Optimal Plant Locations and Sizes for straw based BtL- plants in Austria, using a spatially explicit mixed integer programming model

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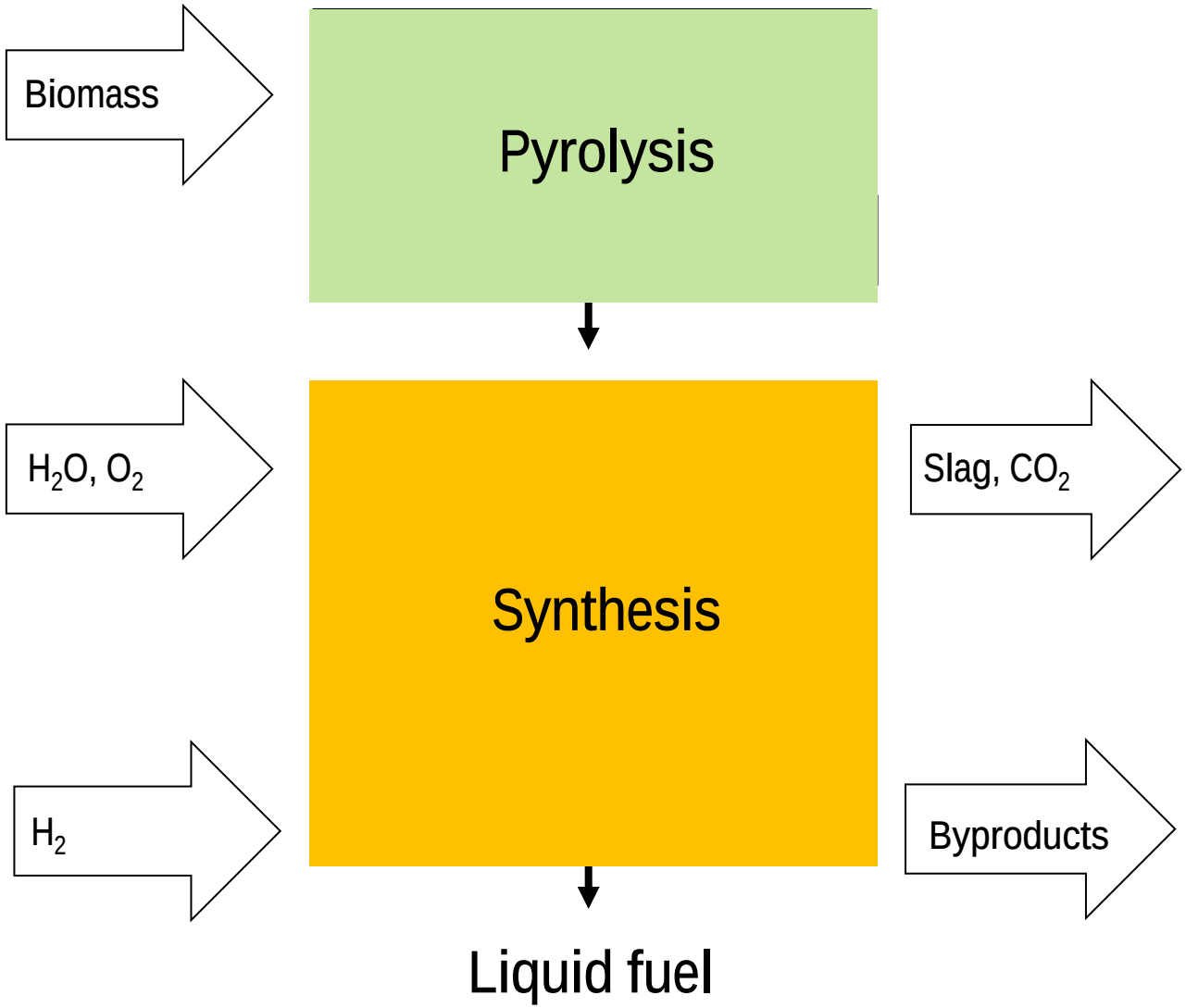
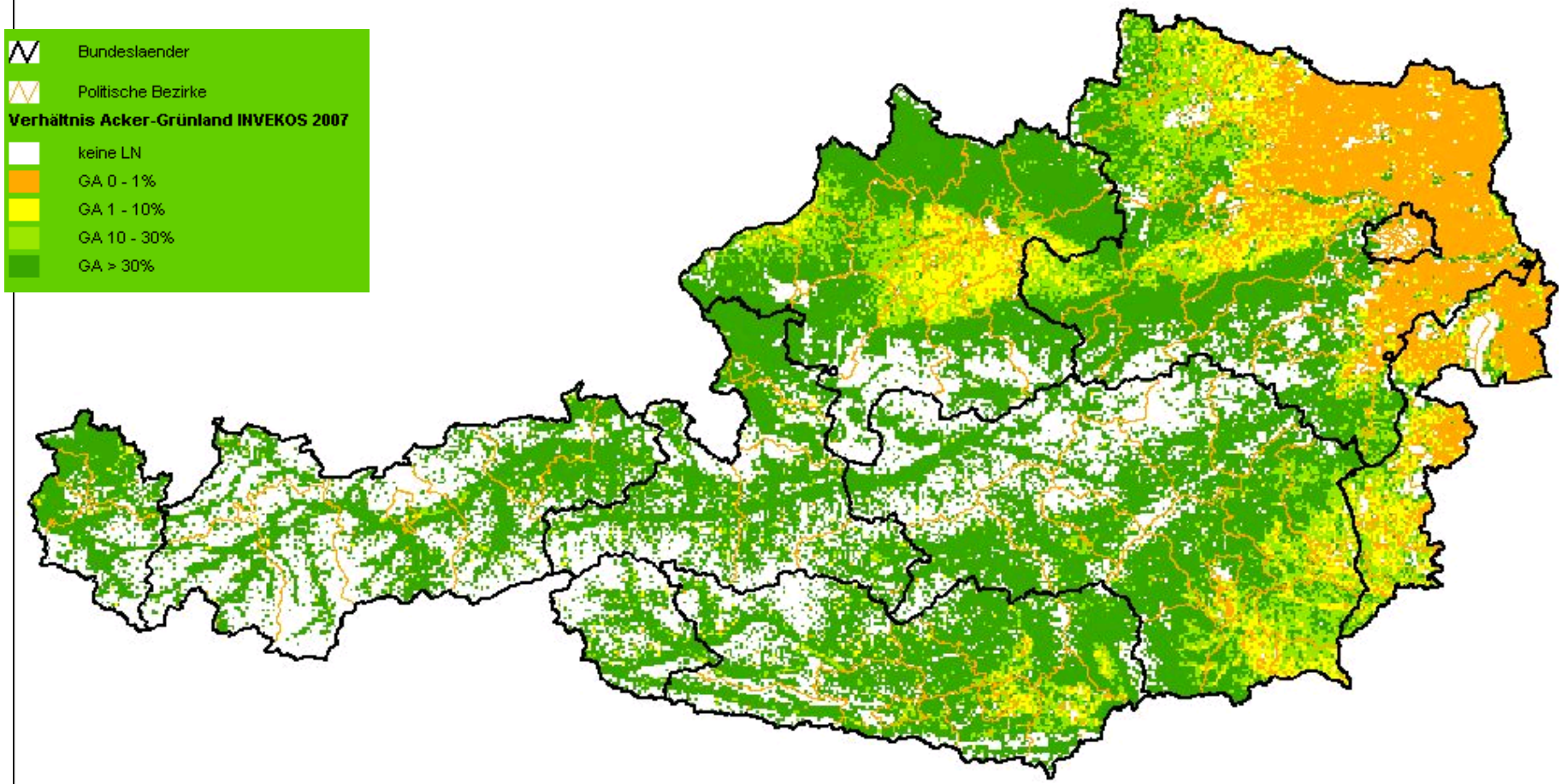
Tobias Moser
Martin Kapfer
Stefan Kirchweger
Jochen Kantelhardt

Institute of Agricultural and Forestry Economics
University of Natural Resources and Life Sciences
Vienna

