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Rome, Italy

The contribution of the FORBIO project to the sustainability development of bioenergy

German case study: Agronomic and techno-economic feasibility

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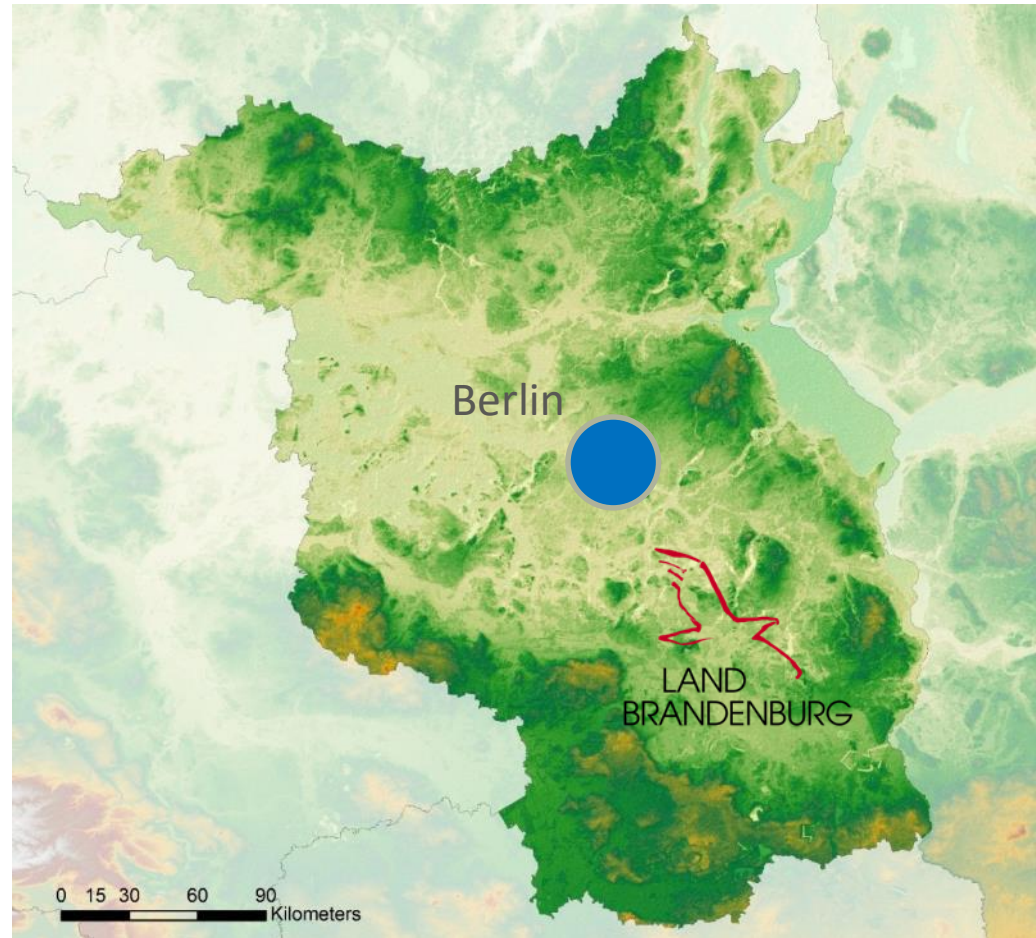


