



From discussion **to implementation**

The impact
of **nutrient recovery targets and legal obligations**
on sewage sludge management in Germany

by **Christian Kabbe**

AGENDA



01

Introduction

02

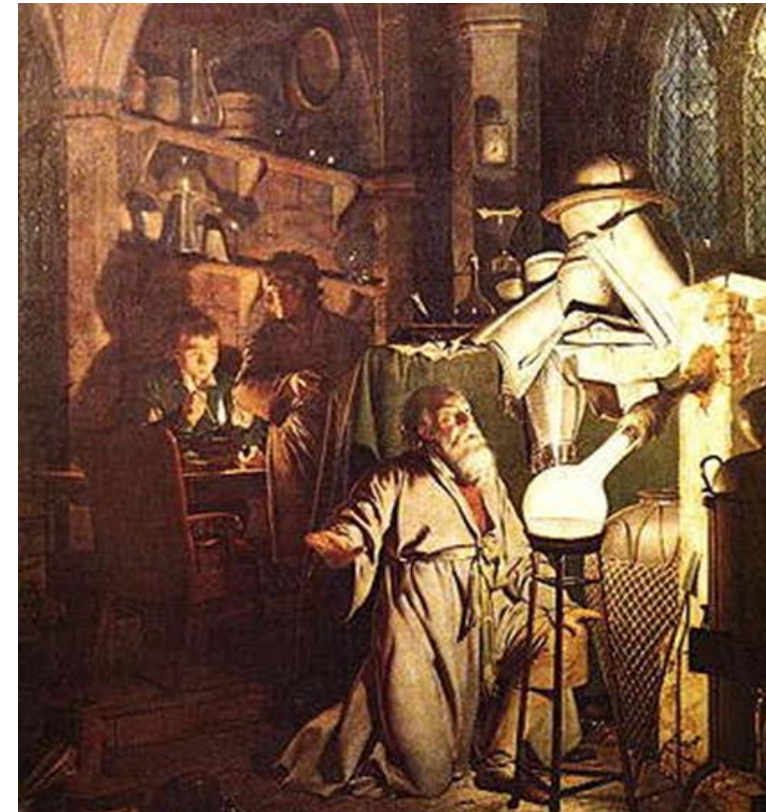
Germany 2017+

03

Recovery to Recycling
and Market issues

04

Outlook



Joseph Wright of Derby: Henning Brand discovering phosphorus in 1669

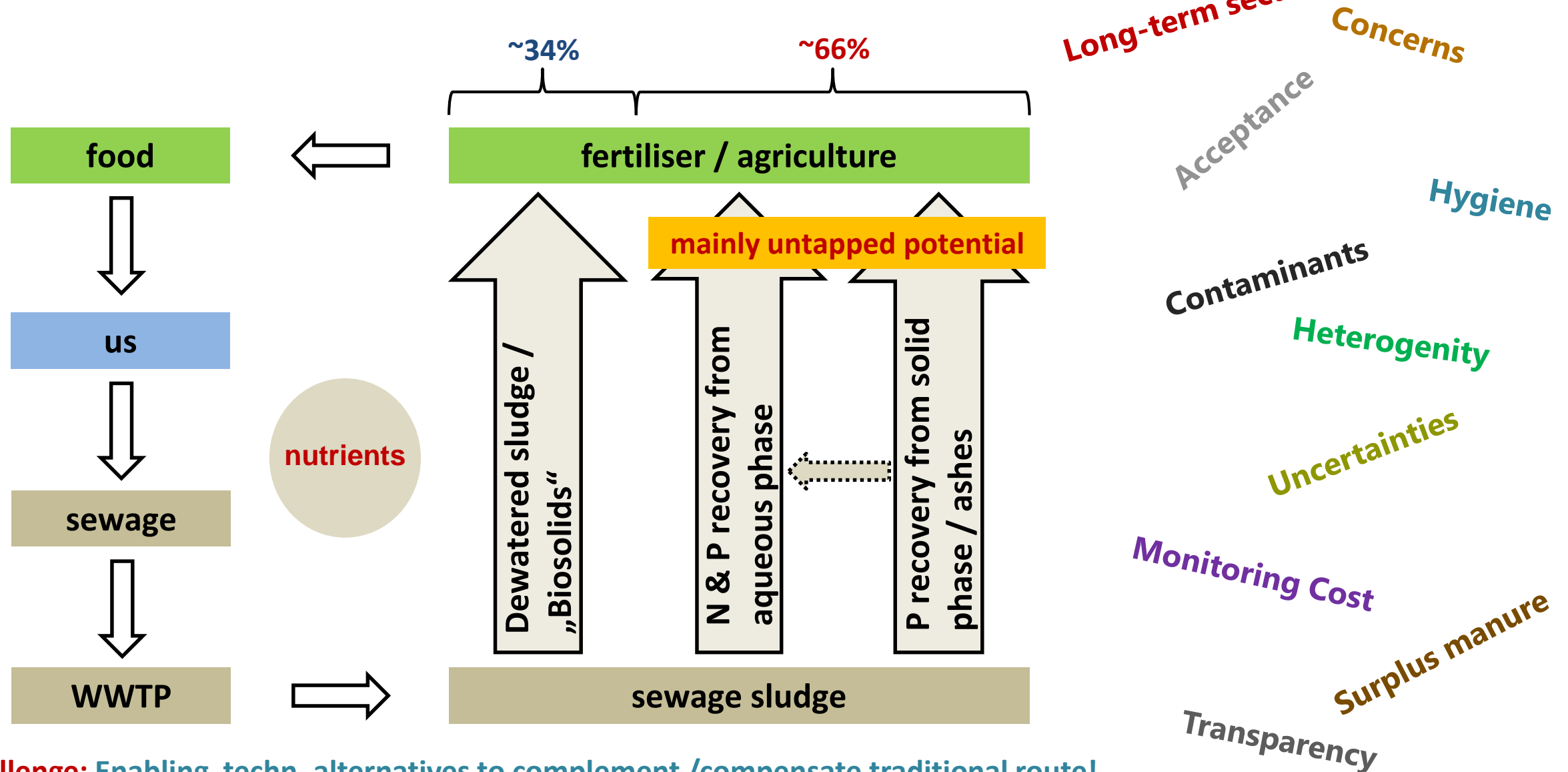
Sewage (sludge) is a
renewable nutrient resource
still waiting to be tapped to
it's full potential
in sustainable ways

