P-REX

Regional implementation

Case Switzerland

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Amsterdam, 11th of June 2015

PHOSPHORUS RECYCLING
FROM PROTOTYPE TO MARKET

University of Applied Sciences and Arts
Northwestern Switzerland

Regional Studies

- Goal: To make decision makers believe that a circular P economy is possible, practical and economically as well as environmentally feasible.
- Four regions investigated (DE, CH, CR, Aragon/ES)
- Recommendations for the European level including future trends

- Regional approach
  - The **properties of recovery processes** are combined with **regional data**
  - **Develop P-recovery strategies** with a long term **goal of recovery of 80%** of the phosphorus eliminated by the WWTP
  - Regional stakeholder workshops to get inputs and reflect results

Process properties for the region

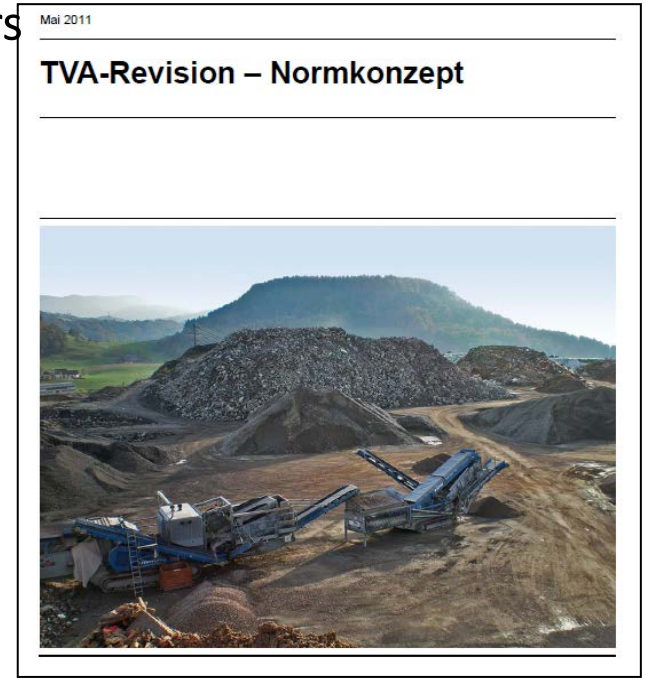
	Recovery rate	Environmental impact	Cost
Sludge precipitation 1 Liquor precipitation 1 Liquor precipitation 2 Sludge leaching 1 Sludge leaching 2 Sludge metallurgic integr Ash leaching 1 Ash leaching 2 Ash thermo-chem integr	Same for all regions	Same LCA-model calculation for all regions fossil fuel demand and soil toxicity (CR, DE, ES) **or** Environmental scarcity points (CH)	Regionally adjusted cost accounting for • raw material phosphorus concentration • Differences in cost types (salary, material costs,…)

Swiss study

- Feedback round from experts on the presented scenarios ongoing
- Final version will
  - feed into the recommendations for the European level
  - be summarized in the P-REX guidance document
  - be presented in Swiss branch press

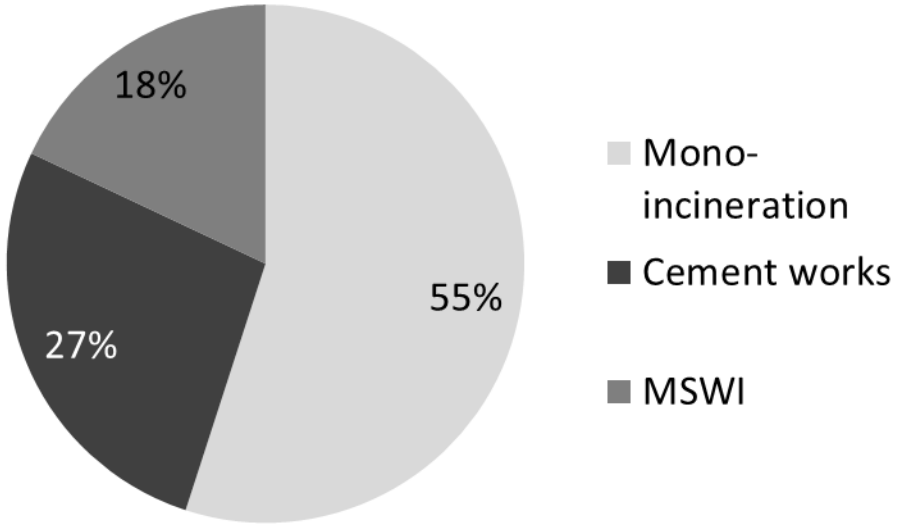
Swiss legislation on sewage sludge

- Landfill forbidden since 2000
- Use in agriculture forbidden since 2006
- New decree on solid waste planned for end 2015
  - Phosphorus recovery obligatory after 5 years
  - Sewage sludge and meat and bone meal
- Implementation aid planned with
  - BAT/ yield
  - plant availability



