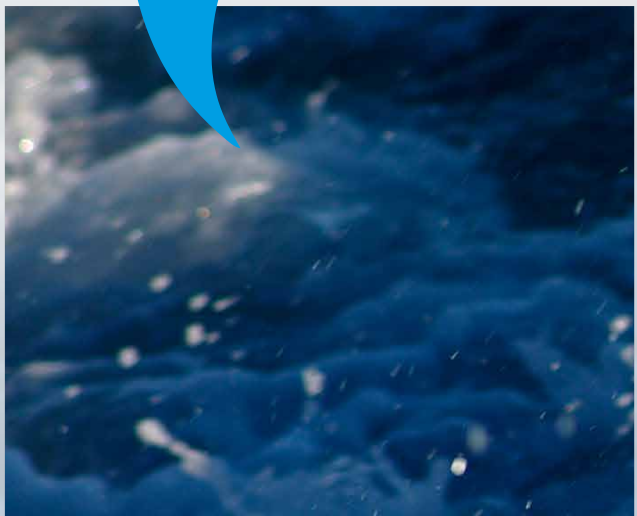
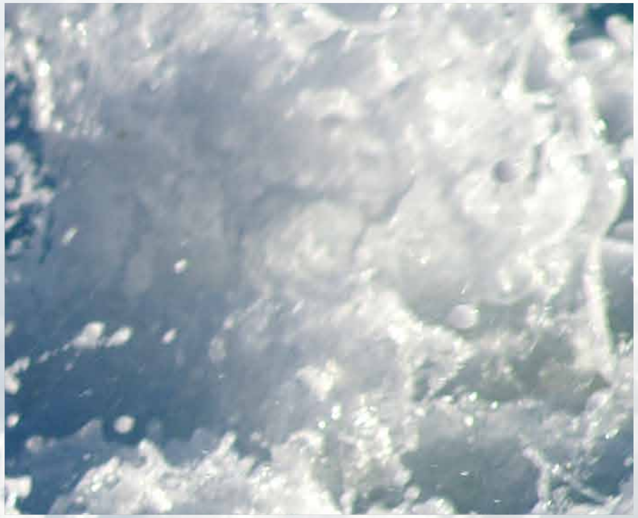
Roadmap Wastewater management

Vision brochure

Wastewater management roadmap towards 2030

A sustainable approach to the collection and treatment of wastewater in the Netherlands





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Foreword

Where is wastewater management (including sanitation) going to be in 2030? And how will we get there? This vision document contains the answers. In this document, we present an agenda for the new developments in the collection, transport and treatment of urban wastewater in the Netherlands for the coming years.

Fundamental change

In this document, the Association of Netherlands Municipalities and the Association of Regional Water Authorities present a united vision. We consider this roadmap an extremely important resource for showing you what we want to achieve. It is our firm conviction that the way we think about wastewater management is changing fundamentally. In 2030, the wastewater management partners will contribute substantially to the sustainability of our society. Regional water authorities and municipalities will be converting waste into clean raw materials, clean energy and clean water. Our vision is compatible with the commitments of the Association of Netherlands Municipalities and the Association of Regional Water Authorities on partnership in wastewater management and the Administrative Agreement on Water, and reflects the shared goals of municipalities and regional water authorities: increasing effectiveness, quality and reliability.

Opportunities abound

The process of producing this roadmap has resulted in more than just this inspiring vision document. We have discovered enormous potential to couple sustainability and efficiency. We have also seen that the wastewater management partners are already applying many of these concepts in practice. A number of partners are already operating power plants, and that number is set to grow in the very near future. Others are experimenting with raw materials extraction. Several municipalities have started local energy companies. Meanwhile, the regional water authorities are moving with these changes, utilising knowledge from the market wherever possible. The future has already begun!

Smart coalitions

Naturally, the changes in wastewater management are not happening in a vacuum, but are closely connected to changes outside of it. This is why we are seeking smart coalitions with other parties. We envision coalitions for construction, industry, agriculture, energy, and on and on. The challenges we face are big. To meet them, we need all hands on deck!

Coordination and cooperation

This long-term vision did not come about overnight. It is the result of a process that we began in 2010 with our knowledge partners and wastewater management partners, resulting in two previous roadmaps, in 2010 and 2011, both part of the MJA3 multiyear energy efficiency commitments. The regional water authorities signed these commitments in 2008.
We have also incorporated a number of other commitments and initiatives into this vision. Please find below a few of the more important examples:

- A group of dedicated experts met in 2009 around a vision of water management in 2050: 'Interconnecting water.' We worked closely with the booster team behind this vision.
- At the end of 2011, regional water authorities and municipalities collaborated with the cabinet on the adoption of a Local Climate Agenda as a follow-up to the climate agreements.
- The Association of Regional Water Authorities and the cabinet signed a Green Deal and a Phosphate Chain Agreement.

This roadmap is also a response to the innovation section of the water services chapter in the Water Administrative Agreement. The challenge now is to plant this roadmap firmly on the agenda in the municipalities' and water authorities' regional implementation of the commitments from the administrative agreement. The arrangements in the roadmap also present an excellent resource for making the smart investment decisions for the long term that will ultimately save money on the way to reaching the goals.

Contributions of many

We would like to thank everyone who contributed to this vision. Of course, we would like to gratefully acknowledge the financial support of the Ministry of Economic Affairs, Agriculture & Innovation. In addition, there are two people we would like to mention by name: Renze van Houten, Project Leader on the preliminary study, and Pieter de Bekker, Project Leader on the roadmap. This roadmap is the product of the many and varied efforts of various experts at regional water authorities, municipalities and other organisations, all of whom contributed in their own ways. Each of them did this with unfailing dedication and with an appreciation for the realities of the challenges we face. We also benefited from the constructive contributions of professionals at universities, consulting firms and industry stakeholders.

We trust that this vision will inspire you as it inspires us, and we wish you every success in your own efforts to pave the way to a sustainable future for our wastewater management!

Gert Verwolf
Member of the Board of the Dutch Association of Regional Water Authorities
Chairman of the Veluwe Regional Water Authority

Ina Adema
Chairwoman of the Water Commission of the Association of Netherlands Municipalities
Mayor of Veghel

1. Introduction

Where will we be in 2030? What are our big opportunities? What road will we take? This brochure presents our long-term vision for wastewater management. We have developed this vision in close cooperation with our partners inside and outside of wastewater management.

Core of our vision

Fundamental change

A fundamental change. This is the only way to describe what awaits wastewater management in the coming years. In 2030, we will be a major factor in our society's sustainability and in closing chains and cycles. Regional water authorities and municipalities will be converting waste into clean raw materials, clean energy and clean water. Of course, we are also looking for ways to cut costs. We place a high priority on smarter investments in flexible systems.

Meeting challenges head on for innovation

Other parties know that we are on the front lines of the challenges we face, and the innovations to meet them come from us. These are the parties we want to get on board and work with. We are at the cutting edge of new treatment and energy technologies. We seize the opportunities for new solutions.

Integrated approach

We see the big picture in everything we do. Our spatial solutions fit into the environment. Our clients know they can count on specially tailored solutions. We provide a broad range of services.

Open attitude

We go into the changes with an open attitude. We see the transition as both a fine opportunity and a challenge. We aren't afraid to experiment. In everything we do, our goal is to be able to provide even better services in the future.

The reason behind this vision

Starting point

We see our vision as a starting point for the conversation inside and outside of wastewater management. We want to close chains and cycles, and make them more sustainable. We work closely with partners in agriculture, the chemical industry, food production and the energy sector, and with housing cooperatives and project developers. We listen to them, and are flexible enough to work with their input. Our vision is by no means set in stone.

Source of inspiration

With this vision, we offer inspiration to our wastewater management partners, customers and suppliers. Together we determine where cooperation is feasible and desirable. Regional water authorities and municipalities use this vision as a source of inspiration for their long-term strategies and to look for promising innovations.

Working from different local perspectives

What innovations in wastewater management are most promising is very much a matter of the specific local context. This concerns the physical environment, the administrative structure and the priorities for spatial planning. The local need and availability of raw materials, energy and water are relevant as well. We have detailed a set of local perspectives to help the local government in choosing the right innovations for their area. These local perspectives present potential future pictures for sustainable solutions that can be applied to the specific local context. These are not ready-made blueprints, but should be seen as a useful starting point for identifying the opportunities and ambitions.

Reading guide

The main features of what wastewater management will look like in 2030 are described in Chapter 2. Chapters 3 through 5 describe the following three chains: raw materials, energy and recycled water. What are our expectations for the future, and where are our biggest opportunities?

Chapters 6 through 9 describe the four local perspectives: urban environment, industrial area, land-based industry and rural area. These local perspectives are not intended as ready-made blueprints, but should be seen as a starting point for identifying the opportunities and defining the ambitions.
A complete module for an urban area would normally be a cohesive package of several of these local perspectives. Chapter 10 is a summary of the challenges during the transition process.
In Chapter 11, we present our vision of transition. Chapter 12 describes where we go from here.

After reading, we feel it is worthwhile to take some time to reflect on the current state of our wastewater management.
We present a picture of this in the first annex. A great many general developments can have a major impact on the transition process. You can read more about these in the second annex.
In the third annex, we briefly describe the method we used in arriving at this vision. In it, you will also find a list of the participants in the project group and the three working groups.

The future has already begun

Sweeping changes are in store for wastewater management in the Netherlands, and the first signs of these changes are already clearly visible in a number of places. The brief examples presented below show that the future has already begun.

Raw materials

Bioplastics from wastewater
Ten water authorities and Veolia Water are exploring the technical and commercial feasibility of the production of biopolymers. It is anticipated that this technology can be applied within three years.

Recovering raw materials from manure and urine
The source pilot being conducted by the Aa and Maas Regional Water Authority and the agricultural sector (ZLTO) has shown that approximately 60 percent of potentially reclaimable phosphate can be recovered as struvite. For practical-scale reactors, figures of 80 to 90% would appear to be attainable. A cost analysis shows that SOURCE would be very competitive with other types of manure processing.

Sneek sanitation project
The local sanitation project in the Dutch town of Sneek is an example of a much more comprehensive integration of the water, energy and raw materials chain. Multiple types of wastewater qualities are collected in separate flows and treated in the most effective way to recover the maximum potential of phosphate and energy from each.

Energy

Heat for tap water and central heating in Apeldoorn
Since 2010, the sewage treatment plant in Apeldoorn has been supplying electricity for household customers through the electricity network. The gas generated from the digestion of sludge is burned in an engine that generates electricity (cogeneration), and the combustion heat is channelled through an Essent pipeline to a residential area, where it is used to heat homes and domestic tap water.

Residual heat from sewage treatment in Raalte
Wastewater today is a few degrees warmer than it used to be, because we take more showers and wash clothes and dishes at a hotter temperature than we used to. Groot Salland has set up a demonstration project to use this extra heat from the sewage treatment plant, to heat the municipal swimming pool in Raalte.

Green gas in Tilburg
Attero's Tilburg site is home to the first and only green gas hub in the Netherlands. In this hub, biogas generated by multiple parties is refined to natural gas quality in a single facility, supplying it to the gas network. The facility itself is powered by biogas generated from the treatment of Tilburg sewage.

Water

Efteling: effluent becomes park water
The effluent from the sewage treatment plant in Kaatsheuvel is processed and polished on the site itself, into clean water that is used in the ponds at the nearby Efteling amusement park. Some of this effluent is processed through natural helophyte filtering. This eases the burden on the groundwater.

Refining water for DOW Chemical
In Terneuzen, purified wastewater is further processed using membrane filtration techniques for use in quality-intensive applications for DOW Chemical This loop is necessary as fresh water is a scarce commodity in this largely brackish and saltwater region.

Wastewater as quality irrigation water
In the region of Westland experiments are ongoing on using the wastewater from its Harnaspolder wastewater treatment plant, as high quality irrigation water for commercial greenhouse growing. This is one part of making the region more self-sufficient. In addition to reuse in greenhouses, the purified water is being used in the natural environment.

2. Our future vision

What will wastewater management look like in 2030?

Sustainability is key

Regional water authorities and municipalities are major players and partners in transforming the Dutch society into a more sustainable one. They convert waste into clean raw materials, energy and clean water. Recovery is a key part of this. Regional water authorities and municipalities pursue the activities that allow the replacement of fossil fuels and materials with biomass for chemistry, transportation, heating and generation of electricity. The water authorities and municipalities are high-profile players in this effort, by establishing co-locations for biomass, local treatment and purification units and a strong focus on sustainability. Our contributions are highly valued by both society and industry.

Efficient wastewater treatment and for public health and water quality

We are committed to efficient wastewater treatment to promote public health and water quality. Our legal tasks have not changed by content, but the way in which we fulfil these tasks has changed considerably.

Total solutions

The partners in wastewater management (collection and treatment) have a common view to and choose for an integrate approach. We choose spatial solutions that are compatible with the natural system and the urban environment. We coordinate our plans for innovation and expansion with projects for new construction and renovation. Custom work is a key aspect of our services. We offer both consumers and businesses a wide range of services. We close waste recycling cycles for businesses and industrial parks.

Many ways to collect and separate

Waste separation usually begins in the urban and industrial environment. There are many different concepts and technologies in use. The choice of concept and technology for a specific situation depends on:

- The nature and volume of the waste flows;
- The local conditions (aspects such as landscape, spatial planning and ecological challenges).

Specialised maintenance

Some of the maintenance is provided by specialised companies. These businesses operate for specific tasks. Construction and maintenance are integrated in wastewater management. Individual components require different standards of maintenance. The more important a component, the stiffer the requirements. Keeping this whole process on track requires a firm hand. A central control room (primarily virtual) is responsible for this control. The control room keeps a proper balance between costs, quality and risks.

Strategic partnerships

On the strategic front, we work closely with a number of carefully selected parties, in some cases on a temporary basis and in others in a more permanent partnership. This allows us to draw on the specialised expertise of maintenance companies, energy companies, housing cooperatives and waste processors.
We develop new products, services and technologies in cooperation with customers, industry partners, research institutions and local authorities

Meeting challenges head on for innovation

Other parties know that we are on the front lines of the challenges we face, and for the innovations to meet them. These are the parties we want to get on board and work with. We are at the cutting edge of new purification and energy technologies. We seize the opportunities for new solutions.

