HELSINKI
11-13 June
2018

ESPC3

European
Sustainable
Phosphorus
Conference

From discussion to implementation

The impact
of nutrient recovery targets and legal obligations
on practical implementation

by Christian Kabbe

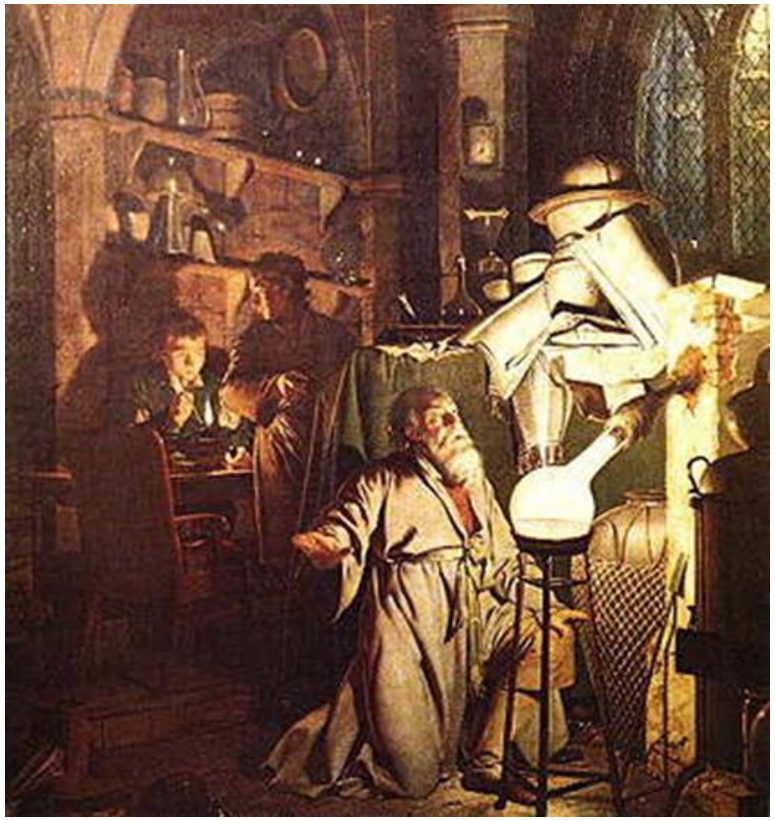
AGENDA

01 Questions to be asked?

02 Nutrient recovery – How and where?

03 Market issues

04 Outlook



Joseph Wright of Derby: Henning Brand discovering phosphorus in 1669

Sewage (sludge) is a renewable nutrient resource still waiting to be tapped to it’s full potential

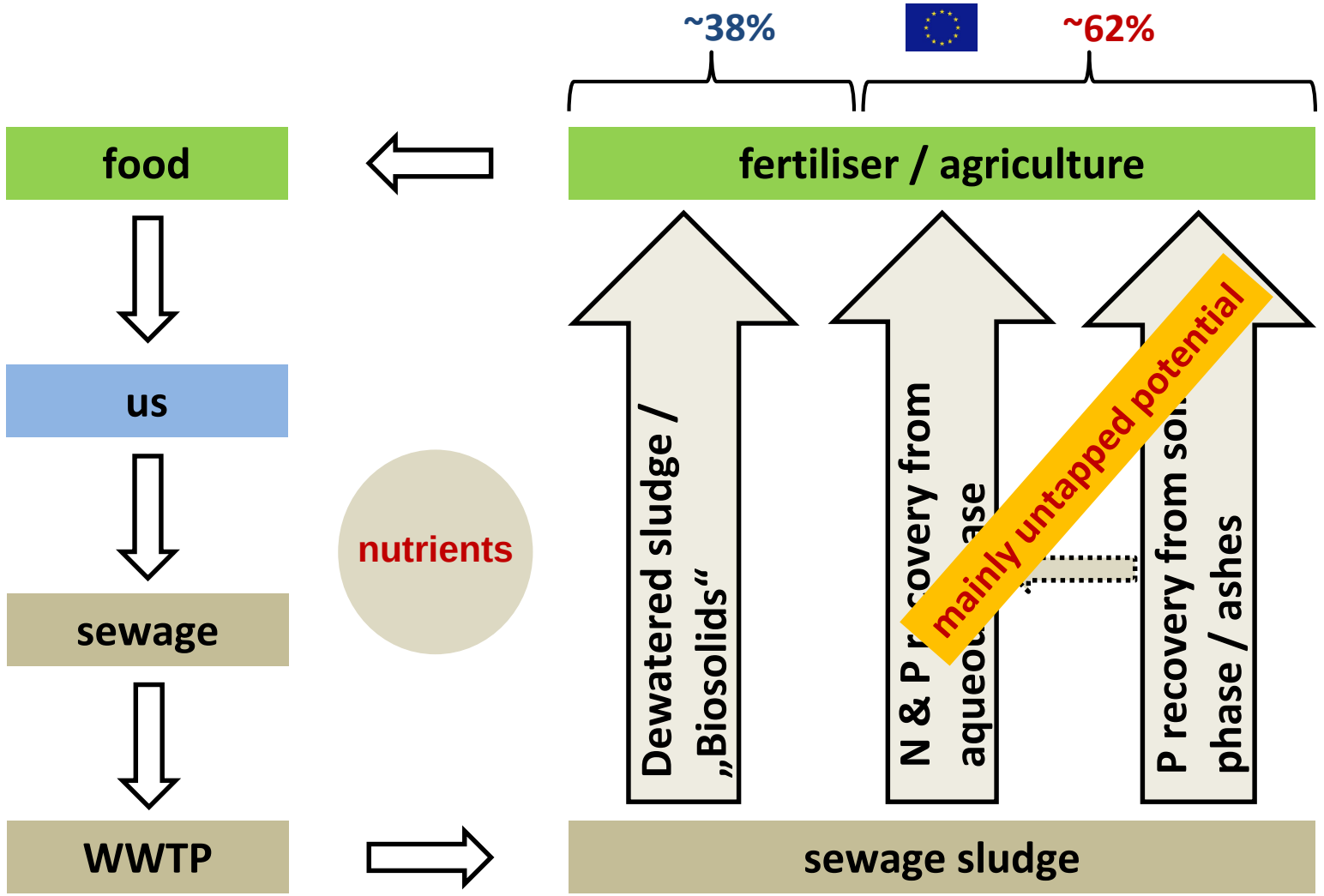
Relevant bio-based waste streams - in Europe?

[**kton P/year**]	Total	Recycled	Potential
Sewage sludge	297	115	182
Biodegradable solid waste	130	38	92
Meat & bone meal	128	6	122
Total	**427-555**	**153-160**	**274-396**
Manure recycling =	**1 736**		
Mineral fertiliser use =	***1 448***		

Van Dijk & OeOverview of phosphorus flows in wastes in Europe", 2013, Fertilisers Europe seminar, 6 Feb. 2013.
Updated Van Dijk et al. 2015nema "