Basics of BtL- production



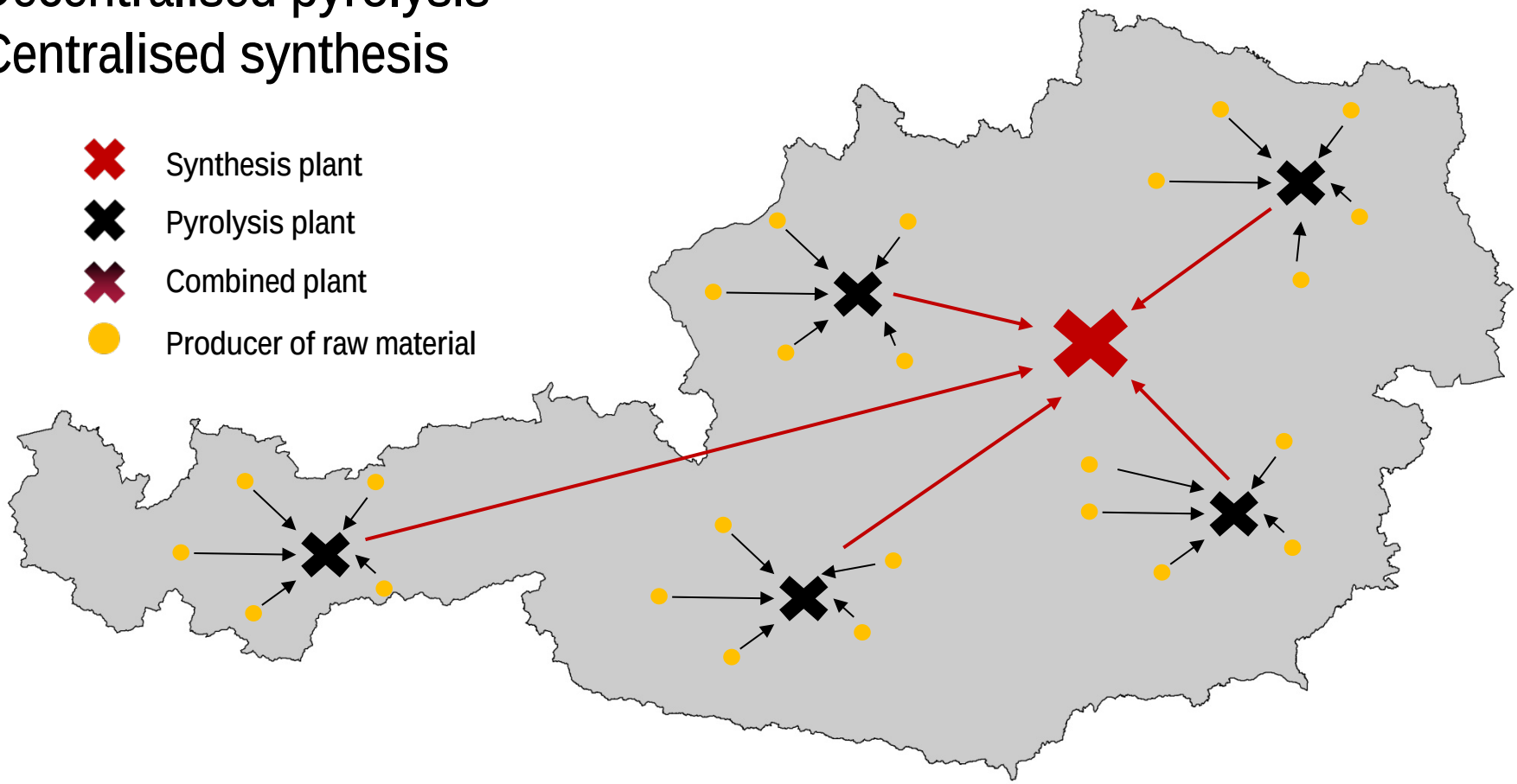
Arable land and grassland on Austrian agricultural area



Source: BMLFUW, LFRZ, 2009

Potential concepts for BtL- systems in Austria

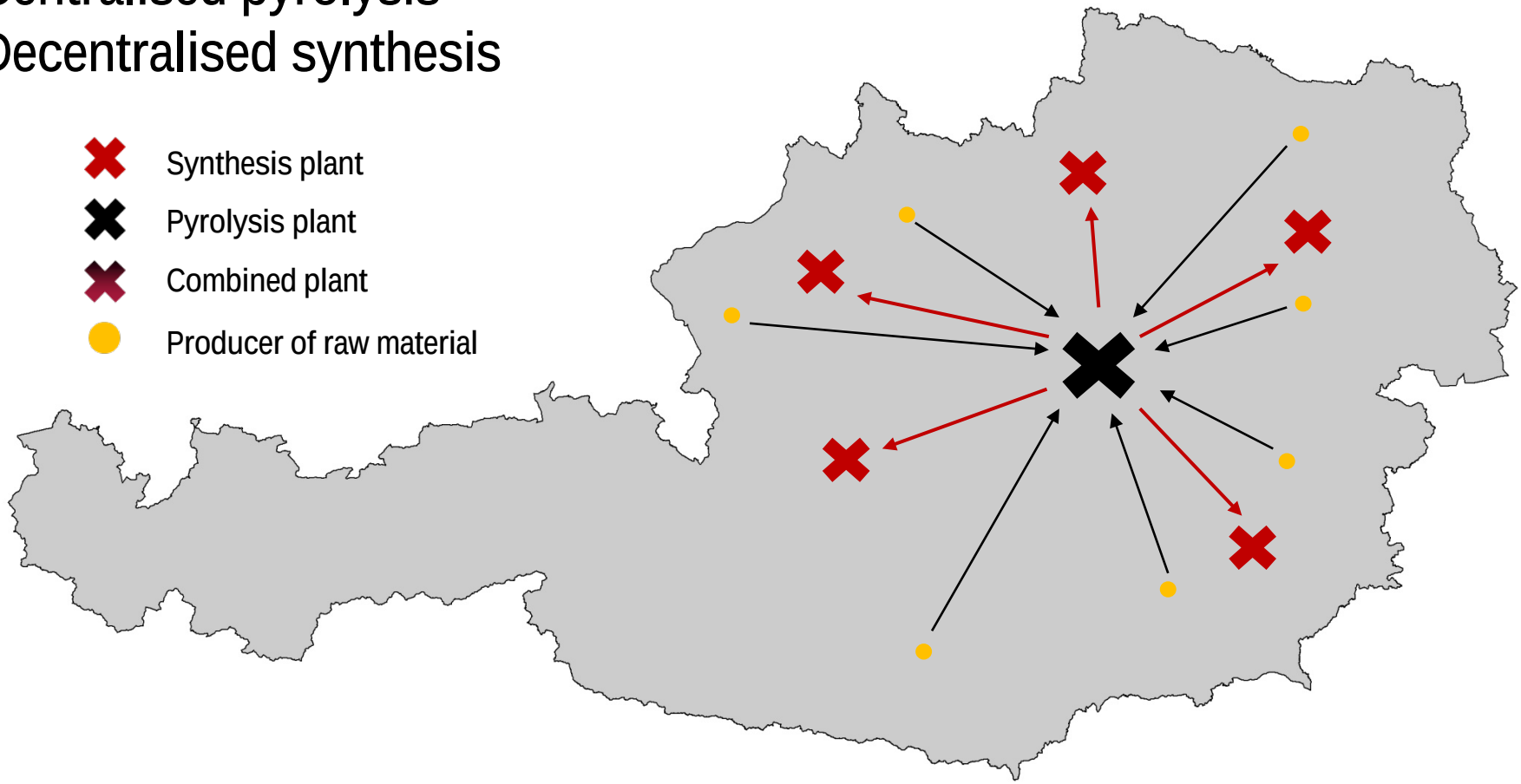
Decentralised pyrolysis –
Centralised synthesis