Open attitude

We go into the changes with an open attitude. We see the transition as both an excellent opportunity and a challenge to improve our performance. We aren't afraid to experiment. In everything we do, our goal is to provide even better services in the future.

Critical role of our employees

An important factor is our staff. One of any organisation's biggest concerns is finding and keeping qualified employees. We offer a competitive employment package and every possible opportunity for personal and professional growth. Our people frequently work in autonomous teams. They are very conscious of their own contribution and responsibility.

Leader in technology

In the Netherlands, we are at the cutting edge of new treatment and energy technologies, and we are the first to use the latest in the field. Intelligent sensors allow us to monitor our processes in real time, so we can make the right, informed, decisions.

Vision: Raw materials 2030

Vision

- Thinking in raw materials cycles
- Linking with other sectors
- Multiple modalities of raw materials processing
- Doing the 'dirty work' for customers and wastewater management partners
- Constant search for new opportunities
- Open innovation environment
- Green image for products from waste
- Flexible production
- Combining steps in refinery train
- Disseminating insights through innovation platform
- Sewage treatment plant as raw materials factory

Opportunities

- Phosphate for fertilizer
- Reuse of toilet paper
- Algae for human consumption, animal feed, chemistry
- Alginate for stabilising liquids
- Nitrogen for ammonia compounds
- CO_2 as coolant
- Syngas for bulk chemicals
- Sulphur for sulphate and various applications

Vision: Energy 2030

Vision

- Full-spectrum, sustainable solutions
- Sufficient technical possibilities
- Important role for business developer
- Regional water authority as driver or forger of coalitions
- Bringing governmental authorities together
- Innovative constructions
- Energy generation and recovery of raw materials
- Sewage treatment plant as energy factory
- Efficient use of operational energy
- Reduction of water consumption from toilet flushing

Opportunities

- Recovering heat in homes and buildings
- Recovering heat from sewage
- Sewage treatment plant as energy producer
- Energy savings for sewage treatment plant
- Wind and solar on sewage treatment sites
- Hydroelectric power from sewage
- Cooling from deep water sources
- Energy from black and green water

Vision: Water 2030

Vision

- Collection (waste)water predominantly separated
- Many quality standards
- Generally tailor-made solutions
- High and low-quality water for industry
- High-quality water for greenhouses
- Urban water self-sufficiency
- Fewer active sludge processing plants
- Many techniques from drinking water for recycling
- Online systems for measuring and monitoring

Opportunities

- Landscaping and recreational water
- Process and cooling water
- Household water
- Water for agriculture and industry
- Effluent for water balance
- Combating urban heat islands
- Saltwater for toilet flushing
- Rainwater storage

3. Raw materials

What will the circular economy of raw materials from wastewater look like in 2030? And most importantly, where are the big opportunities?

Where we will be in 2030

Thinking in raw materials cycles
Thinking in raw materials cycles has become second nature. We are constantly looking out for new sustainable technologies for processing waste flows and closing raw materials cycles. With these techniques, we produce high-value raw materials.

Joining up with initiatives in other sectors
We engage with initiatives in the agricultural, green chemistry and food and feed sectors.
Past successes have included:

- Phosphate production. Sewage treatment plants produce phosphate directly from wastewater or from the ashes remaining after incineration of sludge. The phosphate is used for precision crop fertilization and as an additive in animal feed.
- Supply of cellulose for the production of bio plastics.
- Supply of nutrient-rich wastewater flows for agriculture and algae farming.

Multiple modalities of raw materials processing
In most cases, regional water authorities and municipalities can only supply raw base materials like cellulose and monomers, which then have to be refined by specialised companies to bring them up to the level of quality required for them to be used higher in the chain. Sometimes, however, refining them at the purification stage can be an attractive option. Sewage treatment plants in neighbouring regions are joining forces to create the scale to make this viable. They supply the raw material to the raw materials plant.

Doing the dirty work for customers and partners
We take as much work off the hands of our customers and partners as possible. A 'middleman' organisation connects supply with demand effectively. This organisation also efficiently handles logistics and administration.

Looking for new opportunities
We are continually on the lookout for new building blocks, raw materials and products. We work with waste flow processors, product developers, purchasers and decision-makers in companies in a wide variety of sectors to select the right opportunities. We pack business cases with results from small-scale experiments and pilot projects.

Open innovation environment
Research takes place primarily in an open innovation environment. We take our inspiration from nature ('biomimicry') and experience in other sectors. To stimulate innovation, we put design questions to students and hold international competitions.

Green image for products from waste
Products from waste have a green image. We work closely with supermarket chains to improve the image of our products and understand the sensitivities of consumers. We visit schools with project education to teach about the value of products made from waste.

Flexible production
Wastewater management can lean on flexible production. That makes it possible to respond quickly to the needs and changes in the market. The production apparatus is made up of standardized modular production units and components. Components are easy to add or remove. This allows the organisation to earn back its investment in a component very quickly.

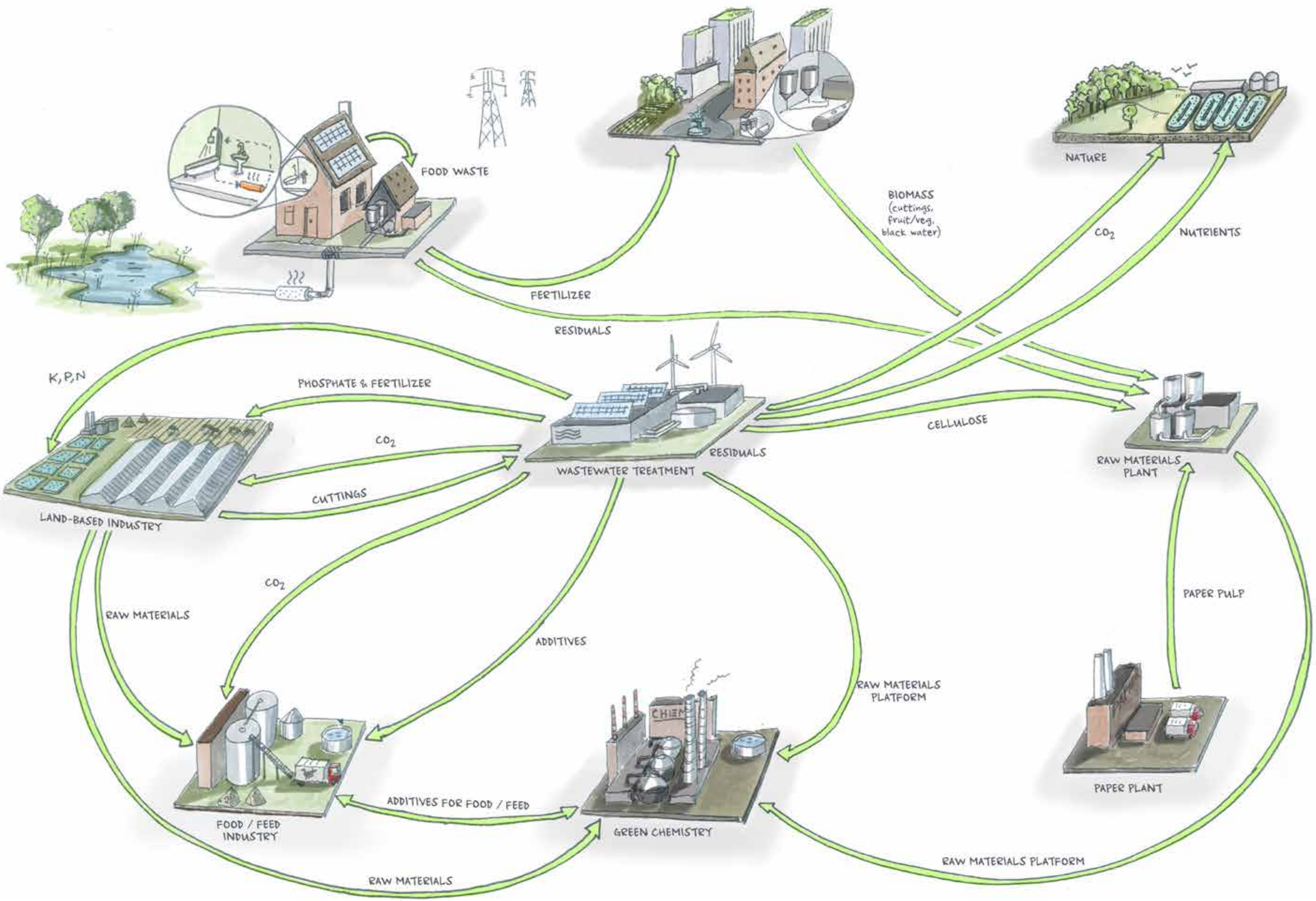
Combining steps in the refinery train
In many cases, refining one or a few products is not economically viable. The solution is the refinery train. Here, steps are combined to refine multiple groups of materials. This is the way to maximally leverage the complexity and value of substances like cellulose, nutrients, fatty acids, enzymes, drug residues, detergents and other organic compounds in wastewater or sludge.

Sharing insights through innovation platform
There is an innovation platform that enables us to get the most out of the insights from research, experiments and pilot projects. The innovation platform:

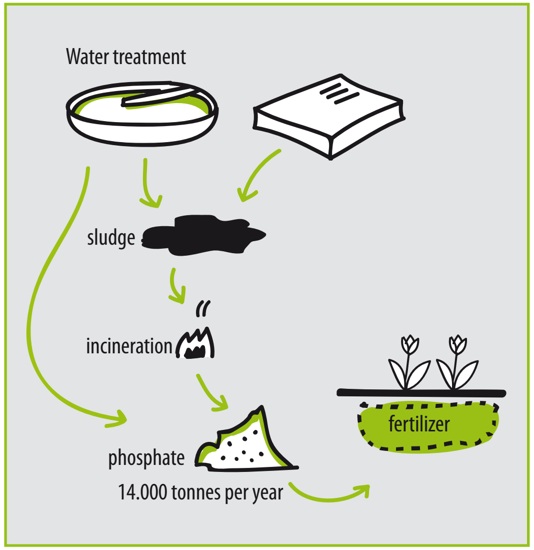
- Sets up research and experiments and analyses the results
- Disseminates the results among the partners in wastewater management
- Establishes relationships with platforms and external research programmes

Wildcards
Alongside the real opportunities, there are a number of wildcards. These are the possibilities that do not yet clearly represent an economically viable potential. Only time will tell whether there is a market for them, and if so, what that may be. The wildcards are:

- Detergents
- Enzymes
- Potassium
- Medication
- Metals
- Residual flows for agriculture

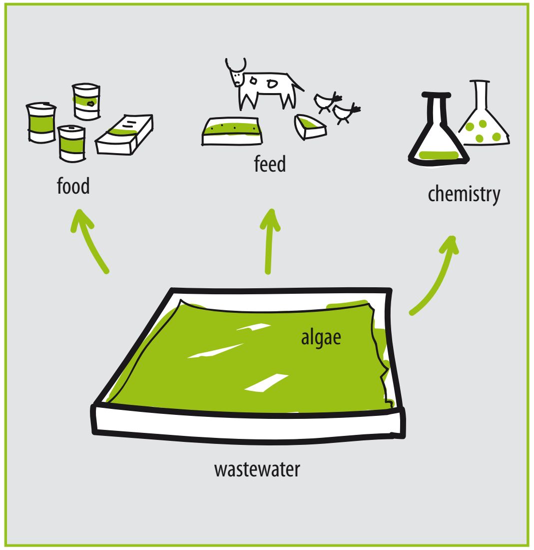

FOOD WASTE
BIOMASS (cuttings, fruit/veg, black water)
NATURE
CO2
NUTRIENTS
FERTILIZER
RESIDUALS
K, P, N
PHOSPHATE & FERTILIZER
CO2
CUTTINGS
LAND-BASED INDUSTRY
WASTEWATER TREATMENT
RESIDUALS
CELLULOSE
RAW MATERIALS PLANT
CO2
RAW MATERIALS
ADDITIVES
RAW MATERIALS PLATFORM
PAPER PULP
PAPER PLANT
FOOD / FEED INDUSTRY
ADDITIVES FOR FOOD / FEED
GREEN CHEMISTRY
RAW MATERIALS PLATFORM
RAW MATERIALS

Opportunities for raw materials



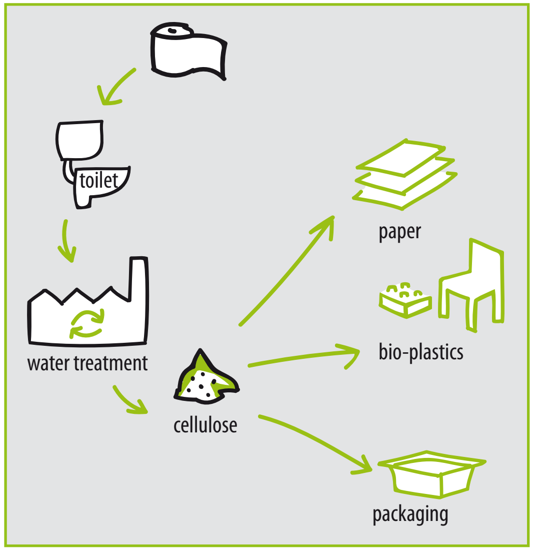
Phosphate for fertilizer

Phosphate ore is an increasingly scarce and expensive commodity. During treatment, or during final processing, we recover some 14,000 tons of phosphate annually. Phosphate is an important raw material for fertilizer. Biophosphate from wastewater is suitable for use in sustainably produced fertilizers.



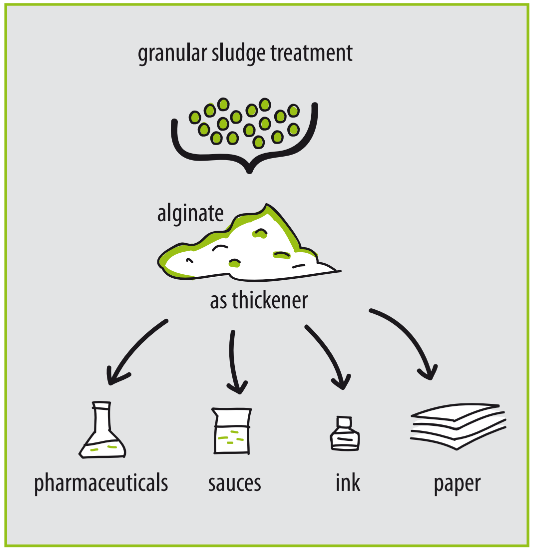
Algae for human consumption, animal feed, chemistry

Algae grow on residuals from wastewater, and they are a raw material for animal feed and fish food. Algae contain raw materials for the production of bioplastics and resins. Specific algae secrete oils used in the pharmaceutical industry. Experiments with algae and other water plants continue.



