GOLD

Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production

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ΚΑΠΕ CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

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Context

GOLD aims to produce clean low-ILUC biofuels by growing selected high-yielding lignocellulosic crops on contaminated lands, and, in long-term, to return these lands back to the agricultural production.

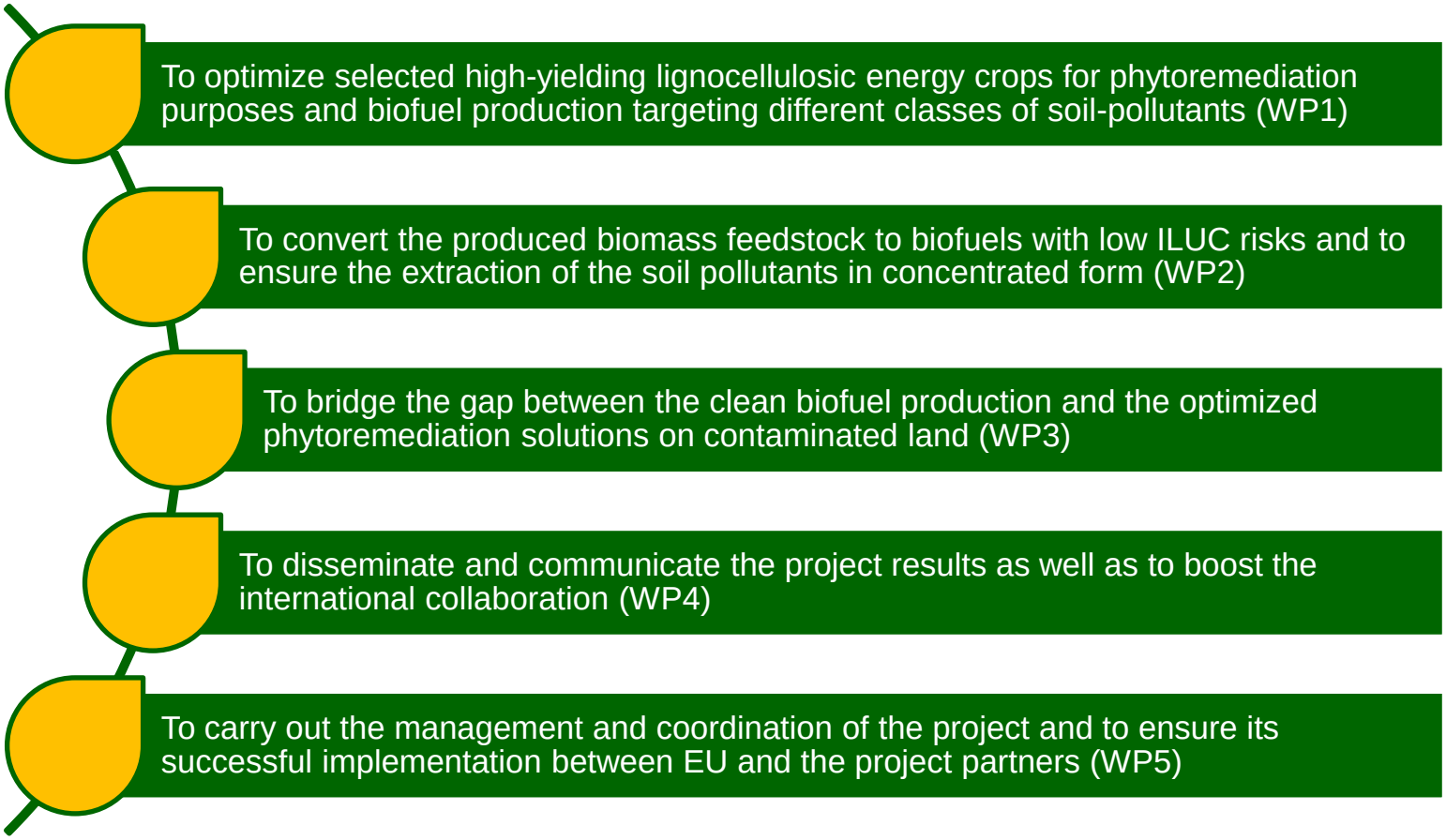
Contaminated lands polluted with organic and inorganic pollutants:

- Aproximately 2.5 million sites in Europe.
- Can not be used for food and feed production.
- Phytoremediation is a "green" and economic method of soil restoration.
- Energy crops are tolerant to pollutants, they can be cultivated to produce biofuels and decontaminate soils

Biofuels with low ILUC risks (RED II directive):

- Biofuels produced from energy crops cultivated on abandoned, unused and seriously degraded lands.
- A target of 14% for biofuels, bioliquids and biomass fuels with low ILUC risks have been set by 2030.
- Energy crops on contaminated land can provide feedstock for biofuels with low ILUC risks.