Intro – Germany and future sewage sludge management

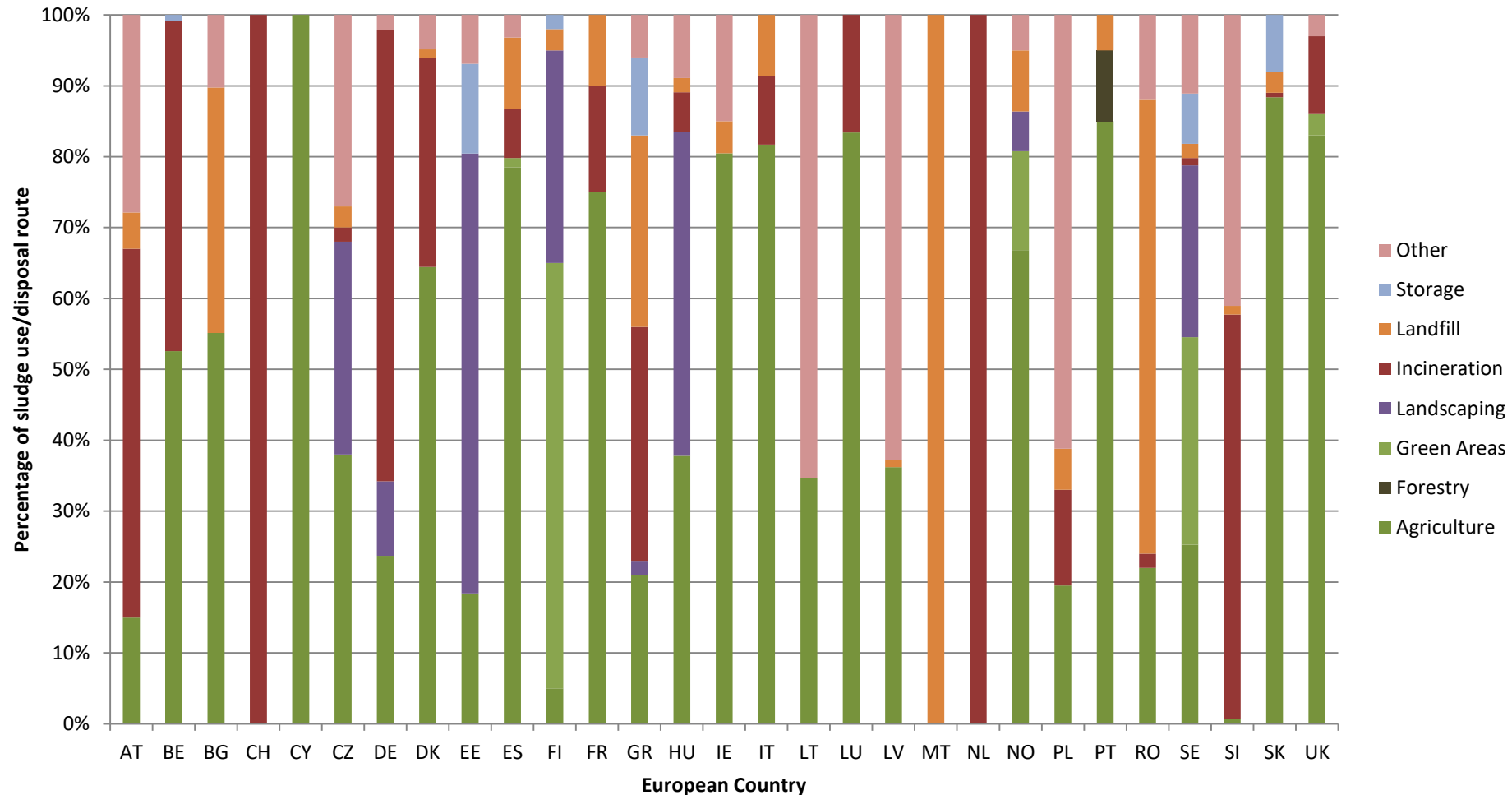


- 2017 – the year of change and shortage
- Stricter requirements (nutrient load limitations, shorter time windows for land application, more monitoring efforts)
- Lack of both, land and incineration capacities (regional diversity)
- Regional cost explosion for sludge disposal
- Collateral impacts on Germany's neighbours
- Utilities start reacting on future proof concepts

Pillars of Nutrient Recovery & Recycling in Germany



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!

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



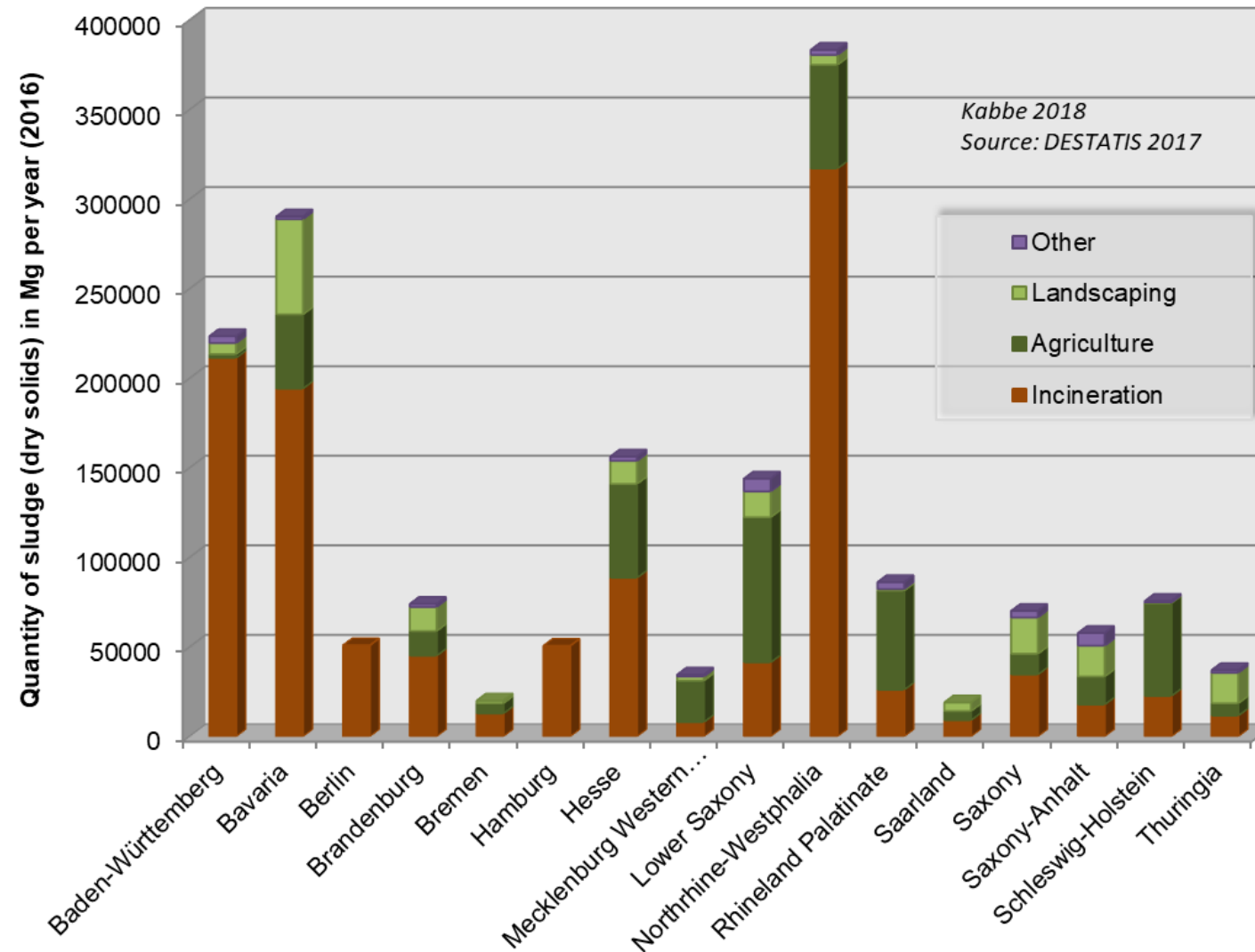
- 2017 – new fertilising ordinance (DÜV) limits nutrient loads applied to land and acutely reduces sludge disposal capacities -> cost explosion!
- new fertiliser ordinance (DÜMV) sets stricter quality criteria (less sludge conform) – monitoring cost
- 2017 – new sewage sludge ordinance (AbfKlärV) enters into force
 - 2023 – all WWTP have to submit sludge management concepts considering P recovery
 - 2029 – P recovery oblig. for all WWTP above 100,000 p.e. (ban from land application)
 - 2032 – P recovery oblig. for all WWTP > 50,000 p.e.
 - Even smaller WWTP have to recover P, if no land application possible
 - On-site WWTP: P recovery to deplete below 20 g P/kg DM or at least by 50%
 - After thermal-pretreatment recoverable separate storage of ash/concentrate or recovery process with >80% recovery rate

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

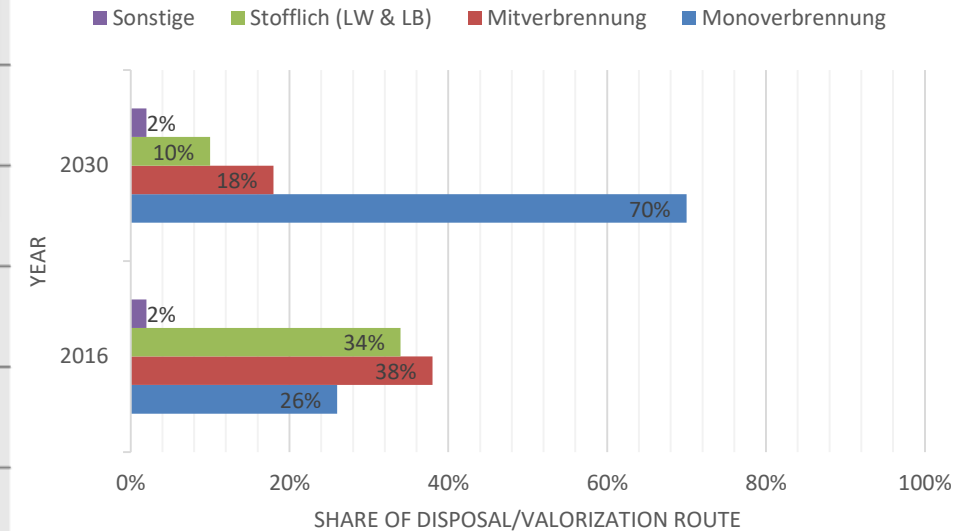
What is missing?