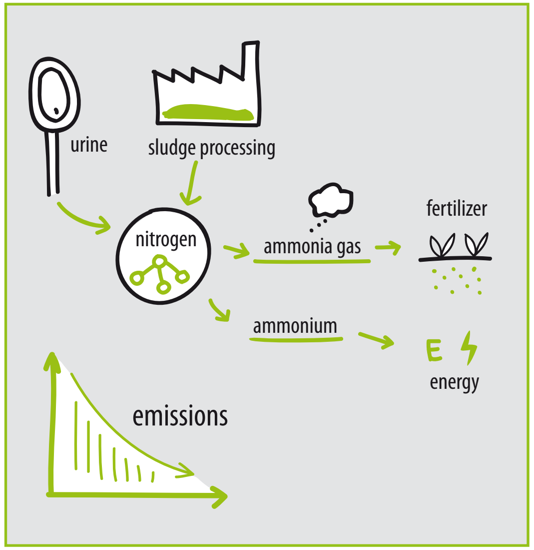
Recycling toilet paper

Cellulose from toilet paper is a raw material for building insulation and road construction. We also use cellulose for chemicals that are refined into bioplastics for furniture, plastic car parts and toy building blocks. Wastewater can provide for 5% of our country's demand for cellulose. The quality and quantity are constant.



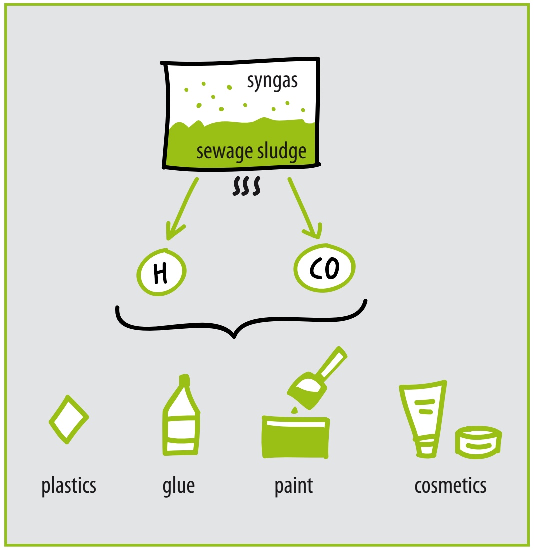
Alginate for stabilising liquids

Alginate is a by-product of the treatment of (granular) sludge. Alginate can be used for emulsifying and stabilizing liquids, i.e. as a thickening agent for ink, sauces, dairy products, pharmaceuticals, paper, etc. Granular sludge is rich in alginate. Alginate represents a somewhat significant financial value.



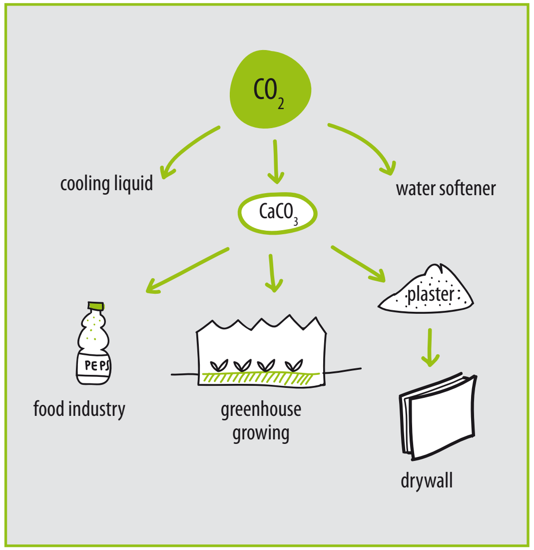
Nitrogen for ammonia compounds

We harvest nitrogen from sewage sludge or urine. With the nitrogen, we make ammonia compounds, which have a variety of uses. Ammonia gas, for example, is needed in the production of fertilizers. In a fuel cell, ammonium can be a source of energy. Harvesting nitrogen is also a way of reducing greenhouse gas emissions. This can be done in locations where there is residual heat available to strip the nitrogen.



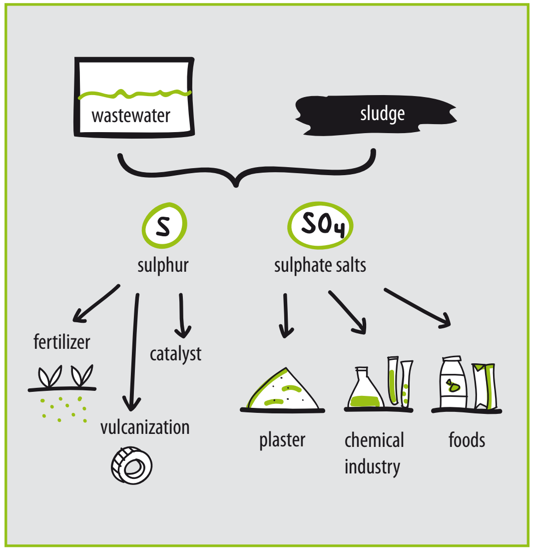
Syngas in bulk chemicals

Syngas is composed mainly of hydrogen and carbon monoxide. It is a component used for the production of chemicals like methanol. Syngas can be used in bulk chemicals for plastic, glue, paint and cosmetics. Gasification of sewage sludge is one way to produce syngas.



CO_2 as useful product

CO_2 can be used as a liquid coolant, water softener or for the production of calcium carbonate. Calcium carbonate is used as the chalky filler for drywall, for soil enrichment, and as a fertilizer for greenhouse growing. CO_2 is also used in a number of other industries, such as the soft drink industry.



Sulphur or sulphate for various applications

We harvest sulphur or sulphate from wastewater or sludge. Sulphur can be used in the production of fertilizer and for vulcanizing rubber. Sulphur is also used as a catalyst in various industrial processes. Sulphate is a useful component in plaster, as a catalyst in the chemical industry and as a raw material in the food industry.

4. Energy

What will renewable energy from wastewater management in 2030 look like? And most importantly, where are the big opportunities?

Where we will be in 2030

Integrated sustainable energy solutions
There is a roaring demand for smart renewable energy solutions. And the wastewater contributes to these solutions. The regional water authorities and municipalities are reliable and robust partners. They are in a unique position to connect energy supply and demand and provide the technical infrastructure. And their local insight facilitates these kinds of partnerships.

Sufficient technical possibilities
We have the right technical capabilities to recover energy from wastewater, whether from homes, non-residential buildings, communities or sewage treatment plants. At various locations, yellow, grey and black water are separated before being transported and converted into energy. We enrich wastewater with fruit and vegetable waste.

Important role for the business developer
The business developer is the backbone of the development of the total local energy project. The developer brings parties together and builds up a project portfolio. The business developer creates a marketplace for buyers and consumers of energy in the city and the urban environment. In many cases, the municipality has a controlling role to play. This is only logical, because the municipality has a lead role in increasing sustainability within the built-up environment.

Regional water authority as driver or forger of coalitions
The regional water authority is the driver and forger of coalitions. The water authority ensures that things happen, and comes up with good examples and opportunities. Through its administrative network, the water authority also sets the challenges and makes other parties enthusiastic. The water authority is a partner on local initiatives. It can provide project financing, which can make starting the project a lot easier.

Bringing governmental authorities together
Whenever a major area development is on the table, municipality, province and regional water authority go after the opportunities for sustainability together. They commission the research into opportunities and the drafting of a business case. They get other partners on board. The costs get shared.

Innovative structures
Smart technical and organizational structures lead to a good balance between costs and revenues. This type of construction inspires, sets a clear tone, and sets the stage for upscaling. The result is vast opportunities for increasing sustainability and attracting green investors.

Combining renewable energy and recovery of raw materials
Harvesting energy and recovering raw materials from waste flows are complementary activities. We first look at the value pyramid to ascertain the potential value from raw materials, and then evaluate the potential as a source of energy.

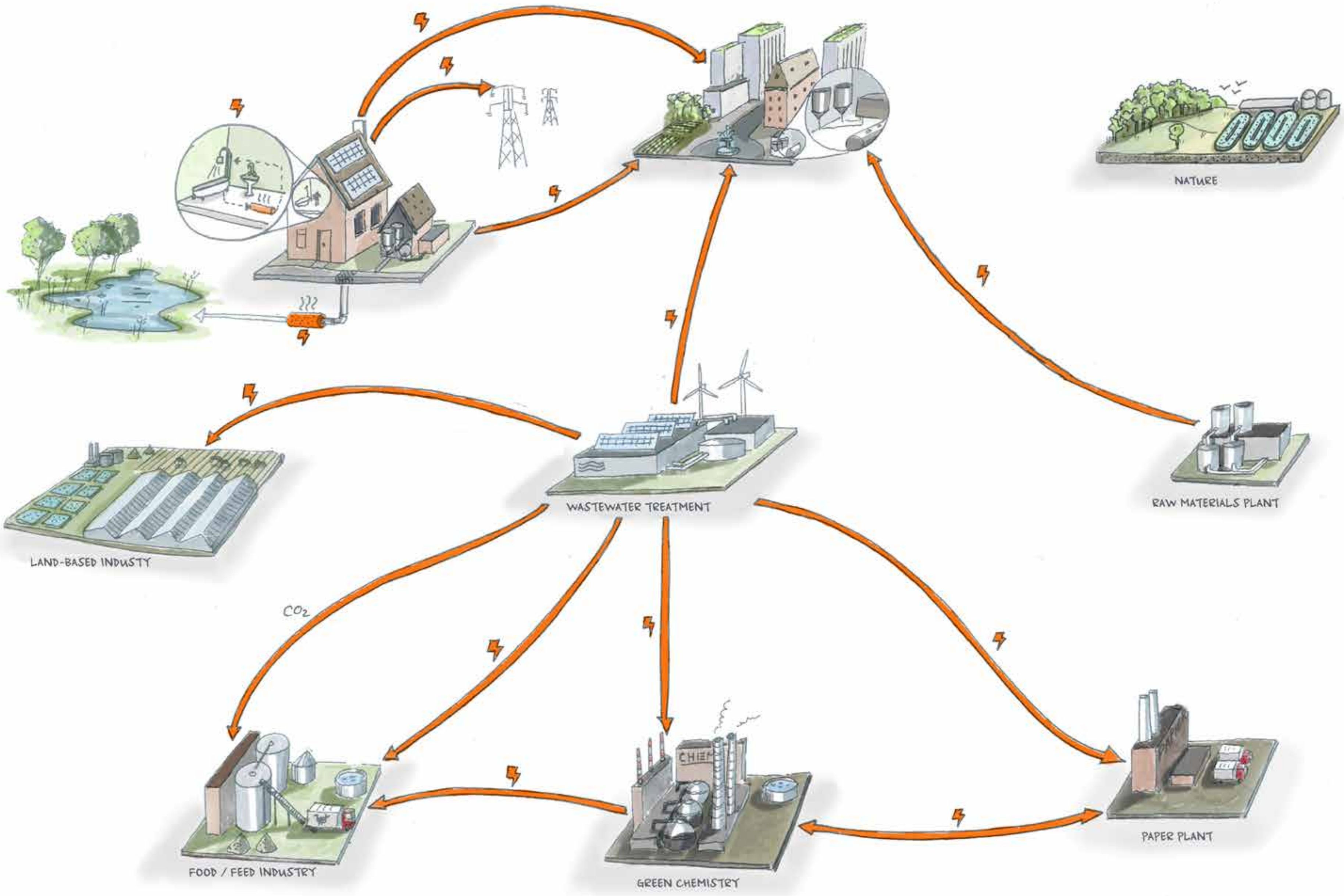
Combination of manure digestion and sludge digestion
There would most likely be more opportunities for joint processing of sludge and manure with certain changes in legislation. It would also be interesting to investigate how fruit and vegetable waste can help boost energy output.

Wastewater treatment plants as energy factories
A wastewater treatment plant is an energy factory. The water treatment system recovers chemical energy from wastewater. There are a number of different variants for the energy factory. The plus and super variants produce the most yield. The plus variant is an expansion of the basic variant, with a fuel cell instead of a gas engine and an extra trapping step for sludge treatment. The super variant expands on this by replacing the digestion with supercritical gasification of sludge and processing the remaining salt slurry. In both variants, the total of treatment steps produces more energy than is consumed.

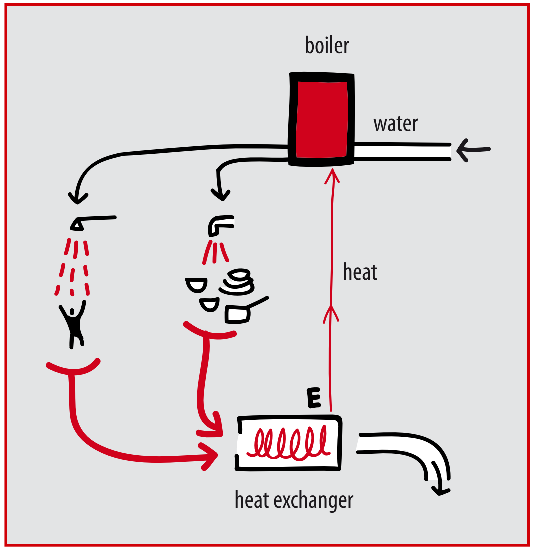
Efficient use of operational energy
The sewage treatment plant uses operational energy more efficiently than ever before. This depends on a number of measures. The obligatory four-year Energy efficiency plan identifies options such as:

- Thermal pressure hydrolysis. In a device similar to a pressure cooker, the sludge is thermally pretreated to improve gasification.
- Improved operations. Replacement of surface aerators with bubble aerators and impellers, lowering the sludge content in aeration tanks, installing on/off regulators on impellers, optimising slip return loops, etc.
- Pretreatment of wastewater with micro-fine filters. This technology separates paper fibres and other floating matter from the wastewater. Energy is then harvested by combustion. The pretreated wastewater also requires much less energy to treat.

