



# Urine separation accomplished, what comes next?

- Newest experiences of on-site treatment  
and transport by pipe or truck –

Martina Winker<sup>1</sup> & Felix Tettenborn<sup>2</sup>

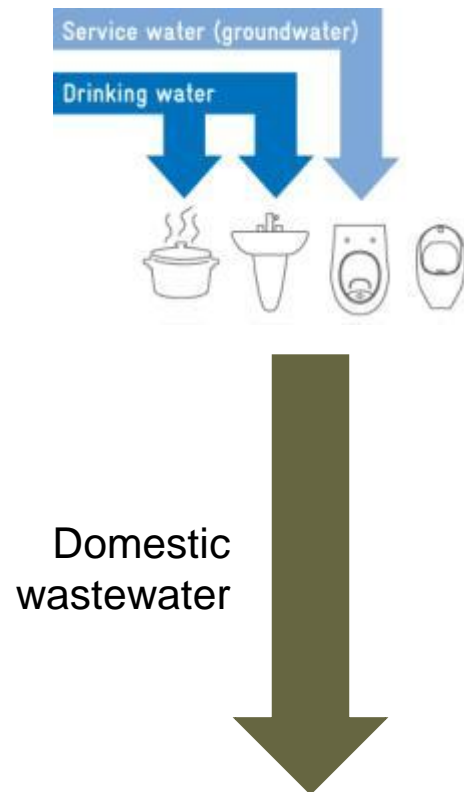
<sup>1</sup>German International Cooperation (GIZ) GmbH

<sup>2</sup>Fraunhofer Institute for Systems and Innovation Research (ISI)