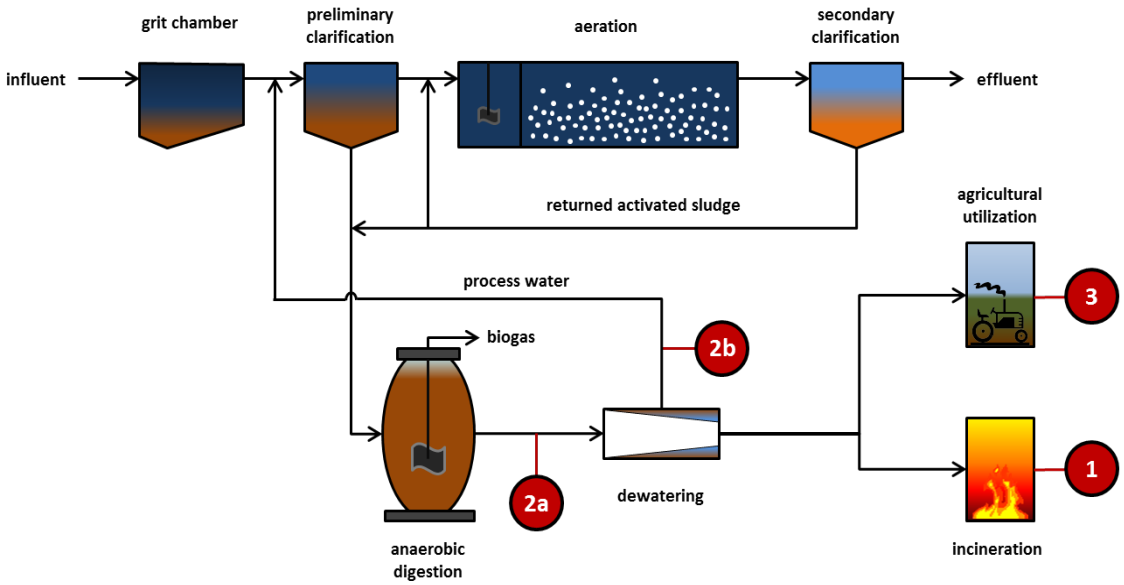
Swiss Sludge Treatment

- 8.2 Mio inhabitants. 16 Mio Person Equivalents (PE)
- 206'000 t DM/a sewage sludge with 2.8% P, in total 5'800 t
- Only few plants with enhanced biological phosphorus removal (EPBR), mostly chemical removal
- Almost 100 % incineration in
  - 11 mono-incineration plants
  - 6 cement works
  - 14 municipal solid incineration plants (MSWI).
- No technical P recovery from sewage today



Binder et al. 2009
FOAG 2013
VBSA, 2013
Cemsuisse, 2014

Swiss main processes



1 ash after incineration

2a undrained sludge after anaerobic digestion

2b sludge liquor after dewatering

3 direct agricultural utilisation of dewatered sludge

Only handful of plants with EBPR
-> Potential in CH below 1%
-> not considered in CH scenarios

Sludge precipitation
Struvia
(Nuresys)

Sludge leaching
Stuttgart

Only handful of plants with EBPR
-> Gifhorn not considered

Sludge and ash metallurgical
Mephrec

Ash leaching
Leachphos
(Ecophos)

Ash thermochemical
ASH DEC

Process properties and scenarios

	Recovery rate	Environmental impact		Cost	
	as fraction of P eliminated at the WWTP	Reference chain mono-incineration and landfill	Reference chain co-incineration and landfill	Reference chain mono-incineration and landfill	Reference chain co-incineration and landfill
	%	kESP/kg P		EUR/ kg P	EUR/ kg P
Sludge precipitation 1	7%	-63	-63	1	1
Liquor precipitation 1	12%	-46	-46	4	4
Liquor precipitation 2	11%	-45	-45	3	3
Sludge leaching 1	49%	-37	-37	16	16
Sludge leaching 2	45%	-5	-5	15	15
Sludge metallurgic integr	81%	-326	-316	-3	-3
Ash leaching 1	70%	115	121	6	6
Ash leaching 2	97%	-154	-145	-1	-1
Ash thermo-chem integr	98%	-49	-41	2	2