Reduction of water consumption from toilet flushing
Energy consumption in the chain is reduced by reducing the consumption of water for toilet flushing. The vacuum toilet, for example, uses only one litre of water per flush.

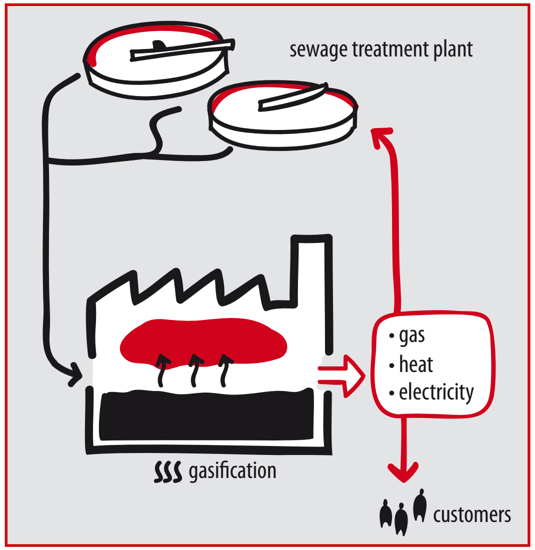

NATURE
LAND-BASED INDUSTY
WASTEWATER TREATMENT
RAW MATERIALS PLANT
CO2
FOOD / FEED INDUSTRY
GREEN CHEMISTRY
PAPER PLANT

Opportunities for energy



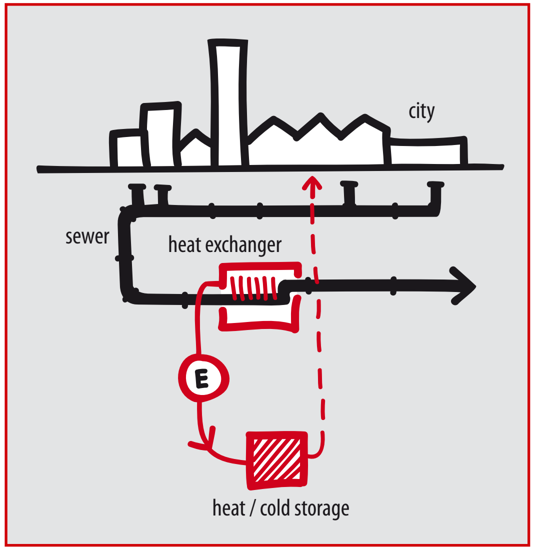
Recovering heat in homes and buildings

Heat exchangers allow residents to reuse the heat from hot tap water in the kitchen and shower. There are two options: preheating of tap and shower water or using a heat pump to generate heat. The heat exchangers are easy to install in new homes and buildings. For larger buildings, a heat exchanger in a well is a good solution.



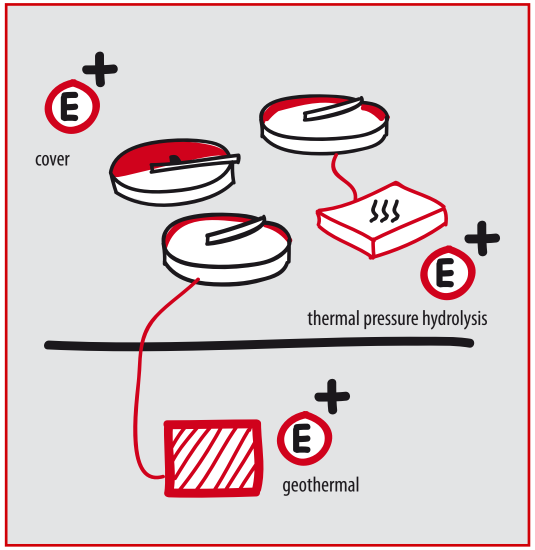
Wastewater treatment plants as energy factories

The wastewater treatment plant converts the chemical energy in wastewater into electricity. The sewage treatment plant uses this electricity to meet its own demand, and also supplies energy to customers. Thanks to supercritical gasification, the sludge no longer requires conventional final processing. In combination with other waste flows, such as manure, the yield is even higher. The sewage treatment plant also reuses the heat from discharged effluent.



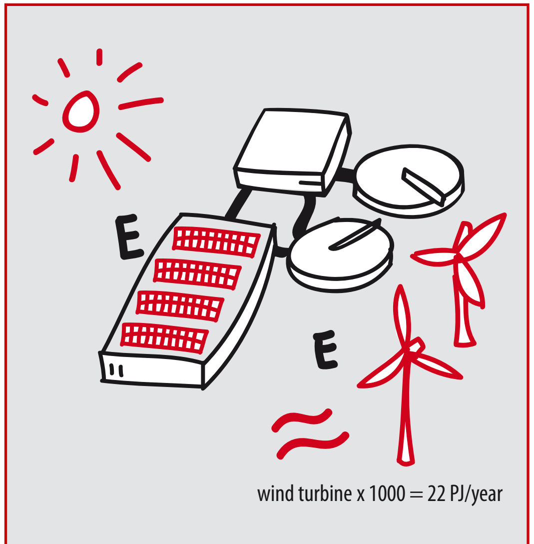
Recovering heat from sewage

In the summer, a sewage heat exchanger recovers heat from wastewater. This heat is stored in a thermal storage system. In winter, a heat pump delivers this high-quality heat to buildings. Sewage heat also helps prevent ice build-up on roads.



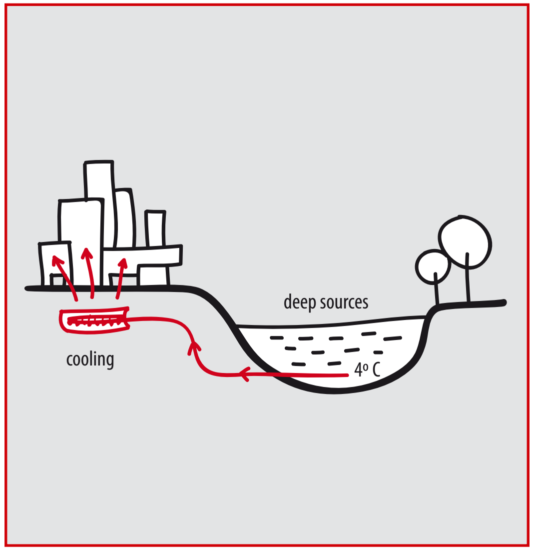
Energy savings at the wastewater treatment plant

Thanks to improved process operations, the sewage treatment plant also saves on operational energy. Techniques like thermal pressure hydrolysis help improve digestion. Geothermal energy, covering tanks and recovering individual heat for sludge drying are other examples of smarter ways to deal with energy.



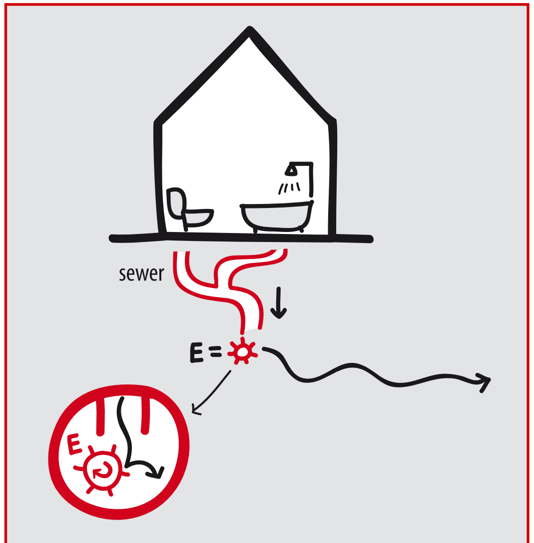
Wind turbines and solar panels on sites

Wind turbines are installed at wastewater treatment sites. They generate electrical energy. A thousand windmills can produce as much as 22 PJ annually. Solar panels on water treatment tanks also make their contribution.



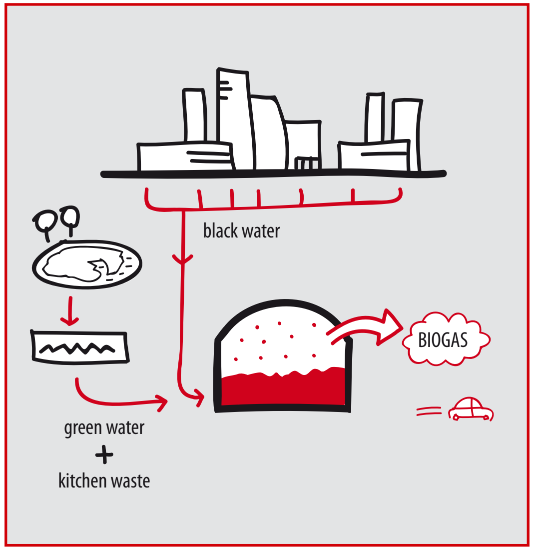
Cooling from deep water sources

We extract cooling from deep water sources in and around the city. This allows us to meet cooling demands for locations like offices and ICT companies.



Hydroelectric power from sewage

We utilise elevation differences in the sewers, which allows us to generate hydro-electric power at some locations in the Netherlands.



Energy from black and green water

In communities, offices and hotels we use vacuum collection to channel black water to a digester. The digester produces biogas. Yield is even greater from green water with organic kitchen waste added. This green water goes to the digester via container or vacuum pipe.

5. Recycling wastewater

What will the approach for recycling water from wastewater look like in 2030? And most importantly, where are the big opportunities?

Where we will be in 2030

Separating sewage from rainwater wastewater

Most sewerage systems are partly or completely disconnected from rainwater flows. Sub-flows are collected and treated separately. Storm runoff no longer has any significant effect on wastewater flows, because precipitation has been largely disconnected from the sewerage system. There are a number of different types of system for rainwater. The older infrastructure is a part of the rainwater system. It is the quality of living environment that is a major factor in determining the structure of the rainwater systems. The infrastructure consists primarily of new, small pipes

Many quality standards

The requirements set on the quality of water vary widely, but we can make the following generalizations:

- Hygienic security is essential for water that enters a food chain or is intended for household use.
- Desalination and removal under Total Organic Carbon (TOC) are relevant for high-quality industrial water.
- When water is to go back to nature, phosphate, nutrients, micro-contaminants, hormones, etc. are being removed to prevent environmental damage.

Usually custom work

Treated wastewater can be used in several ways and for several purposes.. Some of it ends up in the public space and the surface water. Treated wastewater is also sold to public and private consumers. The delivered water meets the quality standards derived from the characteristics of the local environment and relevant legislation. Generally, it goes directly to the end users; the quality level is appropriate for the intended use. As this implies, most deliveries are custom work.

High and low-quality water for industry

Areas dominated by an industrial cluster are supplied with industrial water by a large sewage treatment plant. This water may be of high or low quality. Generally, the sewage treatment plant follows a multiple source strategy, for example surface water in combination with purified wastewater. This reduces the dependence on a single source. The area's water needs are met by one or more water factories.

High-quality water for greenhouses

An area with many commercial greenhouses demands lots of high-quality water for irrigation. The most important source is rainwater. In periods of drought, an extra source is required, particularly if the dry spell is during a growing season. This source can be demineralised water produced from wastewater.

Urban water and self-sufficiency

Some cities are able to provide for all of their own water needs. The characteristics of such an area are small-scale and partially high-quality industry, high-quality public living environment and urban agriculture. The cradle-to-cradle concept is the inspiration for collecting separated flows of wastewater and optimally reusing water and other useful components.

Wide range of applications in rural areas

In rural areas, smaller treatment plants exist side-by-side with conventional sewage treatment plants. These smaller systems deliver water back to the natural environment. For homes in remote locations, this is cheaper than transportation of wastewater. Local agricultural companies recover nutrients and reuse them. In some cases, they even reuse purified water that is still rich in nutrients. Wastewater is an extra source for agriculture in periods of drought. In the west of the country, water shortages can arise from salt seepage and salination of rivers. In the east of the country, groundwater levels are falling, particularly on sandy soils.