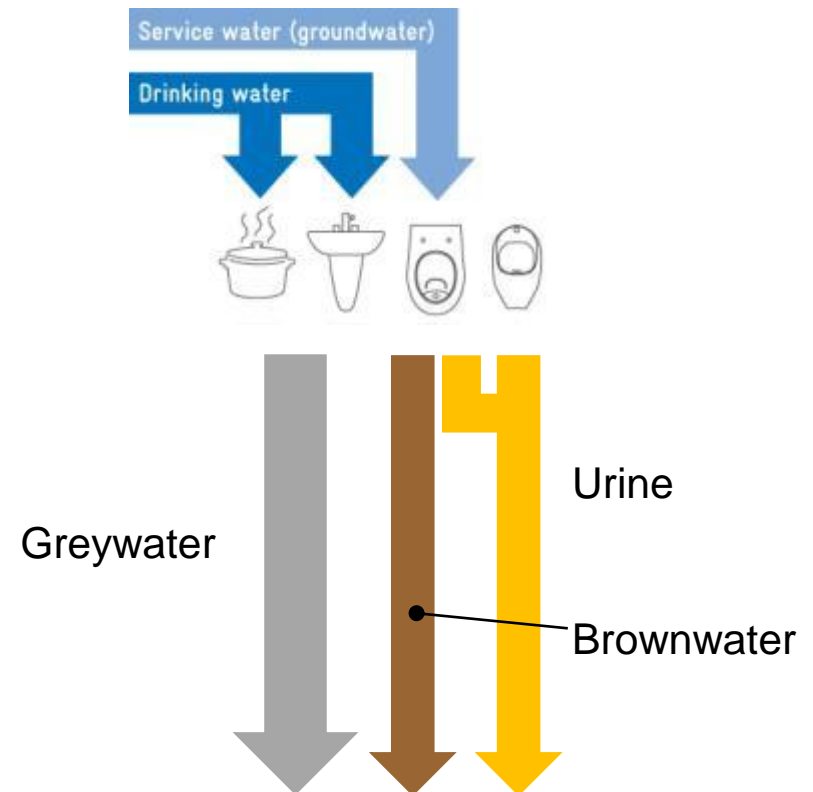


# Separation of urine

## Conventional system

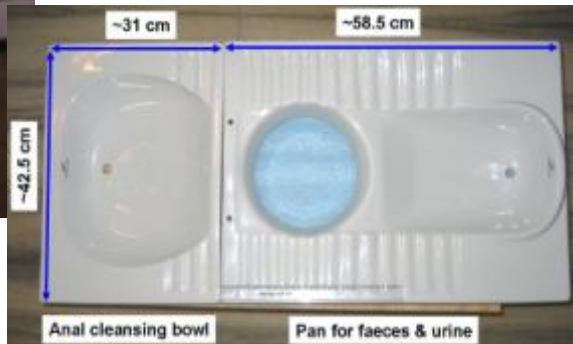


## Urine diverting system





# Applied sanitary technology





# Buildings and demonstration cites



Gebers, close to Stockholm (von Münch, 2007)



SolarCity Linz, Austria (Hochedlinger, 2009)



Forum Chriesbach, eawag, Zurich, (eawag, 2009)



Former GTZ headquarters, Eschborn (GIZ)



# Urine - reuse as liquid

- High concentrations of N and P as well as other nutrients
- Low ammonia emission
- Comparable to liquid manure after field application
- Multi-component fertiliser

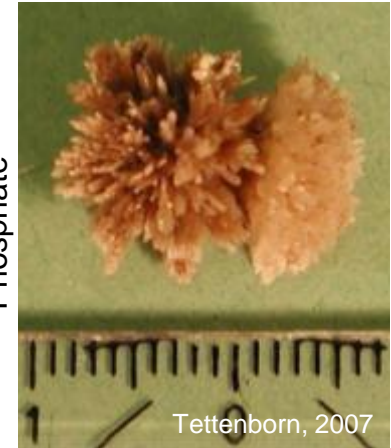




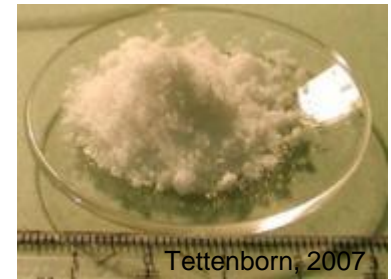
# Urine - reuse of its products

- Mostly derived in high-tech solutions
- Achieved through a combination of various treatment steps
- Limiting factor in production: energy costs
- Different plant availability of different (MAP) products according to specific crop (Simons, 2008)