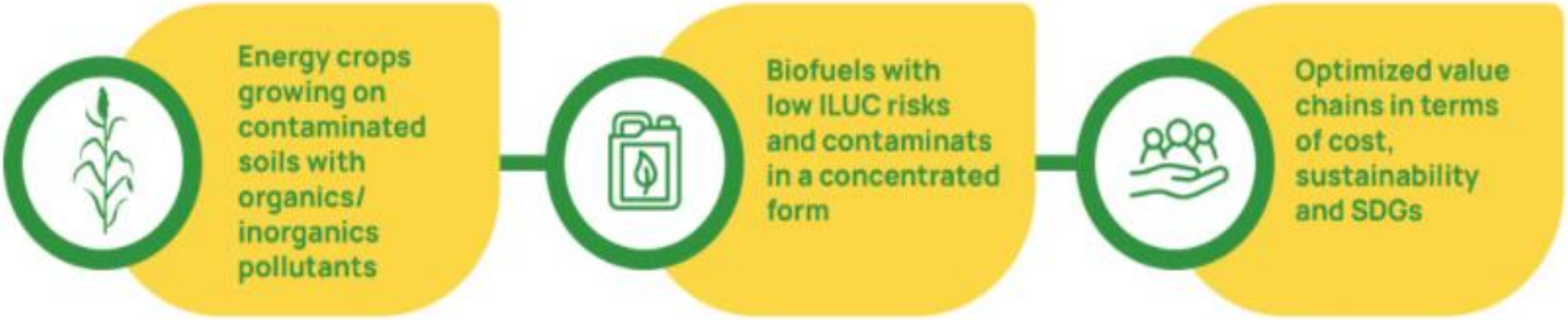
Specific Objectives



Approach

GOLD aims to grow selected high-yielding lignocellulosic energy crops on contaminated lands having two-fold purposes:

- produce feedstock for clean biofuels with low ILUC risks
- contribute to land decontamination by applying optimized phytoremediation solutions.



Four energy crops

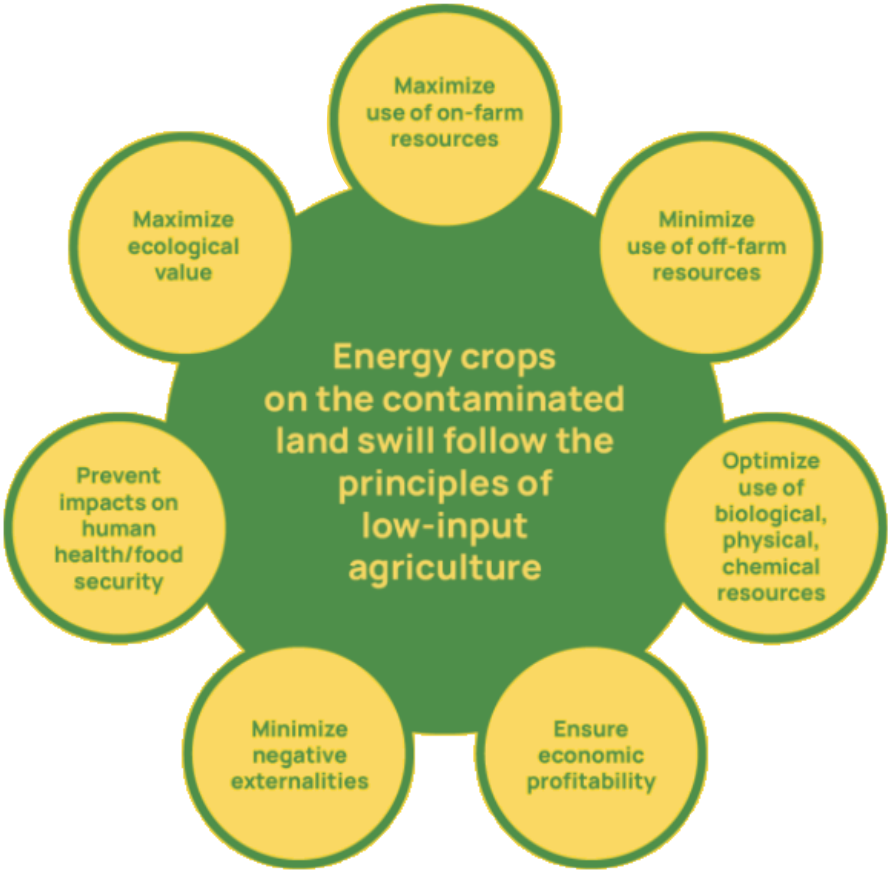
Two perennial grasses
(miscanthus and switchgrass)
and
two annual herbaceous
(sorghum and industrial hemp)