Replacement of activated sludge systems

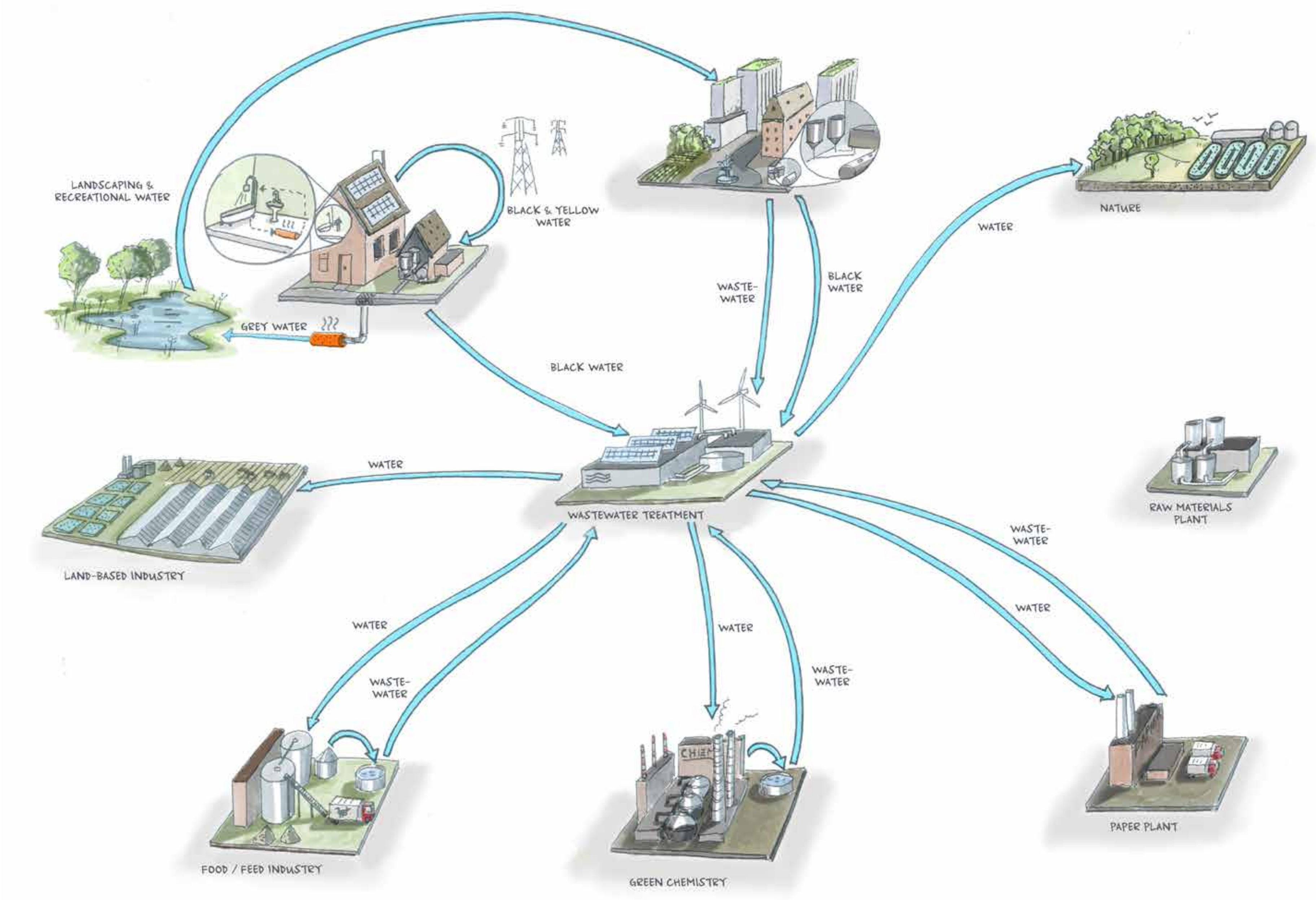
Some of today's activated sludge systems have been replaced by new technologies or hybrid combinations. There are many different post-processing techniques available. Organisations devote special attention to natural post-processing with plants, crops and water organisms. This creates an ecological connection between wastewater management and the water system (water catchment area)

Many technologies for production of drinking water

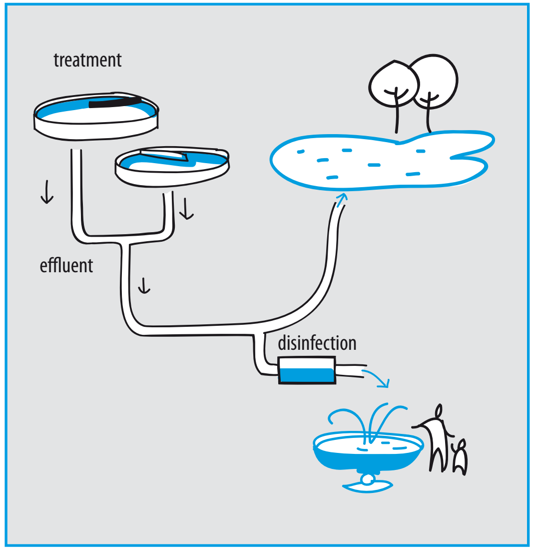
Organisations take many different technologies derived from drinking water production and apply them in more advanced forms to the reuse of water. In our sector, we work closely with the drinking water sector in the development and introduction of technology such as membrane filtration, active carbon adsorption, reversed and forward osmosis, disinfection techniques with ozone, H2O2 and UV, and others.

Online systems for measuring and monitoring

For dry weather drainage, we use the supply system as a buffer to prevent overflow. This measure is made possible by the use of online systems for measurement and monitoring, and real-time quality and quantity control.

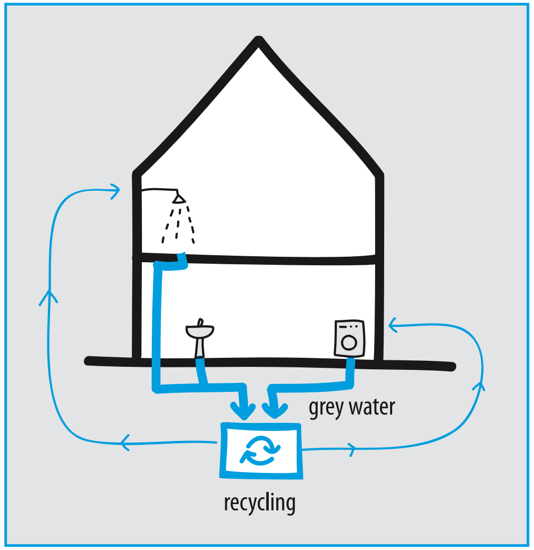

LANDSCAPING & RECREATIONAL WATER
BLACK & YELLOW WATER
GREY WATER
BLACK WATER
WASTE-WATER
BLACK WATER
WATER
NATURE
WATER
WASTEWATER TREATMENT
LAND-BASED INDUSTRY
RAW MATERIALS PLANT
WASTE-WATER
WATER
WATER
WASTE-WATER
WATER
WASTE-WATER
FOOD / FEED INDUSTRY
GREEN CHEMISTRY
PAPER PLANT

Opportunities for recycling wastewater



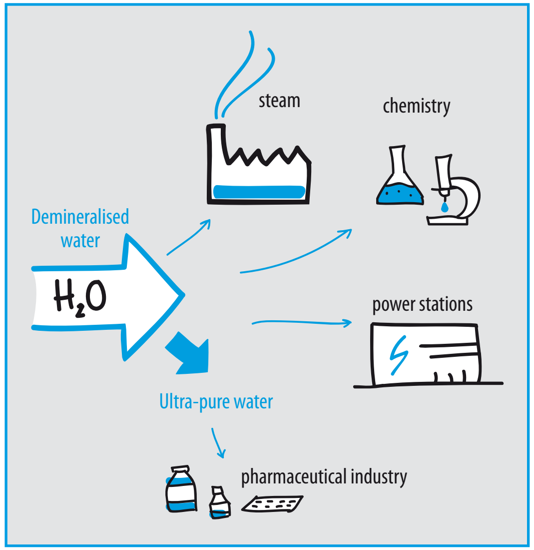
Landscaping or recreational water

In our country, we use effluent as urban, park and recreational water. This takes some of the burden off of groundwater levels. It also means we can irrigate longer in periods of drought. In any situation in which recreational users can come in direct contact with effluent, the effluent is subjected to disinfection processes.



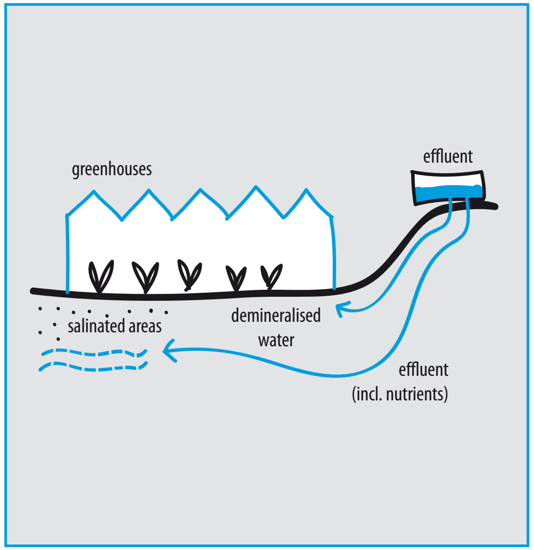
Household water

In 2030, the reuse of water will be much more important than it is now. One example is the domestic use of grey water. It is a trend being driven by the importance of sustainability and self-sufficiency, and the principle of doing locally whatever can be done locally. It also helps reduce consumption of drinking water. Hygiene of the effluent must, however, be guaranteed.



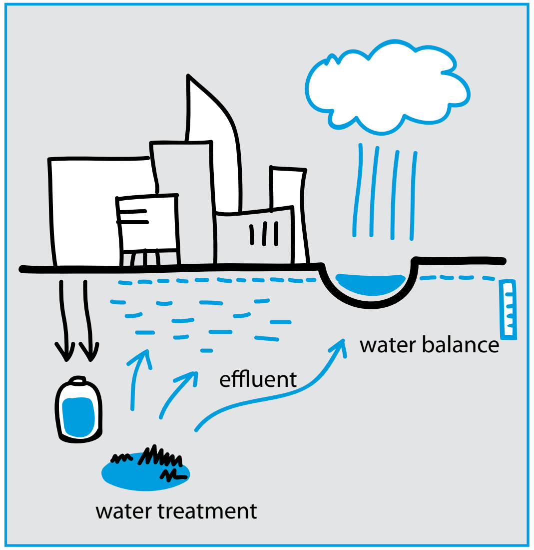
Process or cooling water

From effluent, we create desalinated water with the quality of demineralised water. Desalinated water can be used for the production of steam and processes requiring high-quality water. This level of water quality is in demand among chemical companies, power plants, producers of 'new energy,' and other types of facilities. One special type is ultrapure water, which is used by the pharmaceutical industry.



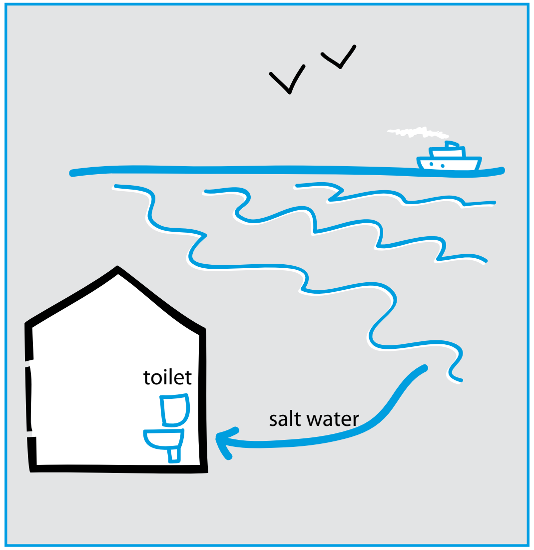
Water for agriculture and greenhouses

We use effluent to maintain the water resources level in agricultural areas through dry periods. It is also used to compensate freshwater shortages in salified areas. Effluent with nutrient content is beneficial to agriculture. In greenhouses, we use demineralised water. Demineralised water is free of bacteria and viruses. Supplying effluent to greenhouses reduces the demand for storage space for water.



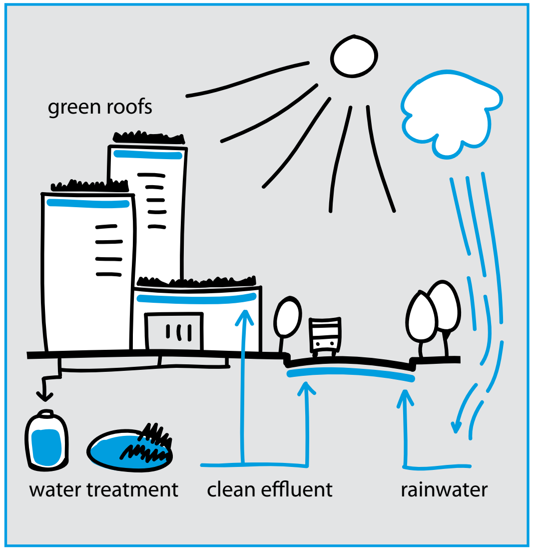
Effluent for water balance

Cities use effluent to maintain water levels. The Dutch city of Leeuwarden, for example, uses effluent to keep up the level of the city canals. As climate change increases the risk of long dry periods, using purified wastewater as a component of maintaining the water balance in urban systems becomes more and more attractive.



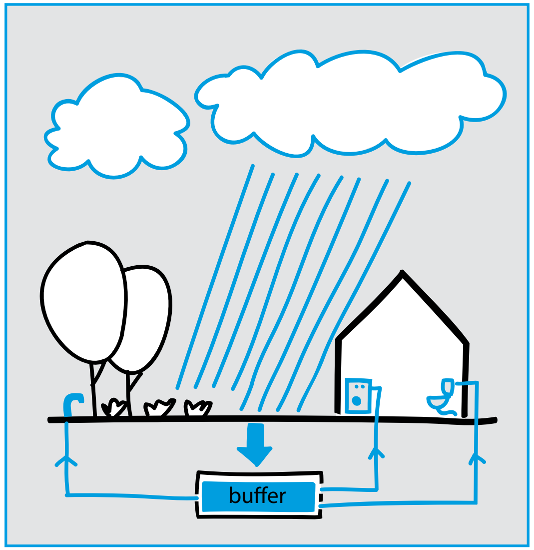
Saltwater for toilet flushing

The city of Hong Kong has been using saltwater for toilet flushing for half a century. The health risks of saltwater are much less than those of grey water. Water for toilet flushing needs no comprehensive pre-treatment. It also requires much less energy than recycled wastewater. In the Netherlands, the coastal areas are densely populated, so there is a lot of potential for the use of saltwater. Whenever there is a connection problem anywhere, the conductive properties of saltwater lead us right to it.



Combating urban heat islands

The densely packed, tall buildings in cities trap a lot of heat in urban areas. This leads to heat stress and urban 'heat islands.' Temperatures can be reduced by using rainwater (for example, under roads and on green rooftops) and clean effluent. Semi-porous pavement can also reduce urban heat stress.



Rainwater for toilet and washing machine

Rainwater storage, for example below the home or above ground in the garden, can help reduce consumption of drinking water. Homes can use rainwater for toilet, washing machine and garden. For gardens, filtration boxes or biosand filters can be useful for buffering and filtering precipitation. This also helps keep rainwater from unnecessarily flowing into the sewers.

6. Urban environment

What would the ideal wastewater management approach in an urban area look like? We formulate ambitions and identify opportunities. This also includes elements from other local perspectives.

Good picture of thermal potential

Municipalities with over one hundred thousand inhabitants document their thermal and chemical demands and the opportunities and potential in an energy atlas. There are a number of different technologies available to help wastewater treatment plants reduce their operational energy consumption. The choice for the optimal combination requires a total consideration.

Closed cycles

Every municipality with over 100,000 inhabitants embraces the concept of the urban metabolism. To increase the quality of the living environment, energy and raw material cycles at the urban level are closed. The municipality undertakes initiatives to close them. Large wastewater treatment plants are 'plus variant' (see Chapter 4) energy factories.

