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

German case study: Agronomic and techno-economic feasibility

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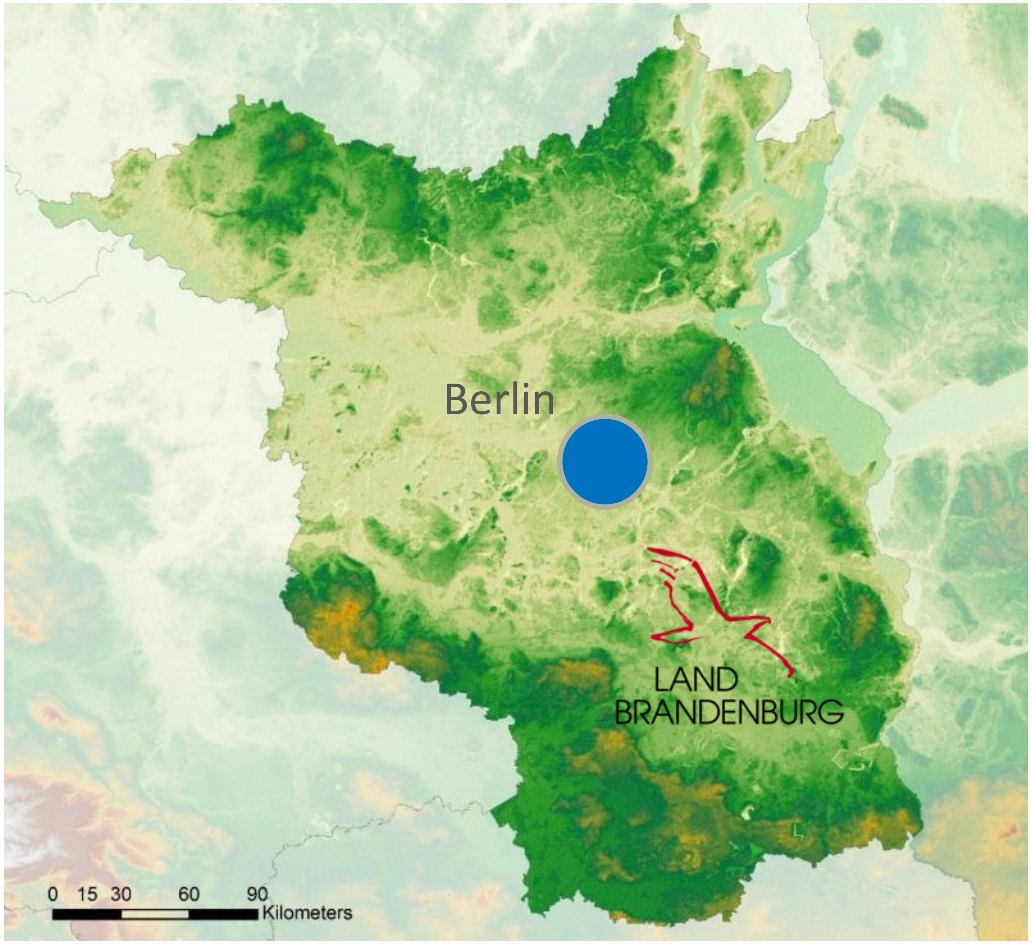
German Case Study –