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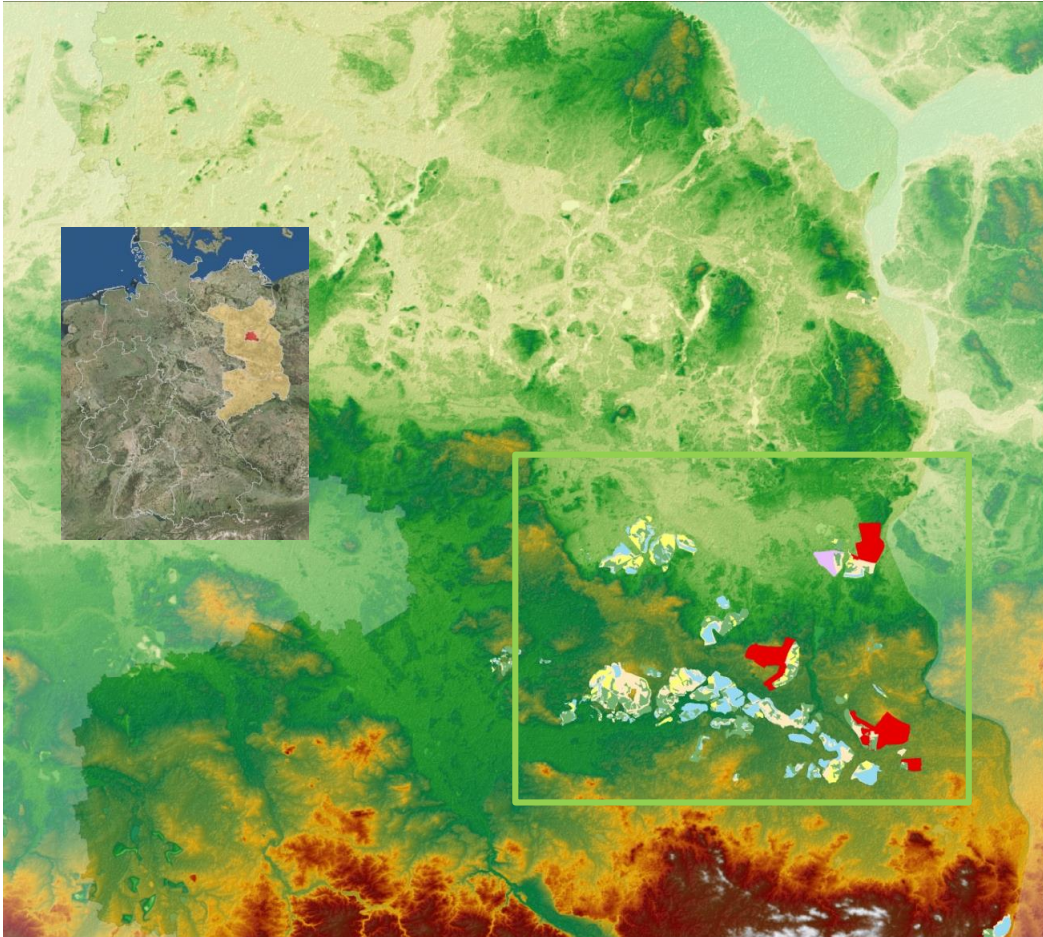
German Case Study – Metropolis region *Berlin & Brandenburg*

Evaluation of the most promising bioenergy value chains on underutilized land

- Lignite Reclamation Sites
- Sewage Irrigation Fields



German Case Study – Metropolis region *Berlin & Brandenburg*



- Northeast German Lowlands
50-180 m a.s.l.
landscape formative:
Quaternary glacial and fluvial
sands covering loose, lignite
bearing sediments of the Middle
and Upper Miocene
- Western Atlantic to
East sub-continental climate
mean annual temperature:
7,0 to 9,5 °C (+/- 20 °C)
average precipitation:
500 to 700 mm
50 % in the vegetation period
climatic water balance (vp):
-150 to -200 mm