Source: Own illustration

Potential concepts for BtL- systems in Austria

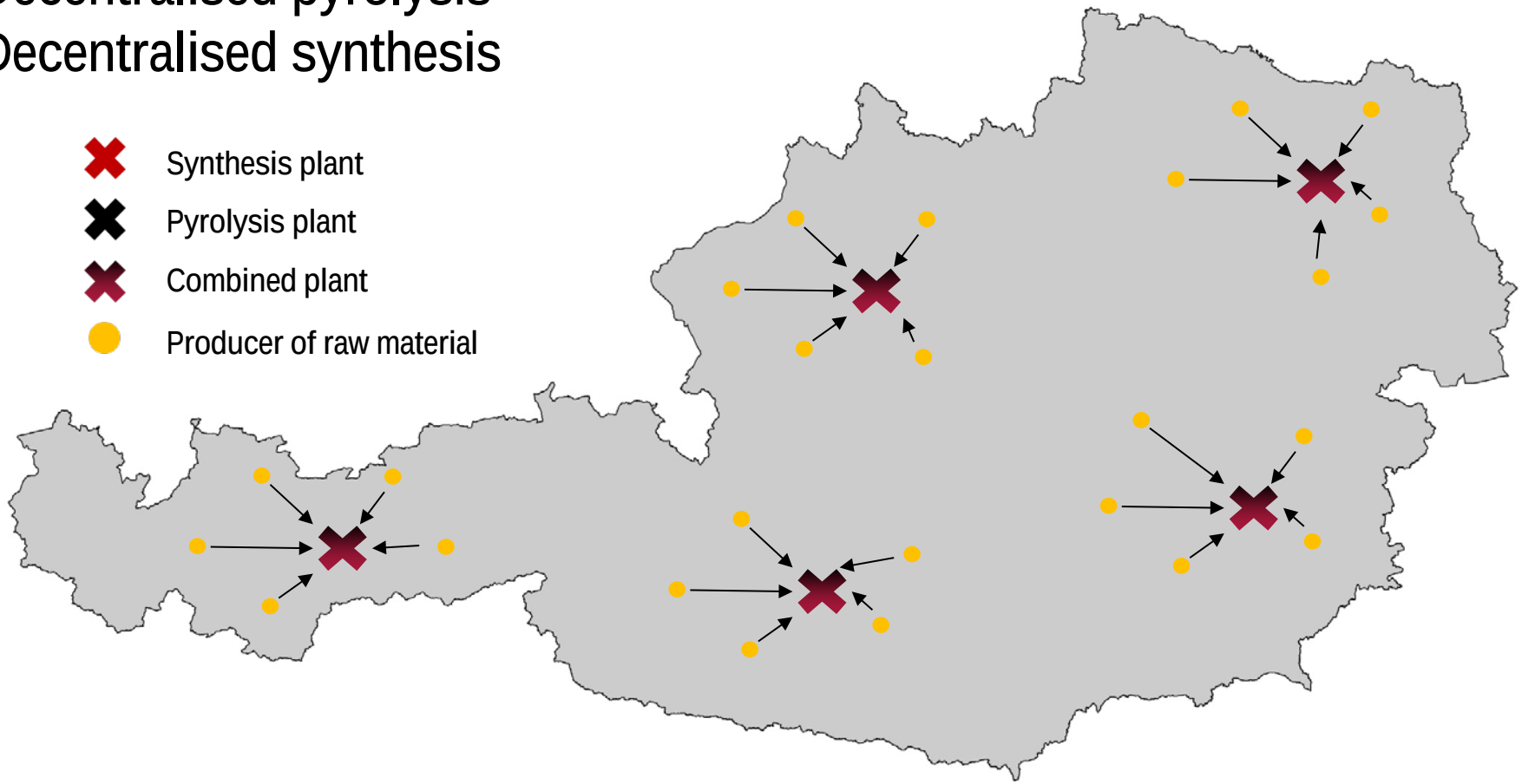
Centralised pyrolysis –
Decentralised synthesis



Source: Own illustration

Potential concepts for BtL- systems in Austria

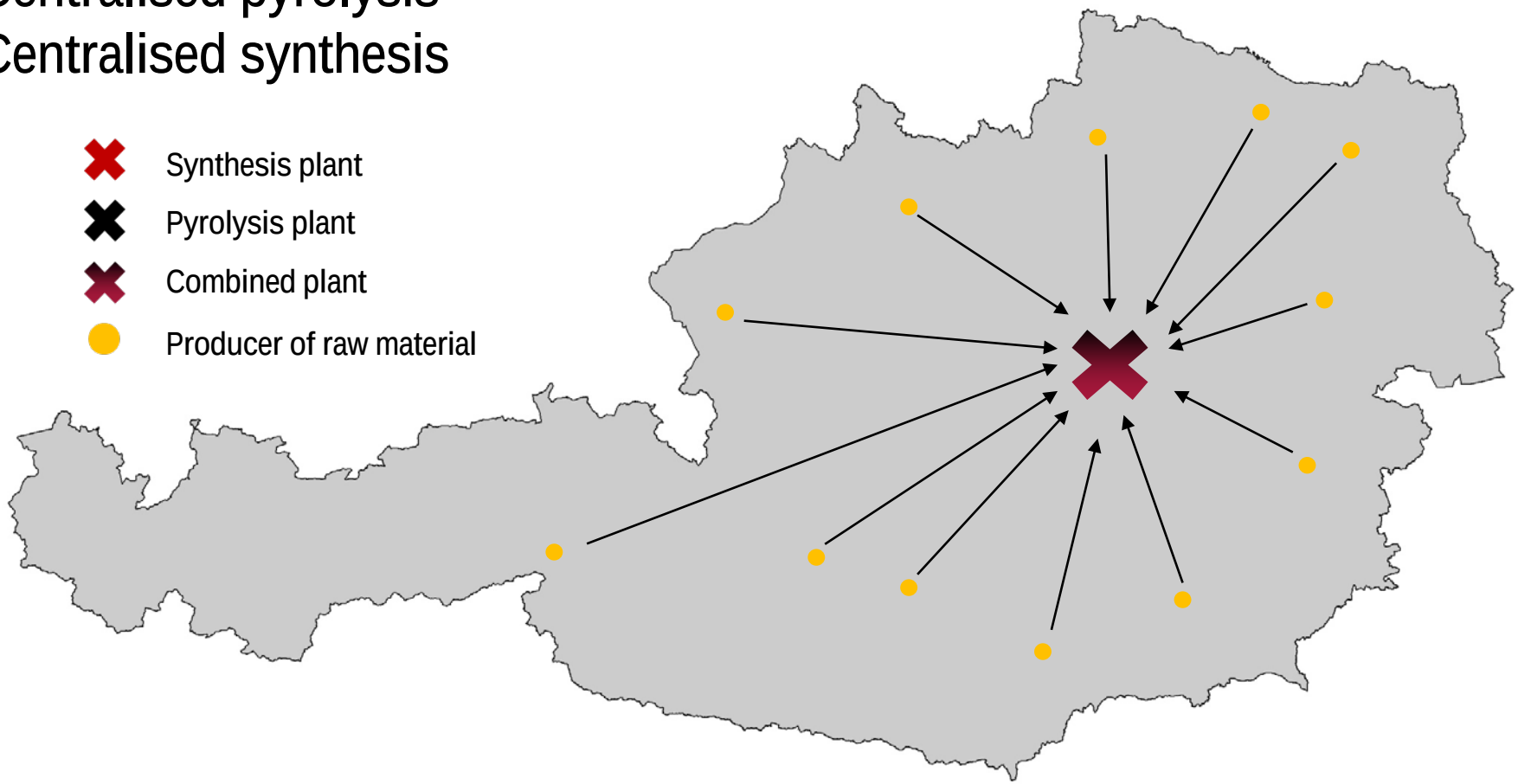
Decentralised pyrolysis – Decentralised synthesis



