Circular economy in the region of Amsterdam (NL) and the feasibility of the 'Power to Protein' concept

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Edwin de Buijzer, Kees Roest, Frank Oesterholt, Tessa van den Brand, Elize Versteeg, Jan Hofman, Willy Verstraete, Jos Boere

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Introduction

Circular economy in the region of Amsterdam

- City of Amsterdam: 75% reduction of CO_2 emissions and total recycle of waste in 2040
- Waternet: energy neutral by 2020 and circular when possible

Insight into and overview of the flow of urban resources related to the water cycle in the Amsterdam region is largely missing… to base strategic decisions on.

Research target

1. Quantitatively map potentially valuable residual (waste) materials and flows (energy, water and raw materials) in the urban Amsterdam region

2. Examine processing techniques and routes in order to know how and where to recover and treat these resources in an optimal way

3. Investigate which resources are available for the application of the Power to Protein concept

Research design

Measurements

- Influent values 2 WWTPs Amsterdam (West & Westpoort)
- Effluent values 2 WWTPs Amsterdam

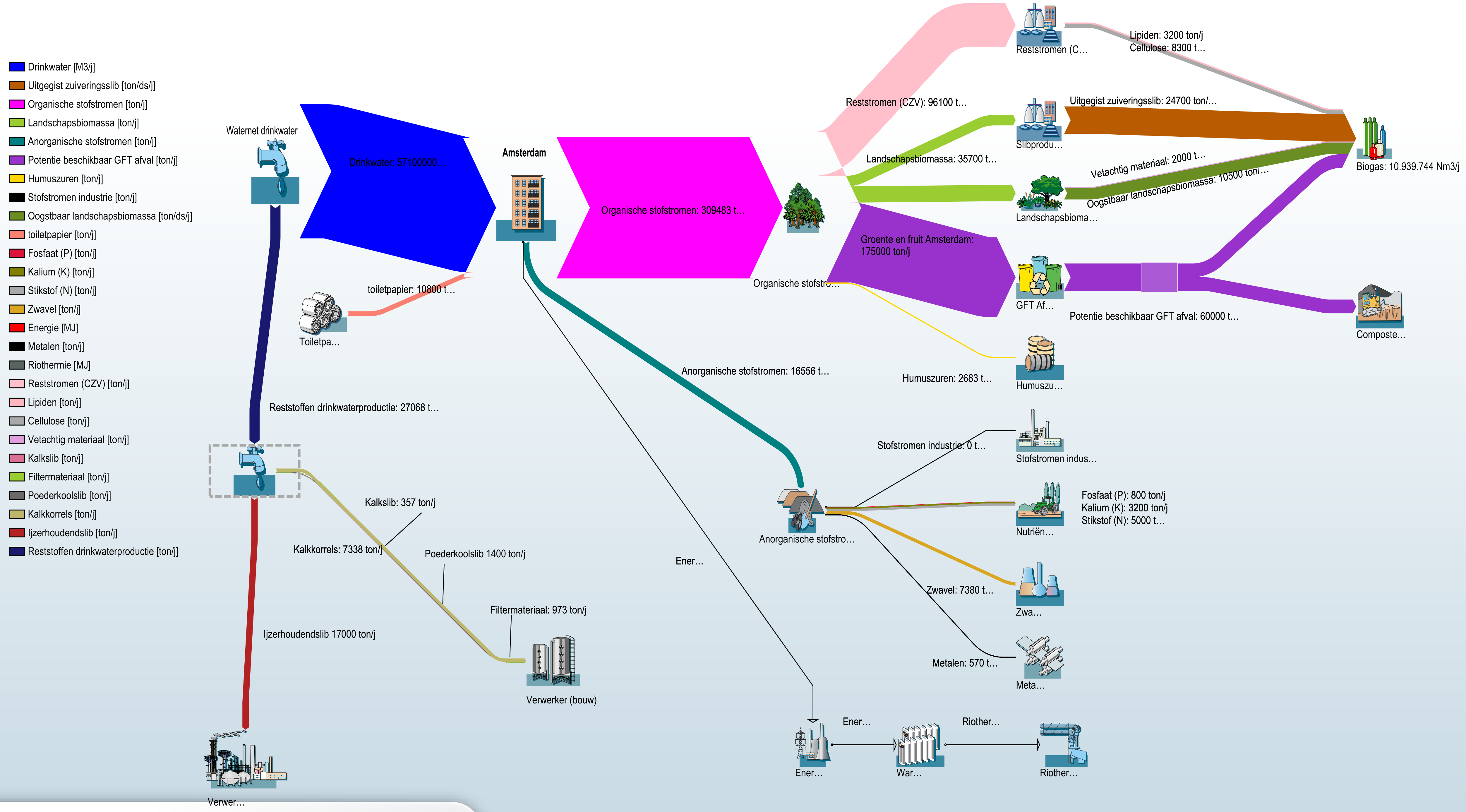
Data extrapolation

Translate (calculate) national and local data to the situation in Amsterdam

For example:

- Amount of landscape biomass in Amsterdam
- Concentrations (certain) metals in effluent of WWTPs in Amsterdam

Results: Quantities of potentially valuable residual



Overview of potentially available flows

A summary of the previous slide

Resource	Yearly flow (1.000 kg)
Organic residuals	> 197,492