German Case Study I - Scenario 1 Lignite Reclamation Sites

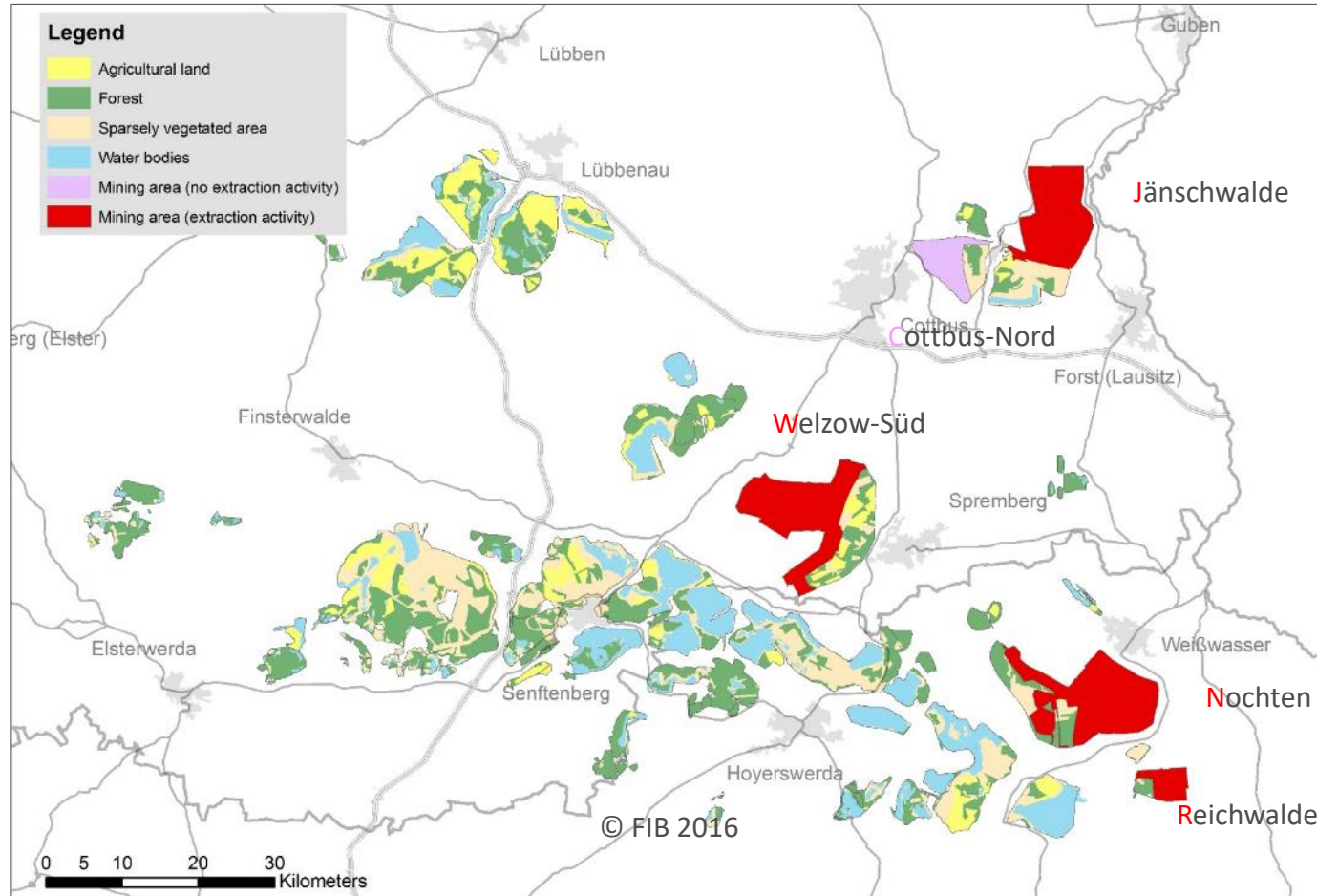


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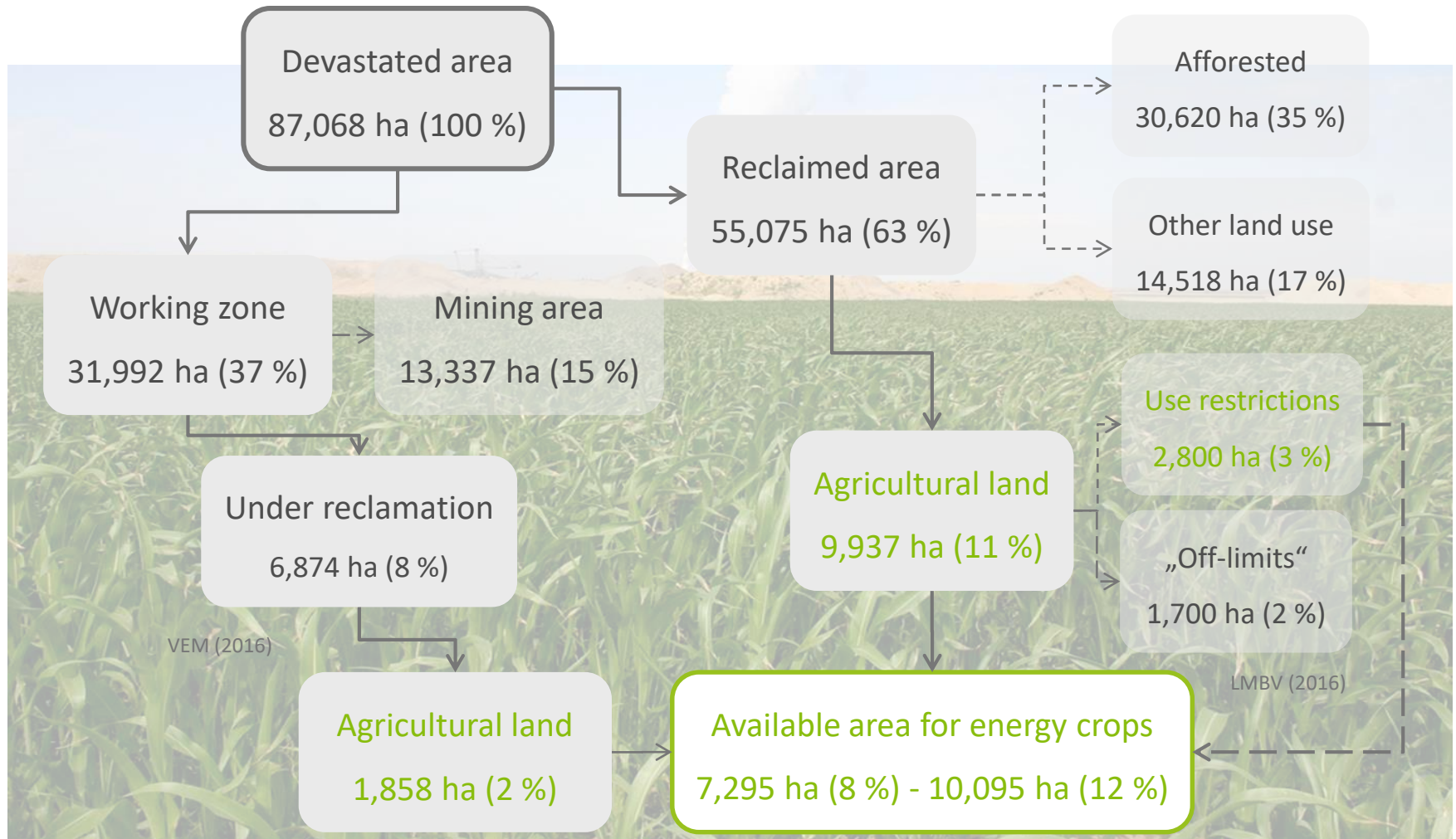