Scenario 1 and 5

Scenario 2

Process properties and scenarios

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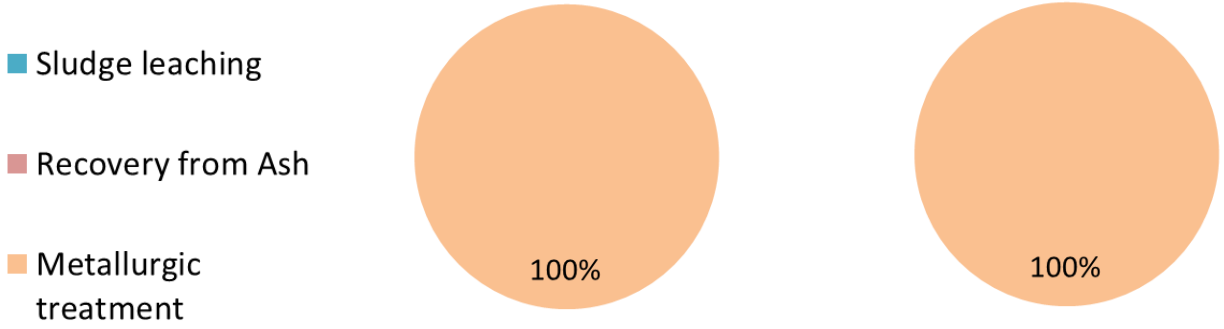
Scenario 4

Scenarios 1 and 5



Reasoning Treatment

- Lowest environmental impact and cost for recovery of 80% of phosphorus
  → metallurgic treatment

Plants

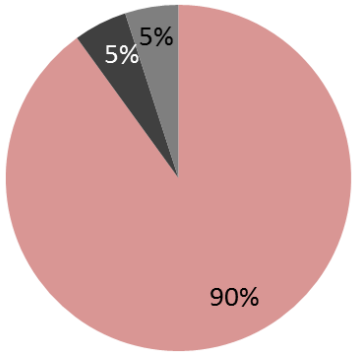
- 16 x 1Mio PE

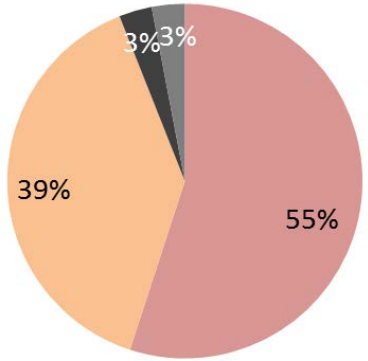
- 2x 8 Mio PE

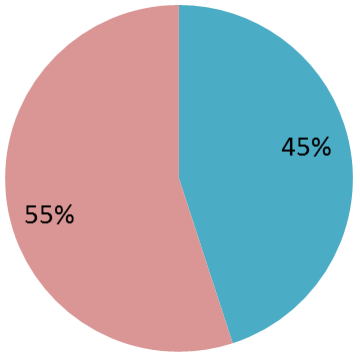
Consequences

- Replaces existing incineration infra
- Integration with MSWI and cement works
- Existing drying infrastructure could be used, additional needed.