Source: Own illustration

Potential concepts for BtL- systems in Austria

Centralised pyrolysis – Centralised synthesis

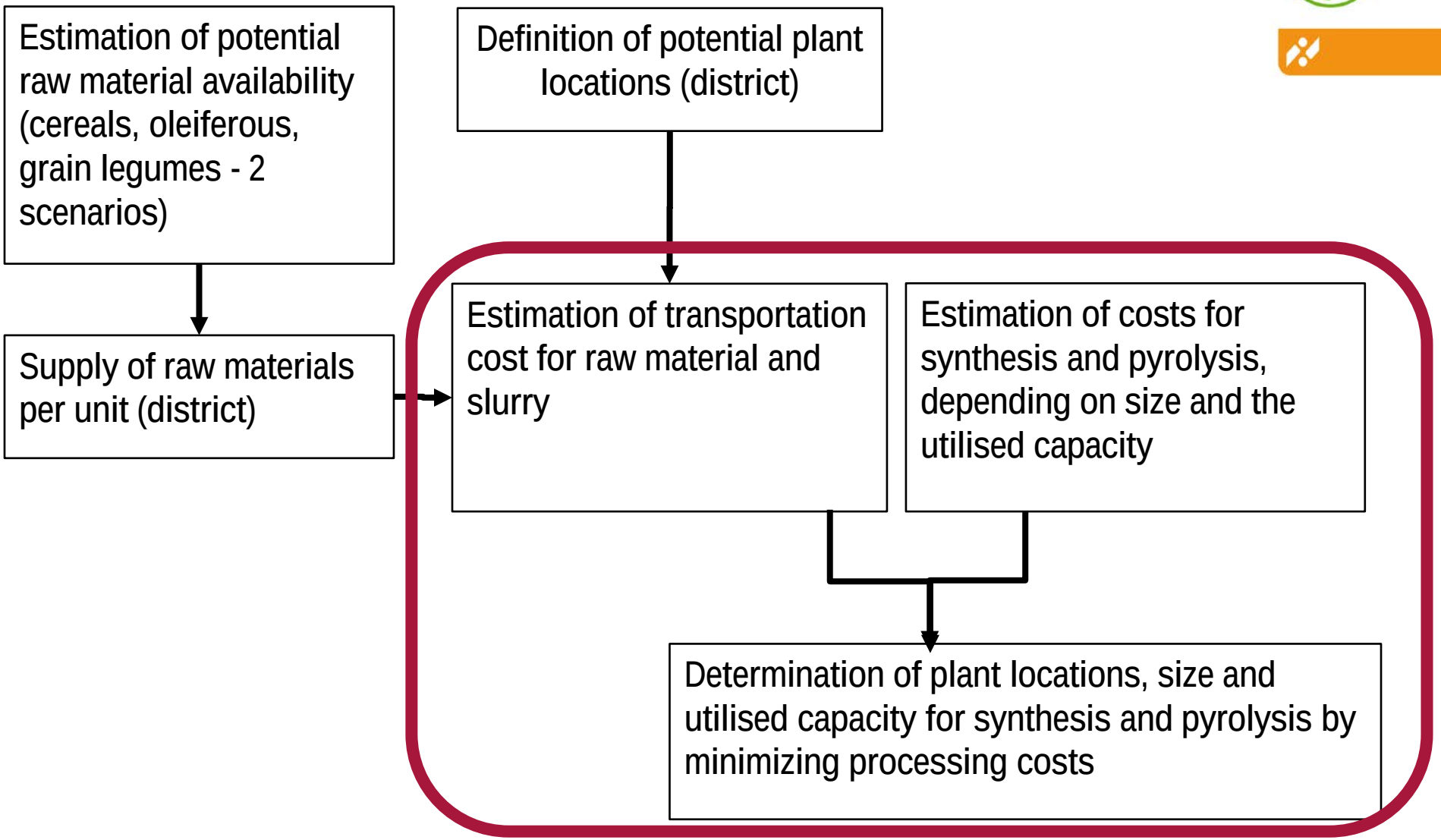


Source: Own illustration

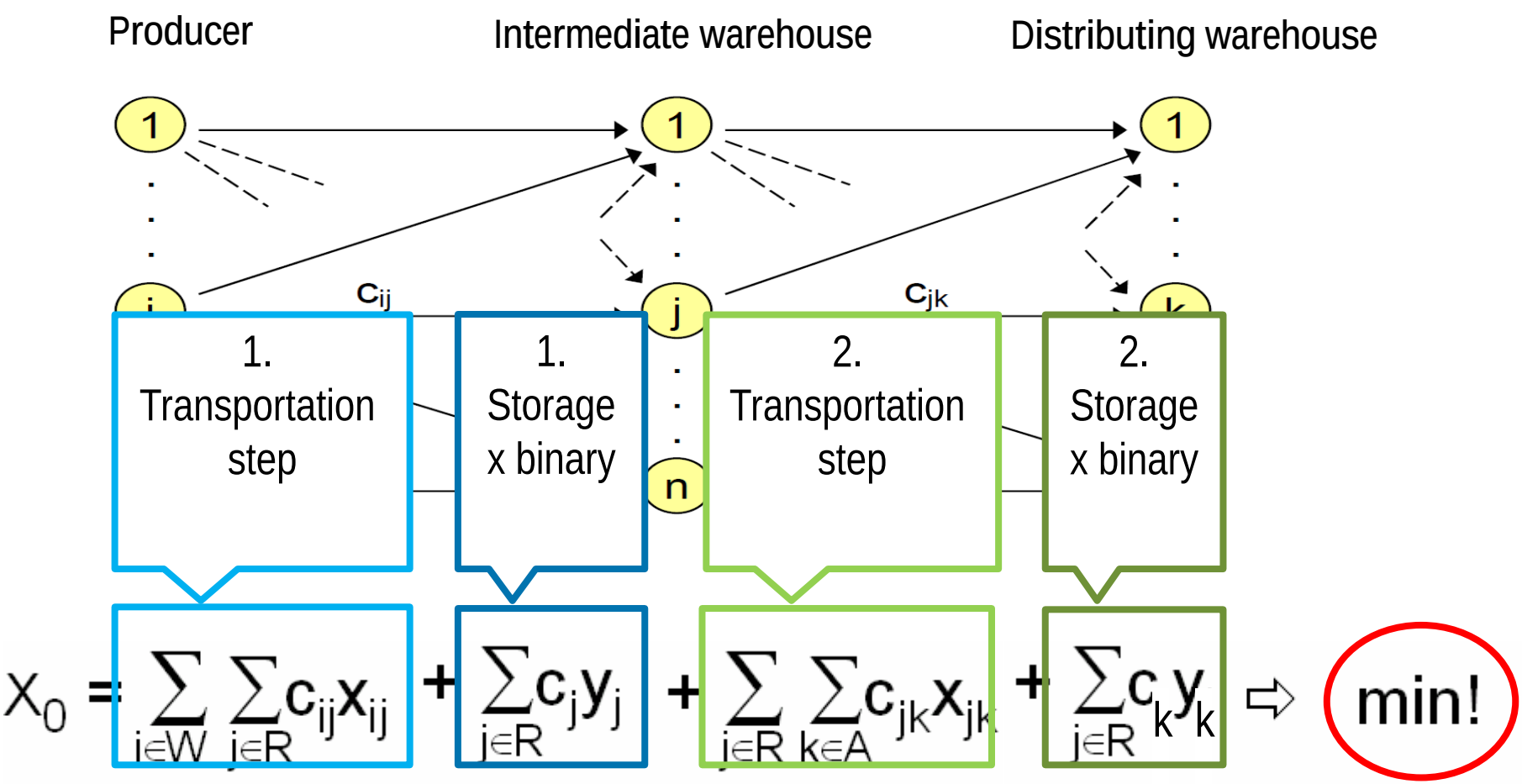
Research questions

- Which concept of BtL-production minimizes processing costs?
- What is the location and capacity of pyrolysis and synthesis plants?