Optimised waste collection

For the sake of sustainability, the city reuses raw materials. The city has a high-efficiency, total waste collection system in place. The sewage treatment plant processes fruit and vegetable waste.

The energy factory is part of a local energy grid

The energy factory exchanges a variety of energy flows with the local environment. The energy factory is a link in the optimal energy use chain.

Recovery of heat from shower water

In both new and old buildings, residents are recovering heat from shower water. Housing cooperatives and project developers have set up project organisations especially for this purpose. Residents buy do-it-yourself kits from hardware stores and home improvement centres. Plumbers offer a professional and competitive service package for recovering heat.

Total concept for heating and cooling storage

Underground is the domain of the government. This is partly because the market parties want it that way. The municipality ensures that the sources for heating and cooling storage are used optimally. Riothermics, the recovery of heating and cooling from the sewers, are part of the metabolism of the city. The municipality uses this concept to solve other problems as well, like low groundwater levels and groundwater pollution. The municipality offers heating and cooling storage as an integrated total concept. The user doesn't buy a system, but instead buys heating and cooling.

Collecting wastewater locally, processing it centrally

Large and small municipalities collect separated flows of raw wastewater in local districts, and then process it centrally at another location. Local collection happens mainly in renovated and new communities. The wastewater is purified locally where this can be done more economically.

Local plant for recovering raw materials

A local plant recovers phosphate from locally collected urine. The recovered nutrients commonly serve as raw material for urban agriculture and gardens.

Fighting heat islands with effluent

Urban areas use effluent to combat heat islands.

Full self-sufficiency within reach

Some cities are able to fully provide for their own water needs. These tend to be areas with small-scale and some high-quality industry, high-quality public living environment and urban agriculture.

Development in urban environment up to 2030

2012-2015

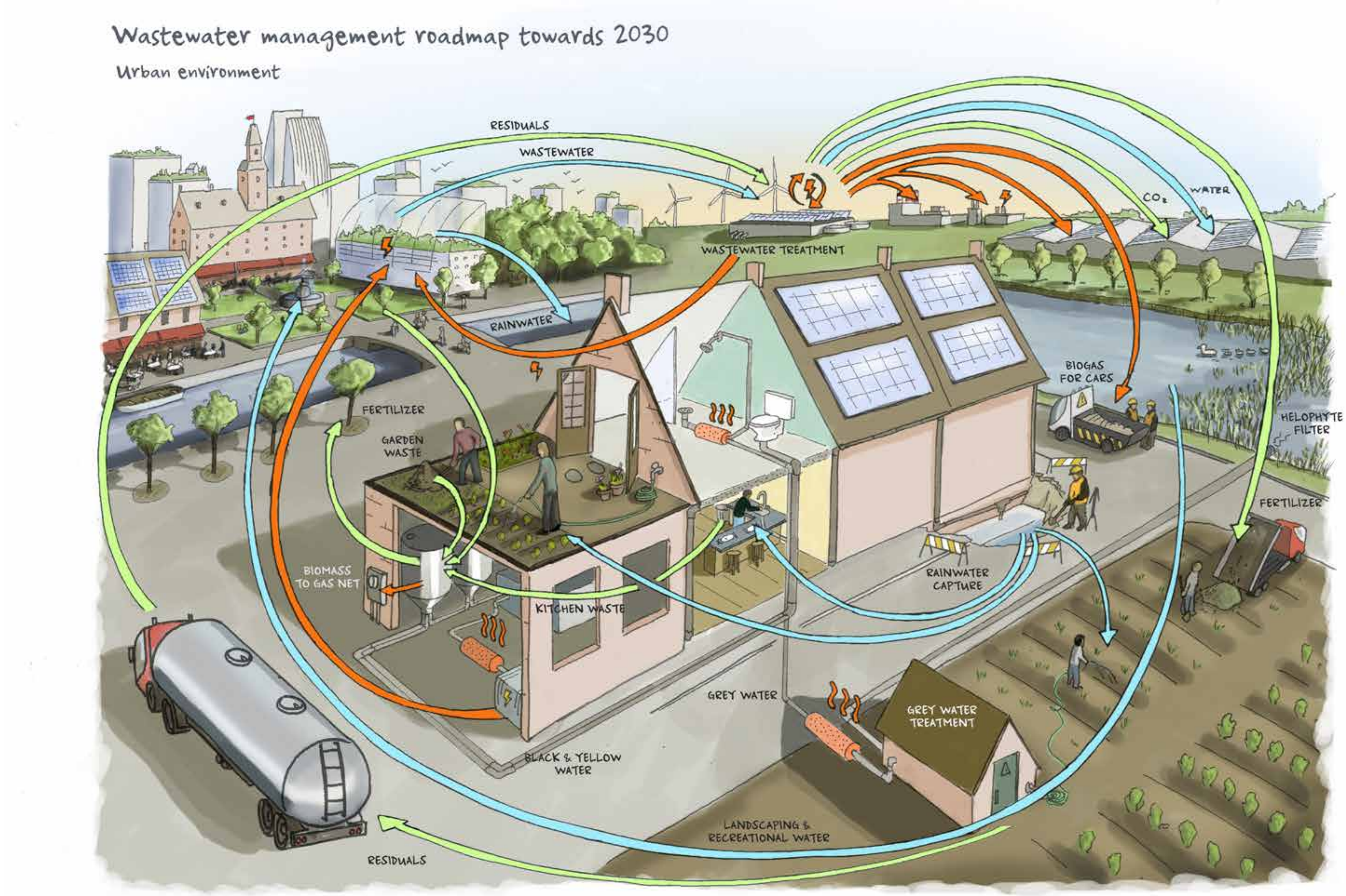
- Coordination of plans with services partners
- Small-scale pilots and evaluation of experiments with local treatment
- Development of robust stand-alone technologies for raw material production
- Utilisation of chemical potential
- Identifying thermal potential
- Heat reclamation from shower water standard in new construction
- Processing of fruit and vegetable waste and conversion into chemical energy

2015-2020

- Production of raw materials in part directly from separated collections of wastewater
- Closing of cycles in municipalities of > 100,000
- Optimisation and integration of waste collection
- Full utilisation of chemical potential
- Recovering of heat from shower water in existing construction
- Energy production is integrated link in optimal energy utilisation
- Integrated heating and cooling total concepts with role for wastewater
- Pilot projects with local treatment

2020-2030

- Local collection and processing, central treatment
- Construction of local plants for raw material recovery
- Local initiatives to make urban areas water self-sufficient


Wastewater management roadmap towards 2030
Urban environment
RESIDUALS
WASTEWATER
WASTEWATER TREATMENT
CO2
WATER
RAINWATER
BIOGAS FOR CARS
HELOPHYTE FILTER
FERTILIZER
GARDEN WASTE
FERTILIZER
BIOMASS TO GAS NET
KITCHEN WASTE
RAINWATER CAPTURE
GREY WATER
GREY WATER TREATMENT
BLACK & YELLOW WATER
LANDSCAPING & RECREATIONAL WATER
RESIDUALS

7. Industrial area

What would be the ideal approach to wastewater management in an industrial area? We formulate ambitions and identify opportunities within this perspective.

Partnering with the green chemical industry

Regional water authorities and municipalities work with partners in the green chemical industry to develop shared innovation agendas. In the process, they are exploring new markets and developing business local perspectives. Much of their research focuses on the valorisation of raw materials, but small-scale testing of techniques to produce semi-manufactured products or base chemicals for green chemistry is another area emerging from this partnership.

Cellulose, bioplastics and platform chemicals

Some sewage treatment plants or treatment plant consortiums supply cellulose and platform chemicals to local industry, mainly chemical, plastic and construction industry firms. These plants produce the basic raw materials that green chemistry needs, like cellulose and monomers. These firms can use screenings, and in some cases organic waste and cuttings. They produce and market bioplastic products made from basic building blocks obtained from wastewater management.

Feeding heating and cooling networks

Is there a surplus of energy coming from the sewers, and from local and regional sewage systems? Then this energy is incorporated into local heat and cold networks for business parks. Energy is supplied as heating, electricity or gas. CO_2 serves as a coolant for refrigerators and freezers.

Refinery train for broad-spectrum raw materials plant

In many cases, refining a single product or even several products is not economically viable. Multiple groups of products can be recovered in what is known as a 'refinery train.' This is the way to maximally leverage the complexity and value of the wastewater flow and the substances in it: things like cellulose, nutrients, fatty acids, enzymes, drug by-products, detergents and other organic compounds in wastewater or sludge. A few large sewage treatment plants are shifting towards becoming full-spectrum raw materials plants. This is happening in close consultation with the agriculture, chemical and food industries. The plant selects some of the raw materials to produce based on customer specifications.

A possible process in the refinery train:

- Removal of paper fibres with microfine sieves.
- Conversion of fibres into cellulose or monomers.
- Conversion of residual organics into sludge, which is then used for the generation of biogas. The plant also converts the organics into fatty acids, which are then suitable for bioplastics.
- Recovering phosphate as fertiliser from concentrated wastewater flows.
- Utilizing residual concentrations of nitrogen and phosphate for algae production.
- Treating remaining process sludge in a gasification system for the production of syngas (CO, hydrogen, methane).
- Extracting residual phosphate from the ashes.

Sewage treatment plants as a source of industrial water

Areas with many industrial companies are supplied with water by a large sewage treatment plant. The quality of the water is high or low. The plant can use multiple sources, ranging from surface water to treated wastewater. This combination makes the sewage treatment plant less dependent on a single source. Demineralised water is used for the production of steam for chemical companies, power plants and 'new energy' producers.

Development in industrial area up to 2030

2012-2015

- Draft innovation agendas and research programmes
- Identify opportunities for alliances
- Early adopters implement no-regret measures
- Experiments with cellulose, bioplastics and platform chemicals
- Growth from the current two to five referents in supply of industrial water

2015-2020

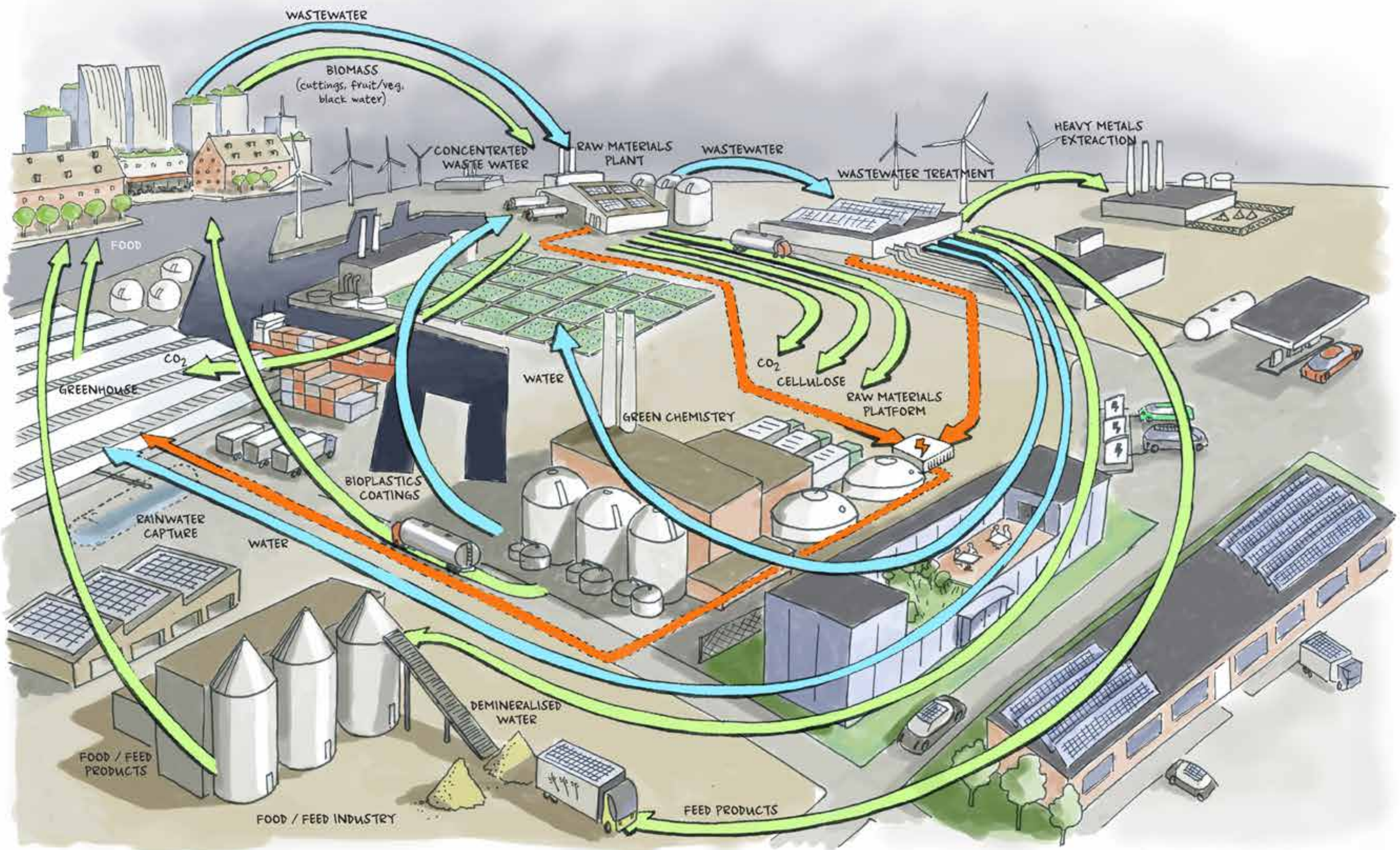
- Cellulose, bioplastics and platform chemicals for chemical industry
- Scaling up and refining
- Production of semi-manufactured products from wastewater by networks of companies
- Energy exchange between industrial environment and sewage treatment plant
- Significant number of pilot projects with larger sewage treatment plants supplying water to industry

2020-2030

- Syngas for green chemical sector
- Refinery train for broad-spectrum raw materials plant
- Maximum utilisation of residual industrial heat in wastewater services and vice versa
- Custom, on-site locations for water from sewage, through modular water 'factories'
- Low and high-quality industrial water sourcing from larger sewage treatment plants
- One or more water 'factories' providing for regional water needs

Wastewater management roadmap towards 2030

Industrial area



8. Land-based industry

What would the ideal wastewater management approach for land based industry look like? We formulate ambitions and identify opportunities within this perspective.