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Eastern German Lignite district – Land use distribution on reclamation sites



Production potential on lignite reclamation sites



Ecosystem development at *Point Zero*



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A profitable feedstock production without endangering the overriding reclamation targets



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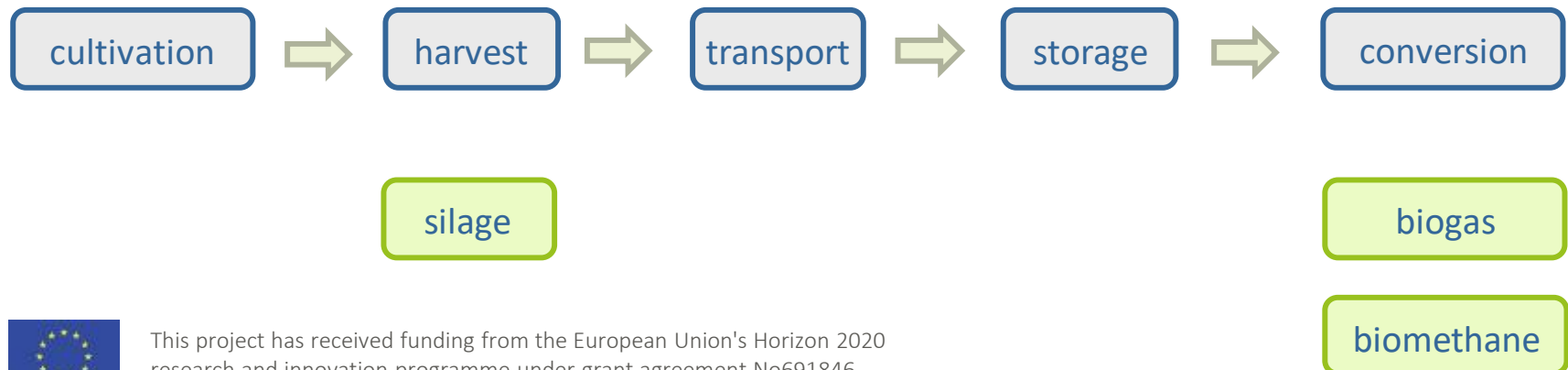
Lucerne + *Sorghum* techno-economic feasibility

Scenario 1 Utilization of biomass in a **new biogas plant** for **biomethane production**, within a **binding crop rotation** for agricultural reclamation sites:
 Lucerne (1-3rd yr) + *Sorghum* (4th yr) + wheat (5th yr) + rye & *Sorghum* (6th yr)

Reference area: 7,295 hectares agricultural land, 6 annual production blocks of 1,216 ha, which ensure a steady feedstock supply