The Model

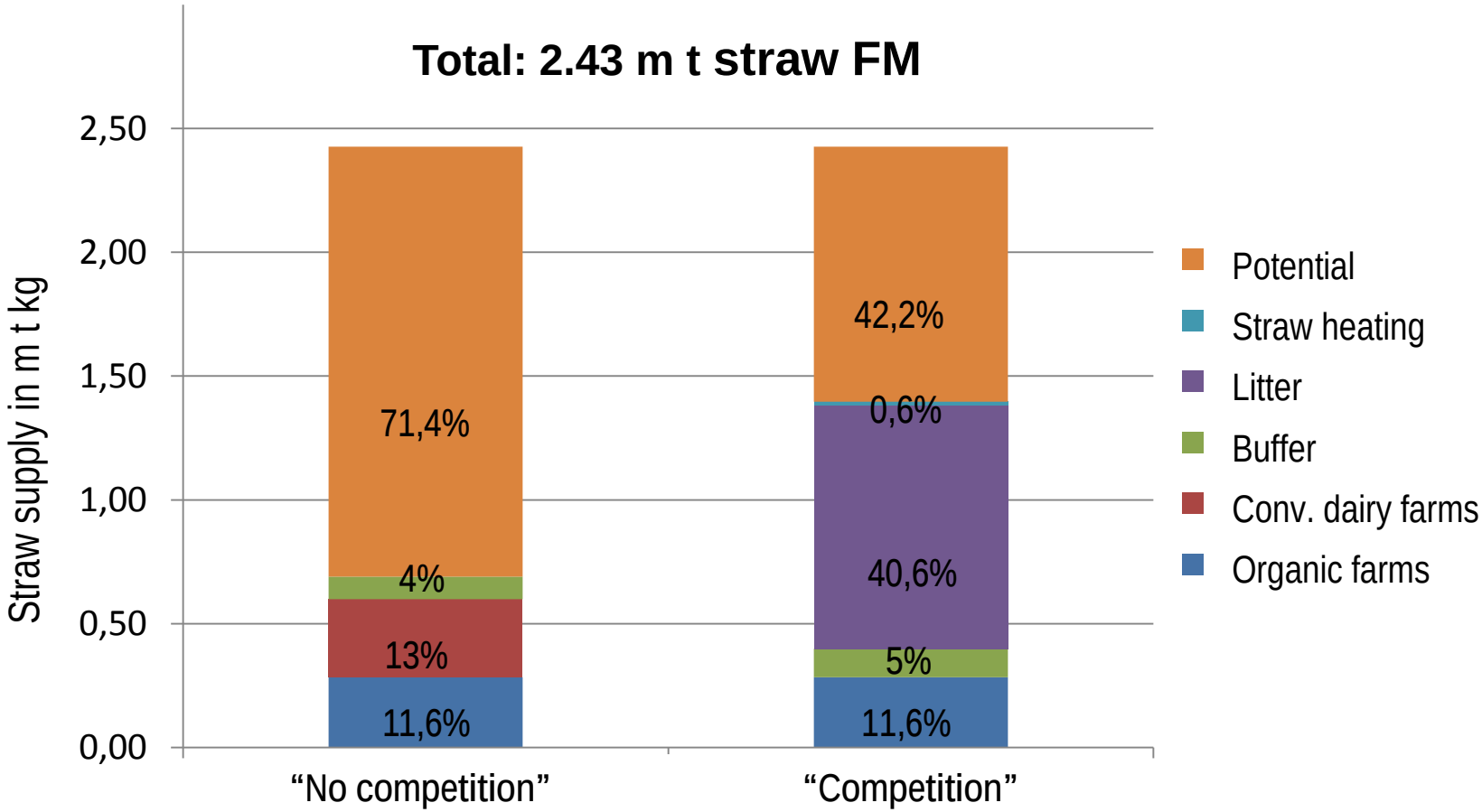

Estimation of potential raw material availability (cereals, oleiferous, grain legumes - 2 scenarios)
Definition of potential plant locations (district)
Supply of raw materials per unit (district)
Estimation of transportation cost for raw material and slurry
Estimation of costs for synthesis and pyrolysis, depending on size and the utilised capacity
Determination of plant locations, size and utilised capacity for synthesis and pyrolysis by minimizing processing costs

Two step warehouse-location-model



Source: Own illustration according to Wäscher, 1998

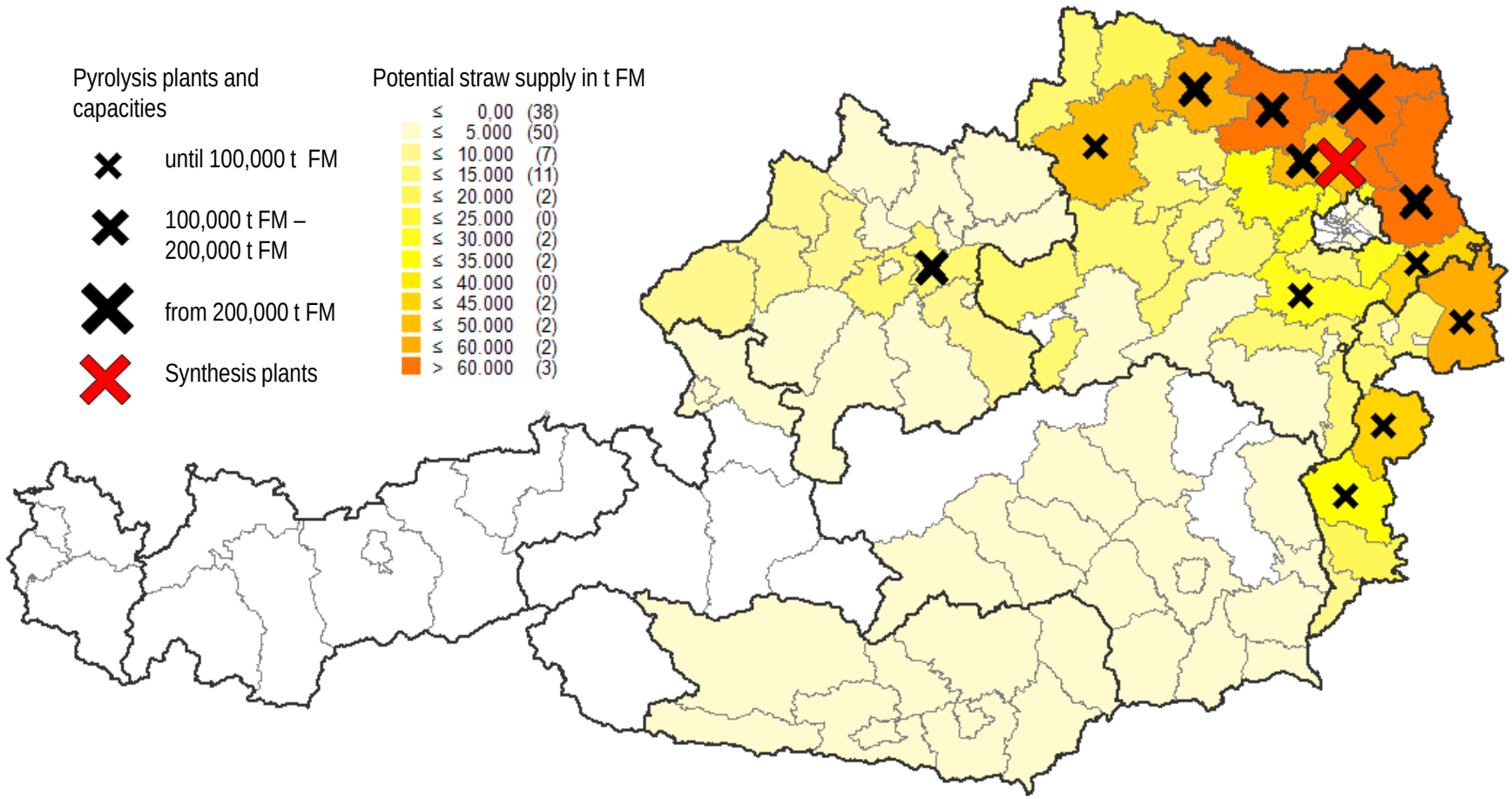
Potential straw supply in Austria



Source: Own illustration

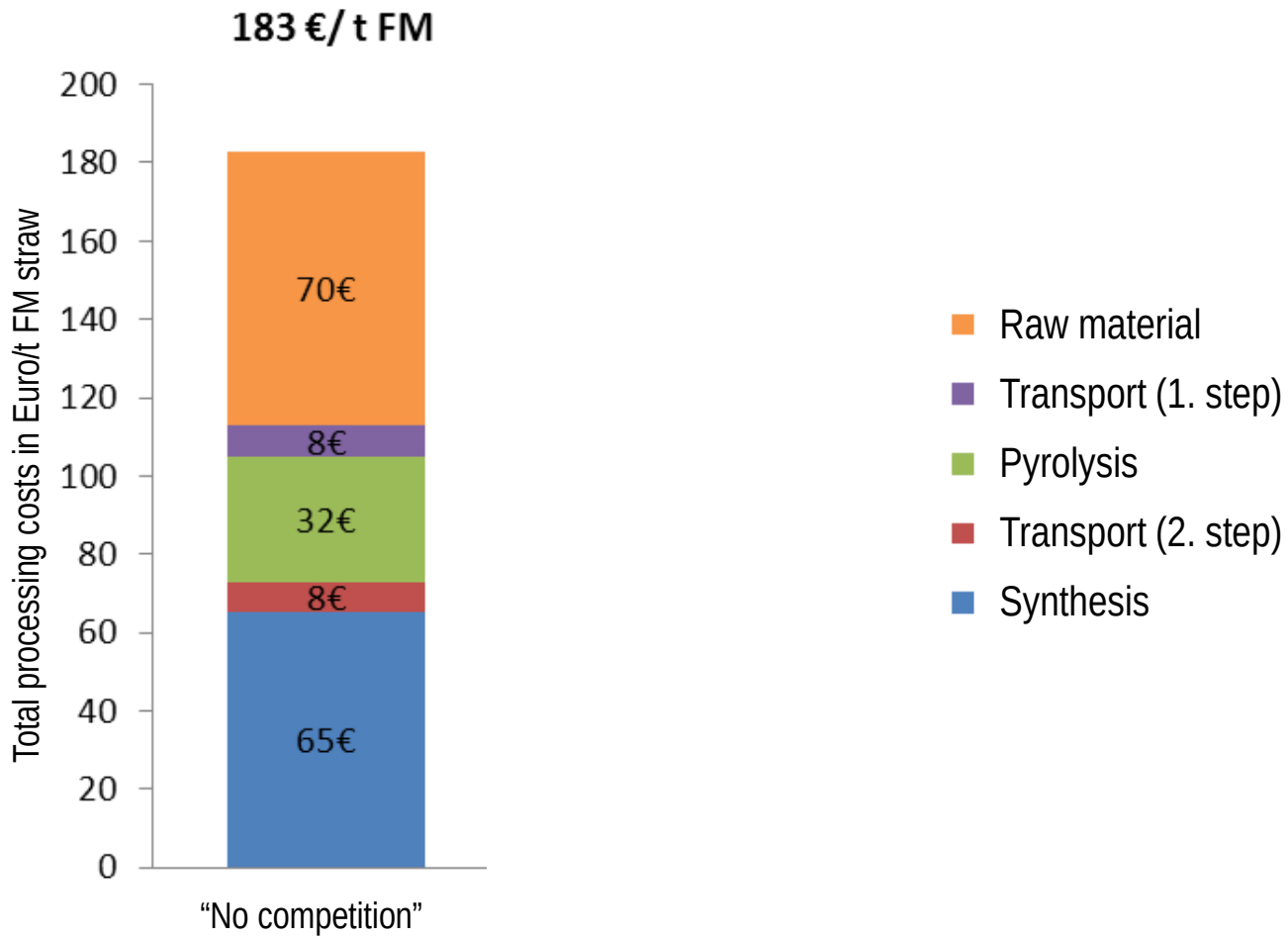
Realised locations for pyrolysis and synthesis in Austria