Potassium Ammonium Phosphate



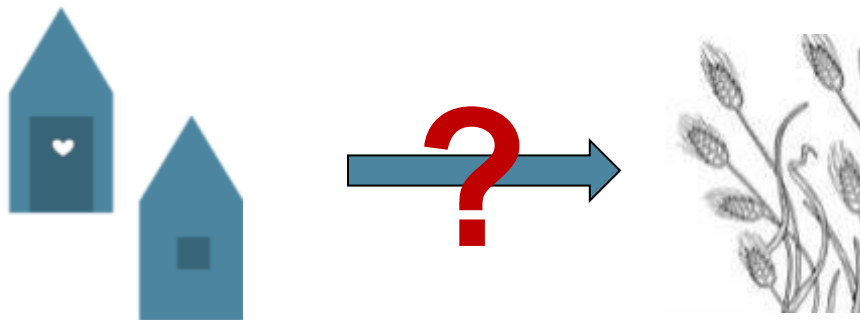
Stercorit







# What comes next?



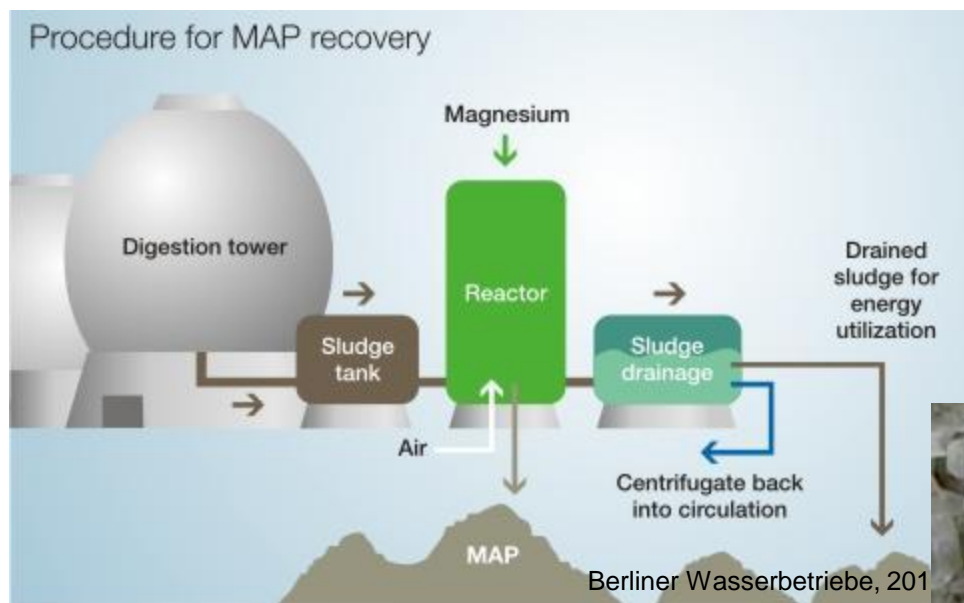
- Dir **TRANSPORT** reuse site
- Direc **TREATMENT** building or neighbourhood
- Transport to a central unit for storage/treatment
  