Industrial Hemp

Sorghum

Miscanthus

Switchgrass



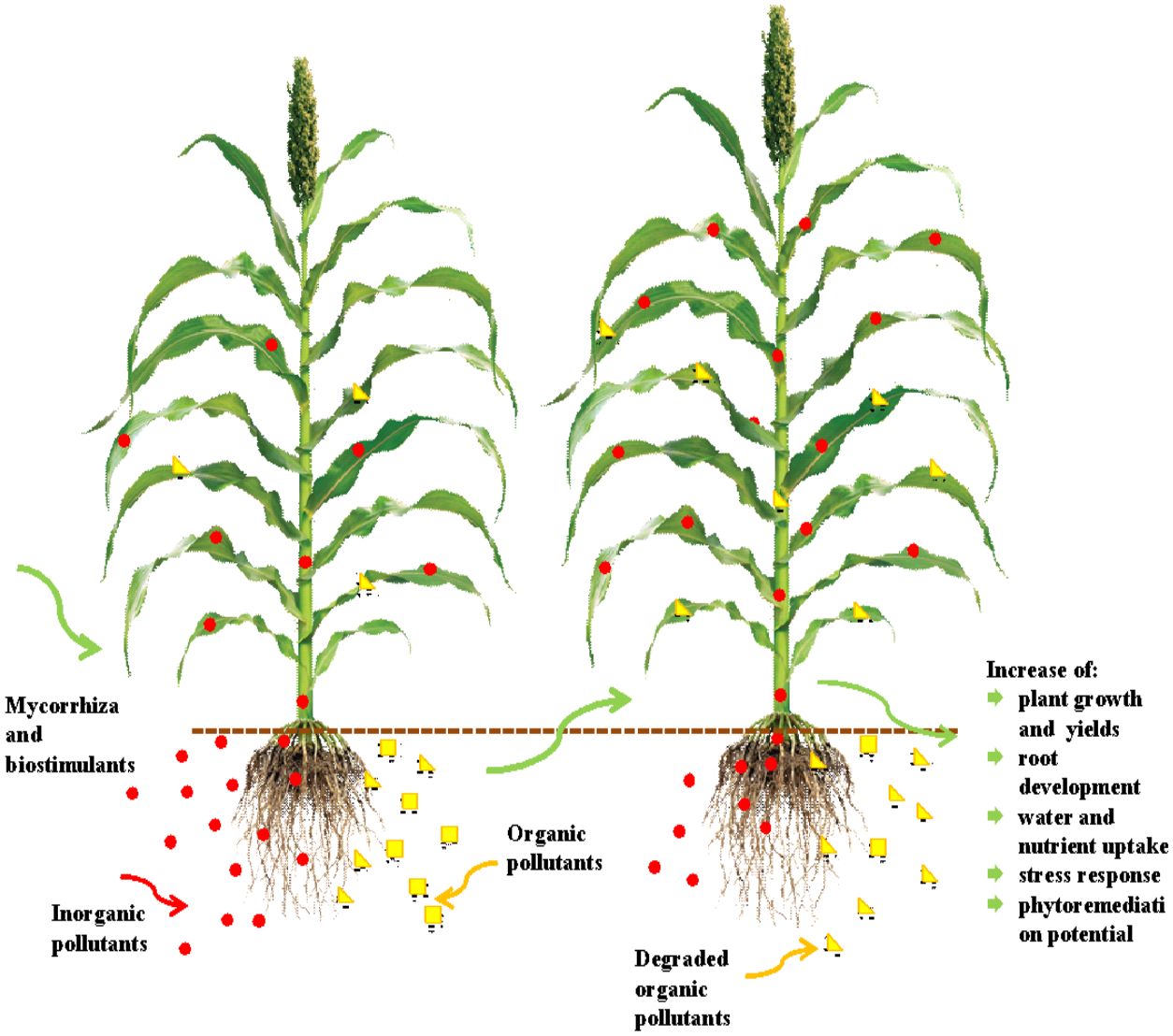
Proper agricultural management for successful phytoremediation

Special attention will be given to the applied agronomic management to support the plant establishment and growth under the stressing conditions of the contaminated sites taking into consideration the low-input concept .