Scenario “Competition“



Source: Own illustration

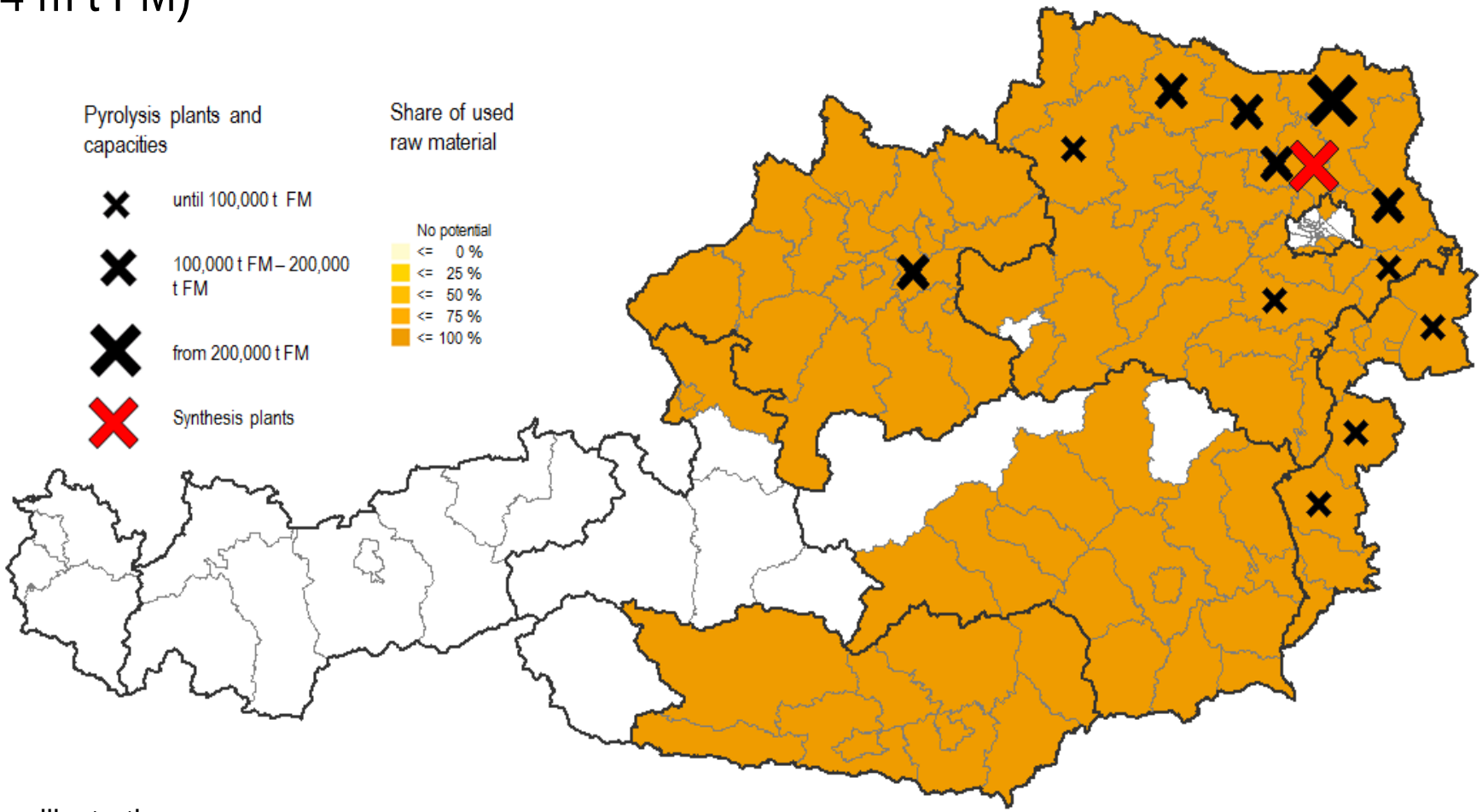
Total processing costs



Source: Own illustration

Sensitivity analysis “Competition”
Change in raw material supply

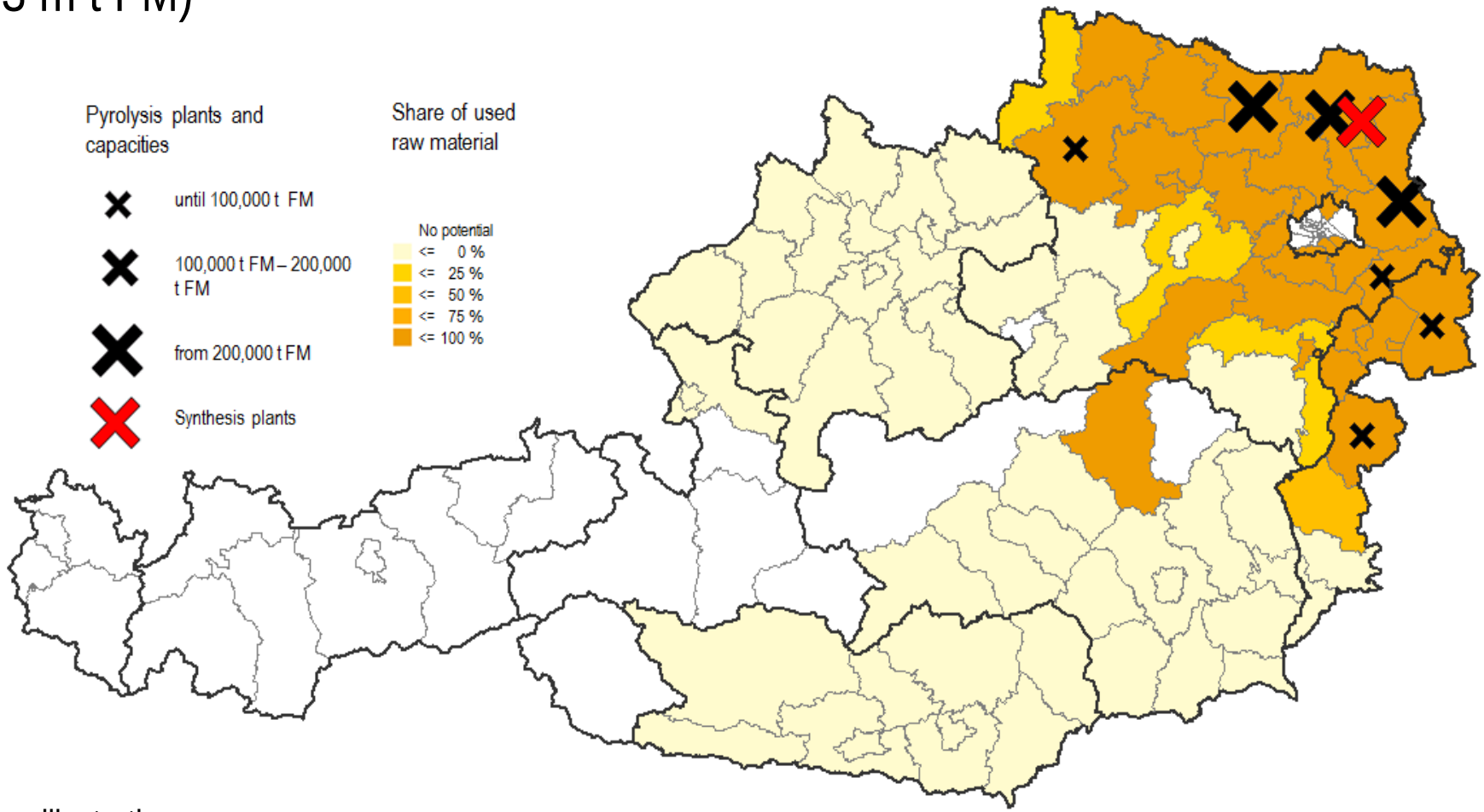
100% of total potential raw material used
(1,04 m t FM)



