FORBIO
Fostering sustainable feedstock production for advanced biofuels on underutilised land in Europe

COMSYN Workshop – European 2nd Generation Biofuels: Opportunities and Applications

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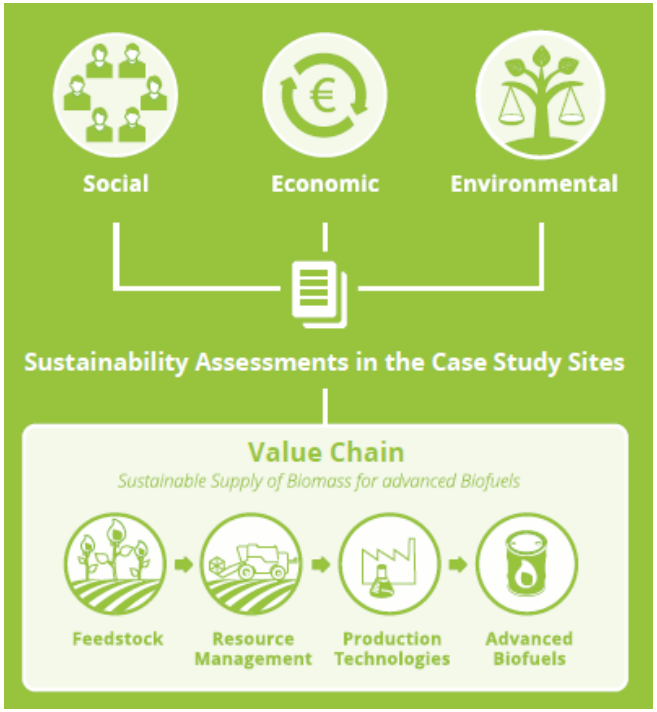
Rainer Janssen, Cosette Khawaja
WIP Renewable Energies
Sylvensteinstr. 2
81369 Munich
www.wip-munich.de

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No691846.

FORBIO objectives

- ✓ Identify social, economic, environmental and governance-related **opportunities and challenges**
- ✓ Evaluate **agronomic and techno-economic potential** of the selected bioenergy value chains
- ✓ Assess environmental, social and economic **sustainability**
- ✓ Analyse economic and non-economic **barriers to the market uptake**
- ✓ **Encourage** European **farmers** to produce sustainable biomass feedstock
- ✓ **Build capacity** of stakeholders for setting up sustainable bioenergy supply chains



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Main results

CASE 1

ITALY
Sulcis, Portoscuso

Contaminated land from industrial activities

22,000 ha

CASE 2

UKRAINE
Kyiv oblast, Ivankiv region

Underutilised marginal agricultural land

Over 20,000 ha

CASE 3

GERMANY
Metropolis region
Berlin & Brandenburg

Sewage irrigation fields & lignite mining

1,140-3,917 ha and 7,295-11,795 ha

- Agronomic and technoeconomic feasibility studies of the case studies
- Potential value chains of bioenergy production on underutilised land
- Sustainability assessment of the most promising value chains

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Italian Case Study

Contaminated land from industrial activities in Sulcis district, south-west Sardinia

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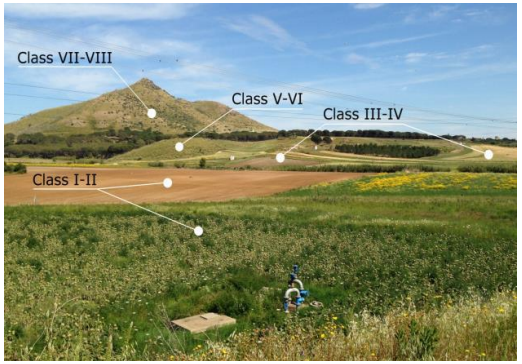
Land available for energy crops based on GIS evaluation results

- **51.000 ha** could be available hypothesizing a supply radius of 70 km to the biorefinery
- In the most contaminated area approximately **1.000 ha** are available. The area is unequipped for irrigation, thus most suitable for rainfed crops such as those identified in this study
- GIS-based evaluation suggest a potential to increase the production of **2G** biomass crops without impacting significantly on food crop production



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Promising energy crops (selection)