- No marketable recycling concepts included
- No measure to secure proper ash quality (all sludge can be inc. in mono-inc.)
- Reference value for P should refer to mineral sludge phase, not to DS
- Who pays for what? (Inc. and recovery from ash monopoly?)

Sewage Sludge - Destinations in Germany 2016

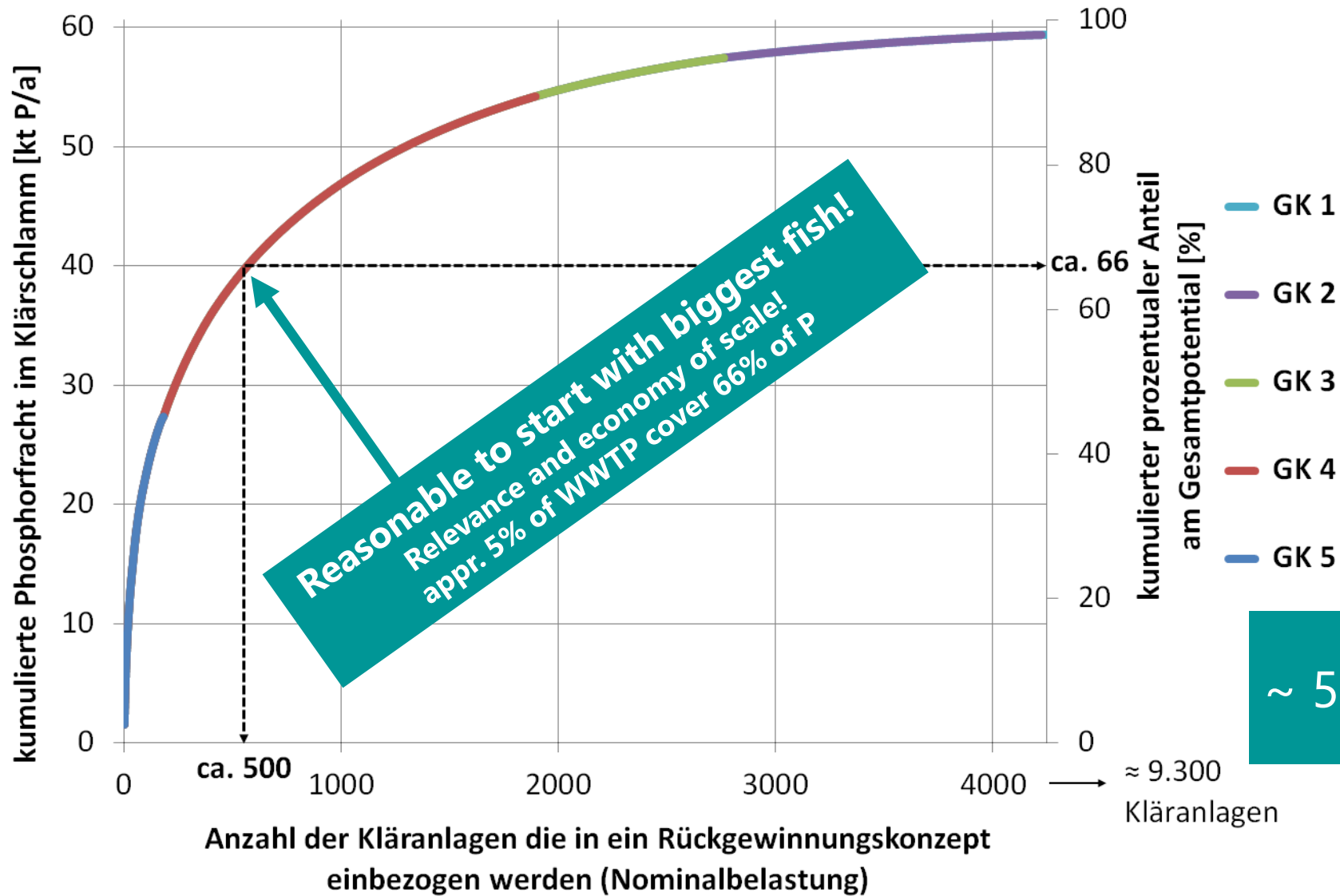


Estimated trend for future disposal routes by 2030



Total municipal sludge quantity: 1.77 million tons of dry solids per year!

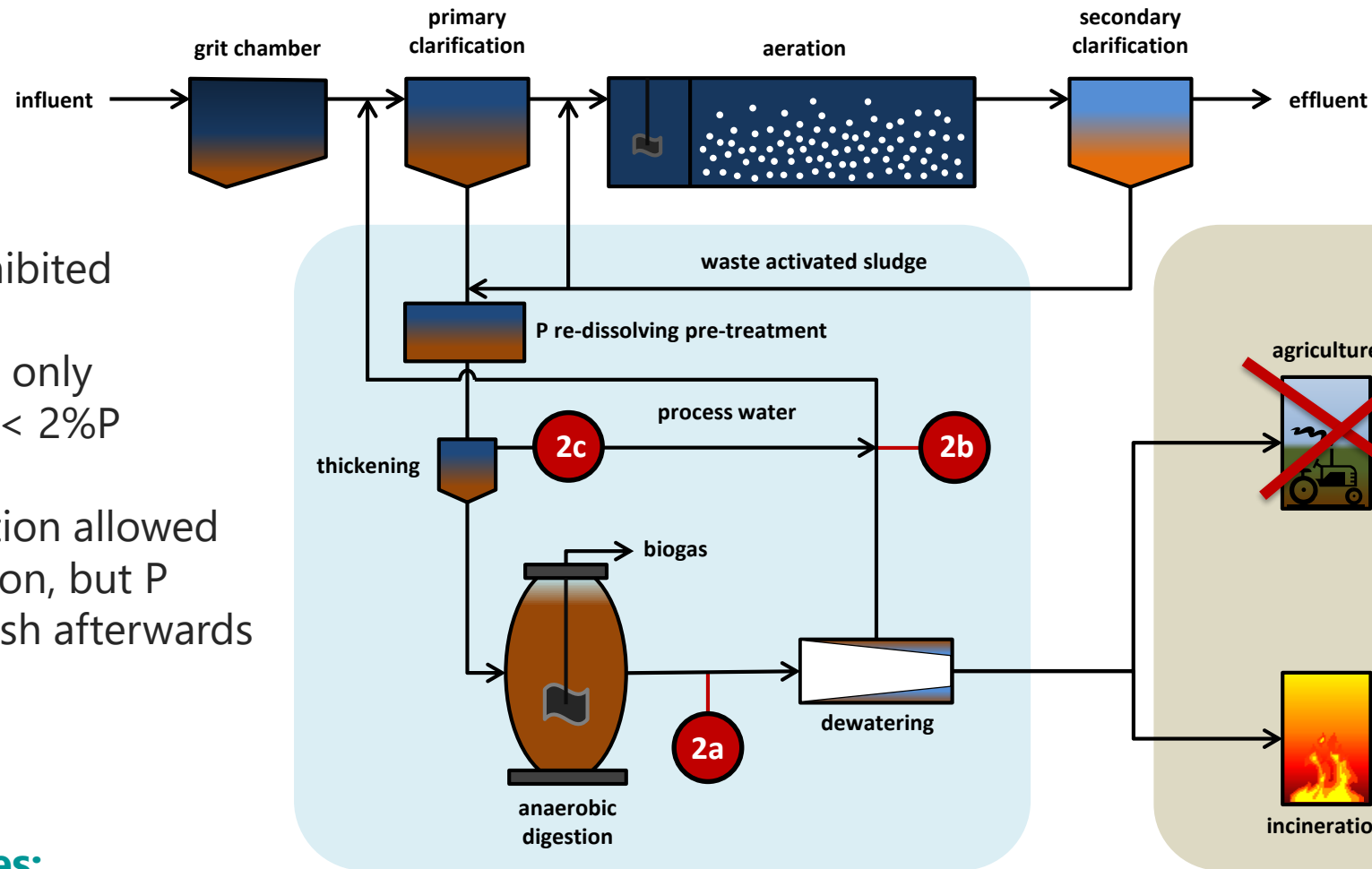
Size does matter – P recovery obligation for WWTP > 50.000 p.e.