Recovering phosphate and production of fertilizer

We apply successful projects from the past on a larger scale. There is sufficient demand for and supply of phosphate from wastewater or sludge processing. Products have the quality required for precision fertilization. We also recover phosphate components directly from waste flows. There is a mature market for processing manure and sludge. The technologies are competitive. The products have a high added value. There are raw materials plants in a few places, and working closely with them, livestock farms are able to close their nutrient cycle.

Increasing phosphate yield by addition of fruit and vegetable waste

Raw materials plants use biomass, concentrated treated sludge and granulated sludge (supplied by sewage treatment plants) to produce valuable components. This increases phosphate yield by 50%. These plants supply to greenhouse growers. In some cases, only products with no food value are used, like plants and cut flowers.

Raw materials for green chemistry

Processing manure and sludge is interesting for more than just phosphate. There are other substances to be recovered, like raw materials for green chemistry. Regional water authorities encourage this development. They were the ones to first gain knowledge in this area, and now that knowledge can be applied in manure processing pilot projects. Regional water boards and municipalities firstly seek to build on existing markets. They make an active contribution to developing new markets to which the raw materials can add real value in the circular economy.

Extra energy source

Any time the sewage treatment plant and local cooperative facilities for wastewater processing and sewage digestion have a surplus of energy, they use this as an extra energy source for example for greenhouses or local transportation (in the form of biogas and electricity).

Demineralised water for greenhouses

Around the Haarlemmermeer, the Westland and the city of Venlo, there are greenhouses everywhere. Areas with greenhouse clusters like these have a high demand for high-quality water as irrigation water. Their biggest source is rainwater, but that does not get them through periods of drought, especially when the drought coincides with a growing season. Demineralised -water can be an extra source.

Rainwater for farming and greenhouse growing

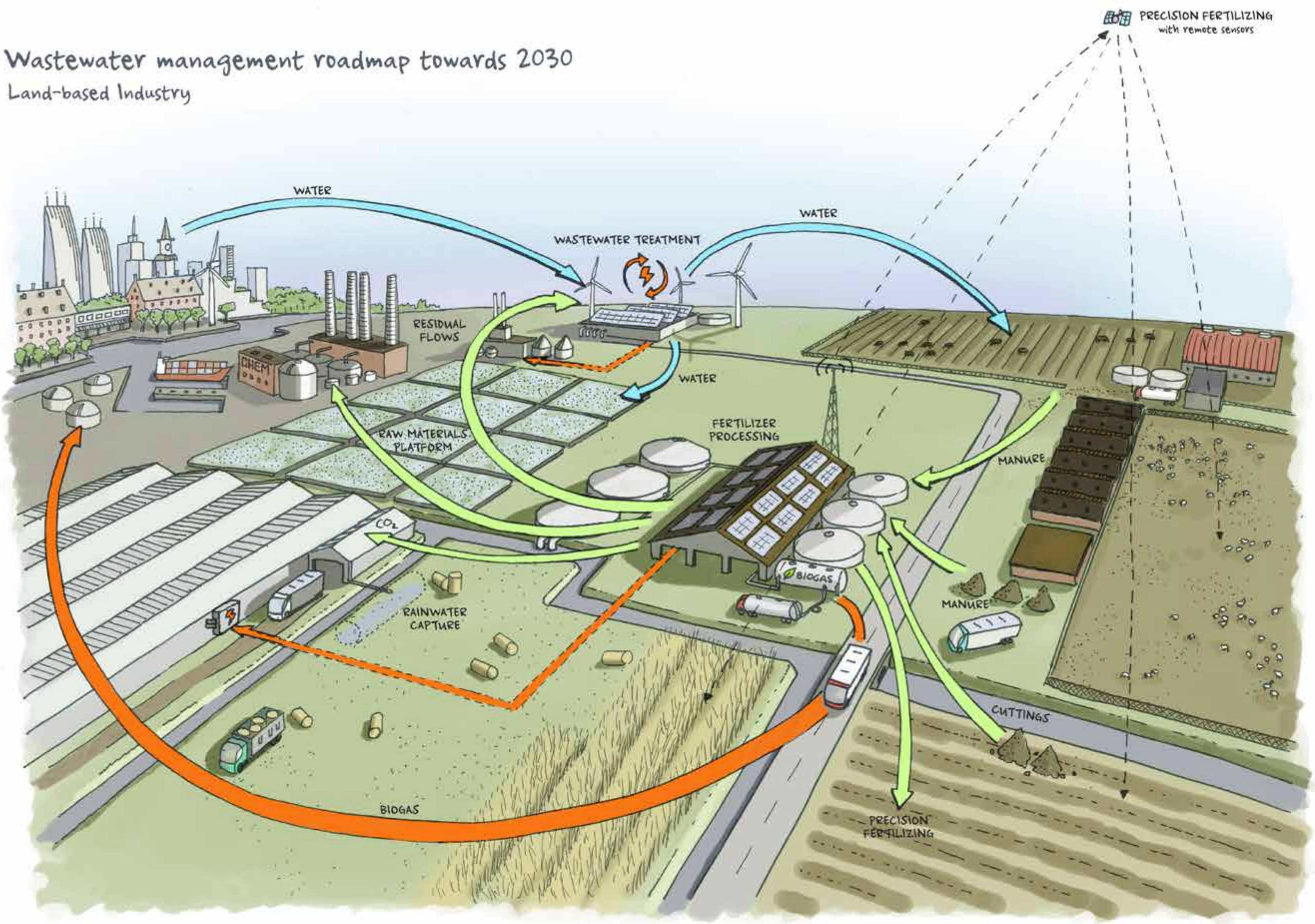
Rainwater is an additional source for agriculture in periods of drought. In the west of the country, water shortages can arise from salt seepage and salination of rivers as a result of climate change. In the east of the country, groundwater levels are falling, particularly on sandy soils, as the result of numerous extractions.

Development in land-based industry up to 2030

2012-2015
- Phosphate production facilities, knowledge exchange with the agricultural sector
- Marketing of biogas as gas or electricity

2015-2020
- Upscaling of phosphate recovery and expansion into fertilizer
- Value study of raw materials for green chemistry
- Connection of sub-areas to central supply of water from sewage treatment plant

2020-2030
- Artificial fertilizer and precision fertilization
- Increase of phosphate yield through addition of fruit and vegetable waste from consumer and agriculture
- Refining rainwater into high-quality irrigation water for green-house growing
- Demineralised water as additional water source during dry periods in growing seasons


Wastewater management roadmap towards 2030
Land-based Industry
PRECISION FERTILIZING
with remote sensors
WATER
WASTEWATER TREATMENT
WATER
RESIDUAL FLOWS
CHEM
WATER
RAW MATERIALS PLATFORM
FERTILIZER PROCESSING
MANURE
CO_2
BIOGAS
RAINWATER CAPTURE
MANURE
CUTTINGS
PRECISION FERTILIZING
BIOGAS

9. Rural area

What would the ideal wastewater management approach in a rural area look like? We formulate ambitions and identify opportunities within this perspective.

Effluent for algae farming

Is an area dominated by open-air farming? Or perhaps wide open spaces with barren ground, like sandy areas? These are areas where the sewage treatment plant supplies effluent with the ideal nutrient composition for algae farming and the production of duckweed and other biomass. In 2015, the yield from these basic raw materials for livestock feed has already overtaken that of traditional crops like maize.

Algae farming basis for food, drugs and cosmetics

Wet agriculture like algae farming is no longer the basis for high-quality biomass, but for livestock feed, fish food, food supplements (like fatty acids) and base materials for drugs and cosmetics. The technologies are competitive. There is a demand for high added value in these products.

Very diverse biomass flows

The sewage treatment plant processes a wide range of different biomass flows. It also uses new chemical (hydrolysis, gasification, pyrolysis) and biological (digestion, fermentation, etc.) techniques to produce high-quality base chemicals for green chemistry (ethanol, sugars, adipic acid).

Using locally treated water

A rural area has a sewage treatment plant as well as other, smaller treatment facilities. These smaller systems deliver water back to the natural environment. For homes in remote locations, this solution is cheaper than transporting wastewater. Local agricultural companies recover nutrients and reuse them. In some cases, they even reuse treated water that is still rich in nutrients.

Development in rural area up to 2030

2012-2015

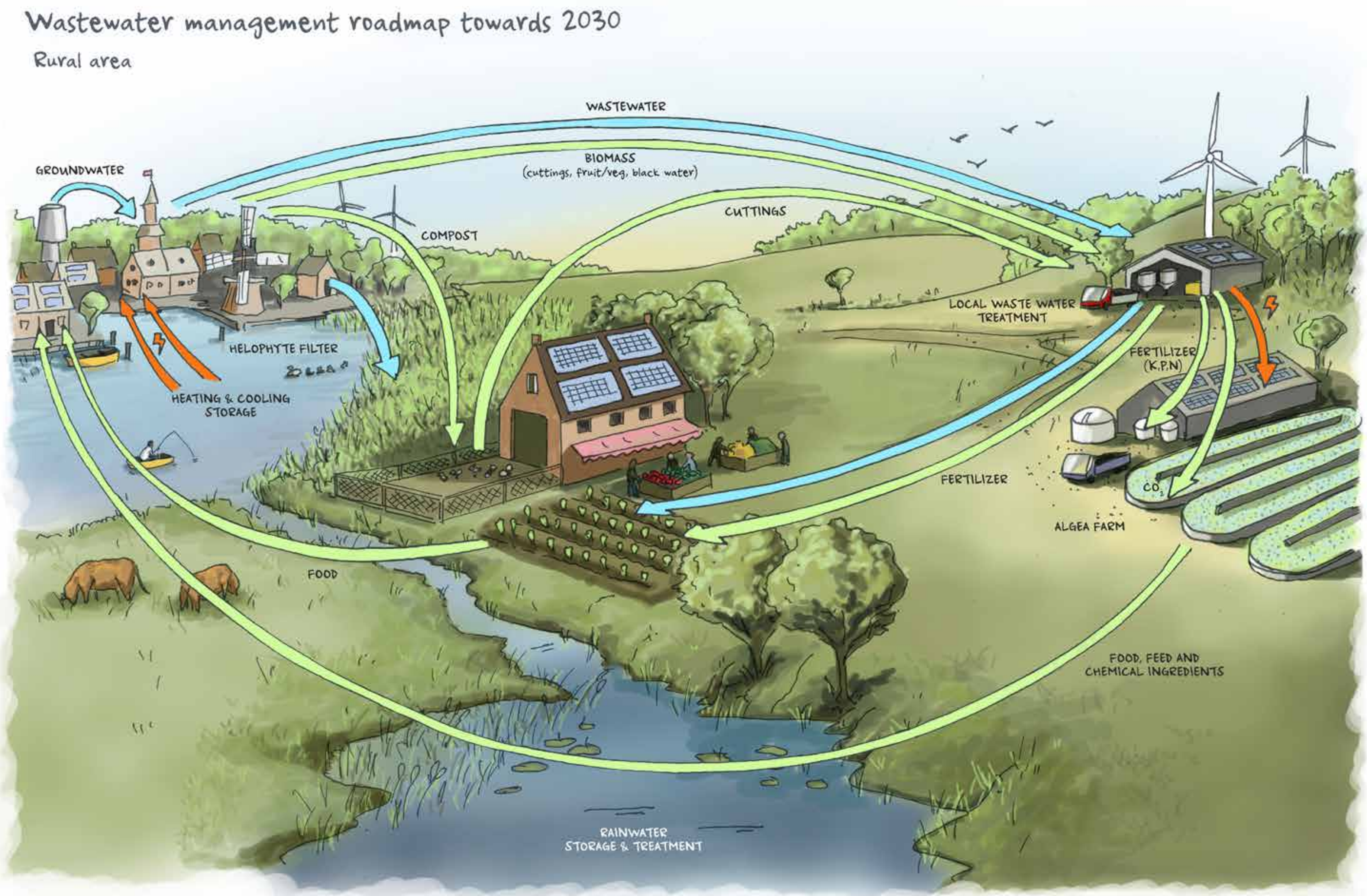
- Plan making on use of water and role of sewage treatment plant and transport infrastructure
- Learning from experimentation with wet agriculture
- Refining effluent into ideal nutrient composition for algae farming
- Feasibility studies for large-scale extensive wet agriculture

2015-2020

- Upscaling, market development and testing of new technologies
- Experiments with new biomass flows
- Pilot projects with local water treatment

2020-2030

- Algae for food, drugs and cosmetics
- Local use of water from smaller treatment facilities (alongside existing central sewage treatment plants) in nature
- Recovering and reusing nutrients or nutrient-rich treated water, for example, by local agriculture


Wastewater management roadmap towards 2030
Rural area
WASTEWATER
BIOMASS
(cuttings, fruit/veg, black water)
GROUNDWATER
CUTTINGS
COMPOST
LOCAL WASTE WATER
TREATMENT
HELOPHYTE FILTER
FERTILIZER
(K,P,N)
HEATING & COOLING
STORAGE
FERTILIZER
CO2
ALGEA FARM
FOOD
FOOD, FEED AND
CHEMICAL INGREDIENTS
RAINWATER
STORAGE & TREATMENT

10. Challenges

We will face a wide range of challenges in making our vision a reality. This chapter describes the main challenges.

Developments in the market

The market for bio-based raw materials and energy is a dynamic market. Many companies and sectors are taking advantage of the opportunities for green raw materials. The regional water authorities and municipalities are, to some extent, 'frenemies in their approach of wastewater management and sanitation' working together as expert partners while at the same time competing. This is all part of drawing attention to the producers of end products, formulating good specifications for raw materials and creating an attractive sales market.

Partnerships with businesses and knowledge institutions

The partners in wastewater management (treatment and sanitation) maintain intensive contacts with the leaders in other sectors and knowledge institutions. These partnerships give us a good picture of the opportunities. They also help us set up the first pilots and demo projects fast and relatively cheaply.
In our partnerships, we:

- Exchange knowledge
- Draft business cases
- Set up and perform transborder pilots

All these activities involve multiple regional water authorities and municipalities. We build partnerships by being active in networks and platforms. Examples include the bio refinery cluster and the bio-based platform.