Metropolis region *Berlin & Brandenburg*

Evaluation of the most promising bioenergy value chains on underutilized land

- Lignite Reclamation Sites
- Sewage Irrigation Fields



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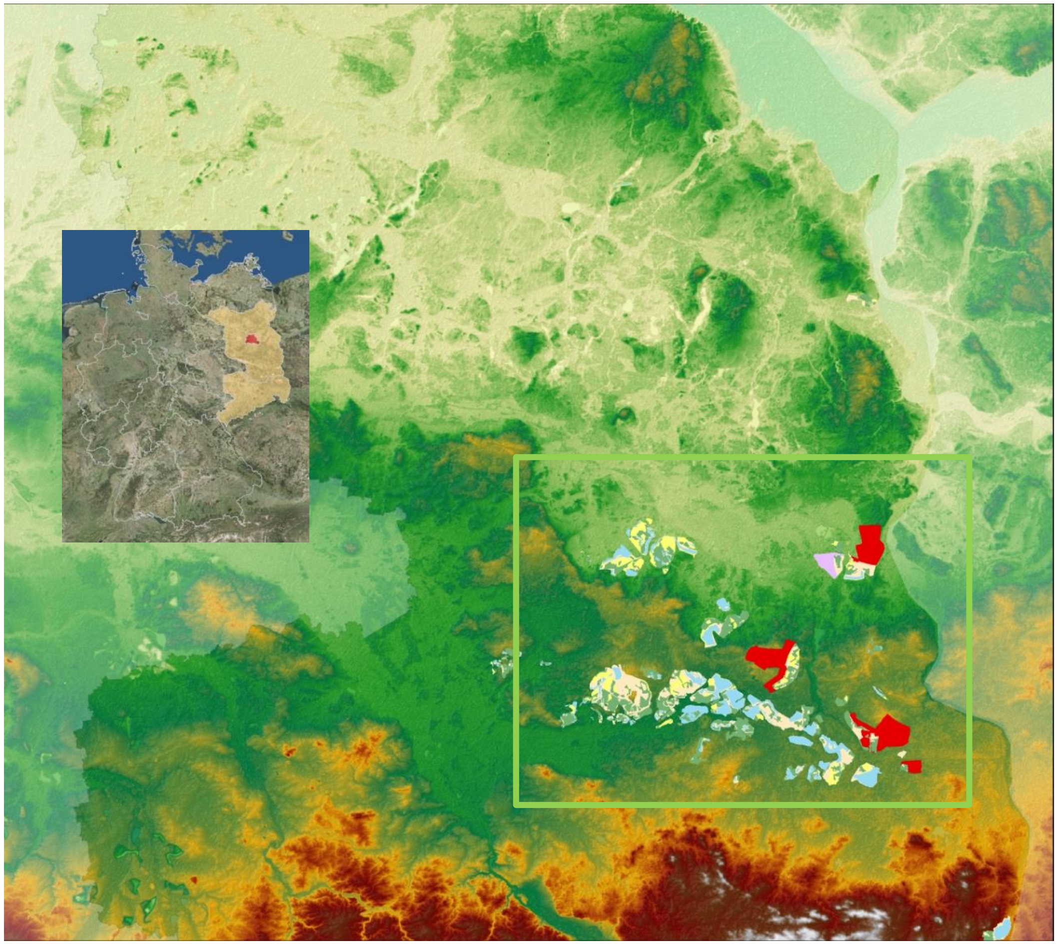
German Case Study –

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 ºC (+/- 20 ºC)

  average precipitation:

  500 to 700 mm

  50 % in the vegetation period

  climatic water balance (vp):

  -150 to -200 mm

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German Case Study I - Scenario 1
Lignite Reclamation Sites