Species	Biomass yield (Mg DM ha^{-1} yr^{-1})	Comments on usage, experience and cultivation
Arundo donax (Giant reed)	up to 25	Low nutrient input, water use efficiency, carbon storage potential. Potential disadvantages are related to invasiveness
Piptatherummiliaceum L. (Smilo grass)	26-45	Low nutrient input, but need further investigation
Dactylis glomerata L. (Cocksfoot)	16-20	Low nutrient input, but need further investigation
Silybummarianum L. Gaertn. (Milk thistle)	9-20	Shows high adaptability for Mediterranean environments (rainfed), good yield even under non-irrigated conditions on alcaline soils

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Value chain: Arundo donax for bioethanol production(10 years)

Input data	
Plant Capacity	40,000 tons/year
Mean biomass productivity	25 Mg DM ha^{-1} yr^{-1}
Area needed for biomass production	8,000 ha
Collection radius from the plant	40 km

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Value chain: Arundo donax for bioethanol production (10 years)

Costs	€/ha year	€/Mg DM year
Landowner fee	600	24
Irrigation fee	210	8.4
Fertilisation costs	100	4
Annual maintenance	80	3.2
Harvesting	332.5	13.3
Pro-anno installation + eradication costs	15	0.6
Pro-anno drip irrigation investments	132.5	5.3
Capital remuneration (2.5%)	2.5	0.1
Supply chain management	50	2
Transport (40 km)	250	10
TOTAL COSTS	**1,772.5**	**71**

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Ukrainian Case Study
Kyiv oblast *Ivankiv region*

Underutilised marginal land

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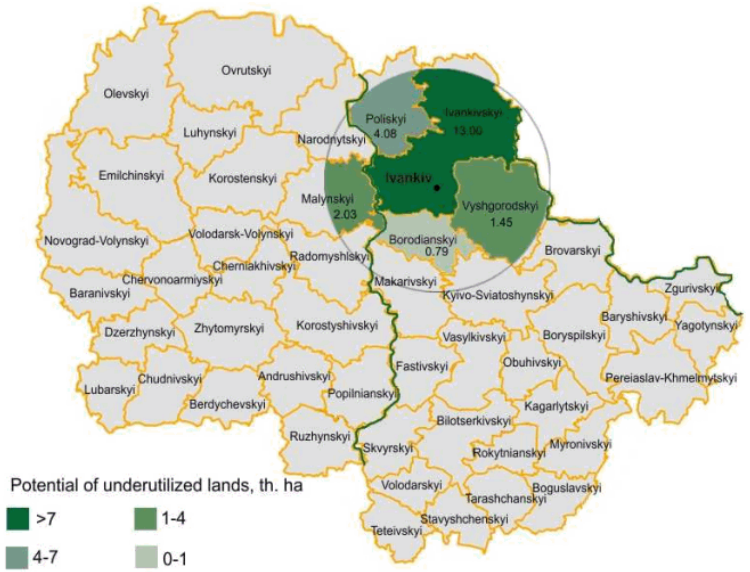
Underutilised land availability and potential for energy crops

Two categories of land are considered as underutilised in the assessment:

- Abandoned agricultural land, i.e. land that is not needed any more for the production of food and feed crops or for other purposes;
- Degraded or low productive land, i.e. land that is not suitable or no longer suitable for conventional commercial agriculture.

Regions	Distance* from Ivankiv town to the remotest points of the region, km	Underutilised land within 50 km zone, thousand ha
Ivankivskyi	40	13.00
Poliskyi	52	4.08
Malynskyi	85	2.03 (part of the region)
Vyshgorodskyi	55	1.45
Borodianskyi	49	0.79
Potential in the regions located in 50 km radius from Ivankiv		21.35

* Measured by roads



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Promising energy crops (selection)

	Energy crop	Soil pH	Annual precipitation, mm	Temperature, °C	Life cycle, years	Frequency of harvest	Biomass yield (Mg DM ha^{-1} yr^{-1})
	Salix Viminalis L.	5-7	650 -700	15-26	20-25	1 per 3 years	6.2-11.3
	Miscanthus x giganteus	5.5 – 7.5	500-700	25-32, frost-resistant	20	annually	15-20 (after 2nd year)
	Panicum virgatum L.	5.5-7	380-760	drought-resistant	10-15	annually	7-14
	Columbian grass	5-8.5	460-760	drought-resistant	8-10	annually	10-17
	Silphium perfoliatum	5.5-7.5	Resistant to floods	5-40, frost-resistant	15-20	annually	15-20
	Populus sp. L.	6-7	≥600	15-25	20-25	1 per 2-3 years	10-20 (after 3-4 years)