Waste from the production of drinking water	27,406
Sludge wastewater treatment (dry matter)	26,283
Others, like: nutrients, metals, sand	> 16,950

The resource recovery strategy

1. Focus on recovery of critical raw materials (like phosphate) and (rare earth-)metals.
2. Recover resources with large quantities or with a higher value level (value pyramid).
3. For certain specific substances it is interesting to examine on short term the use and value: cellulose, fatty acids and lipids, thermal energy and residuals of drinking water production (especially humic acid).

Opportunities, for:

Production

1. Collect as much as possible of the organic residual flows of Waternet (and others) to digest and produce biogas or green gas (energy), as long as there is no technology (or market) for a higher value product.
2. Collect fibers from biomass to produce building material, and apply in your own processes.
3. Producing humic acids as product for agriculture and horticulture.

Research

1. Perform exploratory measurements of the concentrations (rare/earth) metals in wastewater and sludge of WWTPs.
2. Develop a standard method to determine the amount of cellulose that can be collected at WWTPs.
3. Develop a framework for the circulair economy, wider than the CO_2-footprint.

Others

1. Agreements for publishing and measuring resources (in the same units)
2. Explore options for local marketing, like struvite as a fertilizer [is realised in june 2015]
3. Create a collecting system for the intake of external organic residual streams for fermenting, especially organic waste from households in Amsterdam.
4. Marketing humic acids as product for agriculture and horticulture.