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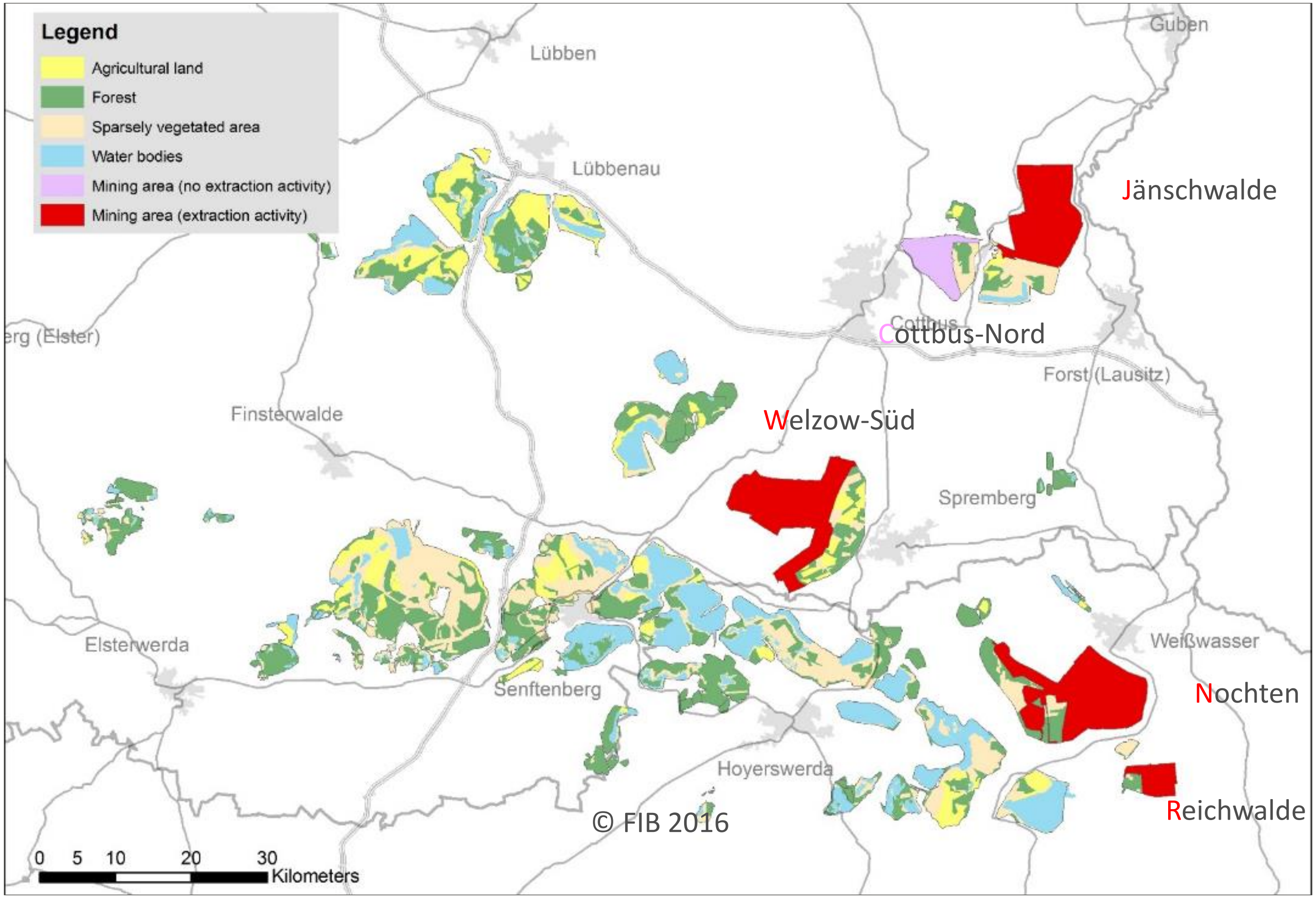
Eastern German Lignite district –
Land use distribution on reclamation sites