Investment period: 20 years

Yield:
 Lucerne 5 Mg_{DM}/ha/yr
Sorghum 10 Mg_{DM}/ha/yr



Lucerne + *Sorghum* crop rotation - costs & income

Costs		Million EUR/20 yr
investment	biogas plant for biomethane (3.1 MWe)	7.7
	upgrading installation (amine gas treating)	2.0
operating	10 % of investment per year	1.0
cultivation	Lucerne: 534 EUR/ha/yr; <i>Sorghum</i> : 751 EUR/ha/yr	37.7 + 36.5
<i>total costs (new investment)</i>		85.1

Income		Million EUR/20 yr
biomethane	feed-in of biogas into the gas grid (0.07 EUR kWh)	54
direct payments	255 EUR/ha/yr	31
<i>total income</i>		85



Conclusions

- At *Lignite Reclamation Sites* the biomethane production based on a conventional energy cropping sequence is **economically questionable** at the moment.
- The striking point is the added value by **upgraded products**, calling even more for individual solutions and synergies on farm level.
- Both, national biorefineries roadmap and the regional energy strategy claims for a wide-ranging **combined material and energetic utilization** and **cascade use**.
- All the more it makes sense to use and develop already **well-established production** and **processing structures**.



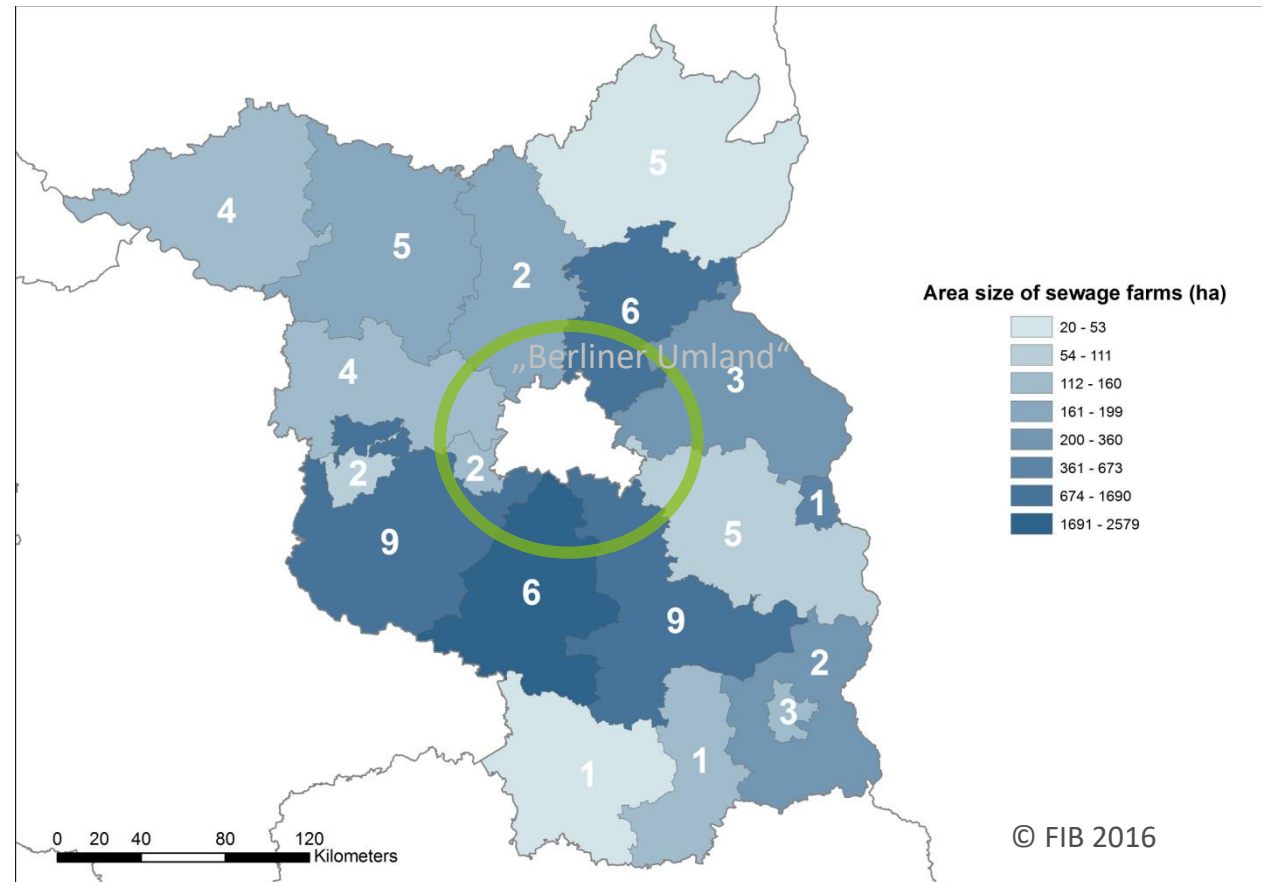
German Case Study II - Scenario 2 and Scenario 3 Disused Sewage Irrigation Fields