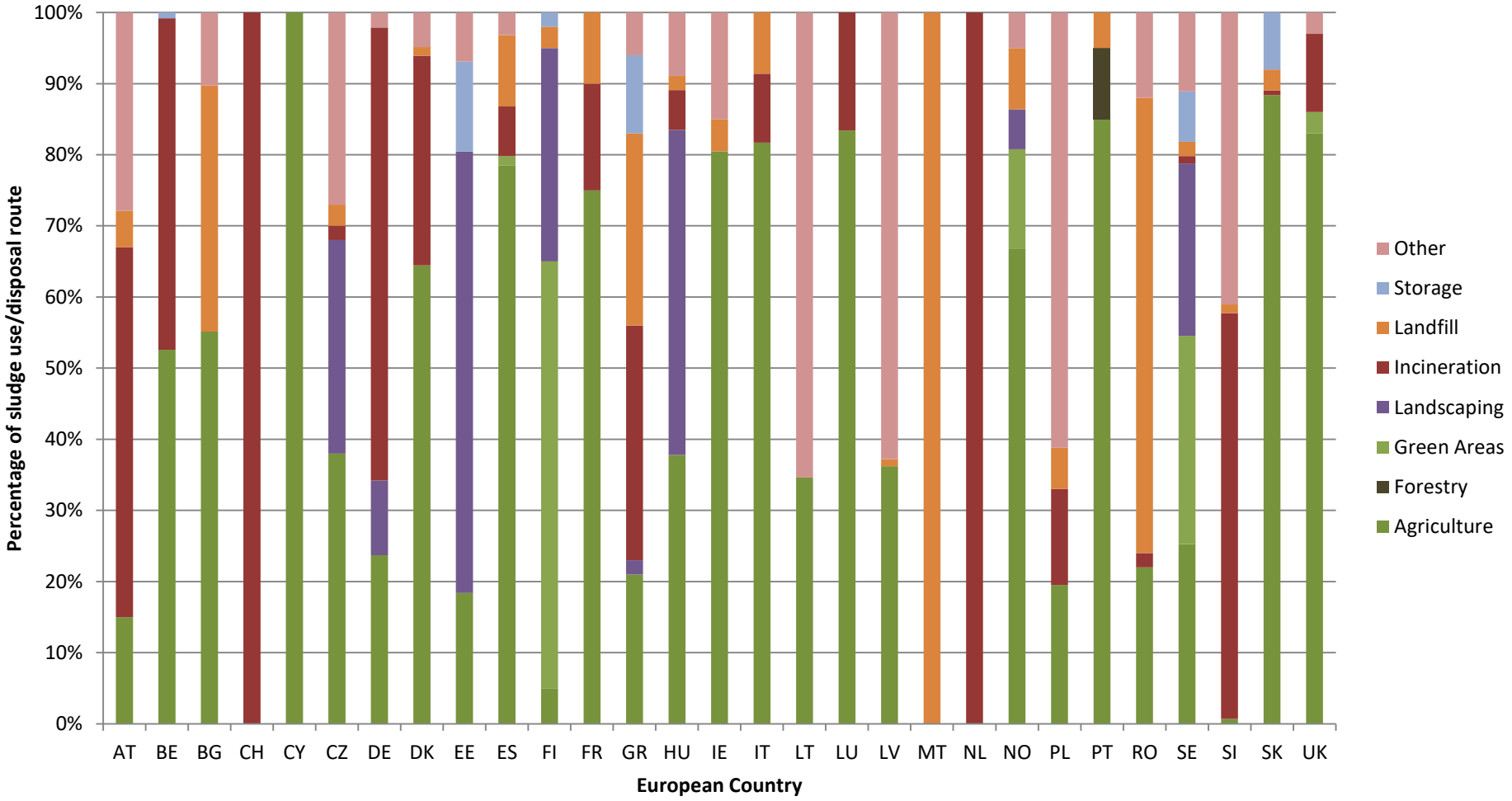
Sewage (sludge) is the second most relevant renewable waste stream for P recovery & recycling in Europe!

Pillars of Nutrient Recovery & Recycling



Challenge: Enabling techn. alternatives to complement /compensate traditional route!

Sewage Sludge - Destinations in Europe - Diversity



Sources: EurEau 2016, EUROSTAT 2016, DESTATIS 2016, BAFU 2016

Total sludge quantity covered: appr. 10 million tons of dry solids per year!

Do we know and have a right to choose …

… what's in our food and where it comes from?

Burning Questions?

Why legal framework needs adaption?

- Is nutrient recovery and marketing considered responsibility of wastewater utilities?
- What are the drivers for implementation besides legal requirememements? (pressure and needs)

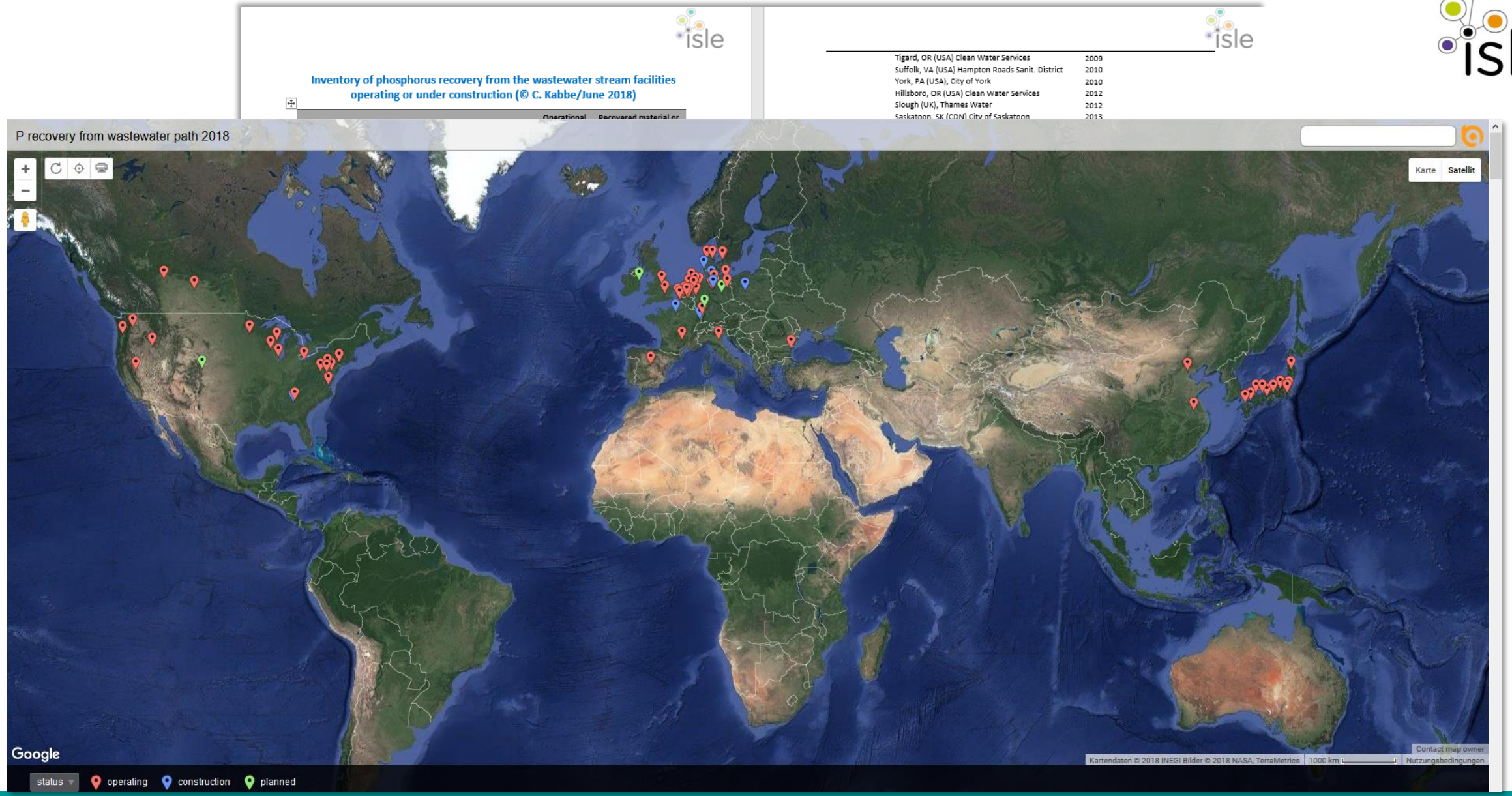
How?