- Piping system
- Wheel based pick-up system



# Treatment processes are scaling up



## ■ Berliner Wasserbetriebe

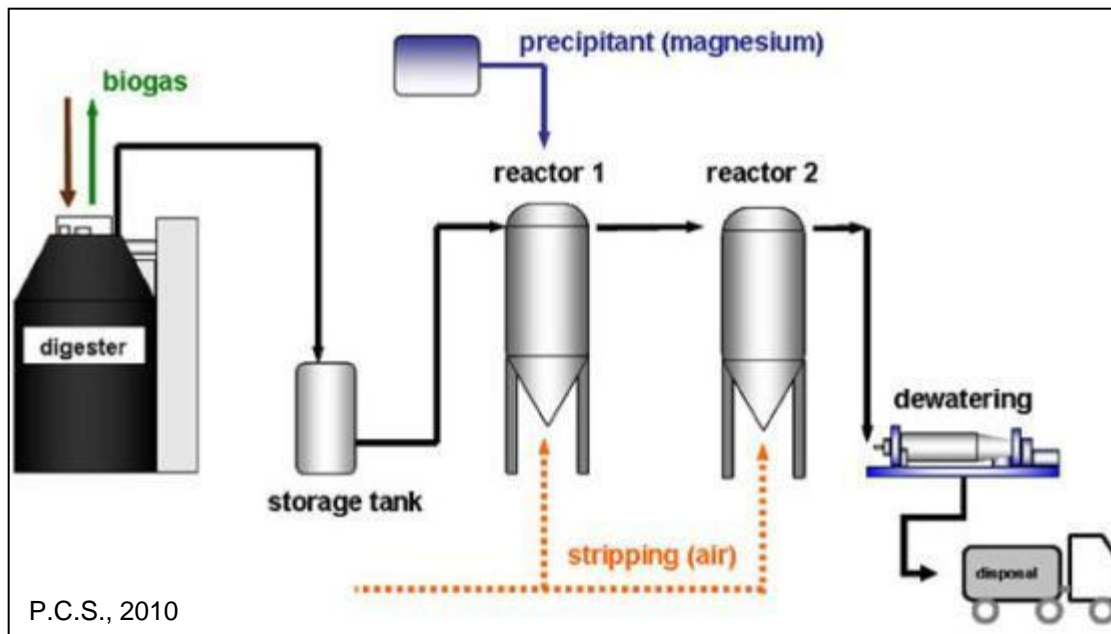






# Treatment processes are scaling up

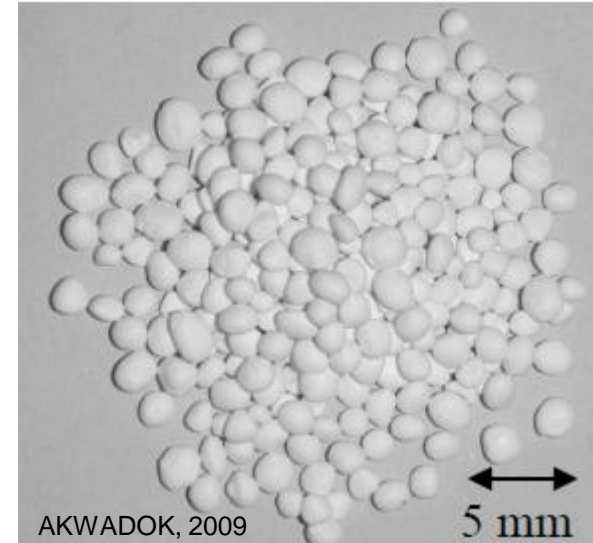
- Berliner Wasserbetriebe
- AirPrex procedure of P.C.S.





# Treatment processes are scaling up

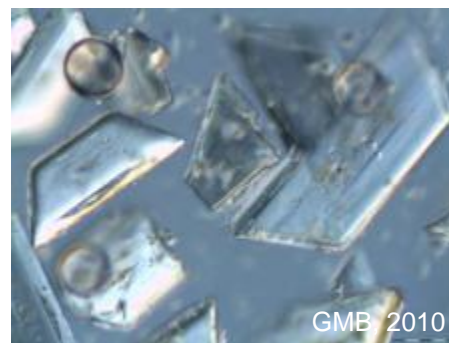
- Berliner Wasserbetriebe
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- NuReSys technology of AKWADOK





# Treatment processes are scaling up

- Berliner Wasserbetriebe
- AirPrex procedure of P.C.S.
- NuReSys technology of AKWADOK
- SaNiPhos of GMB





# Treatment processes are scaling up

- Berliner Wasserbetriebe
- AirPrex procedure of P.C.S.
- NuReSys technology of AKWADOK
- SaNiPhos of GMB
- MAP reactor of HUBER SE



- Treatment of urine
- On-site: volume reduction and nutrient recovery



# On-site treatment at GIZ, Eschborn

- Urine collection system in the building
- Urine storage in the basement
- approx. 200l collected per working day
- MAP = Magnesium-Ammonium-Phosphate  
also called struvite



Federal Ministry  
of Education  
and Research



# MAP reactor



HUBER SE, 2010

Inside view



Filter bags



MgO conveyance

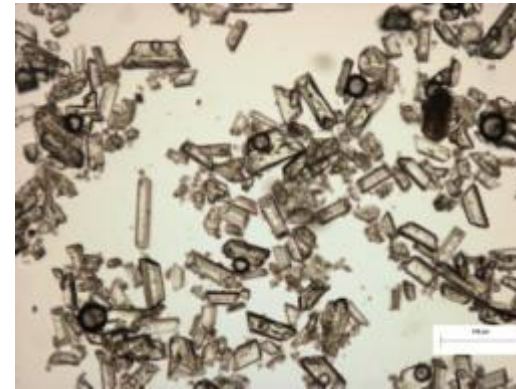


Drying box for bags





# Product: MAP



RWTH, 2010

- 1l of urine = 0,6g MAP
- Composition:
  - 110g P/kg
  - 42g N/kg
  - 100g Mg/kg

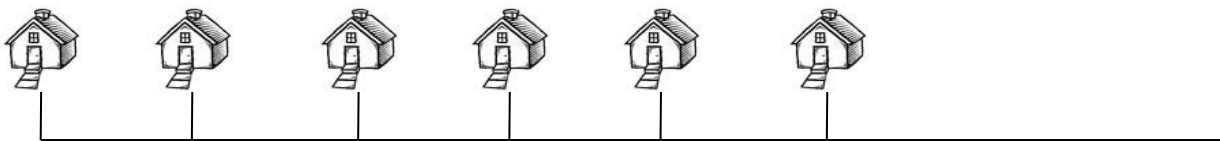
No pharmaceutical  
residues contained.