Disused irrigation fields for urban and industrial waste-water cleaning

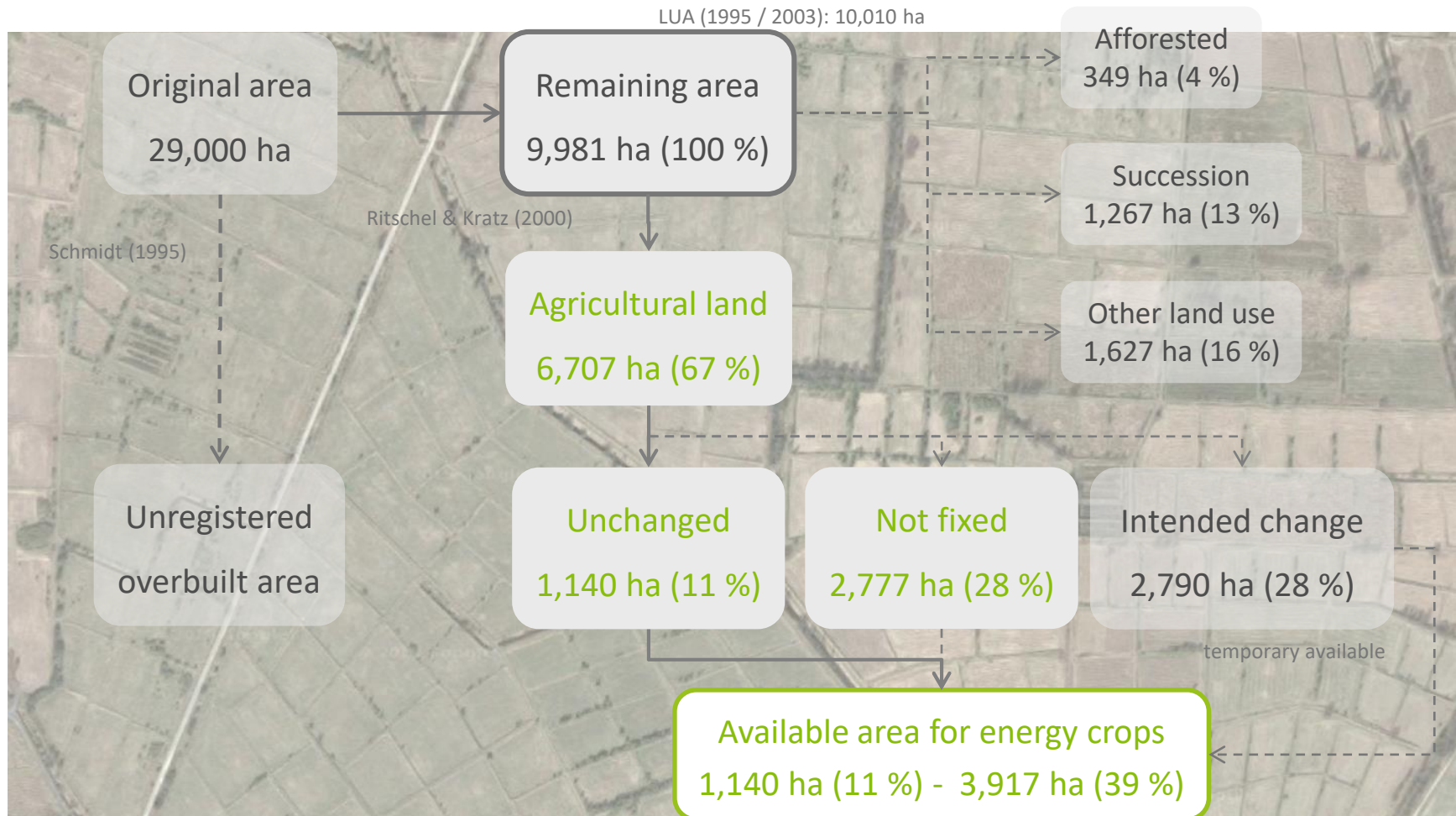
Total area:
9,981 hectares
71 complexes

data source: Ritschel & Kratz (2000)



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Land-use change and perspectives for energy cropping