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Value chain: *Salix* for 2G ethanol
Estimation of chips cost at plant gate (10 years)

Input data	
Plant Capacity	40,000 tons/year
Mean biomass productivity	10 Mg DM ha^{-1} yr^{-1}
Area needed for biomass production	21,350 ha
Collection radius from the plant	50 km
Annual potential of biomass feedstock	200 Mg DM /year

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Value chain: *Salix* for 2G ethanol
Estimation of chips cost at plant gate (10 years)

Costs	€/ha year	€/Mg DM year
Establishment of plantation	123.4	12.34
Landowner fee	13	1.3
Fertilization costs	32	3.2
Harvesting (single pass for one row)	32	3.2
Eradication of plantation	15.7	1.57
Capital remuneration (2.5%)	35	3.5
Biomass handling and transport (50 km)	35	3.5
FINAL COST AT PLANT GATE		**28.7**

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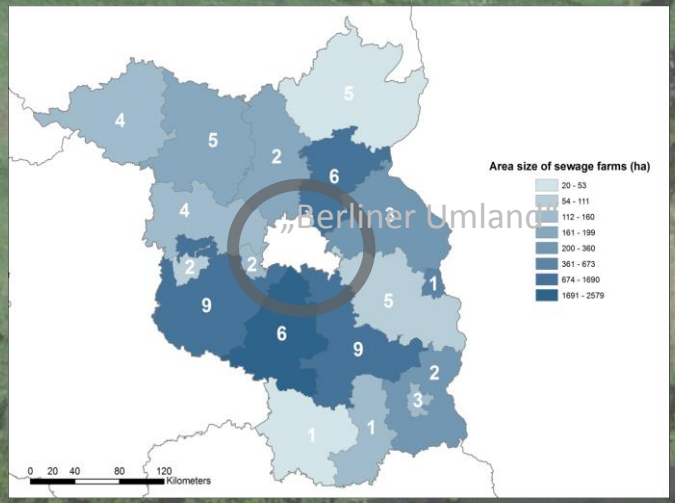
German Case Study - Part I
Metropolis Region *Berlin & Brandenburg*

Disused Sewage Irrigation Fields



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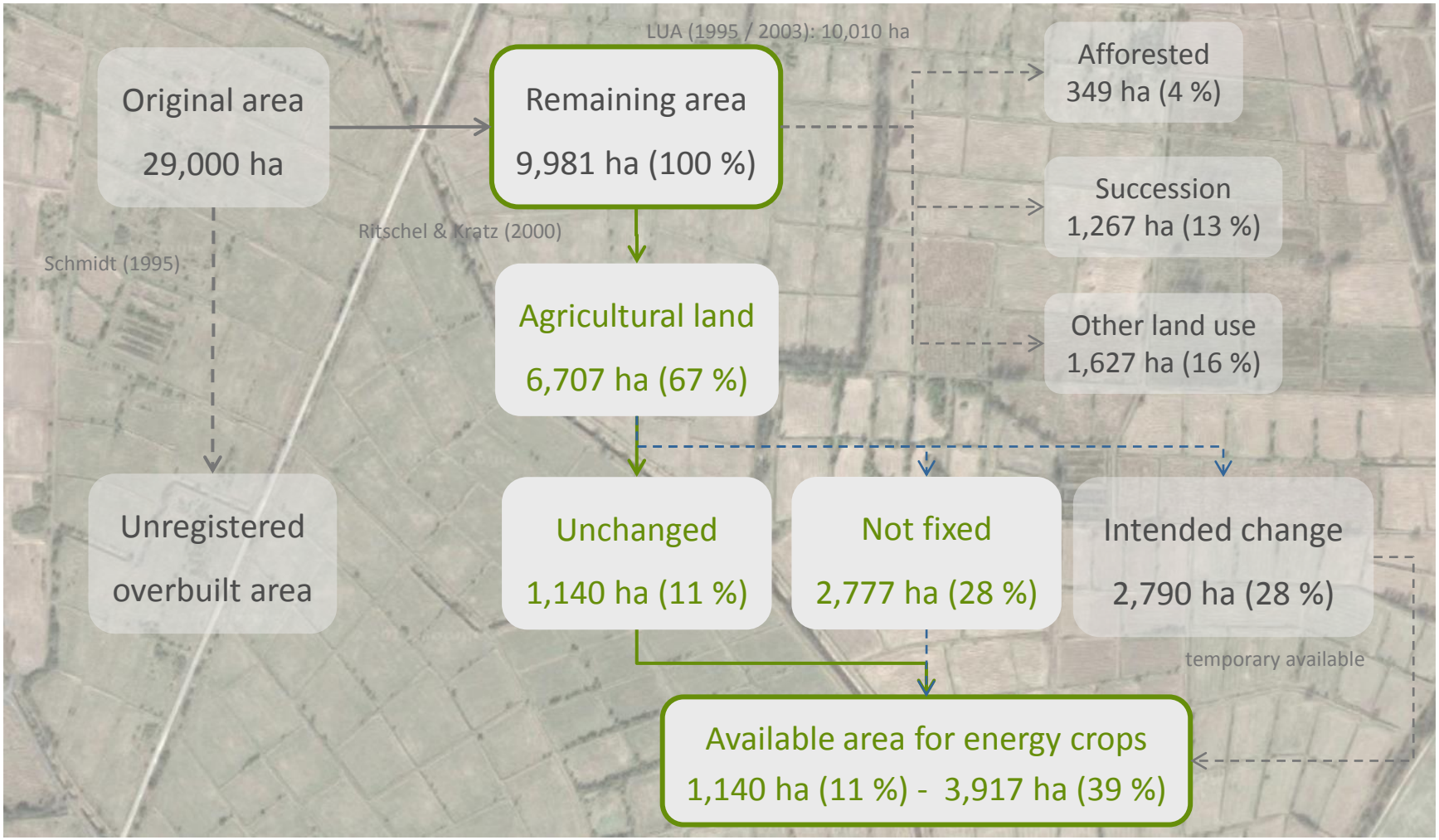
Land use change and perspectives for energy cropping