Winker, Paris, Heynemann, Montag. 2011. Phosphor recovery from urine by struvite precipitation in an office building in Frankfurt. *fbr-wasserspiegel* 16, pp 3-4.



# Transport

- Transport by pipe



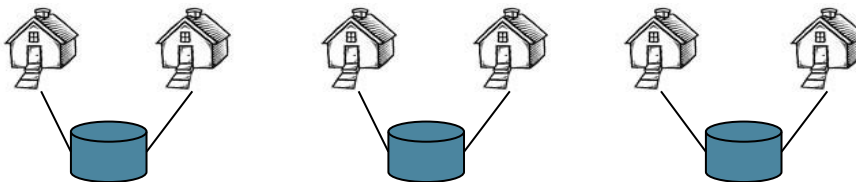
Treatment  
plant

- Transport by truck



Treatment  
plant

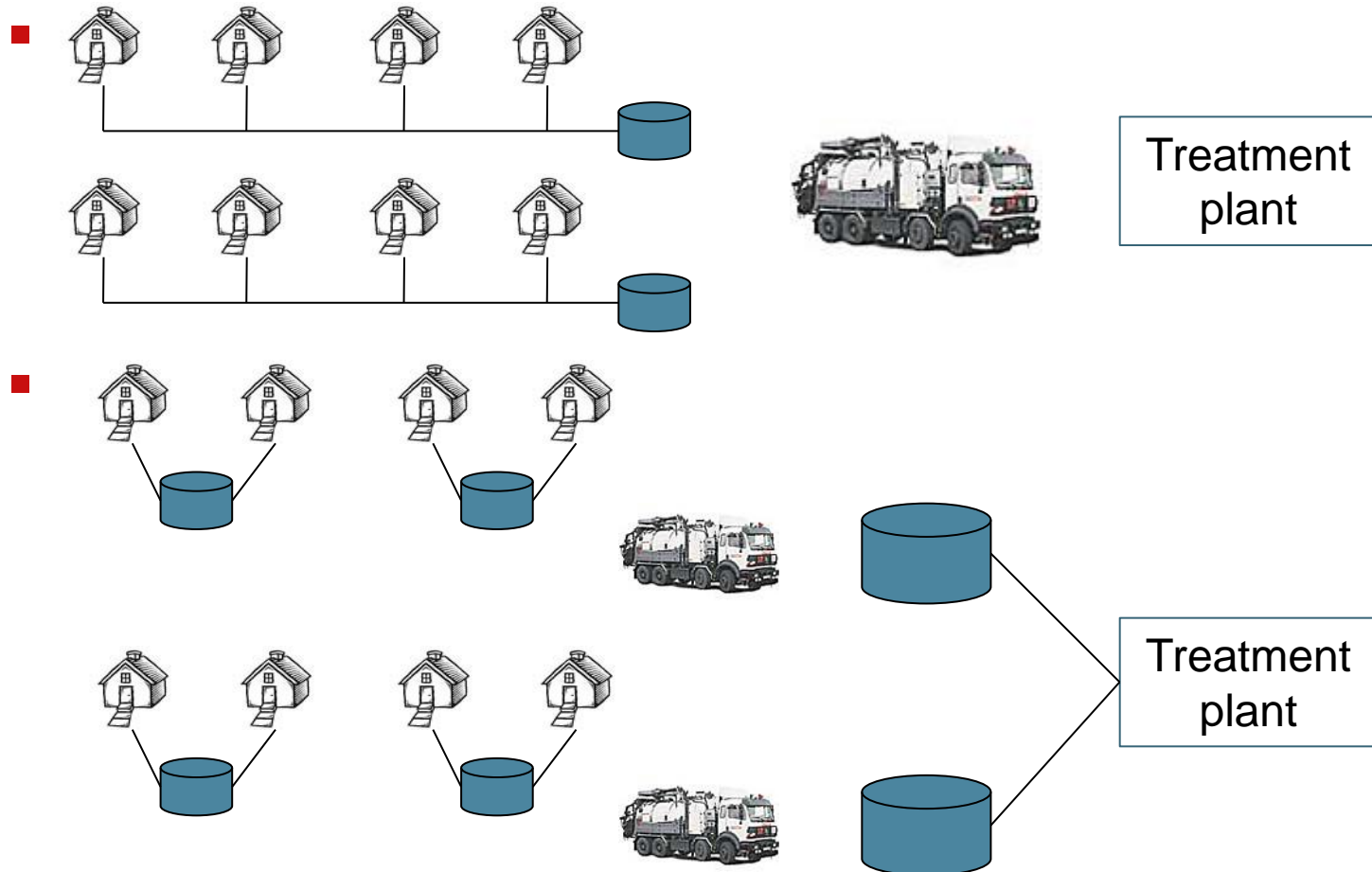
- Combinations...