Source: Own illustration

Sensitivity analysis “Competition”
Change in raw material supply

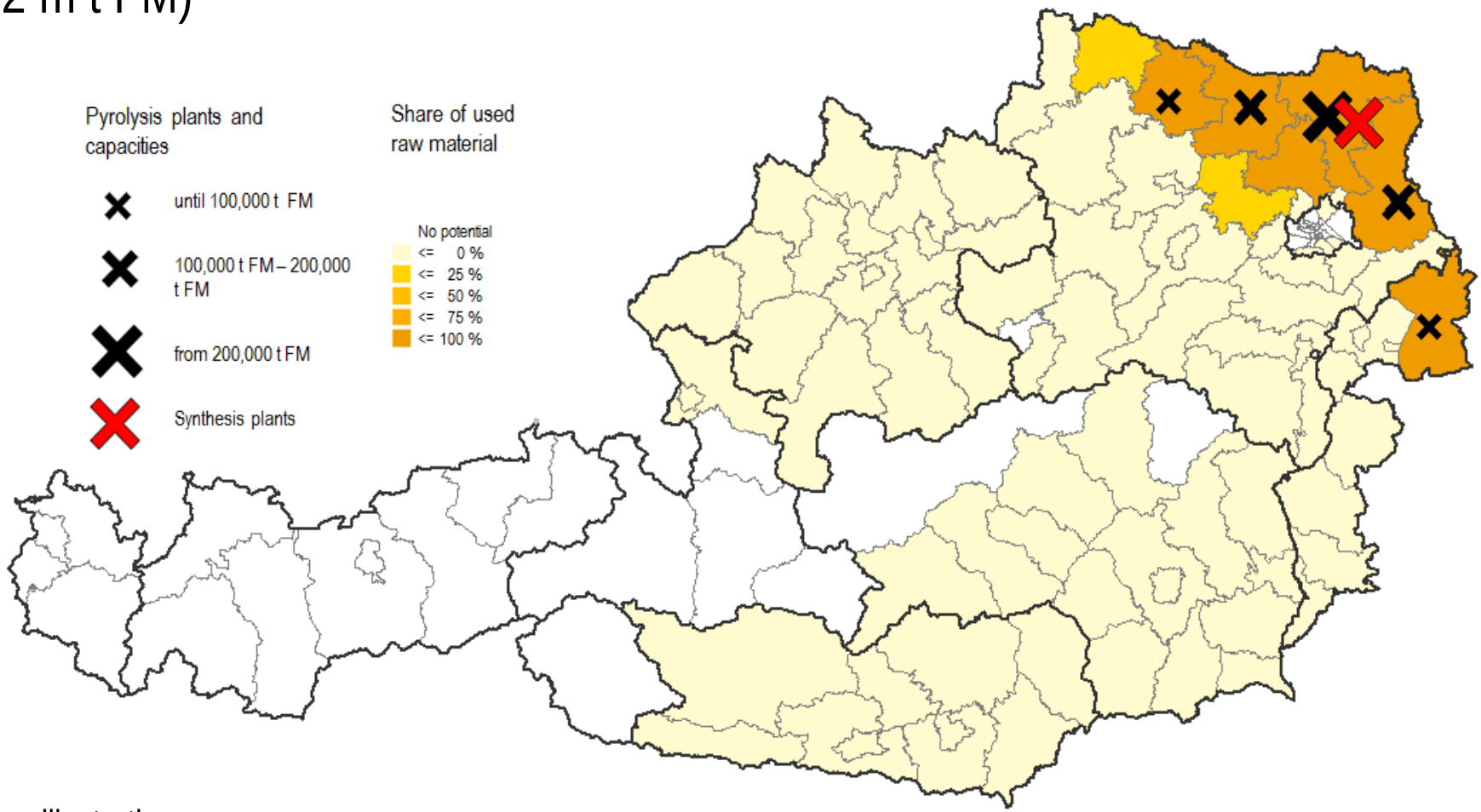
80% of total potential raw material used
(0,83 m t FM)



Source: Own illustration

Sensitivity analysis “Competition”
Change in raw material supply

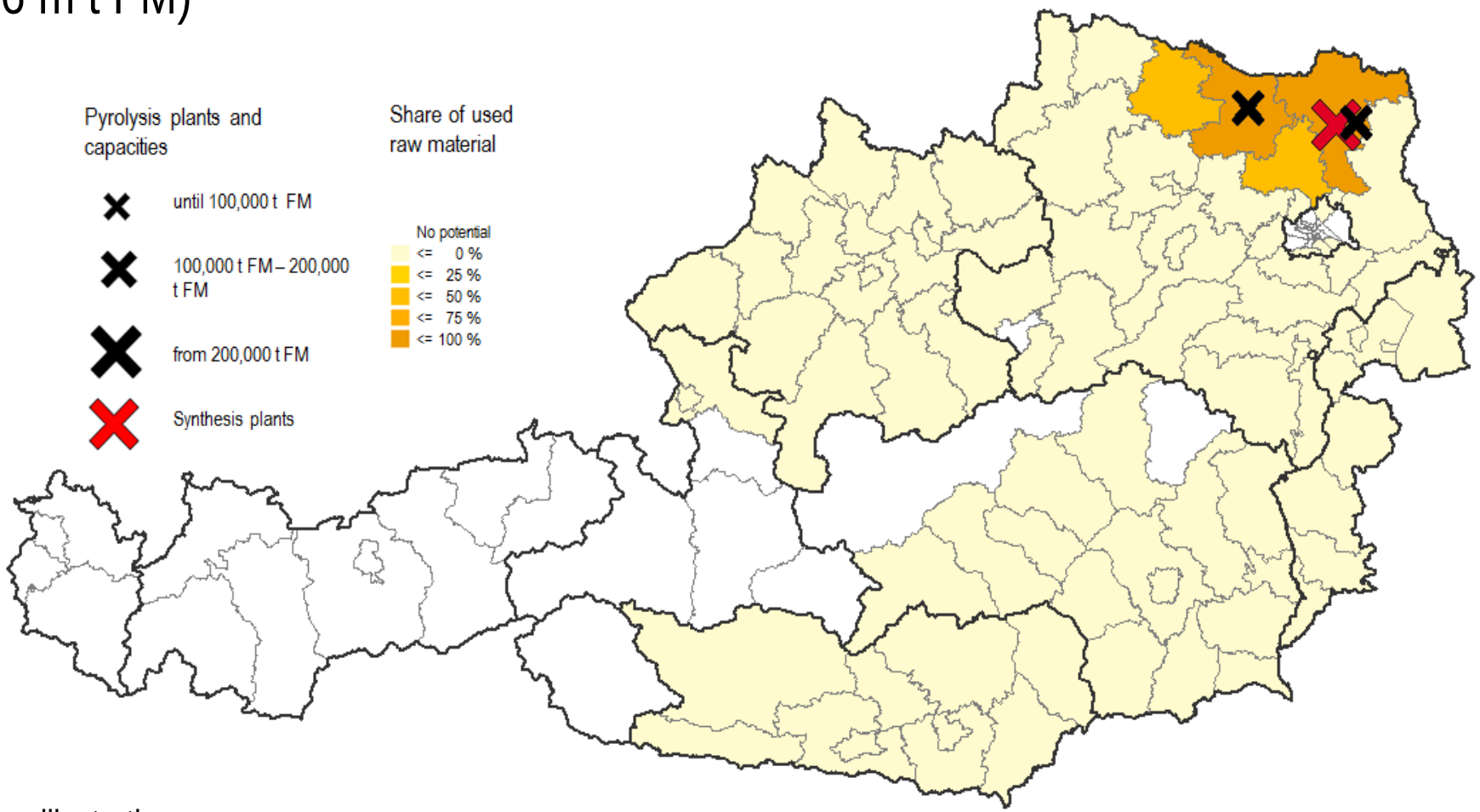
50% of total potential raw material used
(0,52 m t FM)