One of the ideas: Power to Protein

Avecom/Willy Verstraete and Silvio Matassa

May 2015; cover ES&T

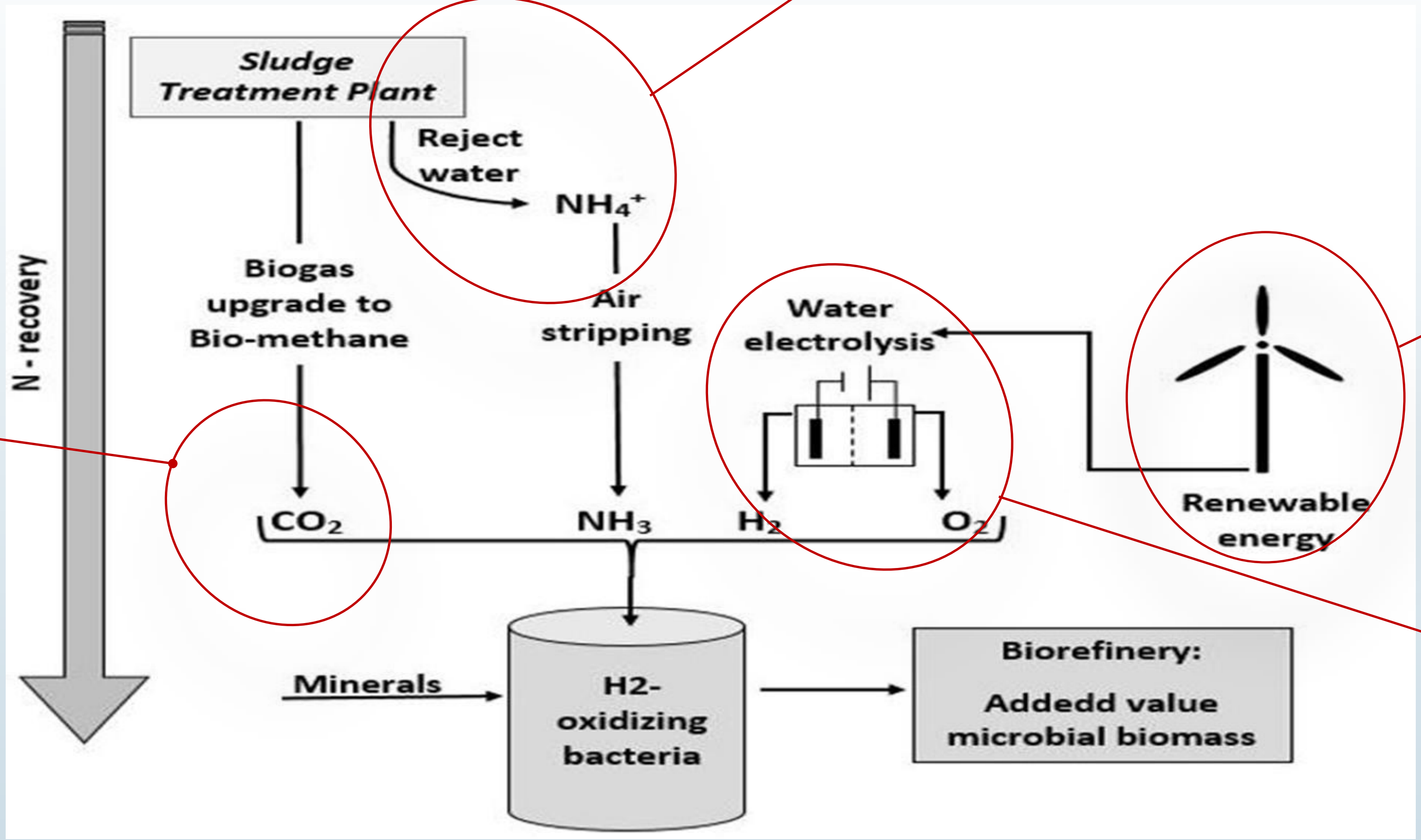
Avecom
Bioproducts & Apps

Concept Power to Protein

Lithotroph hydrogen oxidizing bacteria

Current situation, for example ammonium from reject water.

CO_2 from conversion biogas to methane. In addition other sources in the city.



Exploit off peak renewable energy to produce hydrogen and oxygen (hydrogen economy).

Steam reforming of biogas is another option to produce H_2 and CO_2

Power to Protein in watercycle of the city Amsterdam

Potential and required resources

	Avecom (2014) (kg)	Amsterdam-West reject water (tonne/year)	WWTPs Amsterdam total potential (tonne/year)	Sources
Production SCP	1.000	6.300	24.000	
required:				
ammonium NH_4-N	196	1.235	4.670	from digestate by air stripping
hydrogen H_2	786	5.000	18.900	• from bio-methane through steam reforming • from electrolysis of water using off peak green electricity
Carbondioxide CO_2	3.309	21.000	79.400	• from the production of bio-methane from biogas • as a by-product of steam reforming process • from an external source
oxygen O_2	2.924	18.400	69.600	through aeration

35 % of the net yearly protein requirements of Amsterdam

Outlook

Available materials and flows in the urban Amsterdam region

Resource recovery strategy

The Power to Protein-concept in the watercycle of the city of Amsterdam

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My colleagues from KWR and our partners in these projects

You, for your kind attention