Treatment  
plant



# Transport





# Transport

- Pipe-based transport → higher investment costs
- Cheapest: collection at household level & pick-up trucks
- Costs (European context):
  - Personnel > fuel
  - Vehicles > tank
- Unclear:
  - Raising fuel prices
  - Precipitation in pipes





# Outlook

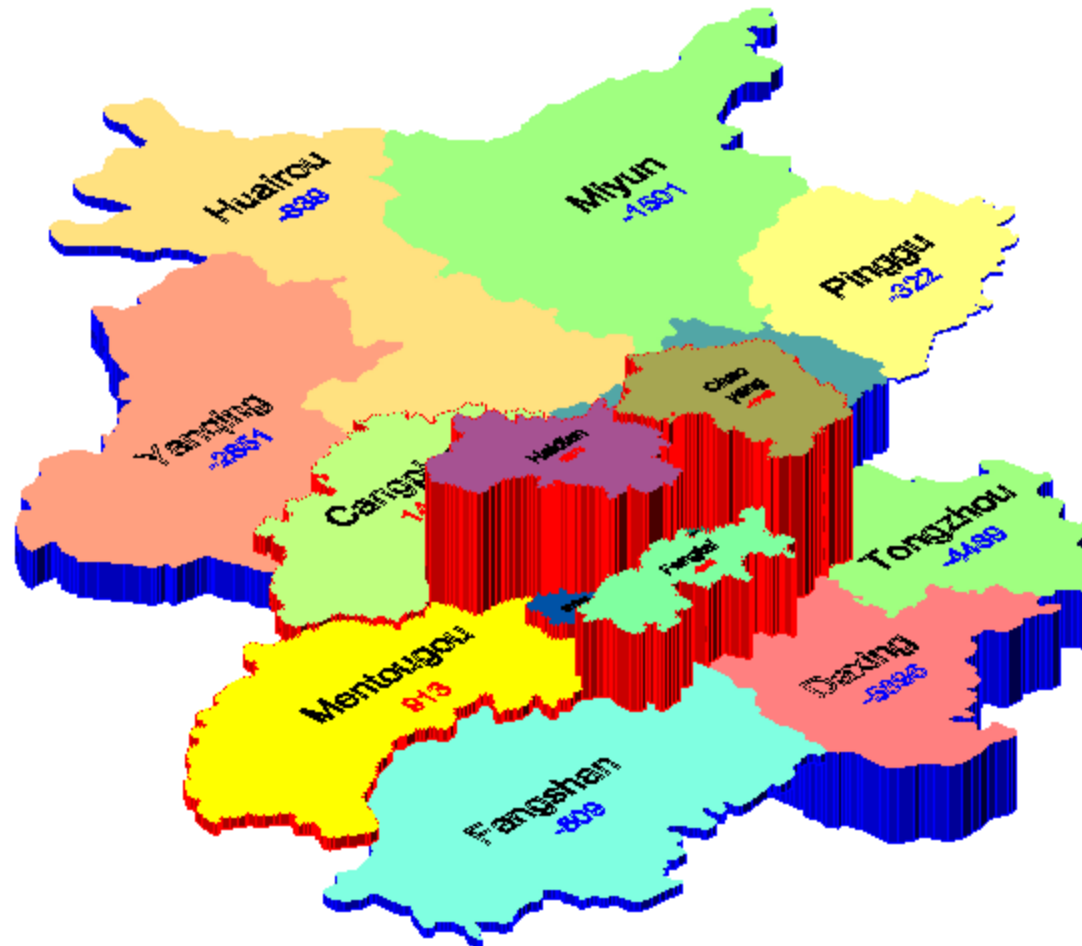
- Interesting scenarios of densely populated areas
- Beijing: 15.8 Mio people (2006)
  - 84% of nitrogen ( $\text{NH}_3$  solution)
  - 43% of phosphorus (MAP)
  - 57% energy saving within fertiliser production and wastewater treatment