- Starting with lowest hanging (feasible) fruits instead of highest hanging (maybe feasible?)
- Regulations should set an enabling frame for both, recovery and recycling value chains, not just demanding for one of them! (Integration instead of parallel structures)

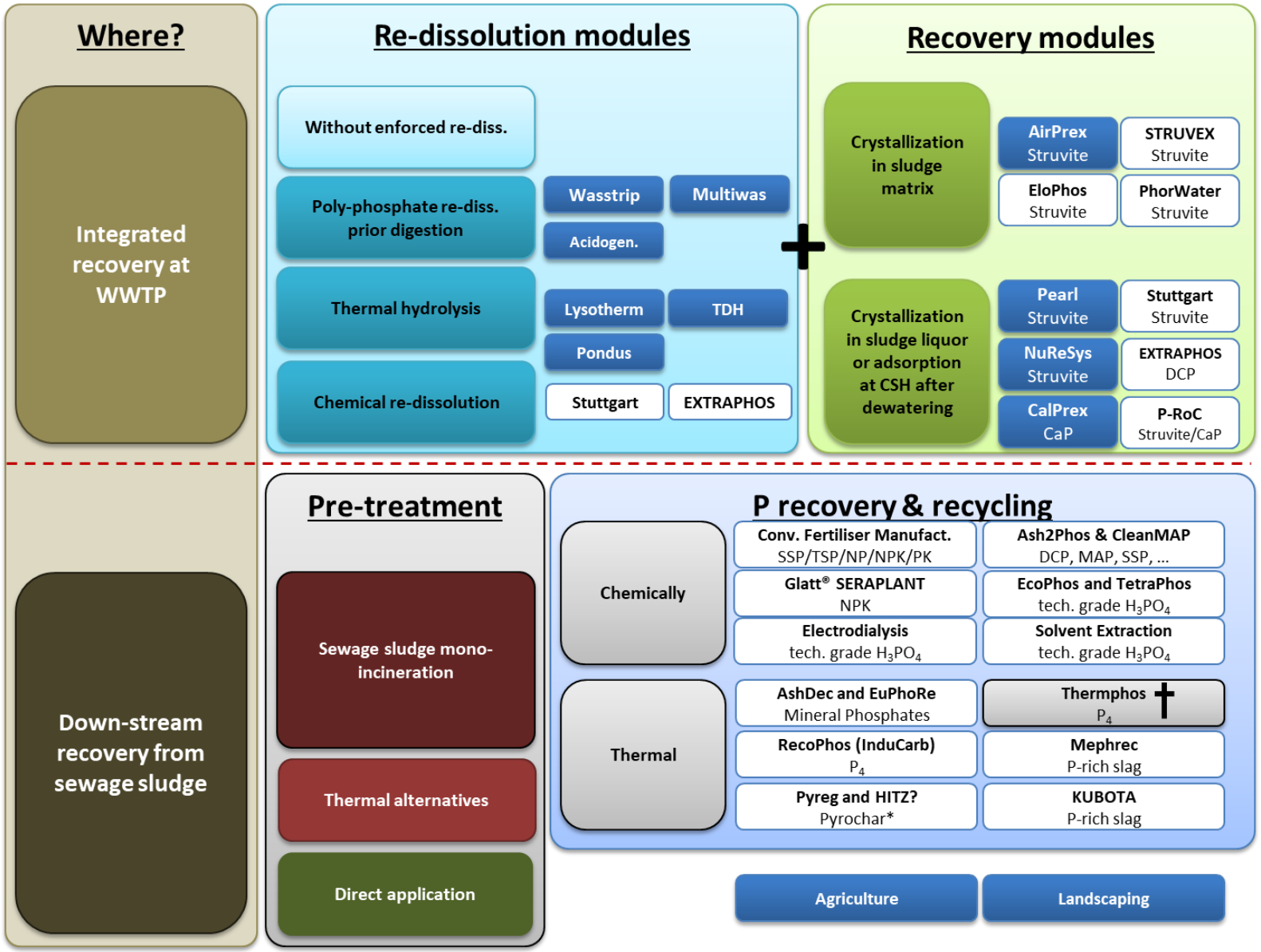
Societal Challenge!

- Sustainability = balanced triangle between social justice, economy and environmental benefits
  Who pays? Who profits? Ratio between cost and benefits (for whom?)

Global implementation – without law enforcement just to recover as such?



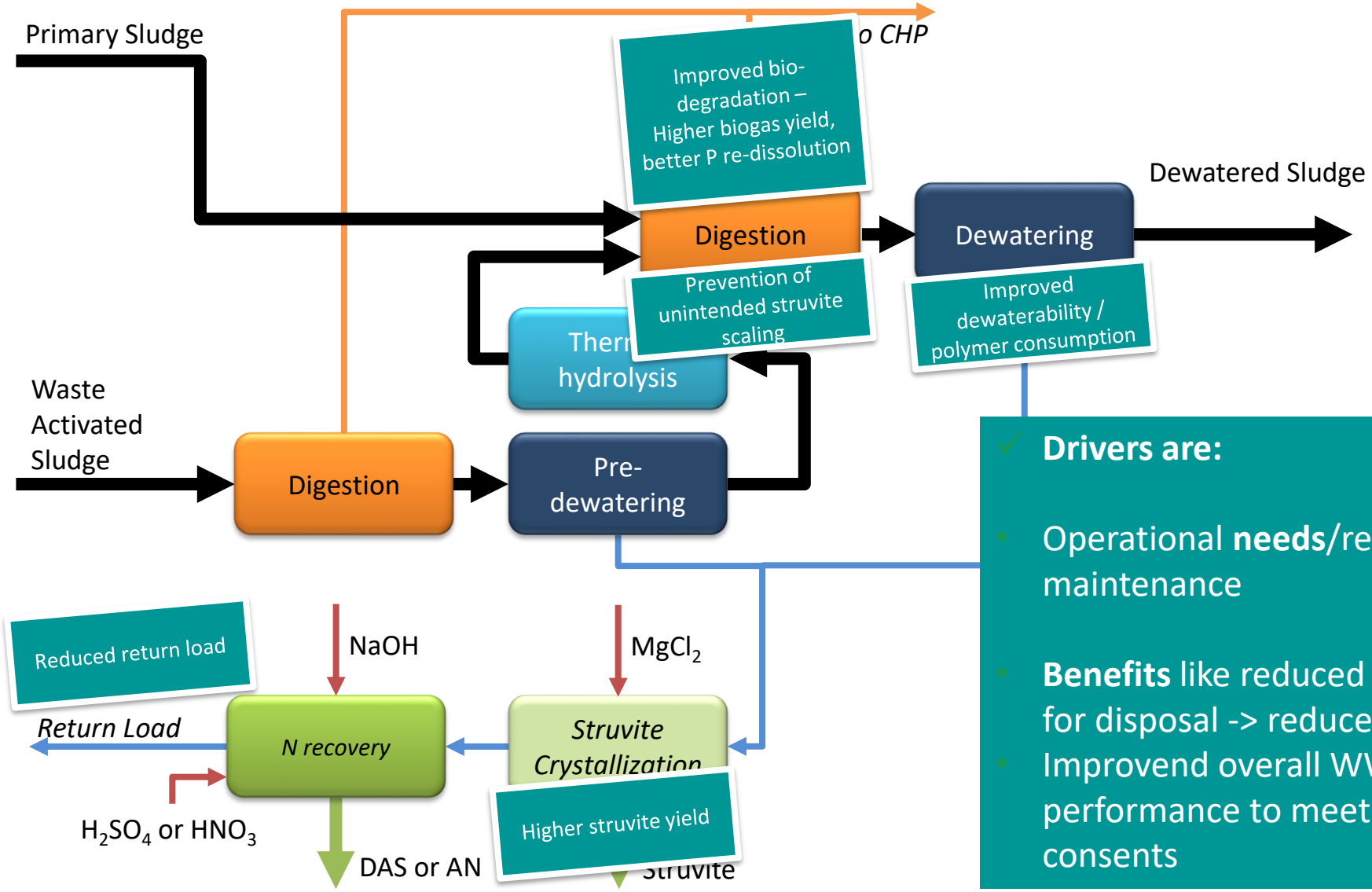
Availability of Solutions?



Amended from P-REX® and Kraus

Full-scale | Demo/Pilot

Nutrient Recovery Cascades for P & N + Energy are state of the art!