~ 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

Integrated in WWTP

Site by Site

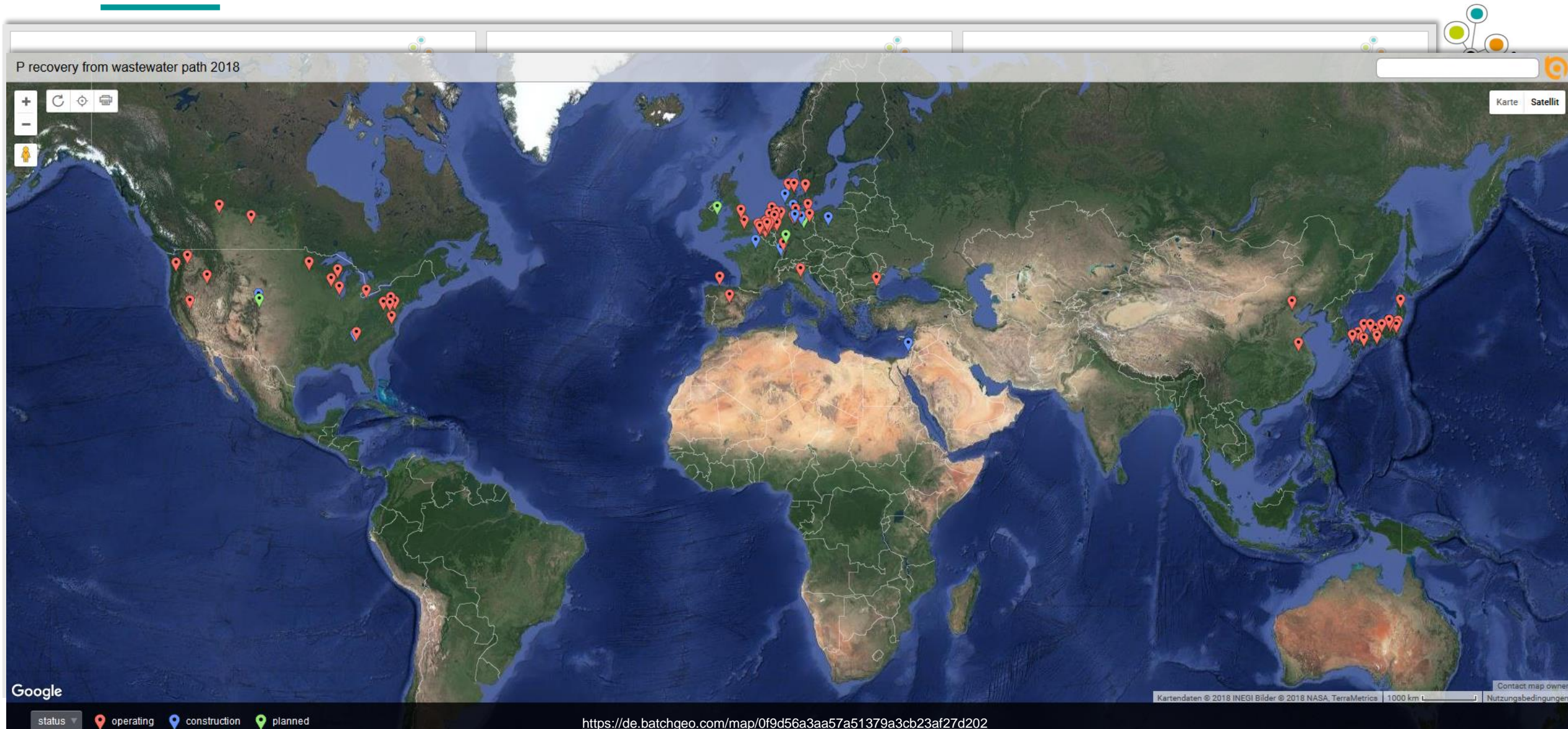
Downstream WWTP

Clusters

Limited! P depletion below 2% P in sludge required or at least 50% extraction to allow co-incineration

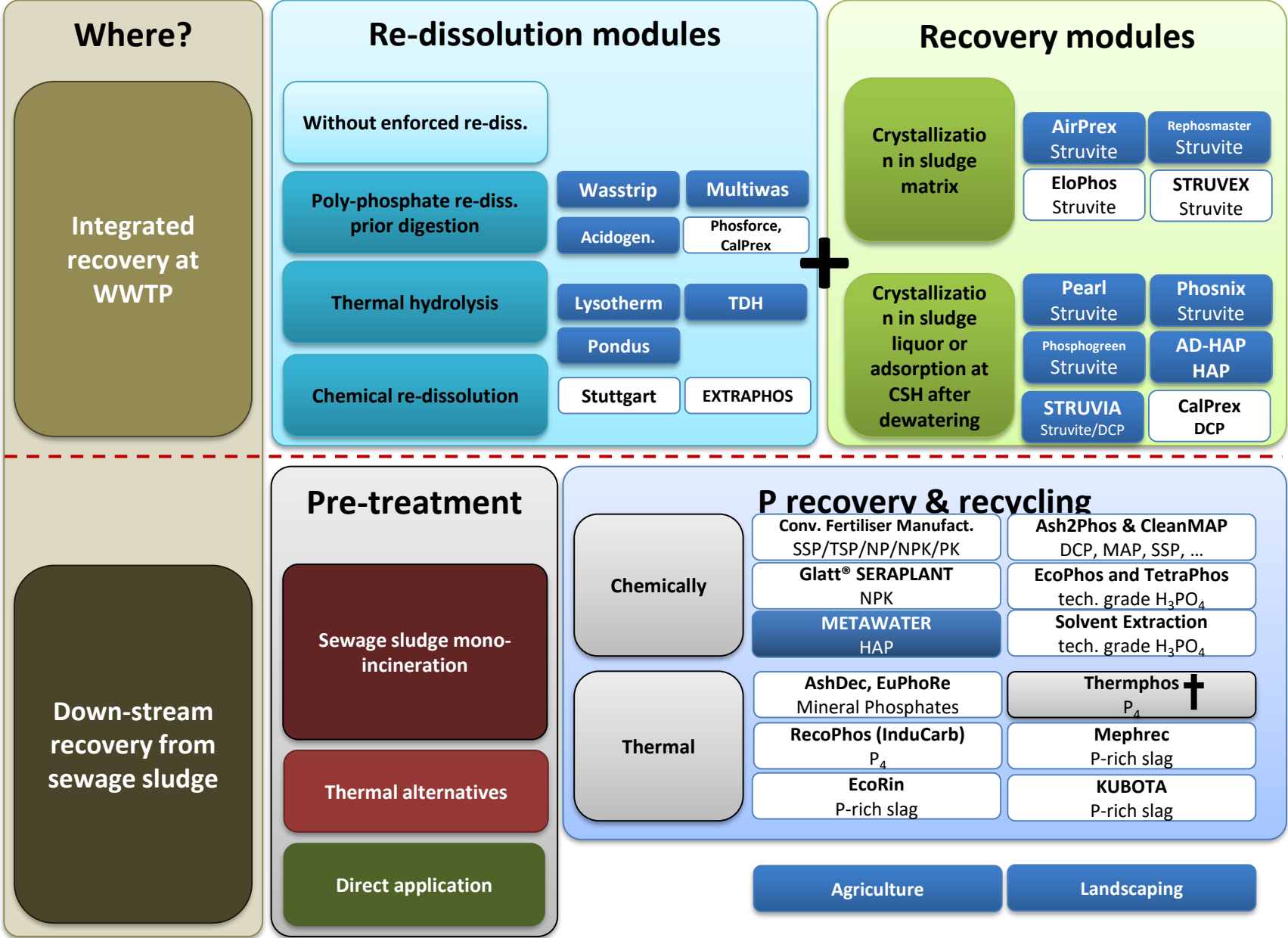
Mono-incineration -
> Main route!
-80% P recov.
minimum