Tettenborn, Stoll, Wang, Winker, Otterpohl 2009. Inventory of agricultural demand and value of the application of ecosan fertilizers in SWITCH demonstration cities - Inventory of agricultural demand in Accra / Demand and distribution of ecosan fertilizers in Beijing's Agriculture, 018530 - SWITCH, Sustainable Water Management in the City of the Future, Integrated Project - Global Change and Ecosystems - within the sixth framework program (2002-2006), D 4.1.5

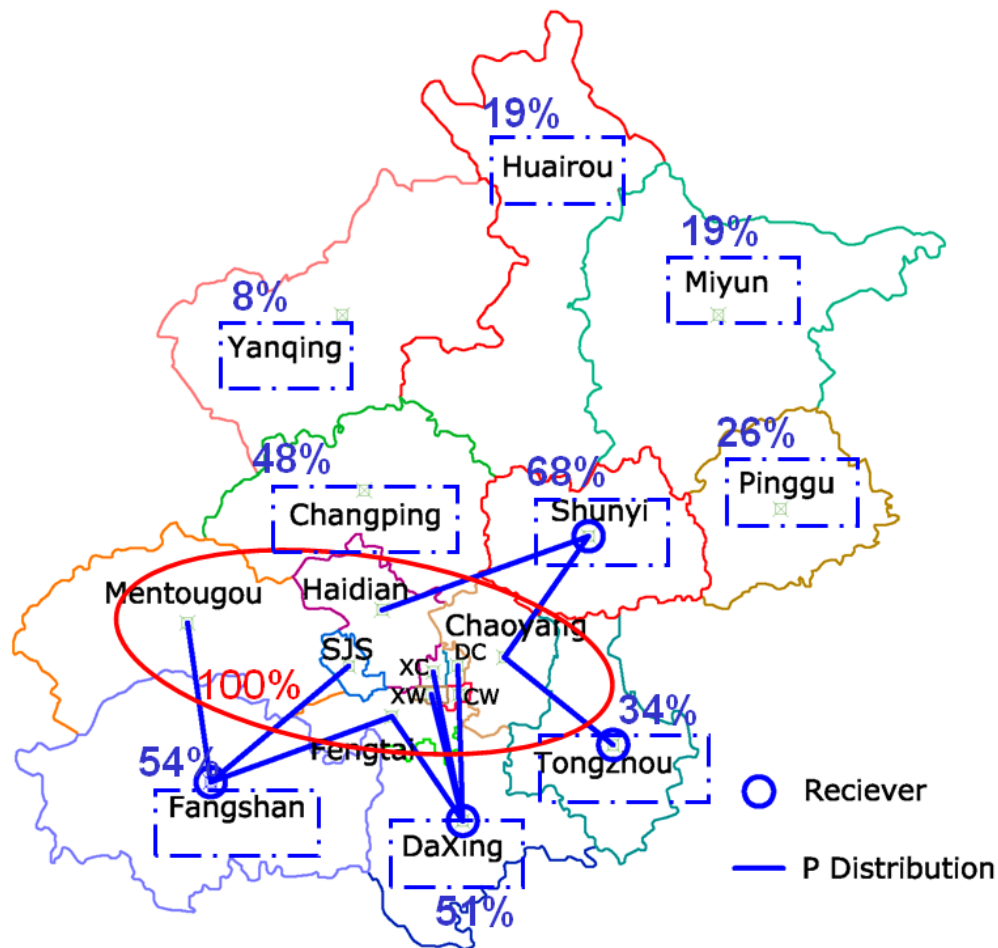


# Nitrogen distribution (Beijing)





# Phosphor recovery (Beijing)



Coverage of P demand: 43%