Phytoremediation Strategies

Two phytoremediation strategies will be deployed in GOLD

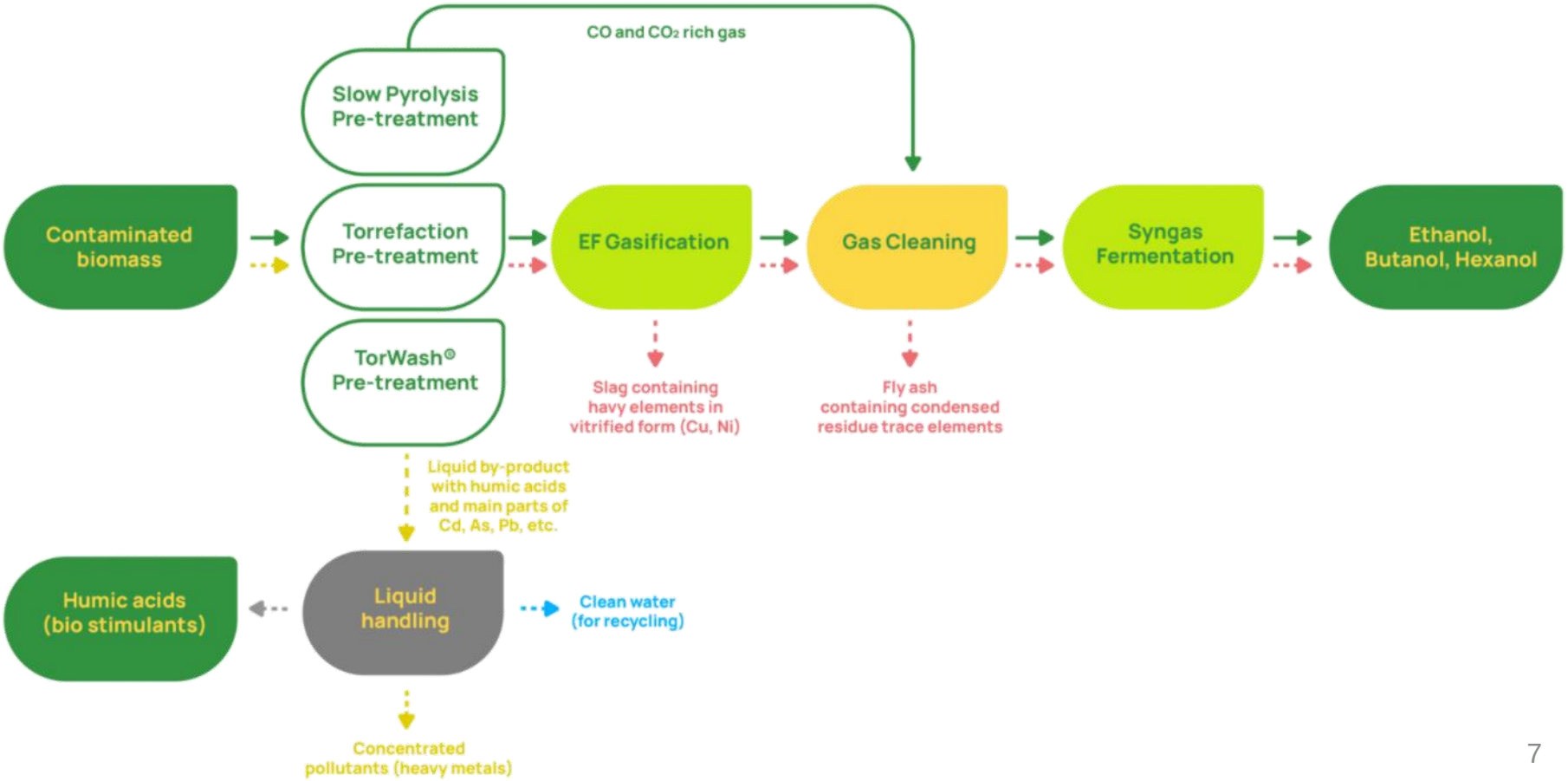
Bioaugmentation: indigenous or allochthonous microorganisms are applied to the polluted soils in order to accelerate the removal of inorganic contaminants or to effectively reduce the organic contaminant load by degrading and/or transforming it into less dangerous compounds (in collaboration with the energy crops).



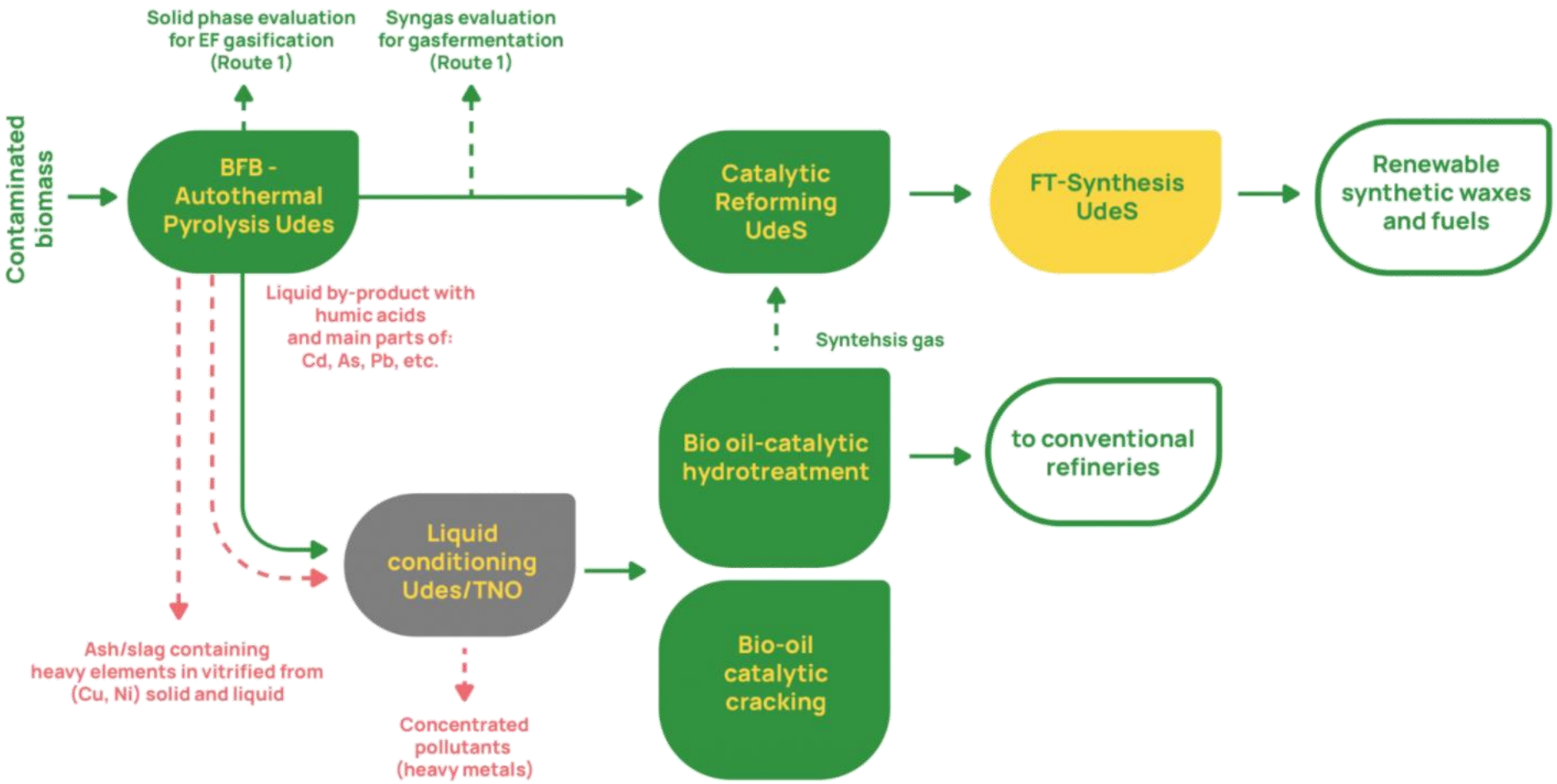
Phytoextraction: plants, capable of accumulating metal(loid)s, are grown on polluted sites and the metal(loid)-rich aboveground biomass is harvested on maturity. As a result, a fraction of the soil pollutants is removed.