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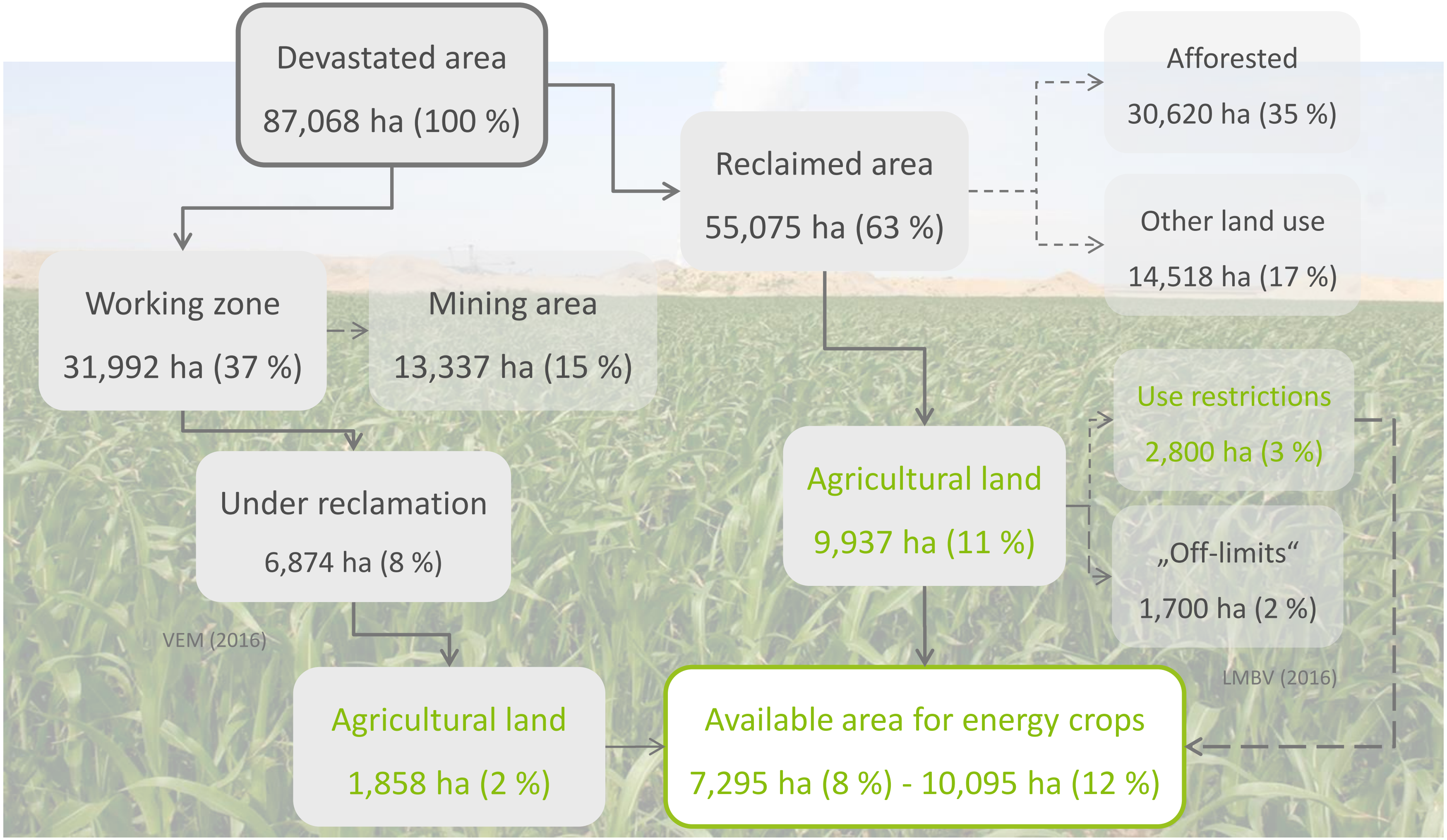
Production potential on lignite reclamation sites



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Vegetation aspects and soil dynamics

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Lucerne + *Sorghum* techno-economic feasibility

Scenario 1 Utilization of biomass in a **new biogas plant** for **biomethan 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

cultivation → harvest → transport → storage → conversion

silage

biogas

biomethane

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Lucerne + *Sorghum* crop rotation - costs & income

Costs		Million EUR/20 yr
investment	biogas plant for biomethane (3.1 MWel)	7.7
	upgrading installation (amine gas treating)	2.0
operating	10 % of investment per year	1.0
cultivation	Lucerne: 534 EUR/ha/yr; *Sorghum*: 751 EUR/ha/yr	37.7 + 36.5
total costs (new investment)		**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
total income		**85**

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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.