Scenario:  
Small plants  
1,340 tours/yr  
33,000 L diesel/yr



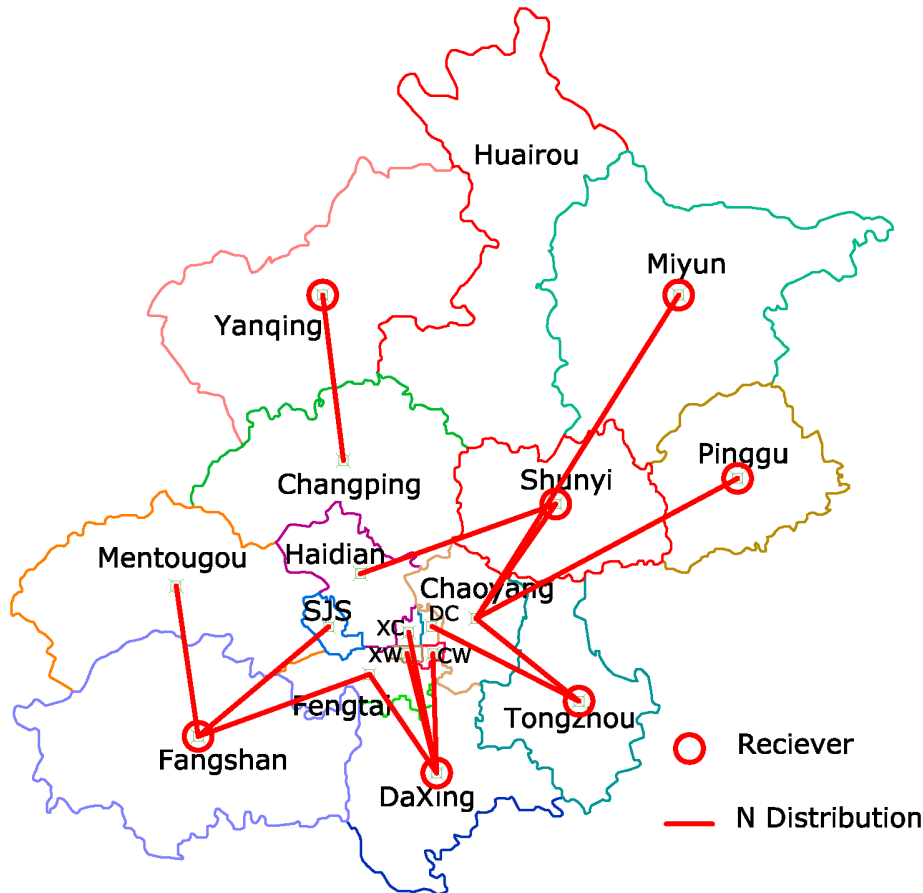
# Outlook

- Barriers exist
  - Demo projects
  - Large numbers required
  - Production costs vs. prices at the world market
- Large potential
  - First companies investing
  - Funding on larger scale seems to start up e.g. in developing countries



# THANK YOU!

# Urine distribution Scenario 1 (small plants): Principles



- Pipelines
  - ➔ Small treatment facilities (45 m<sup>3</sup> Urine/day)
  - ➔ demand area
- Local supply ➔ Redistribution
- Principle of redistribution: the nearest the first