Two conversion routes have been selected for the production of low ILUC risk biofuels

1st Conversion Route – High Temperature Entrained Flow Gasification



2nd Conversion Route – Autothermal Biomass Pyrolysis

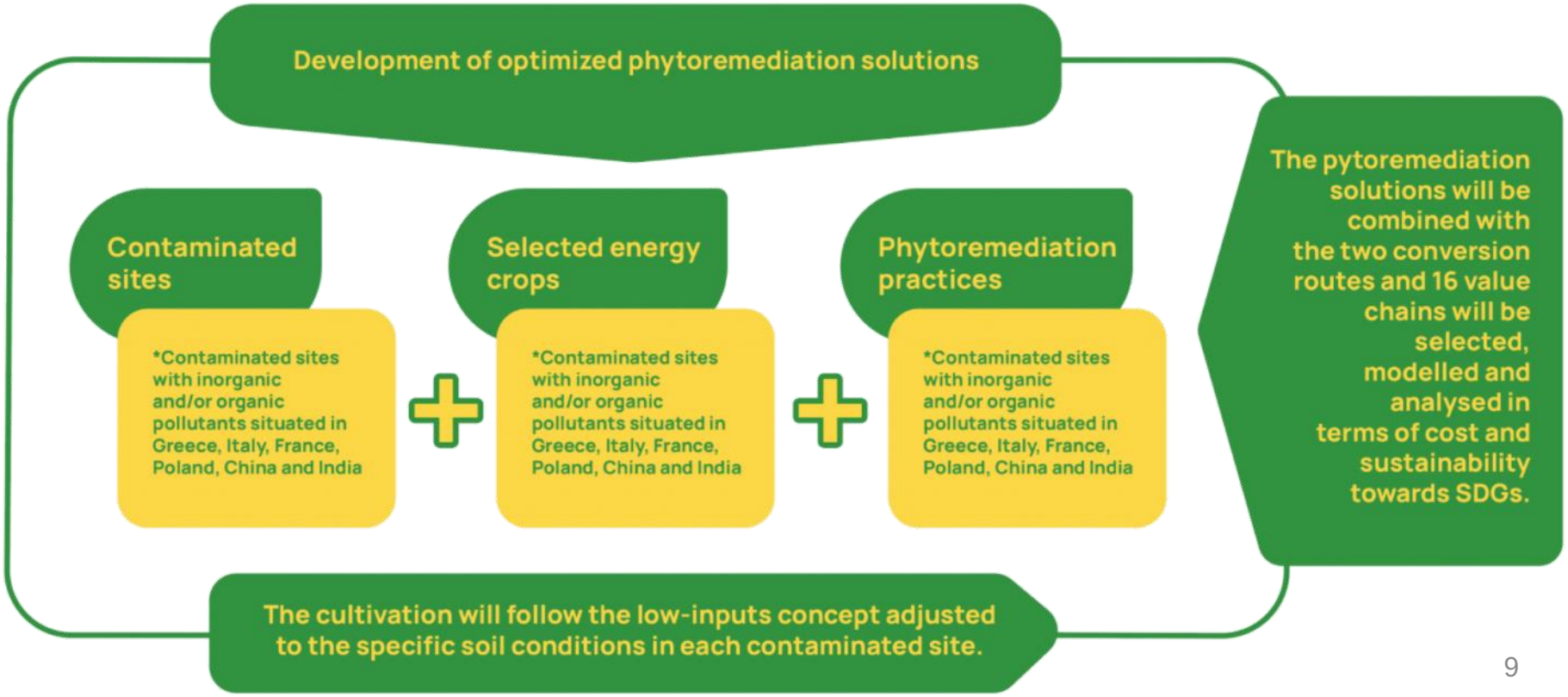


Value Chains Optimization

In GOLD, 44 phytoremediation solutions will be developed by combining different contaminated sites, energy crops, phytoremediation practices, and then evaluated.