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

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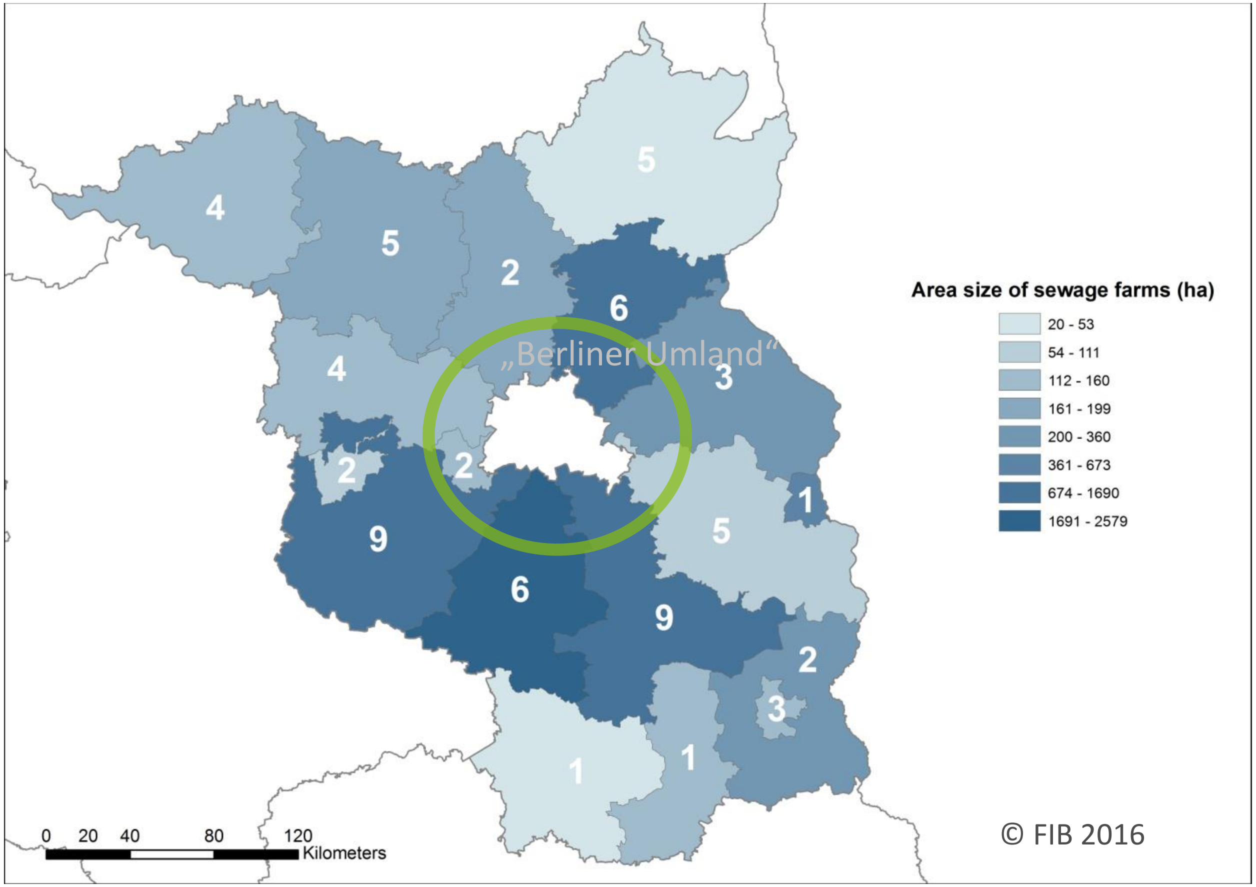
Disused irrigation fields for urban and industrial waste-water cleaning

Total area:

9,981 hectares

71 complexes

data source: Ritschel & Kratz (2000)