Drivers are:

- Operational **needs**/reduced maintenance
- **Benefits** like reduced sludge volume for disposal -> reduced cost
- Improvend overall WWTP performance to meet stricter P consents

Source: amended from Kraus 2016

Challenges and keys to Success and Sustainability?

Only technologies, yielding **homogenous products** or raw materials, **independent from input material quality** and mutually meeting both criteria, **energy efficiency** and **resource efficiency** will have a chance for wide-spread application under sustainability aspects.

Keys:

- ✓ Heavy metal depletion (high quality products)
- ✓ Moderate energy (and chemicals) consumption (cost)
- ✓ Market for "known" recovered P (commercial products) (real value and price)

An enabling regulatory framework can accelerate the market uptake succeeding in a shift from market push to market pull

Germany 2017+: a template to adapt, but not just to copy as is

- 2017 – new fertilising ordinance (DÜV) limits nutrient loads applied to land and acutely reduces sludge disposal capacities -> cost explosion!

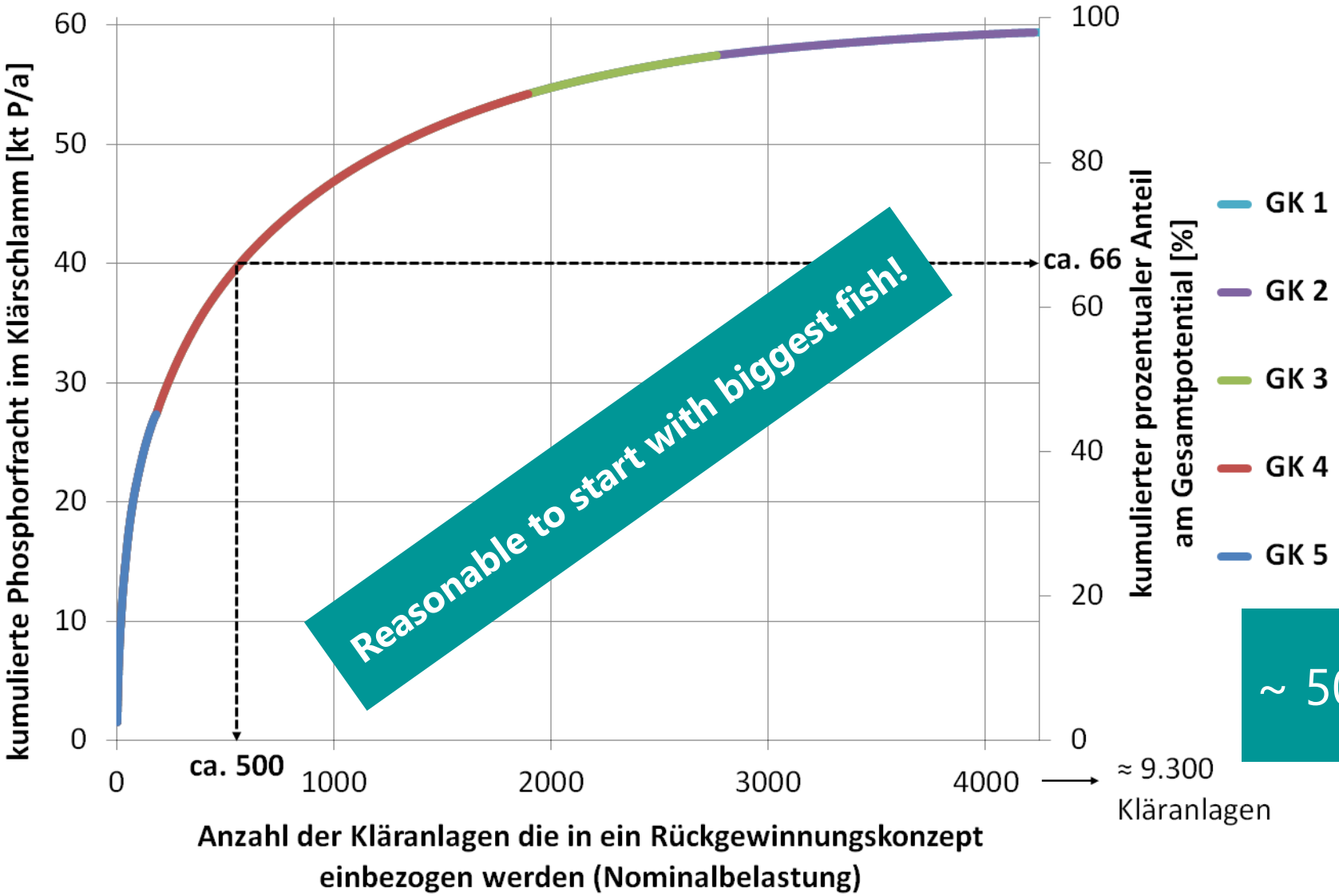
- 2017 – new fertiliser ordinance (DÜMV) sets stricter qu… …teria (less sludge is catching up)

- 2017 – new sewage sludge ordinance (AbfK… …ers into force
  - 2023 – all WWTP have to submit sludge ma… …oncepts considering P recovery
  - 2029 – P recovery oblig. for all WWT… …,000 p.e. (ban from land application)
  - 2032 – P recovery oblig. for all W… …00 p.e.
    - Even smaller WWTP ha… …P, if no land application possible
    - On-site WWTP: P re… …plete below 20 g P/kg DM or at least by 50%
    - After thermal-p… …recoverable separate storage of ash/concentrate or recovery pr… …80% recovery rate

  What…
    - N… …le recycling concepts included
    - …ure to secure proper ash quality (all sludge can be inc. in mono-inc.)
    - …rence value for P should refer to mineral sludge phase, not to DM
    - Who pays for what? (Inc. and recovery from ash monopoly?)

Sludge mono-incineration is favoured and will double in coming years!
Sludge disposal cost have already been doubled regionally last year!

Size does matter – P recovery obligation for WWTP > 50.000 p.e.



~ 500 WWTP directly affected

Source: Kraus 2016

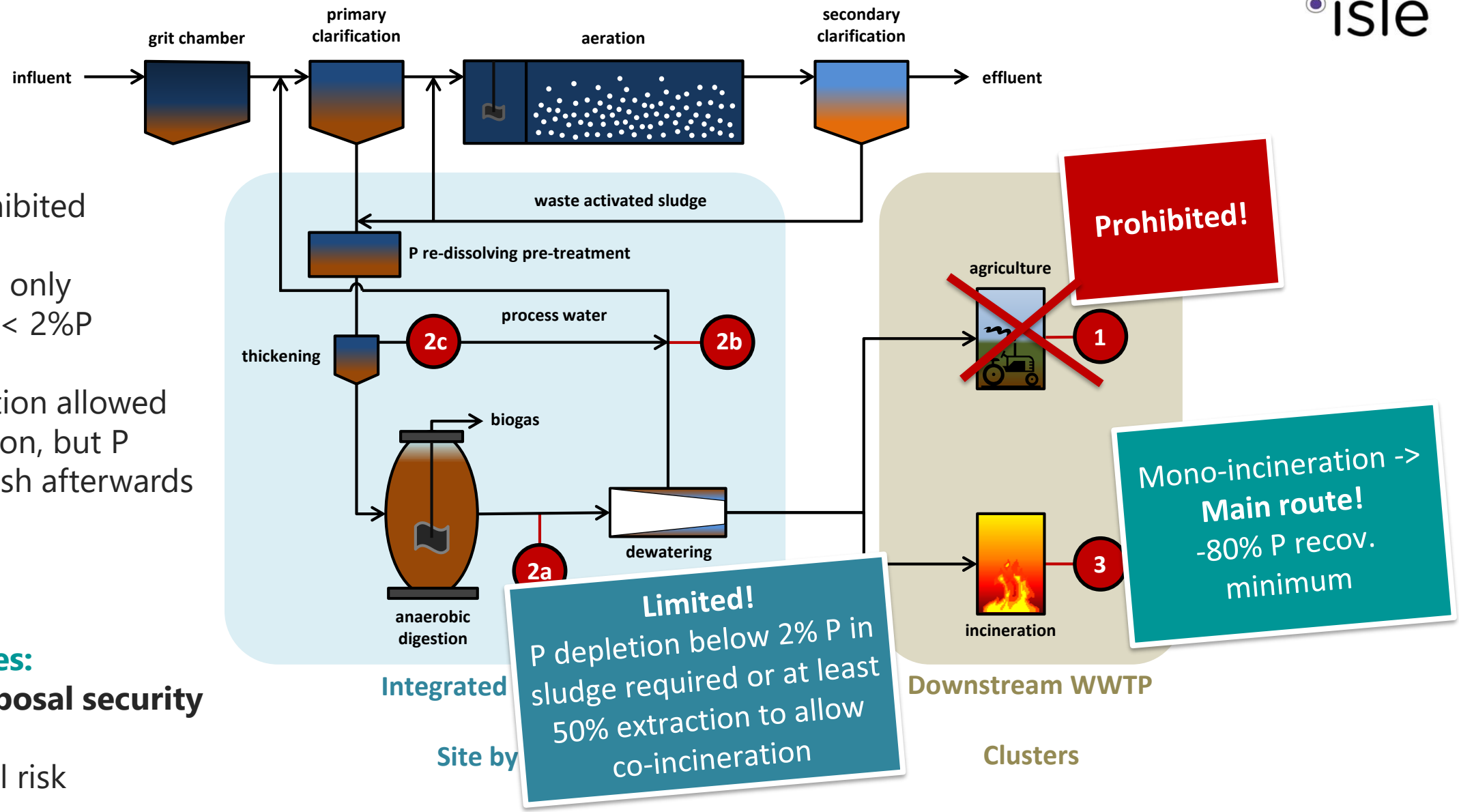
Hotspots for P recovery & Recycling for WWTP > 50.000 p.e.