Cropping on low-yielding and contaminated fields



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Most promising value chains

Scenario 2 *Miscanthus* cultivation and 2 processing pathways

Scenario 3 Utilization of grass and 2 processing pathways

Reference area: 1,140 hectares agricultural land (grassland) in the Southern surroundings of Berlin (*Berliner Umland*)

Investment period: 20 years

Yield: *Miscanthus* 15 Mg_{DM}/ha/yr
permanent grassland 3 Mg_{DM}/ha/yr



Miscanthus - techno-economic feasibility

Option 1 Sale of *Miscanthus* chips to three **existing biomass power plants** nearby (4-20 km): *Ludwigsfelde, Henningsdorf, Königs-Wusterhausen*

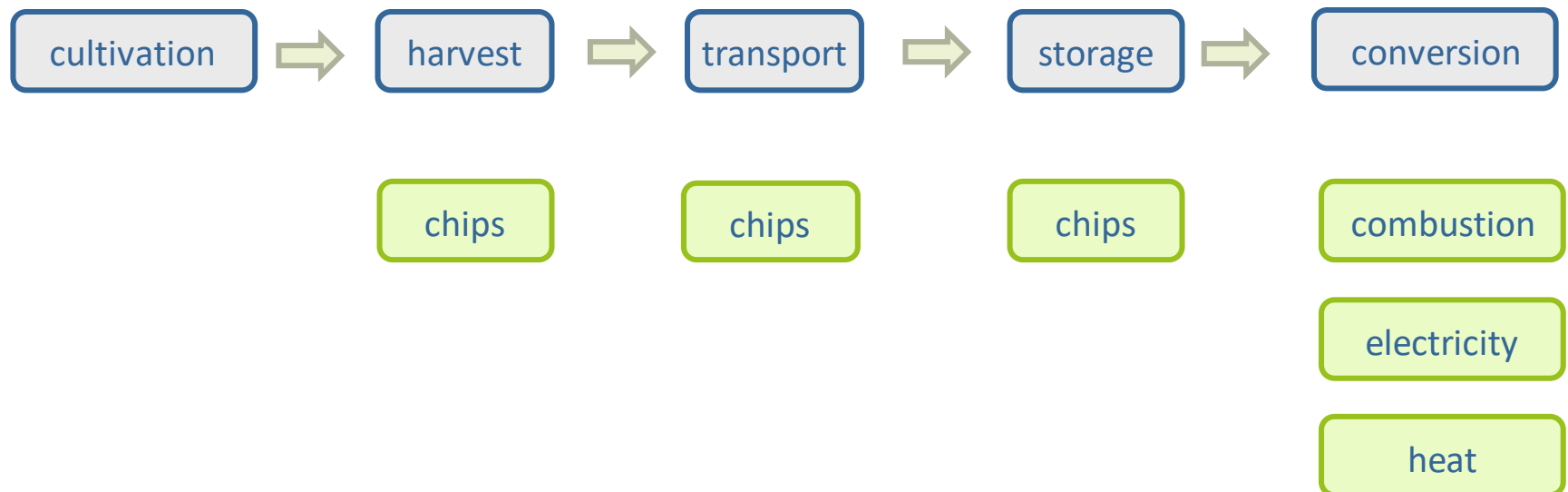
Option 2 Combustion of *Miscanthus* chips in a **new CHP biomass power plant**
- power-heat coupling / cogeneration



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Miscanthus - costs & income

Costs		Million EUR/20 yr
cultivation	establishment of plantation (3.208 EUR/ha)	3.7
management	fertilization, crop protection, etc. (24 EUR/ha/yr)	0.5
logistics	harvest (278 EUR/ha/yr)	6.3
	transport (shortest/average distance)	2.6 - 6.2
Option 1 total costs (existing plants)		13.1 - 16.7
Option 2 total costs (new investment)		40.0

Income		Million EUR/20 yr
Option 1.1	sale of <i>Miscanthus</i> chips (80 EUR/Mg _{DM})	26.4
Option 1.2	sale of <i>Miscanthus</i> chips (50 EUR/Mg _{DM})	16.5
Option 2.1	100 % electricity (0.1488 EUR/kWh)	88.0
Option 2.2	100 % heat (0.05 - 0.09 EUR/kWh)	44.0 - 78.0



Permanent grassland - techno-economic feasibility

Option 1 Sale of grass to an existing **biogas plant** nearby (Ø 12 km, *Groß Machnow, Blankenfelde, Mahlow 1-3*) - biomethane production