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



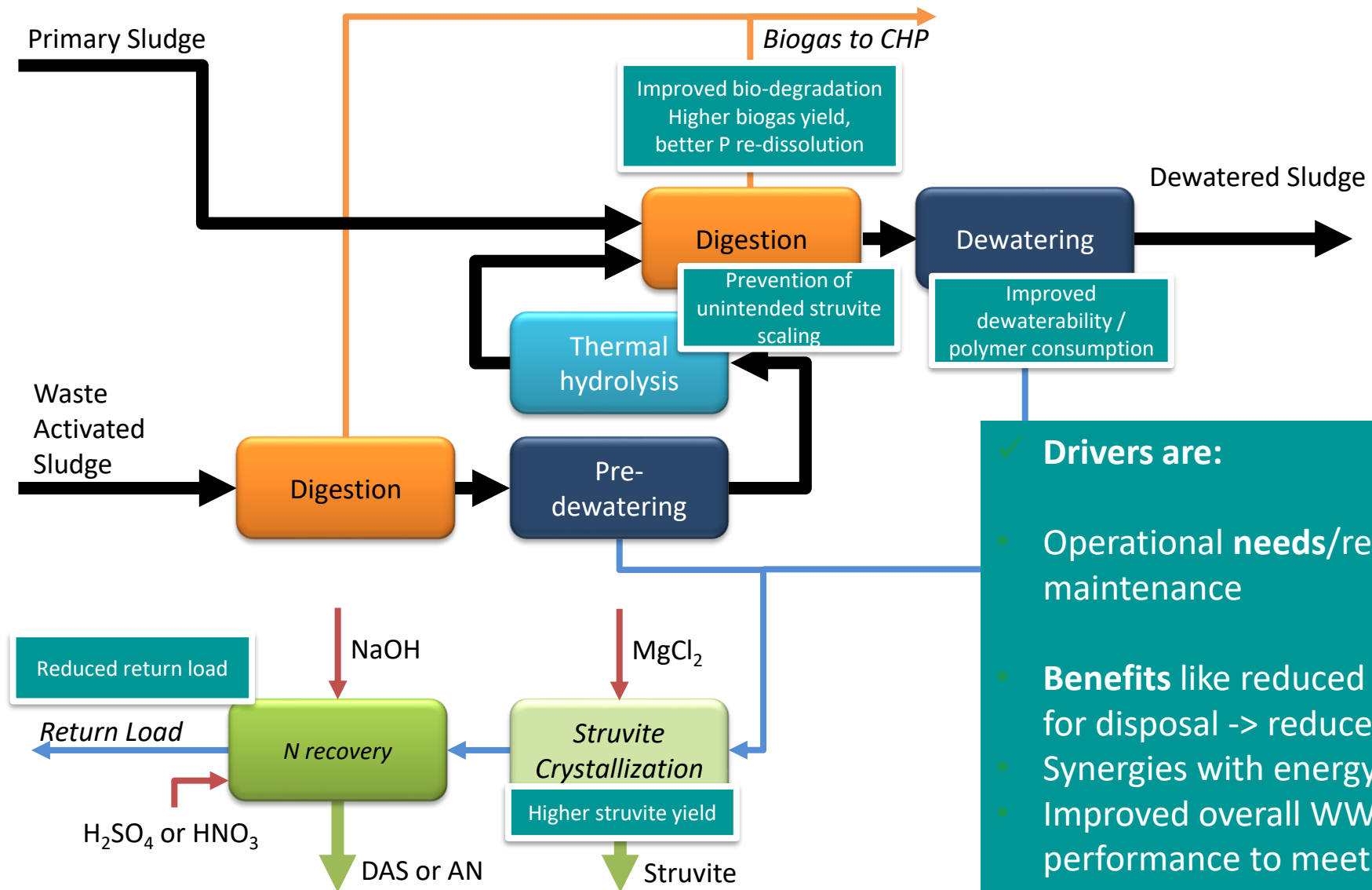
More than 100 full-scale plants operational world-wide! > 80 recover Struvite (> 60 are municipal)

Availability of Solutions? ... Yes! there are ...



Amended from P-REX® and Kraus

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
- Synergies with energy recovery
- Improved overall WWTP performance to meet stricter P consents

Challenges and **keys to Success** and Sustainability?



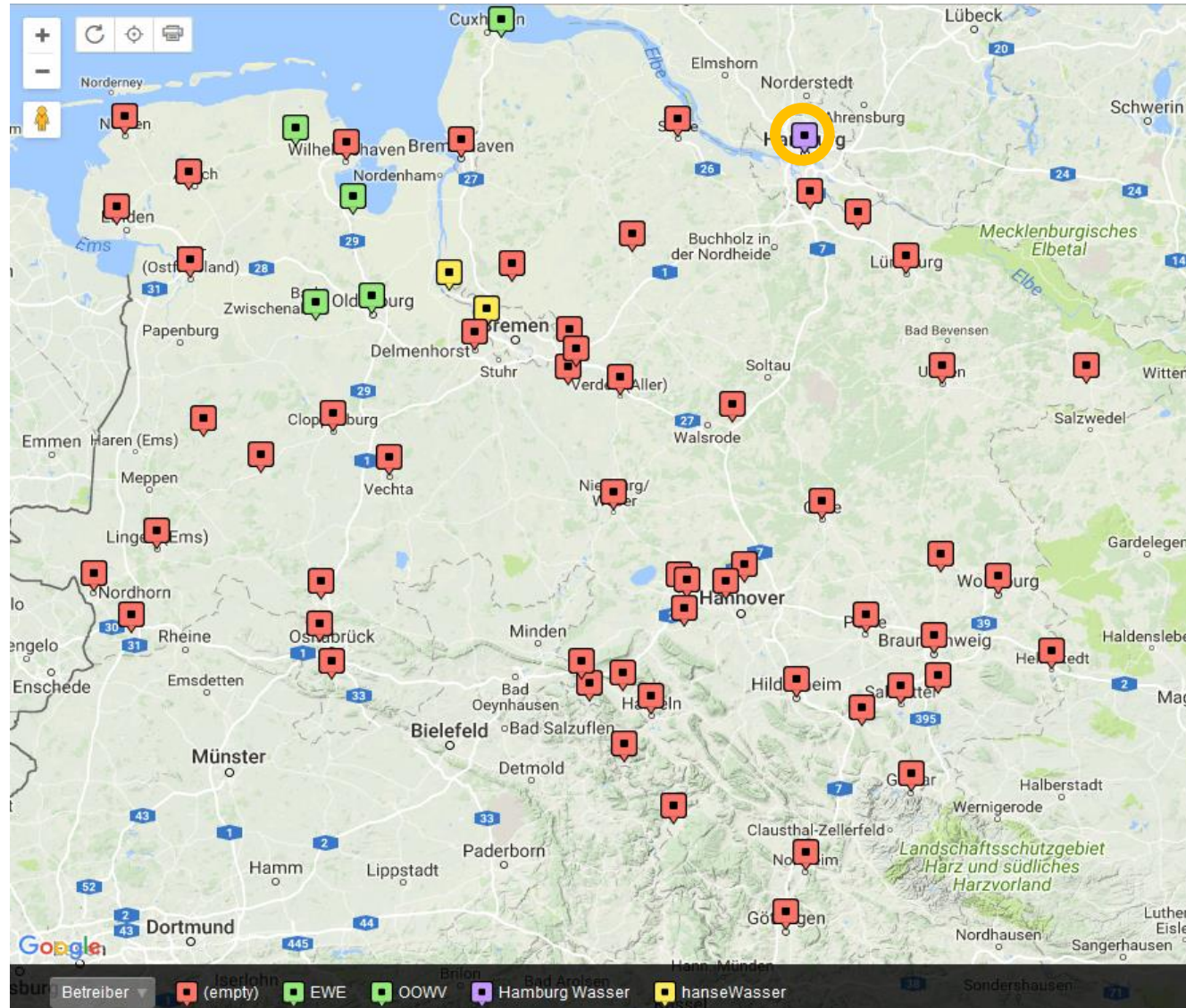
Only technologies, yielding **homogenous products** or raw materials, **independent from input material quality** and mutually meeting both criteria, **energy efficiency** and **resource efficiency** will have a chance for wide-spread application under sustainability aspects.