2029/32+

- Land appl. prohibited
- Co-incineration only for sludge with < 2%P
- Mono-incineration allowed without restriction, but P recovery from ash afterwards required

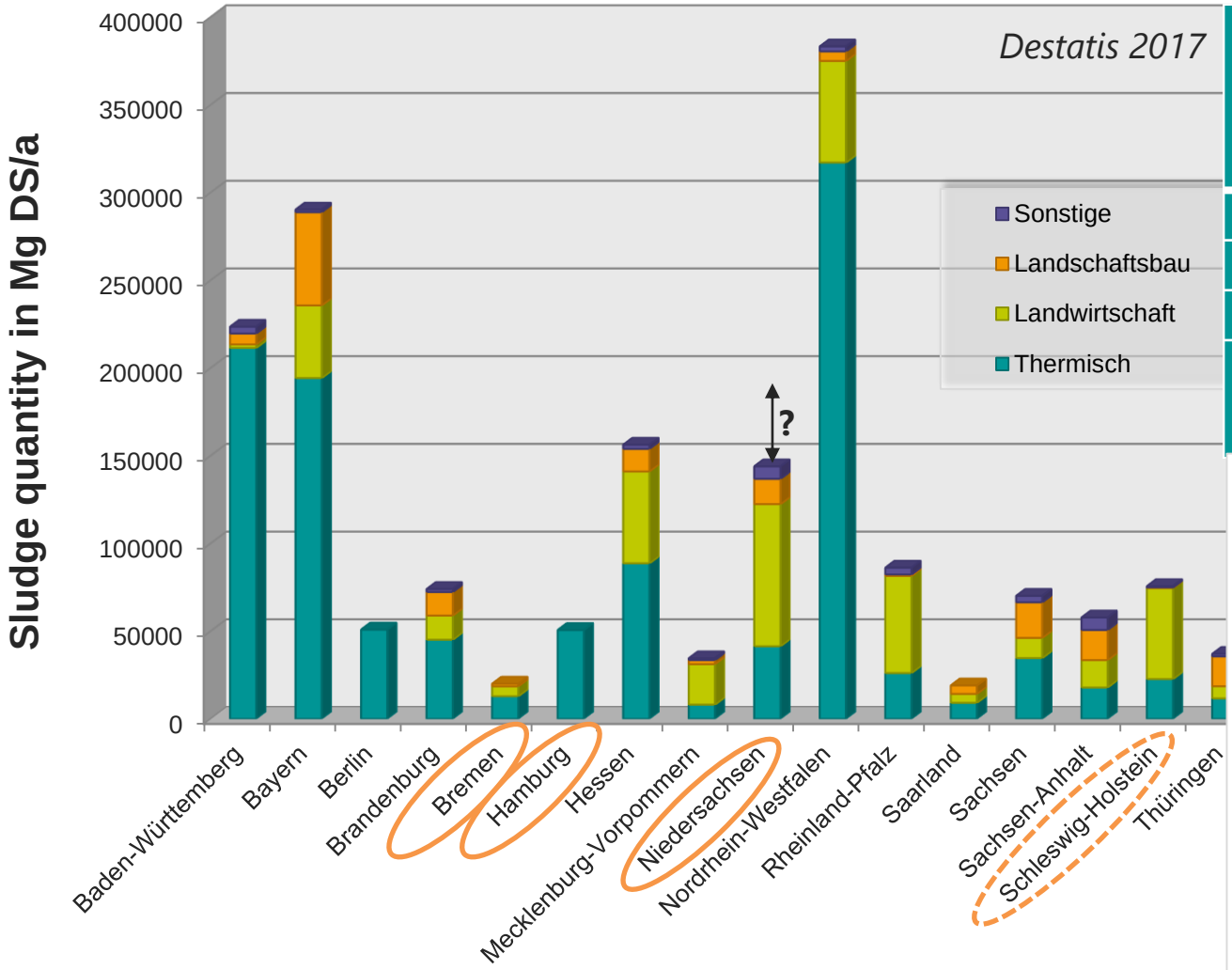
Priority for utilities:

- **Long term disposal security**
- Cost control
- Lowest financial risk

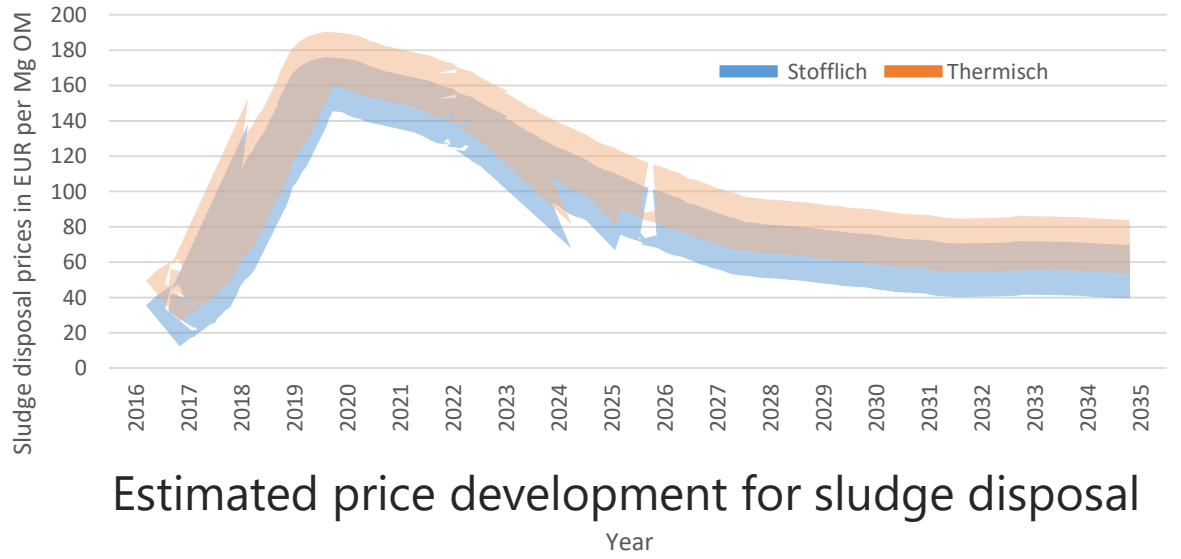


Region North-West Germany – Example 1 – rural setting

- Traditionally high share of land application
- Since autumn 2017 acute shortage of disposal capacities (agriculture) -> cost explosion

