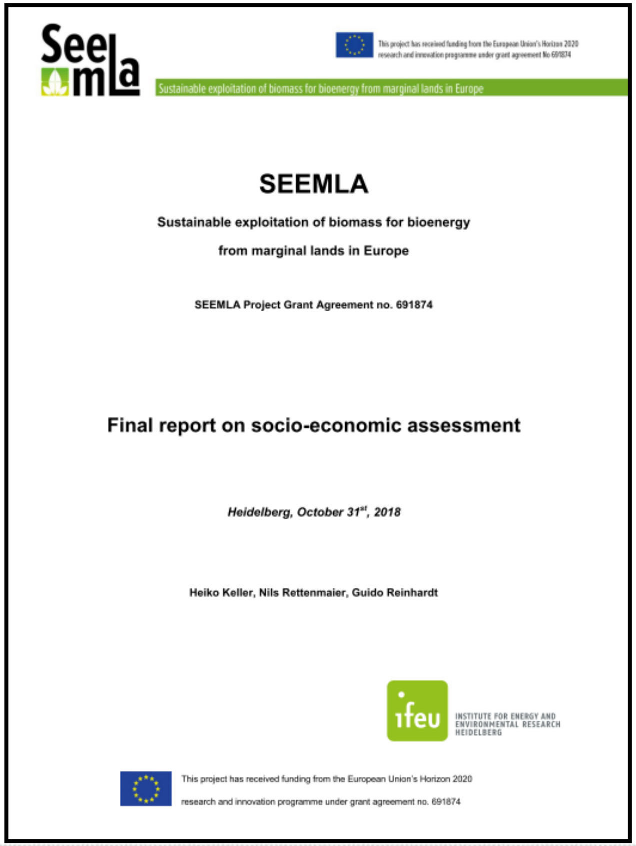
Keller, H., Rettenmaier, N., Reinhardt, G. (2018): **Final report on socio-economic assessment**.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Sustainable exploitation of biomass for bioenergy

from marginal lands in Europe

SEEMLA Project Grant Agreement no. 691874

Final report on socio-economic assessment

Heidelberg, October 31st, 2018

Heiko Keller, Nils Rettenmaier, Guido Reinhardt

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→ This presentation (incl. additional slides) will be made available

Thank you for your attention

- **Downloads:**
  …http://seemla.eu/en/project-deliverables/


Dr. Heiko Keller


Sven Gärtner


Meike Schmehl


Dr. Guido Reinhardt

- **Any questions ?**
  …don‘t hesitate to ask !

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Acknowledgement:
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