Scenarios 2, 3 and 4

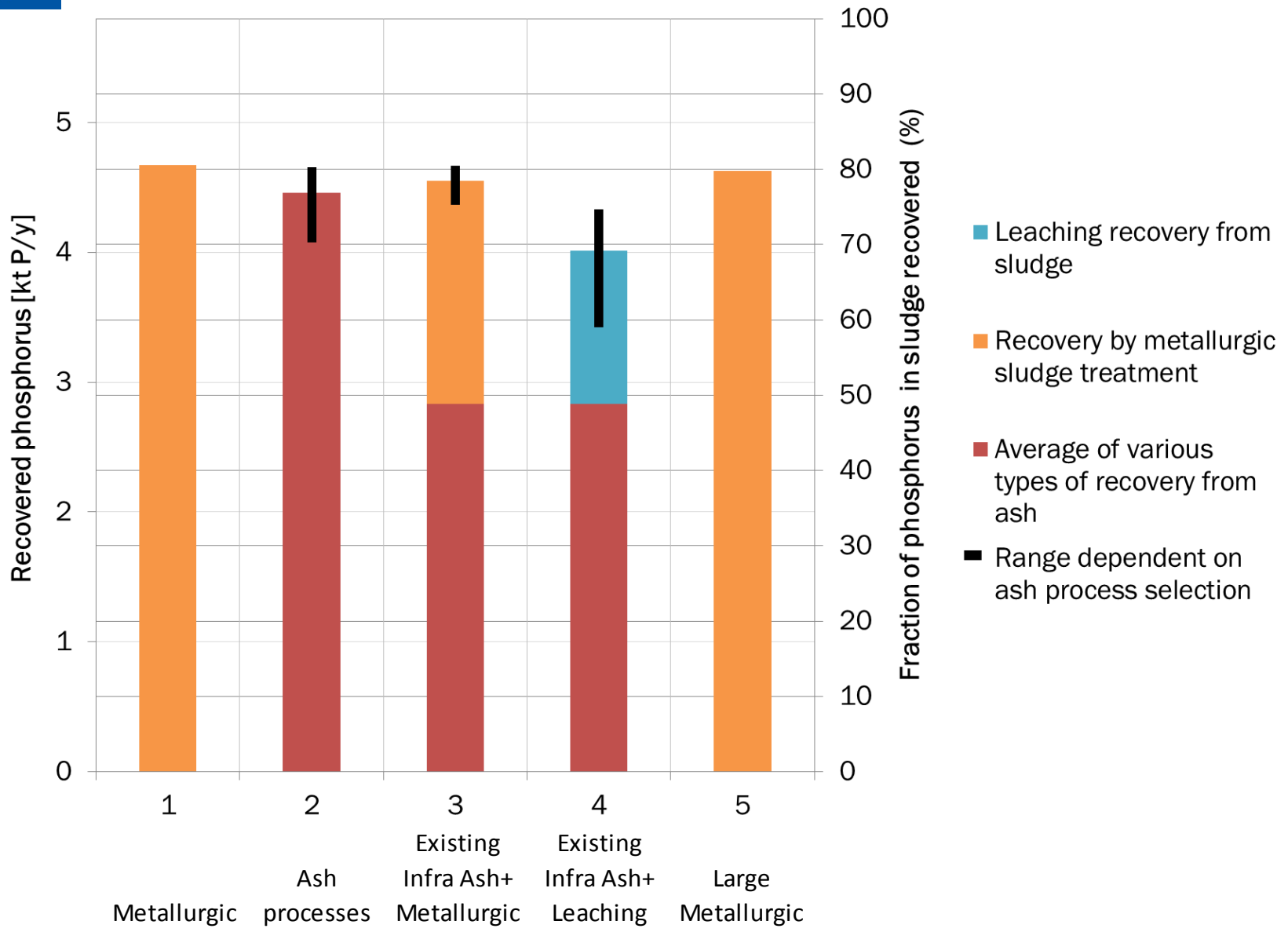




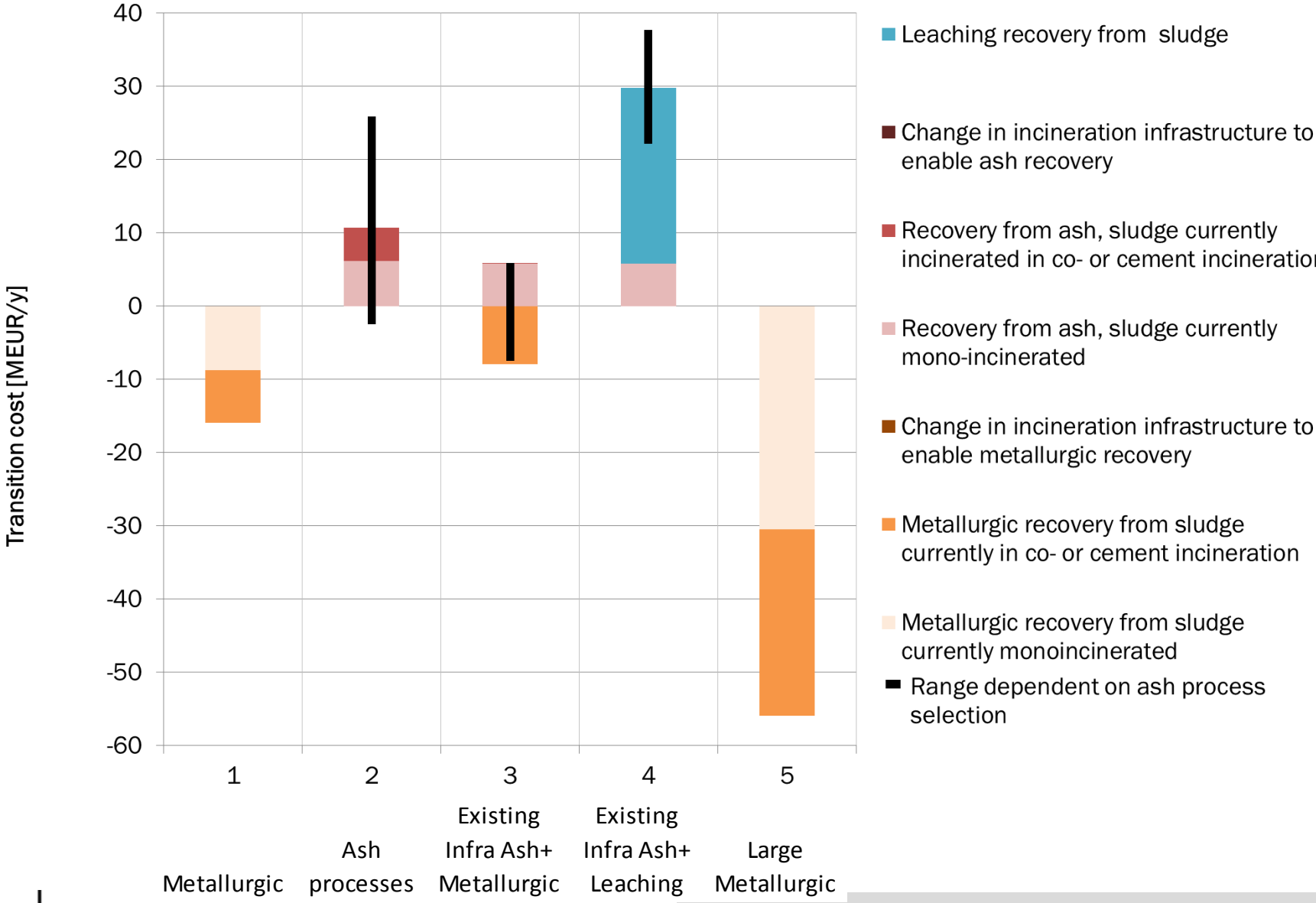


Reasoning Treatment	▪ Ash based processes are low EI and low cost and thus alternatives to metallurgic recovery.	▪ Use current mono-incineration capacities and meet interests of the cement works	▪ Use current mono-incineration capacities and meet interests of the cement works
Plants	▪ 6x 2.5-2.7 Mio PE	▪ 3x 2.5-2.7 Mio PE ash.	▪ 3x 2.5-2.7 Mio PE ash.
Consequences	▪ 80%-100% allocated ▪ More monincineration capacity needed	▪ 5-7 1 Mio PE metallurgic recovery integrated with existing drying, MSWI and cement works	▪ 37x 0.2 Mio PE sludge leaching plants on WWTP or incineration sites