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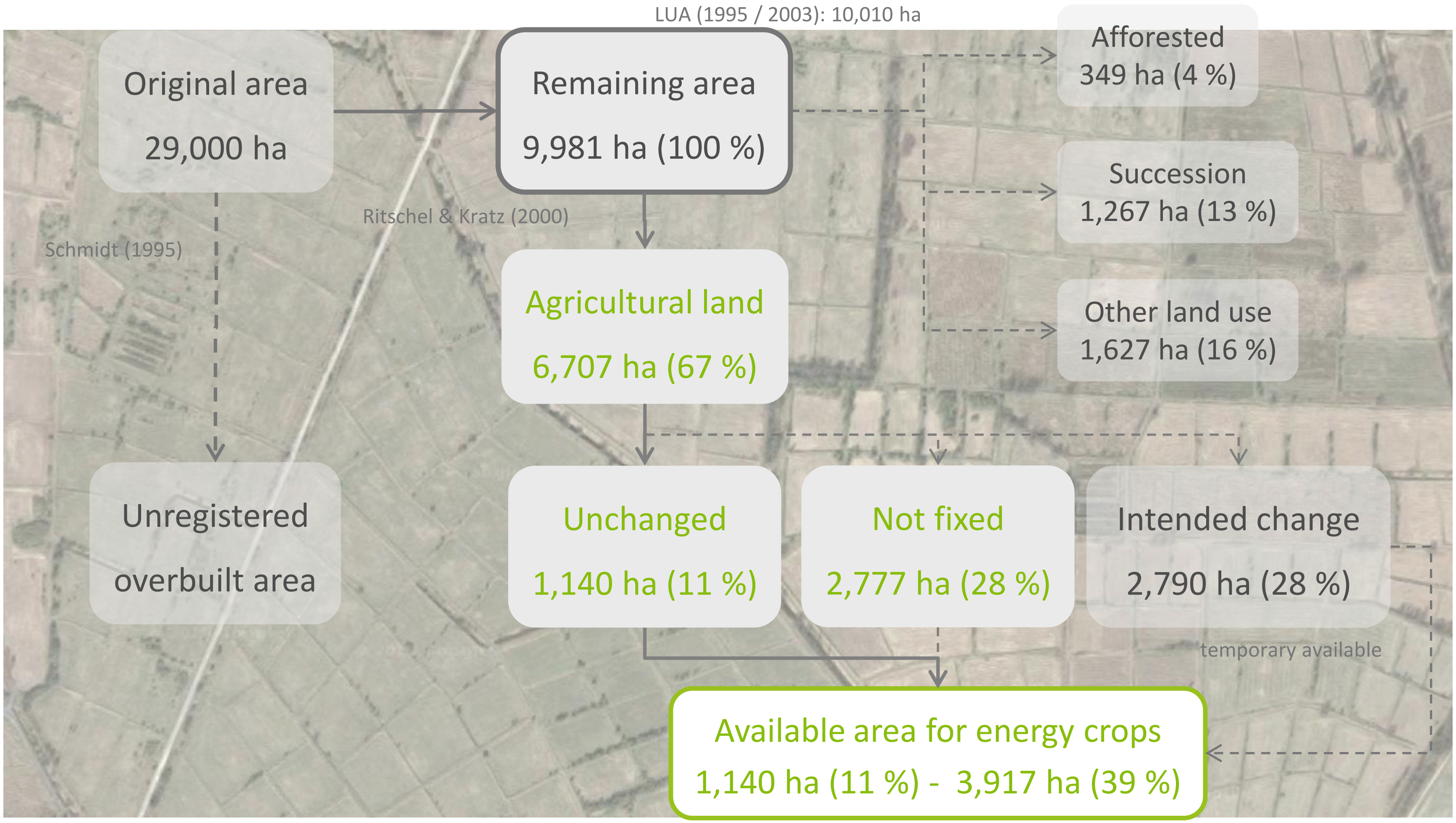
Land-use change and perspectives for energy cropping



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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

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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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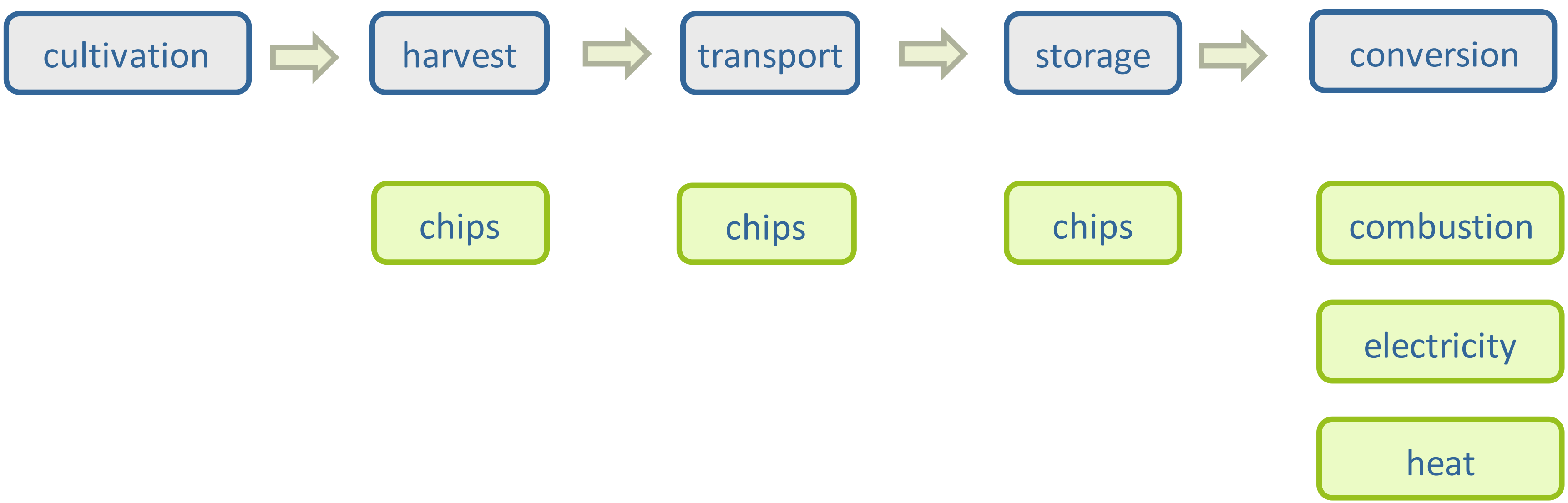