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Promising energy crops (selection)

Species	Biomass yield (Mg DM ha^{-1} yr^{-1})	Comments on usage, experience and cultivation
Miscanthus x giganteus	5-25	No cultivation on disused sewage irrigation fields, but promising to be tested due to the **high biomass yield on low-yielding agricultural soils**
Sorghum bicolor/ sudanense	3-16	In practice on common agricultural land in Brandenburg; first, quite **promising cultivation test** on a disused sewage irrigation field
Silphium perfoliatum	13-18	No cultivation on disused sewage irrigation fields, but promising to be tested due to the **high biomass yield**
Populus x spec.	0.1-12.9	Experience with cultivation in field trials and **SRC on disused irrigation fields**; site preparation and weed control needs to be done consequently; problems with heavy metal (Zn) induced micronutrient deficits (Fe)

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Value chain: *Miscanthus* for heat/electricity
Estimation of costs and income (20 years)

Input data	
Mean biomass productivity second year	5 Mg DM ha^{-1} yr^{-1}
Mean biomass productivity starting from third year	15 Mg DM ha^{-1} yr^{-1}
Area considered for biomass production	1,140 ha
Collection radius from the plant	3-14 km

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Value chain: *Miscanthus* for heat/electricity
Estimation of costs and income (20 years)

Costs	€/ha year	€/Mg DM year	€/20 years
Establishment of plantation	3,208 (1st year)	213.8 (1st year)	3.7 M
Annual maintenance	24	1.6	0.5 M
Harvesting	278	18.5	6.3 M
Transportation to final customer (3-14km)	113 - 314	7.5 - 21	2.6 - 7.2 M
Overall costs	**576.4 - 777.4**	**38.39 - 51.79**	**13.1 - 17.7 M**

Income		EUR/20 a
Option 1	Selling *Miscanthus* chips (80 €/Mg DM *)*	**26.4 M**
Option 2	Selling *Miscanthus* chips (50 €/Mg DM)	**16.5 M**
Total income (for 20 years)		