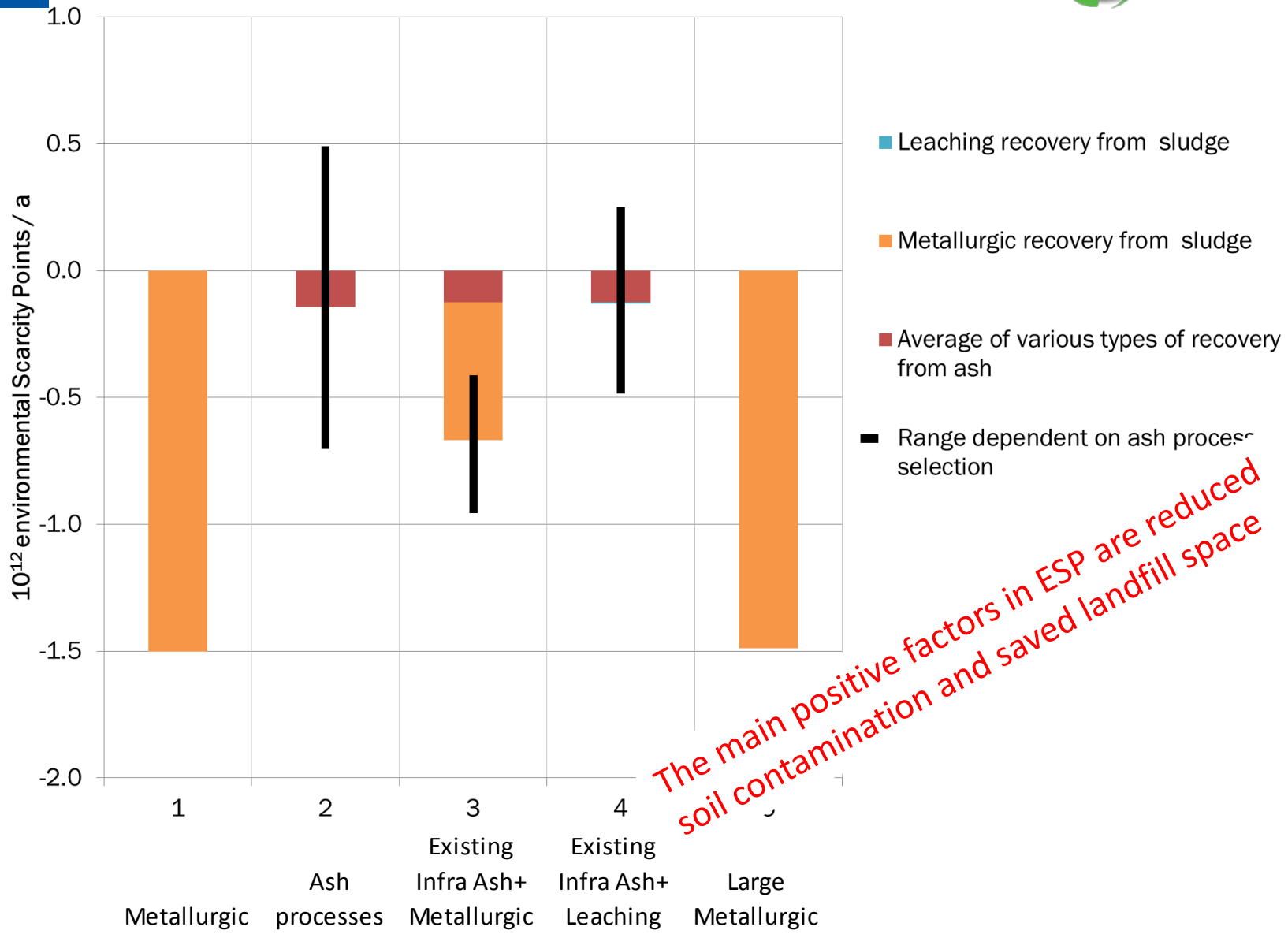
Recovery Rate



Transition cost



Environmental scarcity points



The main positive factors in ESP are reduced soil contamination and saved landfill space

Other aspects

- Additional transport cost necessary for large metallurgic/ash plants comparatively small (<0.3 EUR/kg P; +50 km)

- Mephrec very promising, but no continuous pilot tests yet. So largest technical uncertainty and consequently uncertainty on cost and LCA.

- Scenario investment costs vary from 70 to 390 MEUR

- Small market
  - 70% of mineral P imported as complex fertilizers. 30% as raw materials.
  - P granulation and blending, but no chemical modification.
- Product quality legislation is being adapted
  - Some recovered materials fulfil the stringent recycling fertilizer limits (Chem RRV)
  - Others could be sold as ingredient for EU compound fertilizers
  - Mineral recycling fertilizer category planned for 1.1.2018

Conclusions

- P-REX process knowledge was combined with regional data.
- Swiss scenarios show
  - feasibility of 80% recovery and compatibility with infrastructure
  - in general an improved environmental impact as ESP
  - in many cases lower costs
- Large investments required
  - first generation soon
  - transition period long enough to use current investments in infrastructure and learn from first generation
- Facilitating for upcoming investment decisions would be
  - the implementation aid
  - clarification of product legislation

P-REX

Thank you for your attention!

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Download at www.p-rex.eu :

P-REX Guidance document (Autumn 2015)

This project has received funding from the European Union's Seventh Programme for Research, Technological Development and Demonstration under Grant Agreement no. 308645.

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