The best performing phytoremediation solutions will be tested for replication in other sites, then combined with the two conversion routes developed in GOLD.

16 value chains (4 per energy crop) will be selected, modelled and analyzed in terms of cost and sustainability through an integrated sustainability assessment.

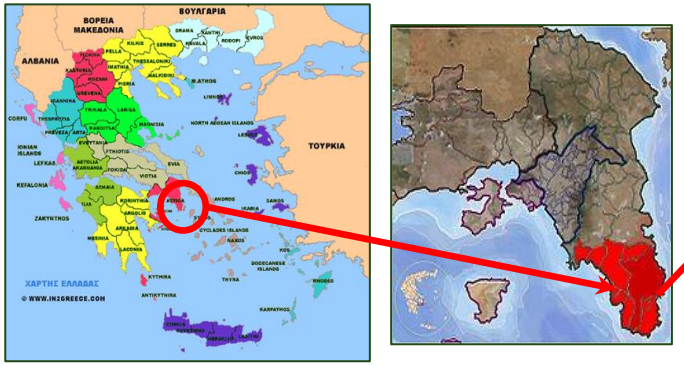


Pilot Sites

The selected pilot sites cover a vast variety of contaminants, namely heavy metals, metalloids and organic compounds. Moreover, the sites represent different types of soil.

Experimental fields in GREECE (two sites)

1st site: in Lavreotiki peninsula (AUA)



A long-term multi-metal contaminated site due to ancient (3000-200 B.C.) and more recent (1864-1982 A.D.) mining and metallurgical activities.

Common values	0.5-2.5		1-3		30-75		5-120		50-300		150-300		0.1-1	
Total Concentration (mg/kg)	**As**		**Cd**		**Ni**		**Cu**		**Pb**		**Zn**		**Sb**	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
	338	**590**	**13,7**	**25**	182	172	101	138	**8509**	**10797**	**2597**	**4959**	**74**	**92**

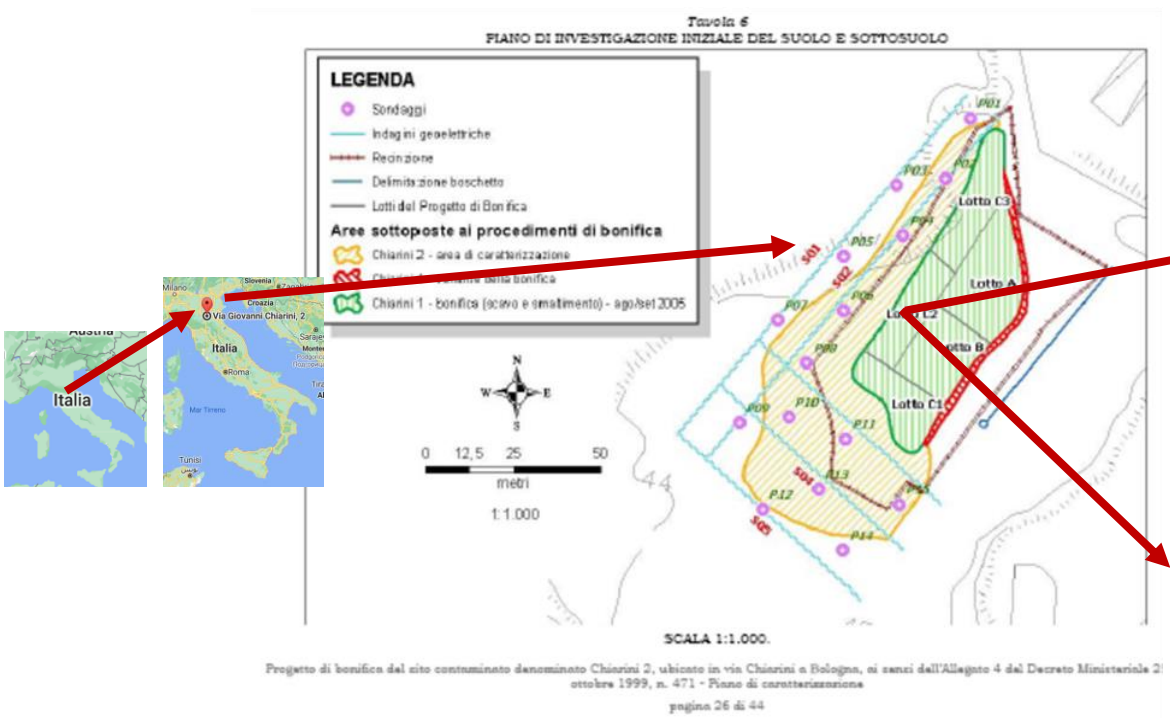
2nd site: in Kozani (CRES & METE)

POTENTIAL CONTAMINANTS					
Heavy metal(loids)					Traces of:
As	Cr	Ni	Pb		Heavy fuel oils

Site located nearby a lignite mining area polluted with ash containing several contaminants.