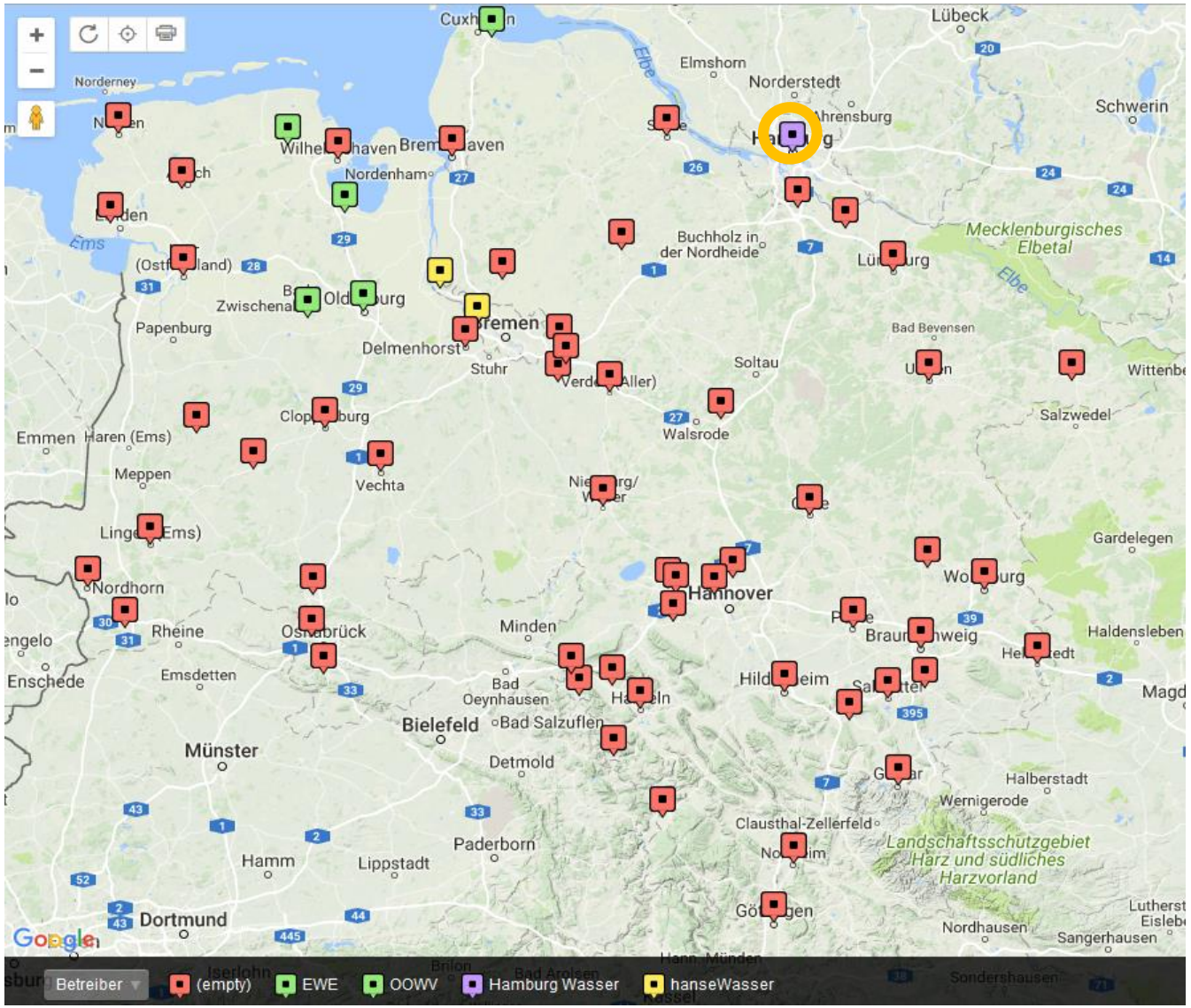


Fed. State	Sludge in Mg DS/a	Mono-inc. Capacity Mg DS/a	Delta in Mg DS/a
Bremen	20.000	0	-20.000
Hamburg	50.000	66.000	+16.000
Lower Saxony	180.000	0	-180.000
Region NW	250.000	66.000	**-184.000**
minus 20%	200.000	66.000	-134.000



Estimated price development for sludge disposal

Direct impact of new fertilizing ord. and mid-term impact of new sludge ord.



Affected p.e.: 12.768.800
Out of 19.410.000 p.e.
(65,8%)

at:

Site-by-site P recovery will not solve the problem of lacking disposal capacities!

31 GK5 WWTP (> 100.000 p.e.)
32 GK4b WWTP (> 50.000 p.e.)

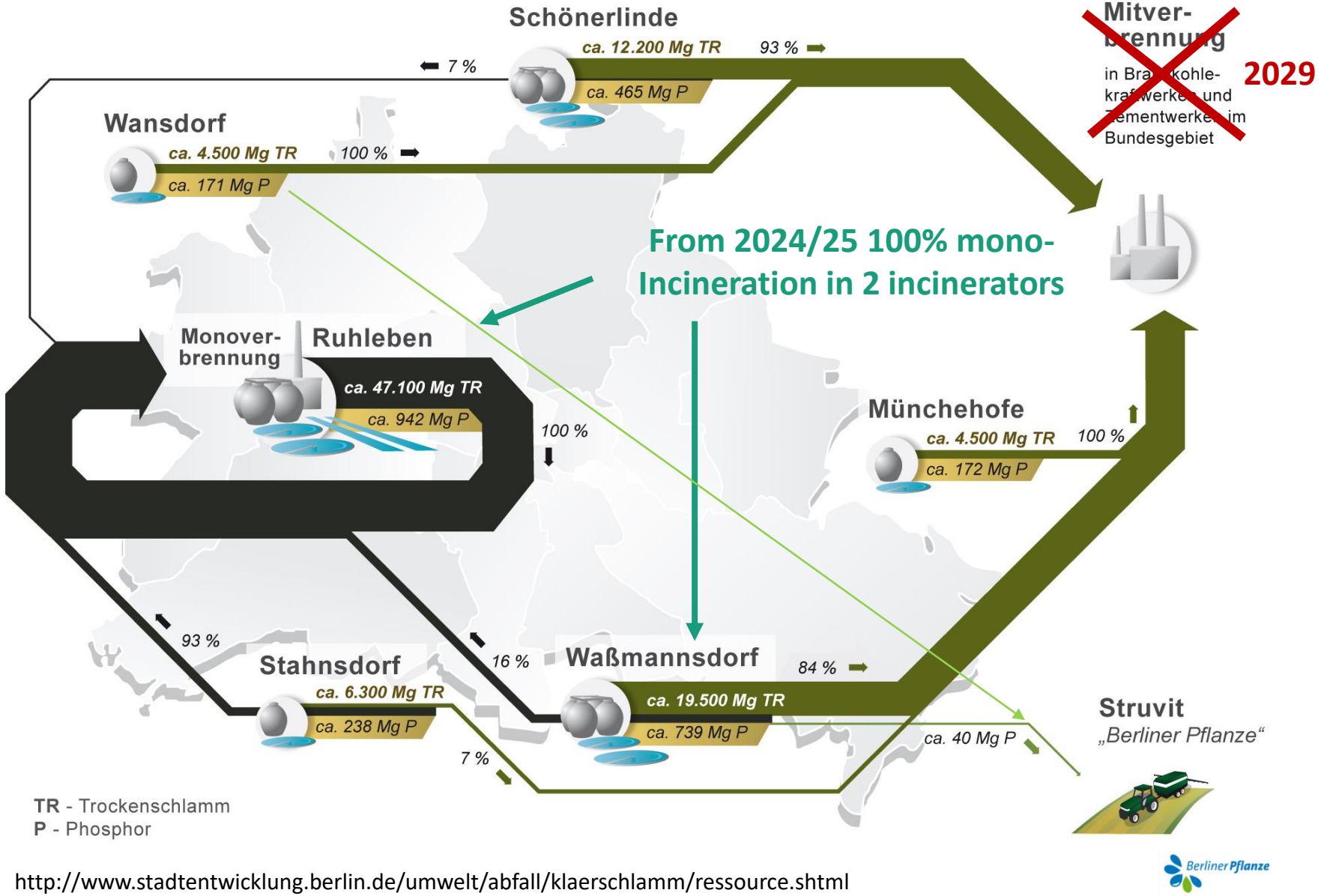
out of:

618 municipal WWTP in NW region in total
(~ 10%)

Only existing sludge incinerator in region NW is VERA in Hamburg

Currently no capacities to legally dispose 26.000 Mg DS! Contracts for another 30.000 Mg DS will end 2018!
No chance for extension!