Keys:

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



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%)**

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

at:

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%)



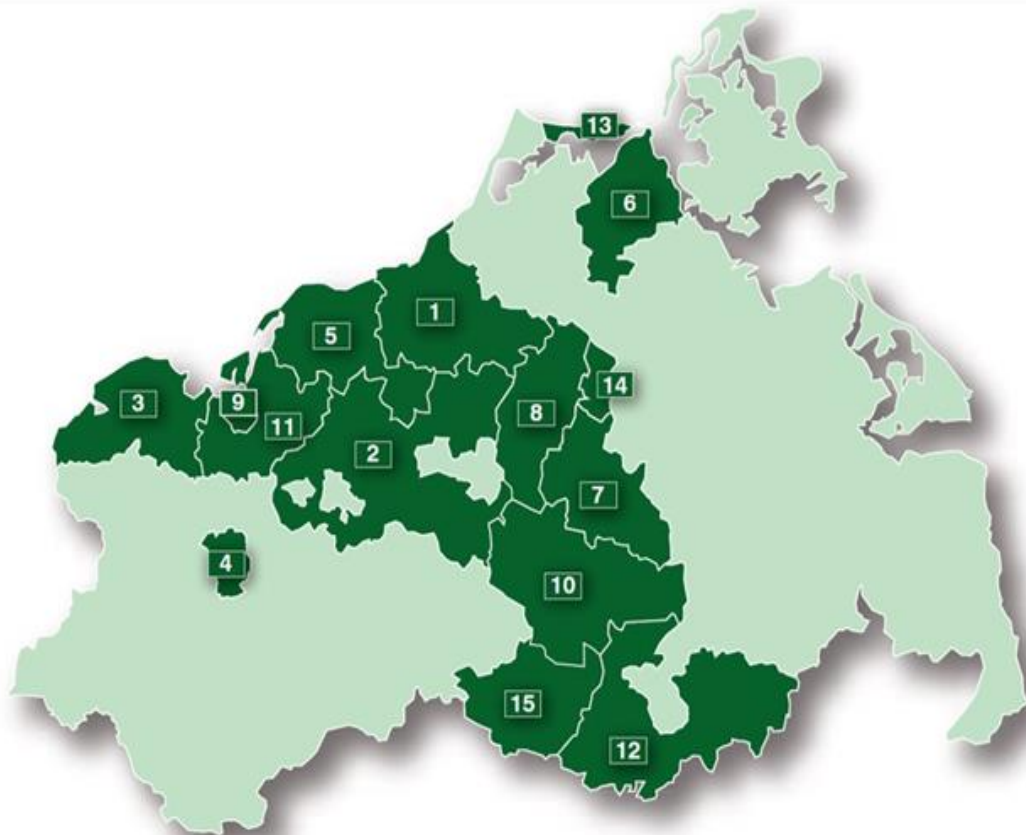
**Only existing sludge
incinerator in region NW
is VERA in Hamburg**