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Miscanthus - costs & income

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 *Miscanthus* chips (80 EUR/Mg_{DM})	**26.4**
Option 1.2	sale of *Miscanthus* 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**

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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

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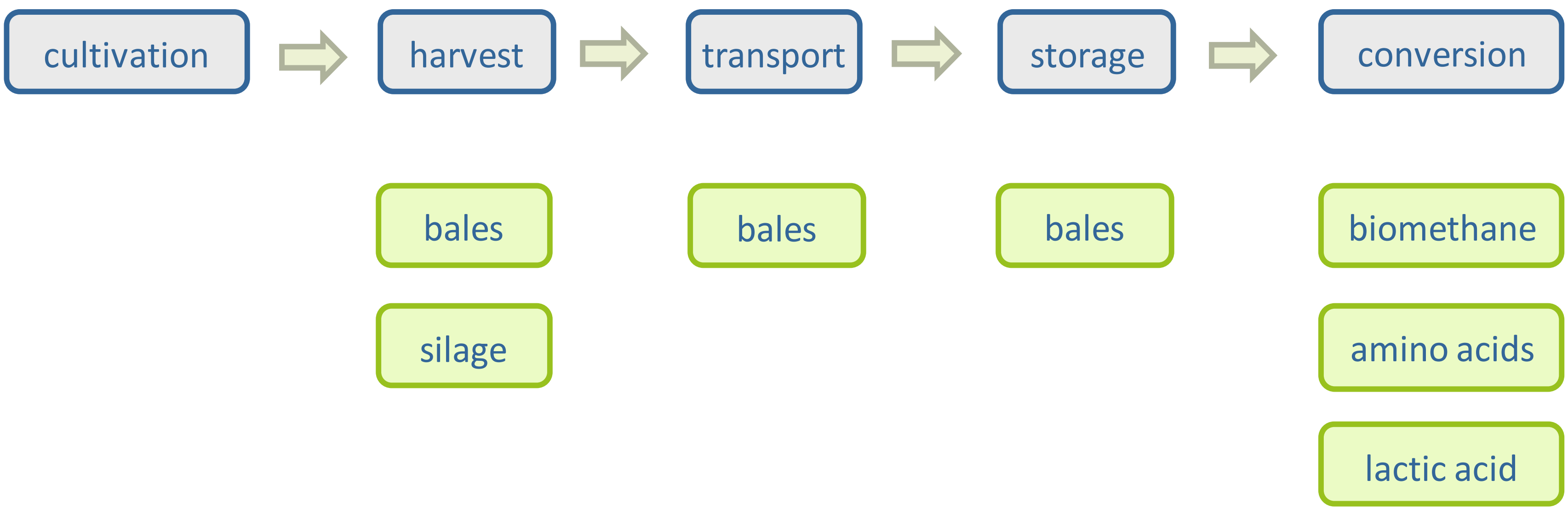

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Permanent grassland - costs & income

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**

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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.**

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Green is the 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.

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Thank you for taking your precious time & paying attention!

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