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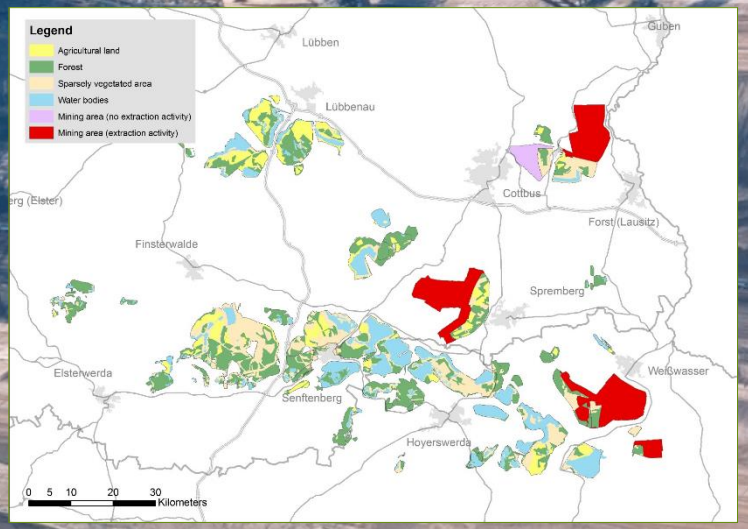
German Case Study - Part II

Reclamation Sites in the Eastern German Lignite District (Lusatia)



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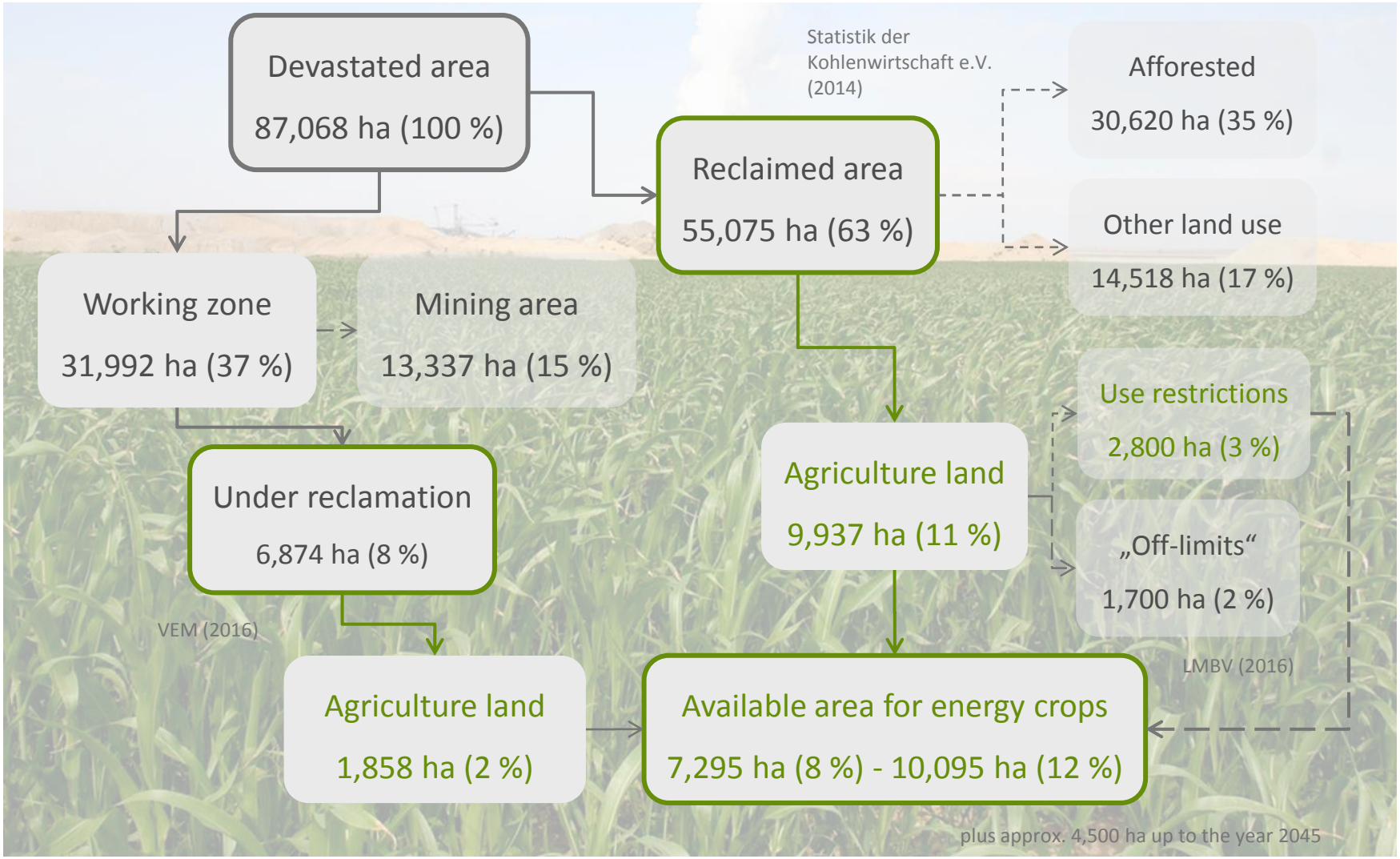
Production potential on lignite reclamation sites