Berlin 2017+: Example 2 – urban setting



Today:
60% mono-inc.
40% co-inc.
Some struvite

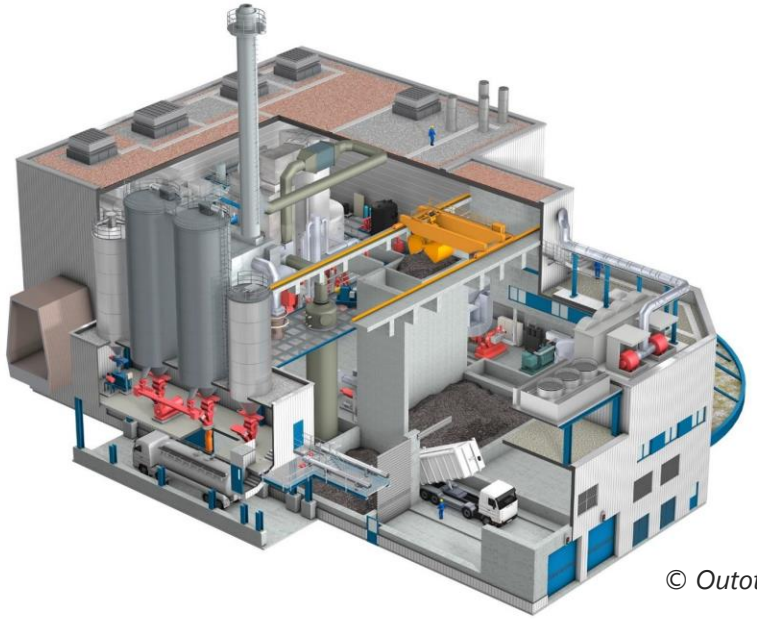
Tomorrow:
100% mono-inc.
Some struvite

http://www.stadtentwicklung.berlin.de/umwelt/abfall/klaerschlamm/ressource.shtml

Germany 2017+ substantial increase of mono-incineration

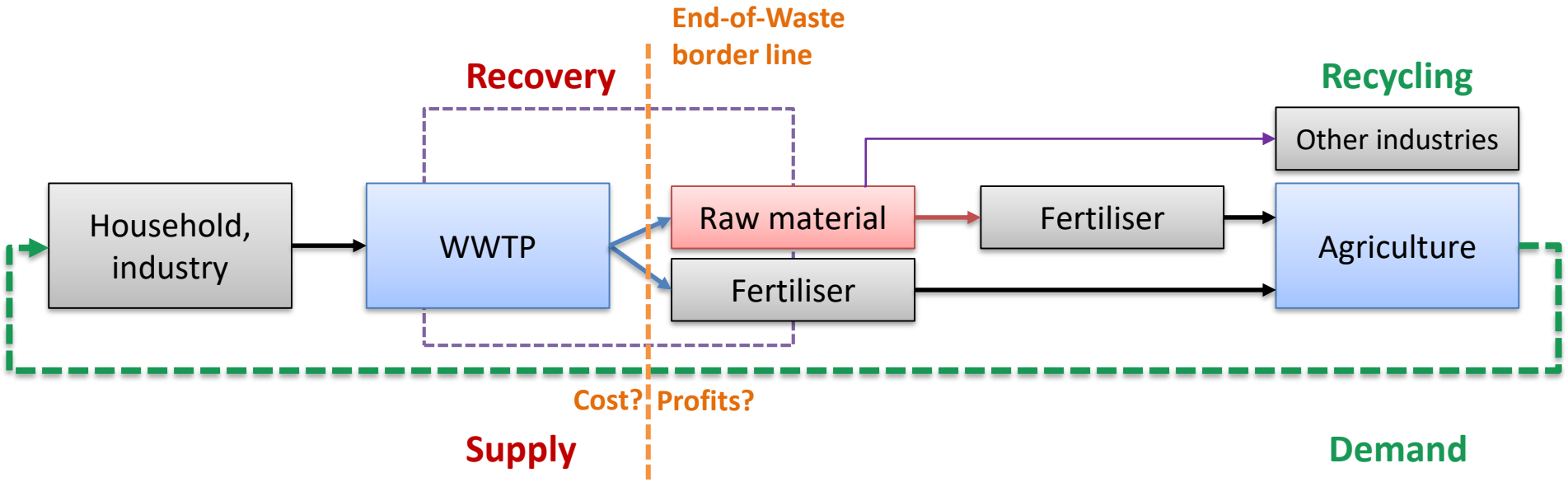
- Currently appr. 665 kt DS mono-incineration capacity 2017 (municipal sludge)
- After 2029/32 at least 1.200.000 Mg DS capacity needed to comply with sludge reg (Ecoprog 2017) … likely more
- Most new capacities between 2022 and 2027 (already +480 kt DS in prep. announced)

-> future SSA quantity > 500.000 Mg/a (>45.000 Mg P/a)