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

Region **North-East Germany** – Example rural setting coop



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

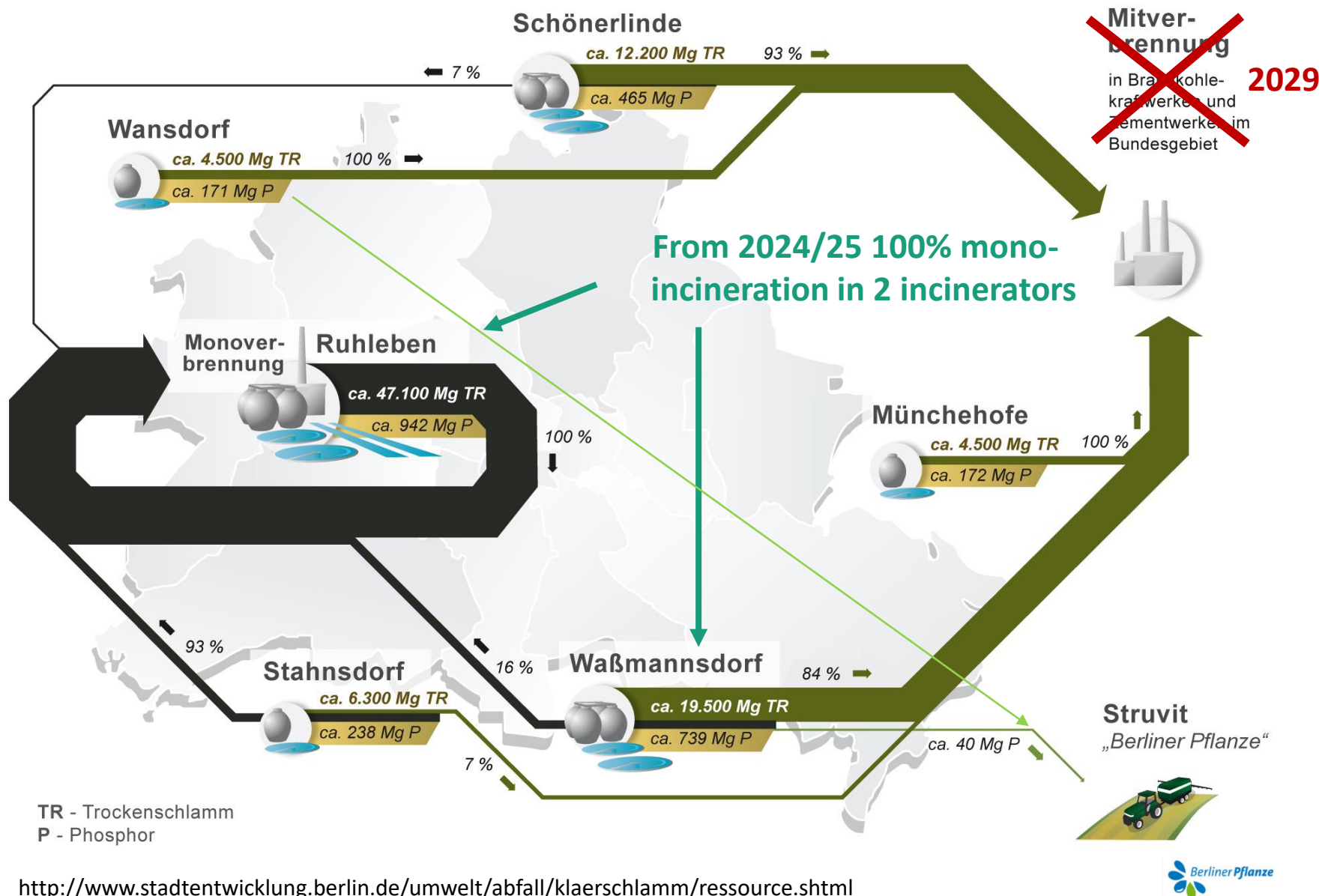


- 1 Warnow-Wasser- und Abwasserverband (WWAV)
- 2 Wasserversorgungs- und Abwasserzweckverband Güstrow-Bützow-Sternberg (WAZ)
- 3 Zweckverband Grevesmühlen (ZVG)
- 4 Schweriner Abwasserentsorgung Eigenbetrieb der Landeshauptstadt Schwerin (SAE)
- 5 Zweckverband Kühlung (ZVK)
- 6 Regionale Wasser- und Abwassergesellschaft mbH Stralsund (REWA)
- 7 Wasser Zweckverband Malchin Stavenhagen
- 8 Zweckverband Wasser / Abwasser Mecklenburgische Schweiz
- 9 Entsorgungs- und Verkehrsbetrieb der Hansestadt Wismar (EVB)
- 10 Müritzwasser-/Abwasserzweckverband
- 11 Zweckverband Wismar
- 12 Wasserzweckverband Strelitz
- 13 Gemeinde Zingst, Abwasserentsorgungsbetrieb
- 14 Stadt Dargun
- 15 MEWA Amt Röbel, Abwassereigenbetrieb

Inter-communal coop
15+2 municipalities
(~66% of sludge volume MV)

More than 25,000 t DS

Berlin 2017+: Example – urban setting



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

Tomorrow:
100% mono-inc.
Some struvite

Germany 2017+ substantial increase of mono-incineration



- Currently appr. 668 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 (Ecoprogram 2017) ... likely more
 - Most new capacities between 2022 and 2027 (already +600 kt DS in prep. announced)
- > future SSA quantity > 500.000 Mg/a (>45.000 Mg P/a)

Challenges/bottlenecks for implementation:

- Suppliers increased equipment prices substantially (cost explosion)
- Capacity of engineering consultants (with recent references?)
- Negative image of incineration

Germany 2017+ substantial increase of drying?



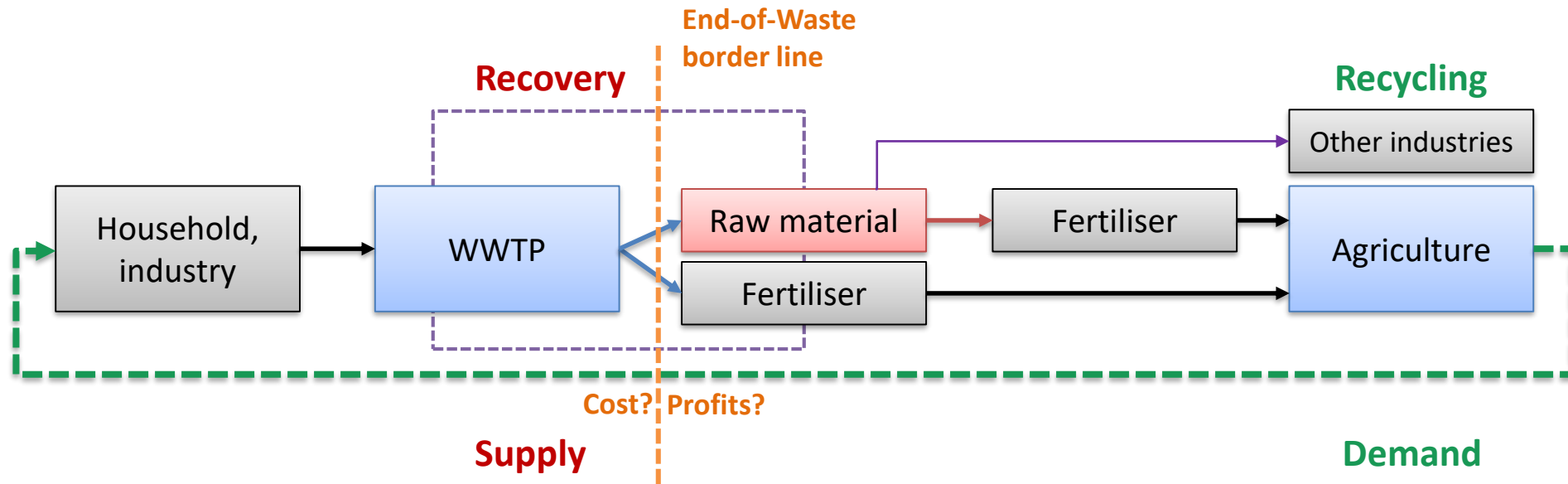
Number of installed sludge dryers in Germany 2017 and throughput

Type of dryer	Number of units	Quantity t DS/a	Capacity ranges / module
Belt	34	133,206	140 – 25,000 t DS/a
Thin layer	14	42,162	
Disk	32	182,420	15,000
Skrew	4	30,780	15,000
Solar	55	16,333	21 – 1,100 t DS/a
Solar with waste heat	35	34,554	88 – 10,000 t DS/a
Drum	7	23,250	
Fluidized bed	1	16,000	
Paddle	2	35,000	17,500 t DS/a
Other	21	43,500	Mainly tapping waste heat from biogas plants
Total	203	557,205	

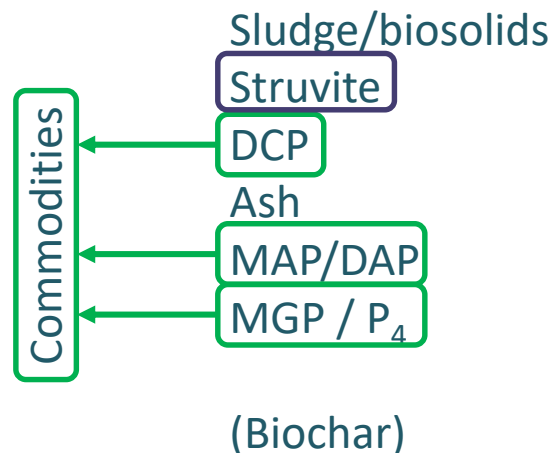
- Currently 60% fully dried (>90% DS) -> for co-inc. in cement kilns, pyrolysis, gasification ...
- 40% partly dried with 42% DS for mono-inc. and 75% for land appl.
- new capacities will be built to reduce transport volume and meet volumes for inc.