Experimental field in ITALY

3rd site: N. Italy, Chiarini 2, (UNIBO)

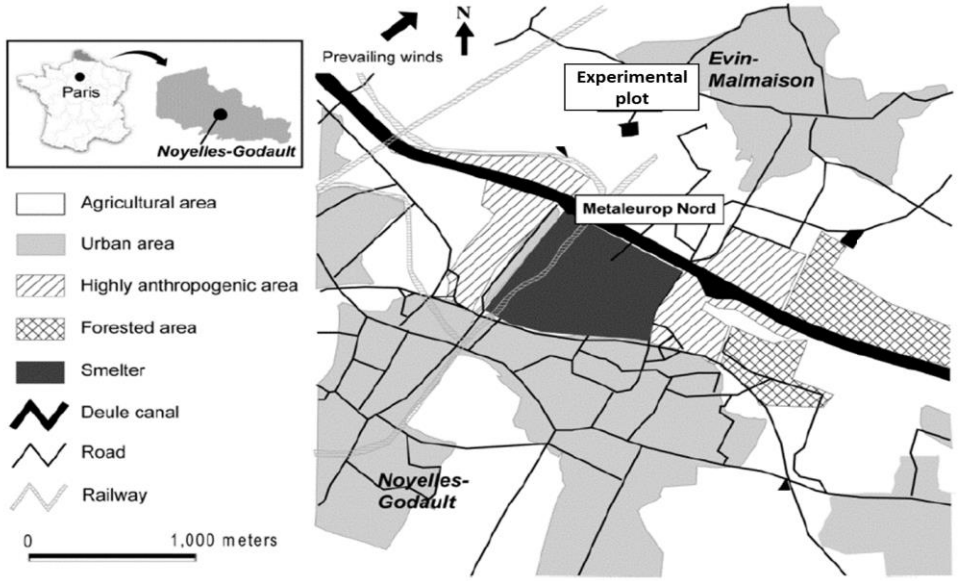


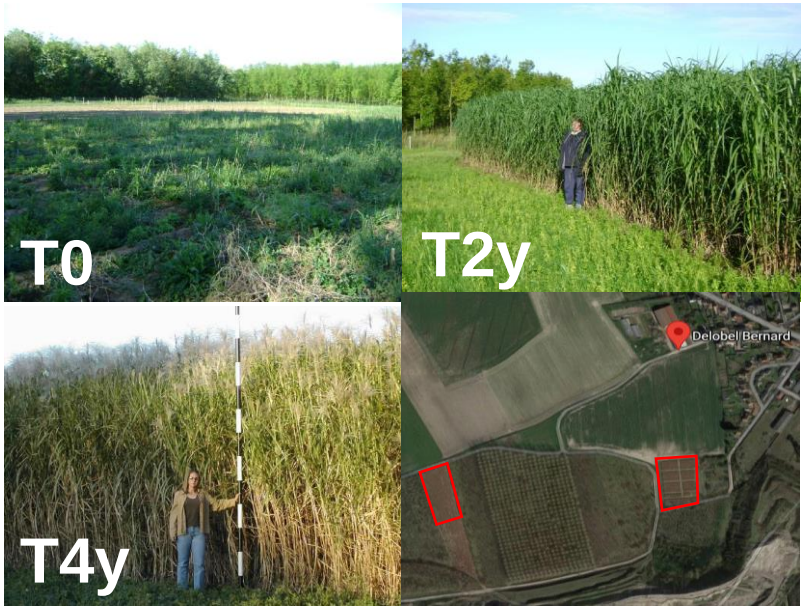
A contaminated site due to dumping of industrial waste.

Potential contaminats	Heavy metals					Traces of:	
	Cd	Ni	Pb	Cu	Zn	Polychlorinated biphenyls	Heavy fuel oils

Experimental field in FRANCE

4th site: Évin-Malmaison (YNCREA)



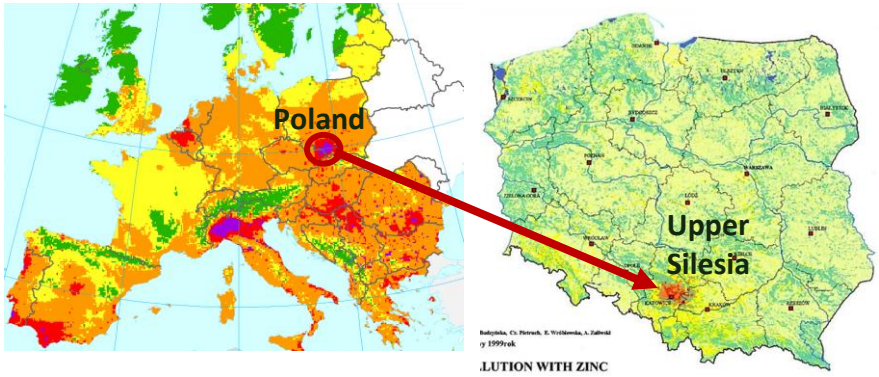


A site contaminated mostly by Cd, Pb and Zn due to the former smelter plant METALEUROP Nord (1894 to 2003) located 300m north of the field.