Source: Own illustration

Sensitivity analysis “Competition”
Change in raw material supply

25% of total potential raw material used
(0,26 m t FM)



Source: Own illustration

Discussions

- Decentred pyrolysis with central synthesis show best results regarding total processing costs for Austria
- Only a small percentage of total energy supply in Austria can be covered by BtL-production from straw (about 3% of total fuel consumption)
- BtL-production from straw is relatively expensive (0.97 € and 1.03 € respective to scenarios)

Thank you for your attention!!

Tobias Moser, Martin Kapfer, Stefan Kirchweger and Jochen Kantelhardt
Institute of Agricultural and Forestry Economics
University of Natural Resources and Life Sciences, Vienna Feistmantelstrasse 4, A-1180 Vienna, Austria.
E-Mail: tobias.moser@boku.ac.at

Berechnung des Rohstoffangebots des Szenarios „ohne Konkurrenz“

∑ Alle in Österreich zur Verfügung stehenden GÖK- Flächen

- ∑ Biologisch bewirtschaftete GÖK-Flächen
- ∑ Getreide- Flächen, welche von Milchviehbetrieben bewirtschaftet werden, (ohne Biobetriebe)

= Flächenpotenzial ohne Puffer

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x 0,95 Puffer für Ernteausfälle (Dürre, Auswinterungen, etc.)

= Flächenpotenzial Szenario „keine Konkurrenz“

x kulturabhängigen Durchschnittserträgen für Stroh

= Strohpotenzial Szenario „keine Konkurrenz“

Berechnung des Rohstoffangebots des Szenarios „mit Konkurrenz“

∑ Alle in Österreich zur Verfügung stehende GÖK- Flächen

- ∑ Biologisch bewirtschaftete GÖK-Flächen

= Flächenpotenzial ohne Puffer

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x 0,9 Puffer für Ernteausfälle und sonstige Einstreu (Pferd….)

= Flächenpotenzial Szenario „mit Konkurrenz“

x kulturabhängigen Durchschnittserträgen für Stroh

= Strohpotenzial ohne Konkurrenz

- ∑ Strohverbrauch durch Einstreu in Milchvieh- & Mutterkuhbetrieben

- ∑ Strohverbrauch durch Verbrennung in Heizkraftwerken

= Strohpotenzial Szenario „mit Konkurrenz“

Ausgangsdaten für die Berechnung der Konkurrenzsituation- Einstreu

	Bedarf in kg FM	Datenquelle
Einstreubedarf Milchkuh Liegeboxenlaufstall	1,5 kg/ Tier/ Tag	KTBL- DATENSAMMLUNG 08/09
Einstreubedarf Milchkuh Tiefstreustall	4 kg/ Tier/ Tag	KTBL- DATENSAMMLUNG 08/09
GVE- Umrechnungsschlüssel		BMLFUW, 2006
Rinderdaten 2009		INVEKOS- DATENPOOL

Ausgangsdaten für die Berechnung der Konkurrenzsituation- Strohverbrennung

Anlagenbezeichnung	Strohverbrauch in t/a	Gemeinde	Bezirk
Bockfließ	1570	Bockfließ	Mistelbach
Deutsch-Brodersdorf	1070	Seibersdorf	Baden
Dobersberg	726	Dobersberg	Waidhofen/Th.
Dürnkrut	3550	Dürnkrut	Gänserndorf
Lassee	3220	Lassee	Gänserndorf
Seibersdorf	1150	Seibersdorf	Baden
Stetteldorf	1200	Stetteldorf am W.	Korneuburg
Unternalb	700	Retz	Hollabrunn
Wolfsthal	2000	Wolfsthal	Bruck
Summe	**15.186**	**t Stroh FM**	

Variable Anlagenkosten in Abhängigkeit der Auslastung in Mio €/ Jahr

Anlage	Größen-klasse	Anlagenauslastung									
		100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
Pyrolyse	**1**	0.29	0.26	0.23	0.20	0.17	0.15	0.12	0.09	0.06	0.03
Pyrolyse	**2**	0.32	0.29	0.26	0.22	0.19	0.16	0.13	0.10	0.06	0.03
Pyrolyse	**3**	0.36	0.32	0.29	0.25	0.22	0.18	0.14	0.11	0.07	0.04
Pyrolyse	**4**	0.41	0.37	0.33	0.29	0.25	0.21	0.16	0.12	0.08	0.04
Pyrolyse	**5**	0.49	0.44	0.39	0.34	0.29	0.25	0.20	0.15	0.10	0.05
Pyrolyse	**6**	0.64	0.58	0.51	0.45	0.38	0.32	0.26	0.19	0.13	0.06
Pyrolyse	**7**	0.92	0.83	0.74	0.64	0.55	0.46	0.37	0.28	0.18	0.09
Pyrolyse	**8**	1.78	1.60	1.42	1.25	1.07	0.89	0.71	0.53	0.36	0.18
Pyrolyse	**9**	4.34	3.91	3.47	3.04	2.60	2.17	1.74	1.30	0.87	0.43
Pyrolyse	**10**	8.57	7.71	6.86	6.00	5.14	4.29	3.43	2.57	1.71	0.86
Synthese	**1**	0.80	0.72	0.64	0.56	0.48	0.40	0.32	0.24	0.16	0.08
Synthese	**2**	1.22	1.10	0.98	0.85	0.73	0.61	0.49	0.37	0.24	0.12
Synthese	**3**	1.94	1.75	1.55	1.36	1.16	0.97	0.78	0.58	0.39	0.19
Synthese	**4**	3.19	2.87	2.55	2.23	1.91	1.60	1.28	0.96	0.64	0.32
Synthese	**5**	4.34	3.91	3.47	3.04	2.60	2.17	1.74	1.30	0.87	0.43
Synthese	**6**	5.43	4.89	4.34	3.80	3.26	2.72	2.17	1.63	1.09	0.54
Synthese	**7**	6.49	5.84	5.19	4.54	3.89	3.25	2.60	1.95	1.30	0.65
Synthese	**8**	9.06	8.15	7.25	6.34	5.44	4.53	3.62	2.72	1.81	0.91
Synthese	**9**	11.56	10.40	9.25	8.09	6.94	5.78	4.62	3.47	2.31	1.16
Synthese	**10**	14.00	12.60	11.20	9.80	8.40	7.00	5.60	4.20	2.80	1.40

Fixe Anlagenkosten für Syntheseanlagen in Mio. €/ Jahr

	Kapazität in t/ Slurry	Fixkosten in Mio. €
Größenklasse 1	50.000,00	10,7
Größenklasse 2	100.000,00	17,3
Größenklasse 3	200.000,00	28,1
Größenklasse 4	400.000,00	45,7
Größenklasse 5	600.000,00	60,7
Größenklasse 6	800.000,00	74,2
Größenklasse 7	1.000.000,00	86,8
Größenklasse 8	1.250.000,00	105,8
Größenklasse 9	1.500.000,00	115,3
Größenklasse 10	2.000.000,00	141,0

Fixe Anlagenkosten für Pyrolyseanlagen in Mio. €/ Jahr (für Szenario „mit Konkurrenz)

	Kapazität in t Stroh FM	Fixkosten in Mio. €
Größenklasse 1	25.000	1,29
Größenklasse 2	28.571	1,30
Größenklasse 3	33.333	1,32
Größenklasse 4	40.000	1,38
Größenklasse 5	50.000	1,49
Größenklasse 6	66.667	1,70
Größenklasse 7	100.000	2,16
Größenklasse 8	200.000	3,65
Größenklasse 9	500.000	8,20
Größenklasse 10	1.037.000	15,91