Source: Heidecke et al. KA 08/2018

No Recycling without Value Chains from sludge to products

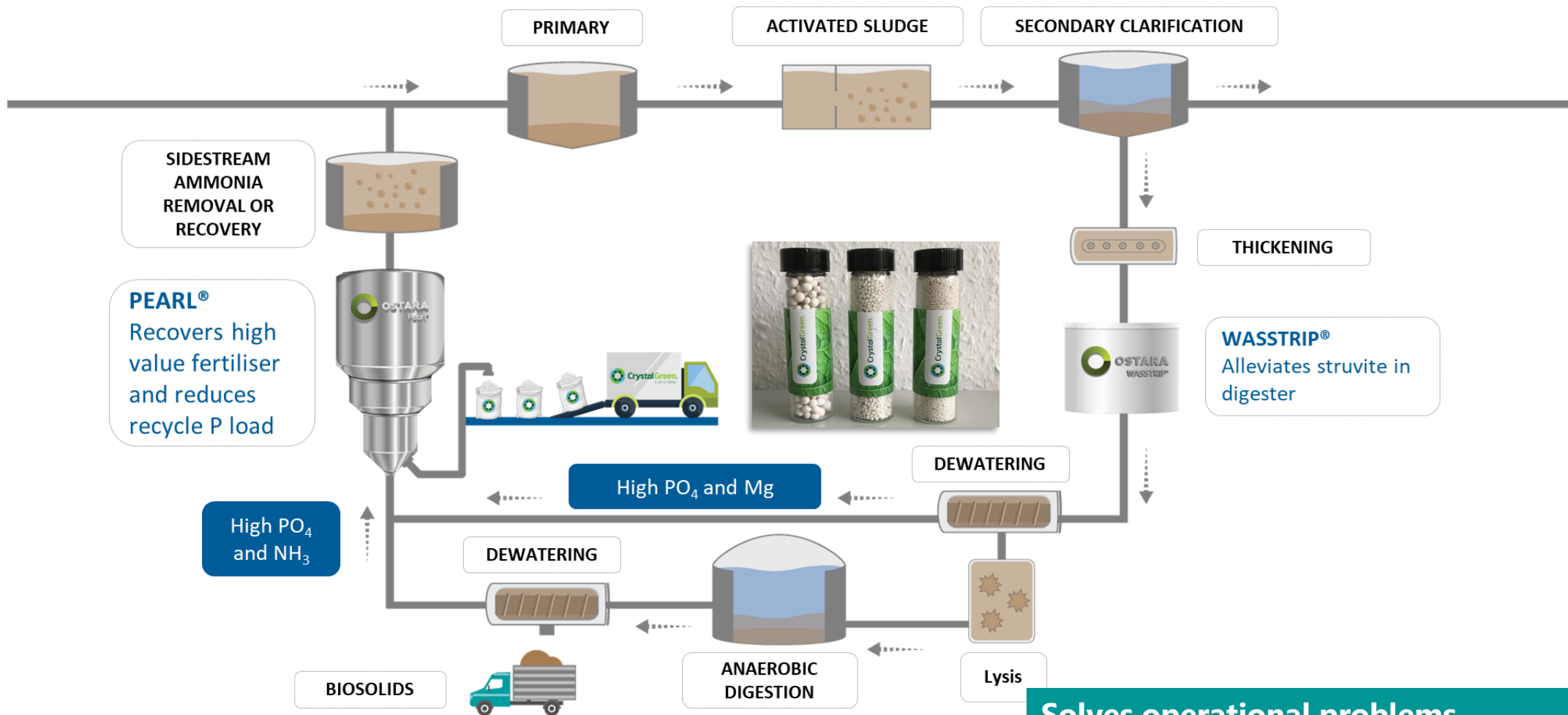


Waste, raw material or product? -> Question of volume, homogeneity and still of origin!



- organic fertiliser
- NP fertiliser in some MS (interesting for organic farming!)
- approved P fertiliser (component)
- generally barely plant available, rather raw material – processing needed
- main N&P components in fertiliser production (commodities)
- commercial products with broad application (commodities)
- actually Pyrochar! No fertiliser!

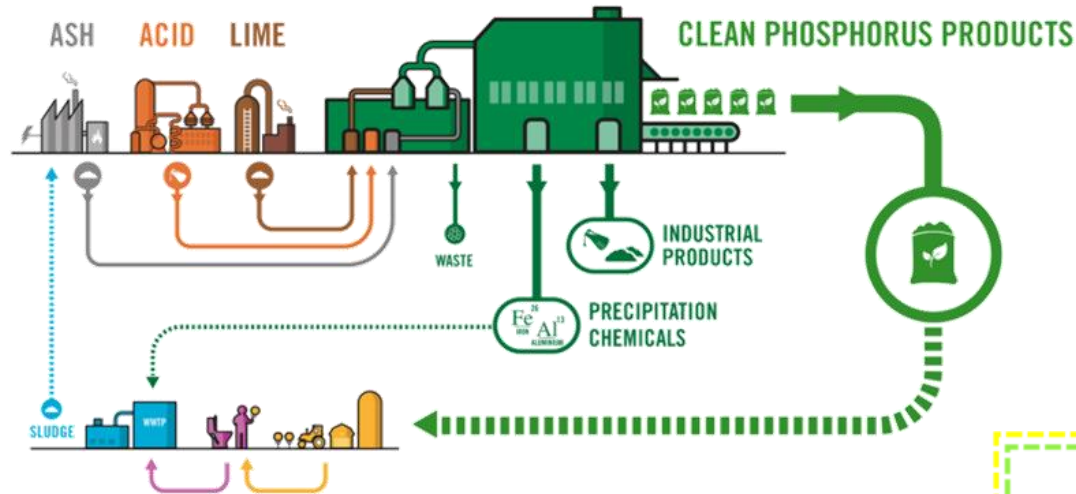
OSTARA's – Value Chain Solution (on-site WWTP recovery)



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

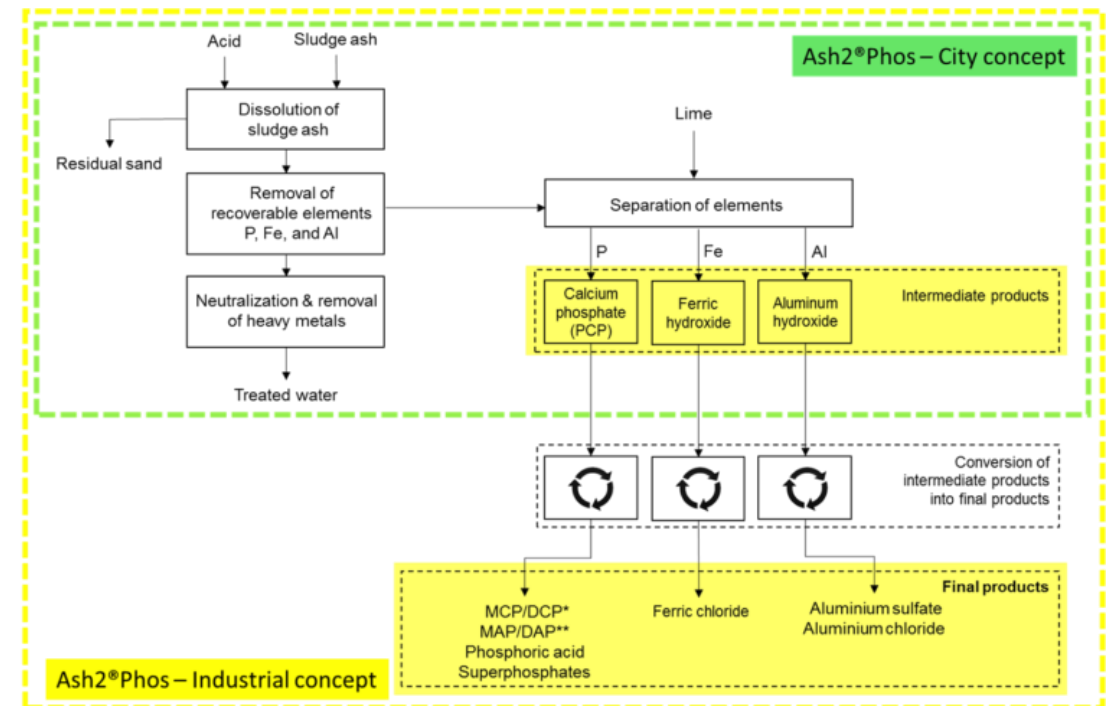
Source: OSTARA

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!

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



- Would there be a change without law enforcement? – NO!!!
- Shortage in legal sludge disposal capacities will remain until mid-to end-2020-ies (timing could be better!)
- Manure is key competitor for land application and farmers first choice!
- New German legislation fosters sludge mono-incineration and therefore drying as well -> co-incineration capacities declining ... as capacities for imported sludge
- German sludge first, imported sludge not even second! Disposal cost already did and will raise substantially! Re-normalization not before 2030 expected!
- 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
- Known materials easier to integrate in market! Recyclates need to fit into existing markets, not the other way around!

Thank you



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Urban Resilience TAG Europe

Copenhagen, 23 January 2019

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