Control plot	0.3 ± 0.1	37.3 ± 1.3	54.6 ± 3.1	6.4	0.4	20.8	69.5	9.7
Experimental plot	**Tot Cd** (mg kg^{-1})	**Tot Pb** (mg kg^{-1})	**Tot Zn** (mg kg^{-1})	**pH**	**$CaCO_3$** (g Kg^{-1})	**Clay** (%)	**Silt** (%)	**Sand** (%)
	13.5 ± 0.3	**747.1 ± 16.9**	**906.0 ± 16.8**	7.3	5.4	19.2	56.0	24.8

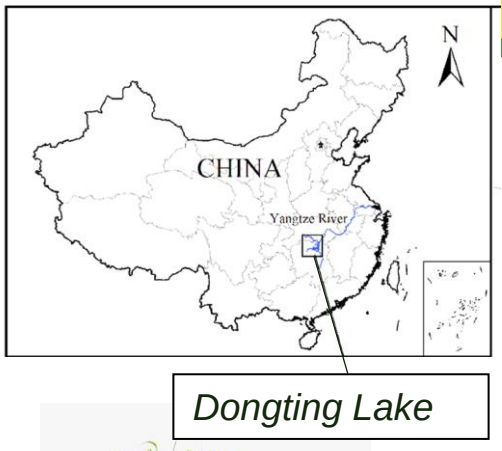
Experimental field in POLAND

5th site: Region of Upper Silesia (UMCS)



A long-term multi-metal contaminated site due to mining and metallurgical activities (dating back to 19 century) (**excessive concentrations of Pb, Zn, Cu, Cd**) and due to chemical industry – activity of former Jaworzno Organika Azot plant (since 1921) (considerable pollution with **persistent organic pollutants, including pesticides and their intermediates: HCH, DDT, DDE, DDD, dieldrin, endrin, organic solvents**).

Experimental fields in CHINA (two sites)



6th site: Hunan Agricultural University

- China has the largest miscanthus growing area (approx. 100,000 ha)
- *M. lutarioriparia* is dominant spp growing wildly around Dongting lake
- Dominant contaminant is Cd
- *M. lutarioriparius* exhibits a great potential as a phytoremediation plant

Site	pH	Conductivity (µs cm^{-1})	TN (g kg^{-1})	TP (g kg^{-1})	TK (g kg^{-1})	SOM (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	**Cd (mg kg^{-1})**	Cr (mg kg^{-1})	Pb (mg kg^{-1})
S1	7.24±0.13	498.50±20.8	0.92±0.03	0.77±0.03	11.29±0.61	25.14±0.11	38.70±2.80	513.25±26.99	233.06±8.14	**9.25±0.40**	100.07±1.33	98.40±6.08
S2	6.53±0.16	259.62±23.6	0.64±0.09	0.38±0.03	8.63±0.80	22.30±1.66	28.73±2.83	319.48±12.59	164.43±13.69	**6.06±1.82**	63.44±0.85	113.46±16.15

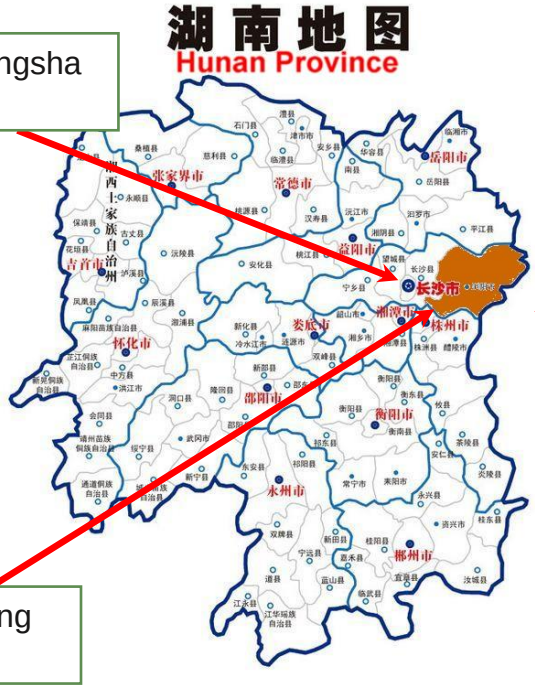
7th site: The experimental field of IBFC

The experimental field of IBFC at Liuyang City

The experimental greenhouse of IBFC at Changsha City

Changsha City

Liuyang City



Cd and As content of contaminated site at Liuyang City: Cd content is 0.988—6.71mg/kg, As content is20.3 –340mg/kg.

Specific Impacts

Three main impacts will be jointly generated by the outcomes of GOLD:

- Create a win-win situation by bringing polluted land back to agricultural production through cost reduction and improved phytoremediation
- Produce clean biofuels with low ILUC risks from selected energy crops grown on contaminated lands
- Promote the international collaboration towards the Mission Innovation Challenge 4 on advanced biofuels

Contribution to the SDGs

Through the developed optimized phytoremediation strategies and solutions, GOLD will contribute to several Sustainable Development Goals.

Partners

The consortium consists of 19 partners (4 non-EU) that are experts on phytoremediation, on energy crops and on conversion processes.

The Consortium

GOLD

Thank you!

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