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Promising energy crops (selection)

Species	Biomass yield (Mg DM ha^{-1} yr^{-1})	Comments on usage, experience and cultivation
Sorghum bicolor/ sudanense	3-17	Profitable cropping **alternative to maize**, very **promising cropping experience** on poor reclamation and marginal agricultural sites in Brandenburg
Medicago sativa (Luzerne)	2-17	Very important for the **re-establishment of soil functions** and achieving defined topsoil target values on reclamation sites
Miscanthus x giganteus	4.5-25	Not yet grown on reclamation sites, but very promising due to **good yield expectation on marginal to medium agricultural soils** in the region
Robinia pseudoacacia	1-11	Overall good experience with the **cultivation on poor reclamation sites**

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Value chain: Lucerne & Sorghum for biomethane
Estimation of costs and income (20 years)

Input data	
Mean biomass productivity Lucerne	5 Mg DM ha^{-1} yr^{-1}
Mean biomass productivity Sorghum	10 Mg DM ha^{-1} yr^{-1}
Area considered for biomass production Lucerne	3,648 ha
Area considered for biomass production Sorghum	2,431 ha
Collection radius from the plant	8-48 km

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Value chain: Lucerne & Sorghum for biomethane
Estimation of costs and income (20 years)

Costs	€/ha year	€/Mg DM year	€/20 years
Cultivation costs	Lucerne: 534 Sorghum: 751	Lucerne: 107 Sorghum: 75	37.9 M + 36.5 M
Investment Biogas plant (3.1 MW_{el})			7.7 M
Upgrading installation			2 M
Plant operating costs 10-15% of investment per year			1 M
Overall costs (for 20 years)			**85.1 M**

Income		€/20 years
Biomethane	37.9 M kWh with 7.3 Cent/kWh	54 M
Direct payments	255 EUR/ha	31 M
Total income (for 20 years)		**85 M**

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Barriers

- ✓ Lack of **better policy, market support and financial frameworks**, notably at national, regional and local level
- ✓ **Financial security of farmers business** (long term vs. short term contracts with farmers)
- ✓ **Access to credit** (loans, microloans, equity, other forms of financing for innovative value chains)
- ✓ **Incentives** (tax breaks, tariffs, etc.)
- ✓ **Capacity development** of local actors
- ✓ **Profitability** (market conditions for biomass production, costs & revenue analyses, etc.) on marginal lands

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Upcoming events

Germany

FORBIO Capacity building event (FIB, WIP)

- Robinia field day, 12 June 2018, Neupetershain

FORBIO Info day (WIP, ATB, FIB)

- Green biorefinery – Innovative added value for the use of grassland, 27 June 2018, Potsdam

More information: www.forbio-project.eu

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FORBIO

Project Consortium

WIP Renewable Energies

Contact: Rainer Janssen, Cosette Khawaja, Dominik Rutz

Food and Agriculture Organisation of the United Nations

Contact: Marco Colangeli, Lorenzo Taverno

Geonardo Environmental Technologies Ltd.

Contact: Ömer Ceylan, Peter Gyuris, Attila Udersky

Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria

Contact: Guido Bonati

Biochemtex Spa

Contact: Stefania Pescarolo

Blacksmith Initiative - UK

Contact: Valeriia Kovach

Scientific Engineering Centre "Biomass" Ltd

Contact: Oleksandra Triyboi

Center for Promotion of Clean and Efficient Energy

Contact: Nicoleta Ion

Forschungsinstitut für Bergbaufolgelandschaften e.V.

Contact: Dirk Knoche, Raul Köhler

Polish Biomass Association

Contact: Maria Smietanka, Magdalena Rogulska

European Landowners' Organization

Contact: Marie-Alice Budniok

University of Limerick

Contact: JJ Lehay

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