© Outotec

No Recycling without Value Chains

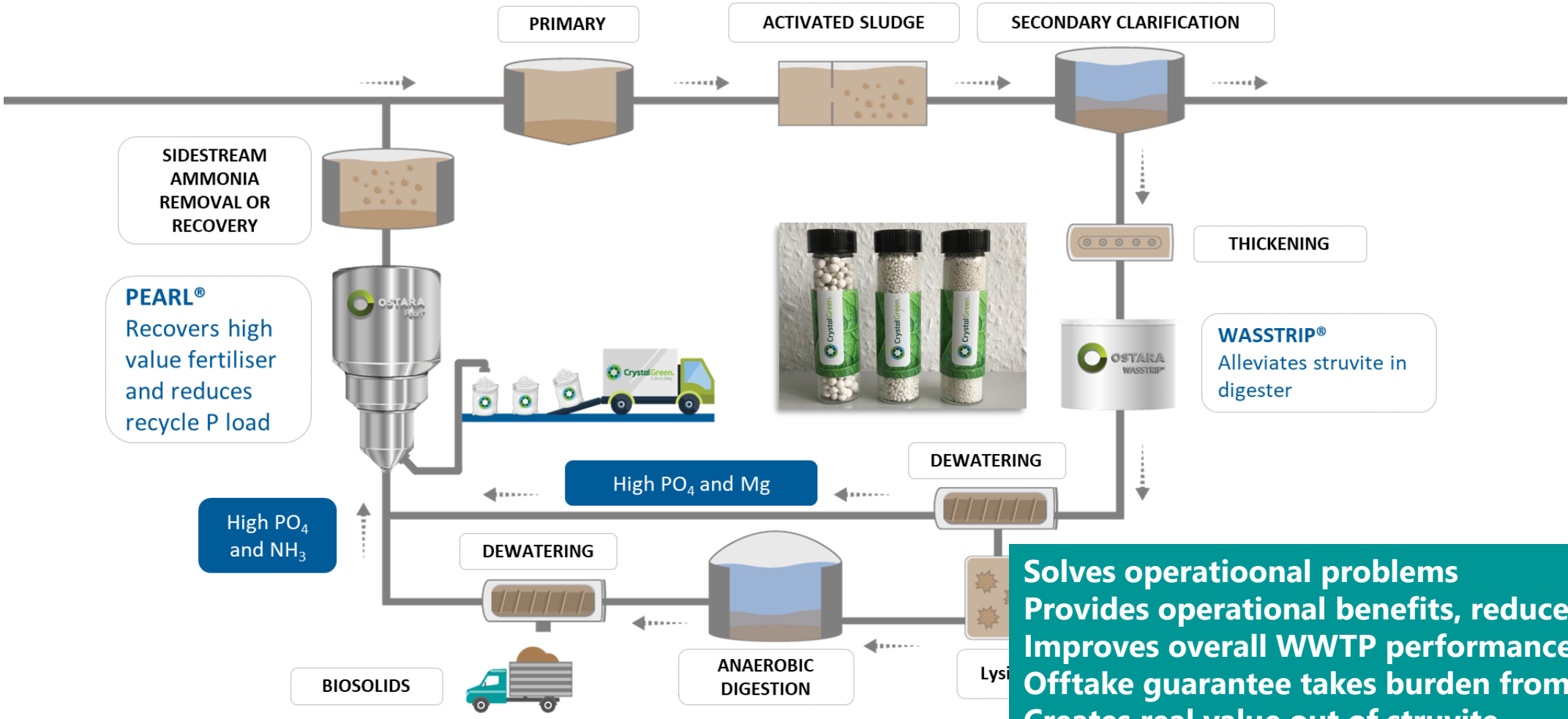


Waste, raw material or product? -> Question of volume, homogenity and <u>still</u> of origin!

Sludge – organic fertiliser
Struvite – NP fertiliser in some MS (proven good fert. eff.)
DCP – approved P fertiliser (component)
Ash – generally barely plant available, rather raw material – processing needed
MAP/DAP – main N&P components in fertiliser production (commodities)
MGP / P_4 – commercial products with broad application (commodities)

(Biochar) – actually Pyrochar! No fertiliser! Soil improver?

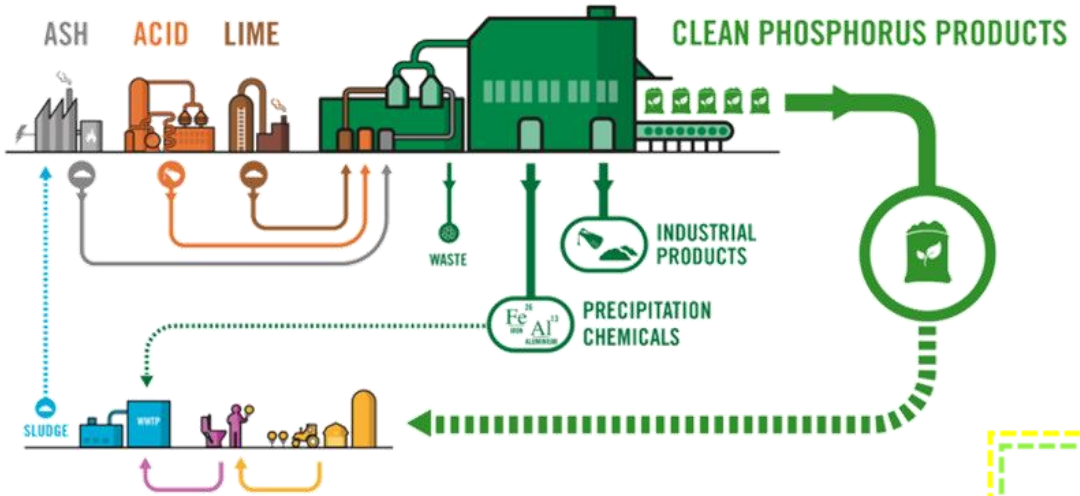
OSTARA's – Value Chain Solution (on-site WWTP recovery)



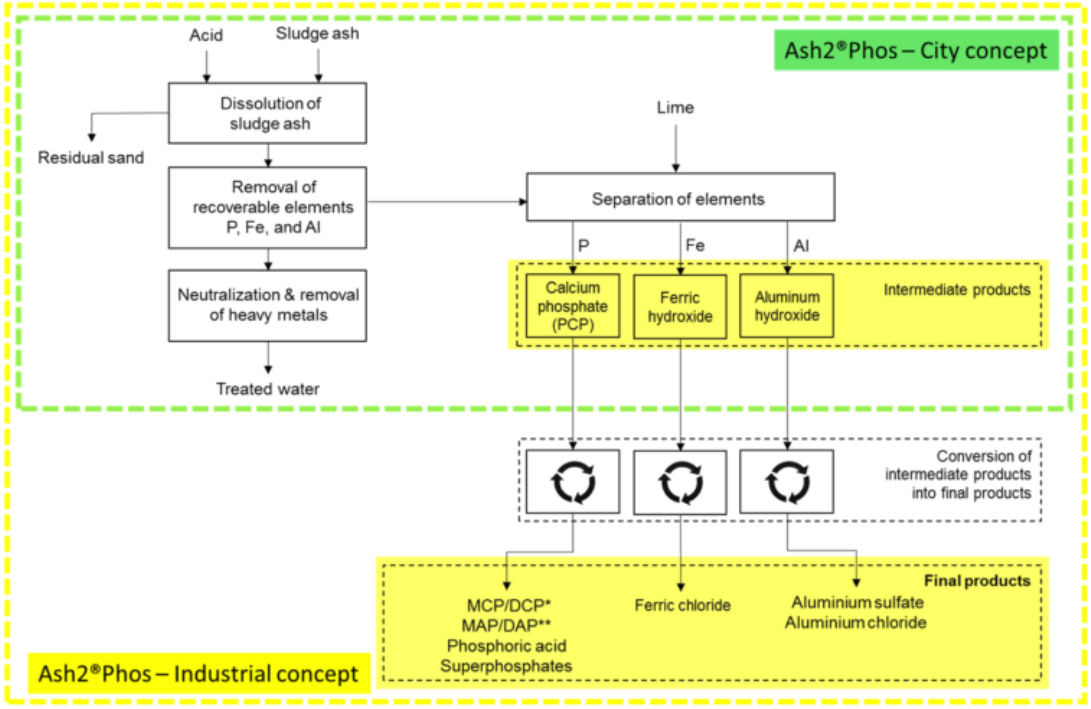
Solves operatioonal problems
Provides operational benefits, reduces opex
Improves overall WWTP performance
Offtake guarantee takes burden from operator
Creates real value out of struvite

Source: OSTARA

Ash2®Phos– EasyMining Sweden AB (ash route)



Commercial HQ products as renew. raw materials
Commercial HQ by-products
Independent of Fe/Al and ash moisture
Real Heavy Metal decontamination
Robust and simple!!!
Substantially reduces waste!



* mono/di-calcium phosphate (feed phosphate), mono/di-ammonium phosphate (fertilizer)

Source: http://www.easymining.se/our-technologies/ash2phos/

Wisdom just written on paper will
be dust one day;
Only the wisdom applied will shape
our future!

Wrap-up & Outlook

- Key driver for P recovery in EU is nutrient surplus in industrial countries (not scarcity)
- Some countries adapt legislation (CH, DE) to foster P recovery, others will follow
- Sewage sludge already is and will be more & more pushed out of land application by farm residues (trend towards incineration in more and more countries)
- Site-by-site P recovery on-site WWTP needs to be linked with operational needs and benefits and will play a limited complementary role
- Ash-based route will become the major route for P recovery from sewage in Germany (>500.000 Mg SSA, > 45.000 Mg P) -> lowest risk for invest. and sludge disposal route
- No recycling without value chains! Legal frame still needs to enable! Border crossing value chains (ash exports!) Adaption of waste and fertiliser regs…!
- Known materials easier to integrate in market! Recyclates need to fit into existing markets, not the other way around!
- Phosphorus must not be considered in isolation (N, C …) … also synergies with other wastes like manure etc? Tap synergies!

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