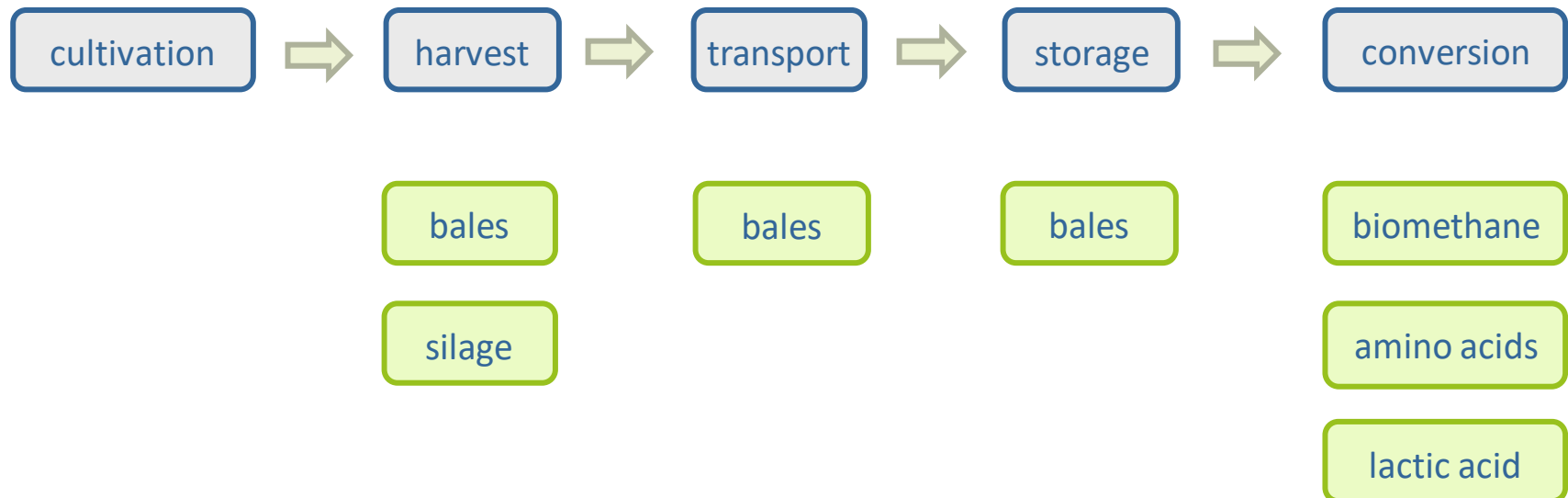
Option 2 Utilization in a **new grass biorefinery** linked to an existing biogas plant (retrofitting) - production of basic biochemicals



Permanent grassland - techno-economic feasibility

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Option 2 Utilization in a **new grass biorefinery** linked to an existing biogas plant (retrofitting) - production of basic biochemicals



Permanent grassland - costs & income

Costs		Million EUR/20 yr
management	mowing (41.5 EUR/ha/yr)	0.6
	baling (14.5 EUR/bale)	1.0
logistics	transport / average distance (68 EUR/h)	0.1
Option 1 total costs (existing plants)		1.7
Option 2 total costs (new investment/retrofitting)		4.0

Income		Million EUR/20 yr
Option 1	sale of grass silage (60 EUR/Mg _{DM})	4.1
Option 2	sale of amino acids (84 - 120 Mg / 4,000 EUR/Mg)	6.7 - 9.6
	sale of lactic acid (36 Mg / 600 EUR/Mg)	0.4



Conclusions

- For disused *Sewage Irrigation Fields* a profitable (1) cultivation of *Miscanthus* is possible, despite challenging cropping and some management risks.
- Even more the low-input (2) utilization of semi-natural grassland as part of the regular landscape maintenance makes sense.
- Because of the scattered ownership structure and inadequate biomass supply any *big solution fails*, especially the biofuel production is quite unrealistic.
- Existing small- to medium-sized processing routes should be exploited, notably by *biorefining* and *co-combustion*.



Green is our color of future

- In both cases - lignite reclamation land and sewage irrigation fields - the production / extraction of **higher-priced basic biochemicals** and other **raw material use options** should be promoted.
- Farmers and other stakeholders must be encouraged to invest in an upgraded decentralized biomass utilization / **retrofitting of existing plants / biorefining**.
- For sensitive sites a **financial compensation** for providing ecosystem services is worthy of discussion: environmental protection - land cover - soil restoration - phytoremediation - landscape maintenance, etc.



**Thank you for
taking your precious time
& paying attention!**



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