New technologies

The partners in wastewater management have a great deal of interest in groundbreaking technologies. We participate in long-term research on raw materials. The partners are also on the lookout for new technologies in fields like chemistry, the food sector and agriculture. We amass knowledge in networks and platforms, we participate in research programmes in the agrofood food cluster, the chemistry top sector, the bio refinery cluster, the food top sector and the water top sector.

Sharing successes

Regional water authorities, municipalities, commercial companies and knowledge institutions have to be able to work well together and share their successes. This is what will make their partnerships effective. Engaging in joint research and pilot studies has to come naturally. Making smart combinations will allow all parties to benefit maximally from research and experiments.

Enterprising attitude

Innovations can and do fail sometimes. Employees, managers and administrators allow for this and develop competences in the process. They pick up new ideas fast and professionally. The boundaries for enterprise are clear. It takes some getting used to at first. Progress is in fits and starts as the field is gradually explored.

Good regulation

Adequate regulations stimulate the development of a promising sales market for raw materials from wastewater. These regulations remove the legislative barriers around waste materials, institute a stimulus plan for the use of recycled materials, differentiate in rates, reassess legislative requirements relating to Legionella bacteria and provide a framework for the use of domestic water. Changes in fertilizer legislation will increase the opportunities for collaborative processing of sludge.

Administrative will

Building up impetus and critical mass demands administrative will. Sectors with a strong will to invest make multiyear commitments. The employees vital to innovation participate in research, experiments and transition projects. Ten to thirty percent of the research budget goes towards long-term innovation.

Green movement

One essential condition for a healthy sales market for raw material from wastewater is to cultivate a green movement. It is unclear whether in the future people will still want to go green.

Competition with other sustainable solutions

Utilising thermal potential competes with other sustainable solutions. A critical issue is developing energy and heat from wastewater into a total concept for tackling climate issues in the urban area. We have to overcome the scepticism of some in the field. We need more technologies for recovering shower heat.

Use of hot water with a lower temperature

Hot tap water has to be heated to temperatures above 60ºC in order to prevent the growth of Legionella bacteria. If tap water of 45ºC could be used without risk, this would offer significant advantages. Urban heating systems would then have less distribution loss, making the systems more sustainable. It would also make it much easier to take advantage of opportunities like riothermics, heat pumps and thermal storage.

District heating in the energy label system

We would like to see district heating be incorporated into the energy label system. This will require adjustment of existing policies and creation of new ones.

Industry's willingness to be dependent

A company involved in the reuse of wastewater becomes dependent on water companies. Such companies have to be able to count on the water being readily available in the desired quality. This demands proven technologies.

Distribution systems

In some cases, recycling of wastewater will require a distribution system. And that generally means a lot of money. The system is suitable for multiple water sources.

Critical technologies: Raw materials

- Slurry filters
- Gasification/supercritical gasification
- Syngas production technologies
- Chemical (hydrolysis, gasification, pyrolysis) and biological (digestion, fermentation) technologies for producing base chemicals
- Fermentation and alternative techniques for processing biomass
- Vacuum sewerage
- Robust stand-alone technology for aerobic/anaerobic treatment and struvite precipitation

Critical technologies: Energy

- Heating and cooling storage from surface water
- Gas water pumps
- Supercritical gasification
- Fuel cell technology
- Sewage heat exchangers
- Heating and cooling storage from surface water
- Use of residual heat for sludge drying
- Use of geothermal energy for drying slides and heating sewage treatment plant processes
- Anaerobic local treatment of wastewater (new sanitation)
- Thermal pressure hydrolysis
- Bubble aeration at sewage treatment plant
- Wind and solar energy on sites

Critical technologies: Water

- High-load systems like AB systems
- Aerobic granular sludge technology
- Cold Anammox
- Membrane filtration and downstream filtration techniques
- Active carbon adsorption
- Floatation and filtering technologies
- Forward and reverse osmosis
- Struvite reactors
- Fermentation technologies
- Fuel cell technology
- Natural postprocessing methods with plants and crops

11. Transition

This chapter presents a vision of the best way to handle the transition process.

Transition: A dynamic and complex process

A transition is a dynamic and complex process between people, organisations, processes, products and systems. In wastewater management , the transition is especially complex due to the mass and collective nature of the transition task.

Living vision

Our vision offers an appealing framework, but is by no means set in stone. This vision is continually fed and built on by the partners in wastewater management and sanitation. The first step is to sit down with key players in adjacent sectors and together identify shared opportunities for the future, in a process of bringing outside inspiration in.

Transition arena and transition leaders

An important aspect is organising a transition arena. This is something that the transition leaders in wastewater management must participate in. They are parties of diverse backgrounds, who will pit perspectives and potential solutions against each other. This will have an inspiring effect on the other partners.

High-potential innovation

Wastewater management benefits from visionary and high-potential innovation outside of existing frameworks. We share the playing field, in which not only the regional water authorities and municipalities are active, but other parties in a range of industries. Apart from projects with concrete output goals, there are experiments with learning objectives for the transition. These experiments have a long-term perspective.

Transition monitor

We translate transition tasks into learning objectives for the experiments. The transition monitor highlights the connection between actions in the short term and impact in the long term.

Innovation task independent of existing regime

A change of system precipitates sweeping cultural and organizational change. The magnitude of this change tends to scare the parties in charge off. This is why it is advisable for research institutes and R&D divisions to take on the innovation task. This stimulates an entirely different way of thinking and working. The alternative is to create an independent programme agency or innovation network for the purpose.

Outward-looking culture

Innovation across the boundaries is possible when people can move relatively freely in wastewater management and among the wastewater management partners. They spur new sustainable business and innovation. The desired cultural change is stimulated by dynamics such as the influx of people of different backgrounds, job rotation and new job descriptions.

Specific competences

As part of the transition process, specific competences need to be placed at specific layers in the organization:

- Employees: Cooperation, reflection, open attitude, multidisciplinary working methods, seizing new opportunities, participation, business acumen, vulnerability.
- Managers: Trust and giving space, inspiring, enthusing, managing for output and long-term goals, cooperation.
- Administrators: Looking beyond the administration period, looking more broadly than the portfolio, being an ambassador, inspiring, exhibiting leadership and managing for the big picture.

Leveraging the strength of existing programs

There are dozens of national and regional initiatives in and around wastewater management. We leverage the power of these programmes. We also actively look for connections with projects in the top sectors and the biggest chains.

12. Where do we go from here

Where do we take wastewater management from here? We have translated our vision into five action lines needed to make the vision a reality. The action lines are detailed in a separate document.

Development of a local vision

The more partners that are aware of the vision, the more real impact the vision can have. One way to engage partners is to translate the vision for their local situations. National and regional ambassadors support this with presentations to regional water authorities, municipalities and coalitions.

Strengthening cooperation

We want to get a good picture of the most promising markets and applications. We also want to activate potential customers and market partners. We do this in part by analysing research and plans in other sectors, building and strengthening networks, and developing a transparent market and business cases.

Research and experiments

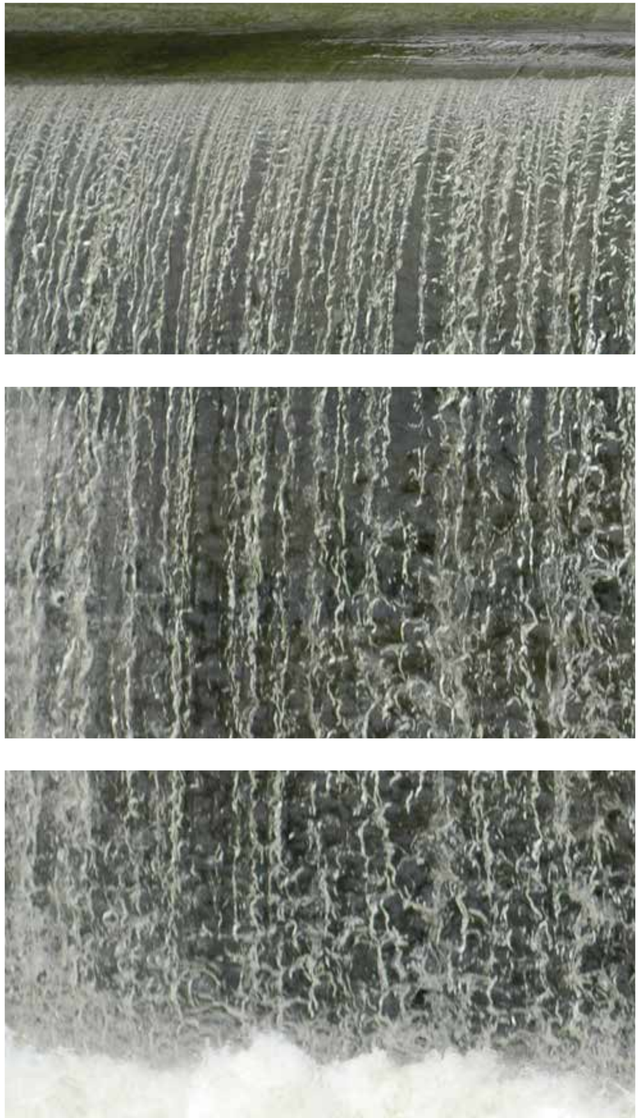
We conduct research, experiments and pilot studies. In this work we closely follow the research of the bio-based platform and the bio refinery cluster.

Facilitating transition and knowledge exchange

We facilitate the transition with training and tools for experiments. We also strive to remove legislative and institutional impediments. Initially, our trainings, learning meetings and peer group sessions are primarily intended for people actively participating in the projects for the roadmap. Later, all employees will be able to participate in competency development activities.

Progress monitoring and communication

We monitor the progress of the transition and communicate about it. For the performance areas, we formulate time-based performance levels.



Annex 1: Dutch wastewater management today

What is the current situation in wastewater management in the Netherlands today? A summary of the most prominent features.

Two billion cubic metres of wastewater treated

Most of the water we use at home and at work ends up in the sewers, as does the vast majority of rainwater. Water flowing into the sewers in several different municipalities ends up in the same sewage treatment facility. The 350 sewage treatment plants in the Netherlands process a total of some two billion cubic metres of wastewater annually. And their output flows back to the surface waters.

The wastewater flows to the sewage treatment plant through the sewer system. Our country has nearly 100,000 km of sewer lines (source of figures: www.ro-web.nl/2010/12/afvalwater). 99.3% of Dutch households are connected to the sewers. About 62% of sewers handle both wastewater and rainwater. These are referred to as 'combined sewer systems.' In 'separated sewer systems,' the wastewater flows to the treatment facility and the storm runoff flows to the surface waters through a separate system. Over the years, many improved variants of these types of system have been built. Specific sewerage technologies have also been introduced to pipe the sewage through thin transport lines with pressure pumps ('pressure sewers') or vacuum pumps ('vacuum sewers').

Proportional composition of wastewater

Water in the sewers and treatment plants is composed of an average of one-third wastewater, one-third rainwater and one-third groundwater. Water coming from individual consumers is generally contaminated primarily with oxygen-binding substances (organics), sulphate and the nutrients nitrogen and phosphate. In addition, this water will contain a high proportion of fibres (toilet paper, textiles) or carbohydrates (starch), proteins, fats and other biodegradable substances from the food industry.

Wastewater as an energy source

In wastewater management, there are a number of places that offer the opportunity to recover energy: in the home, in the sewer, at treatment, in and around the sewage treatment plant and at quays. We make a distinction between thermal energy (heat) and chemical energy. Households and businesses add heat (49 PJ per year and 16 PJ per year, respectively). This thermal energy leaves wastewater management during transport through the sewers (37.5 PJ) and via effluent from wastewater treatment (23.3 PJ). Chemical energy takes the form of oxygen-binding substances that are oxidized in contact with oxygen. Some of this chemical energy can be recovered in the process of sewer sludge treatment. This energy is harvested in the form of biogas. More and more sewer treatment plants are being expanded or refitted to take maximum advantage of the chemical energy from wastewater.

Wastewater as a source of raw materials

Whenever a toilet is flushed, 'waste' is added to the water. Every inhabitant of the Netherlands flushes an average of half a kilogramme of pure phosphorus down the toilet each year. Wastewater from washing and industrial water also have a high content of waste products. Together we can recover these raw materials. Many industrial sectors use these raw materials for sustainable products. Today, ten regional Dutch water authorities are selling dehydrated sludge, which is burned in a central incinerator. The ashes contain high concentrations of valuable minerals, phosphates and phosphate compounds. Several regional water authorities are also in discussions with industry partners on producing plastic, ethanol and fertilizer organically from sewage. The regional water authorities are in preparations for building large-scale facilities for the recovery of phosphate, both at the final incineration of sludge and at the sewage treatment plants themselves.

In 2010 and 2011, the regional water authorities and the national government made a number of sector agreements on the reduction of greenhouse gases, the generation of sustainable energy and the reclamation of phosphate. These were the Climate Agreement, the Local Climate Agenda, the Green Deal and the Phosphate Chain Agreement. Action programmes have been created to implement them.

Water from wastewater

Once wastewater has been sufficiently treated, it is perfectly suitable for use in the natural environment or as urban surface water, as well as for a wide variety of industrial applications, such as a cooling agent or transport resource. Another possible destination for treated wastewater is the agricultural sector. Some parts of the Netherlands suffer from freshwater shortages.

When wastewater is needed for high-quality use, the sewage treatment plant produces desalinated water, usually in the form of demineralised water. This is a type of water used in the production of steam and production processes requiring a high level of water quality with no contamination. Demineralised water can also be used in the greenhouse growing sector.

Annex 2: General developments

External developments have a major impact on the transition process. Here we present the most significant developments in a nutshell.

Raw material shortages and bio-based economy

The world population is growing fast, and standards of living are rising in emerging economies like China and India. This trend brings with it an exploding demand for food, energy and raw materials. In the face of finite resources and the need to move toward sustainability, a transition to a bio-based economy is unavoidable. The bio-refinery knowledge network and the green raw materials platform have set the target of replacing 30% of fossil fuel use for chemistry, transport, heat and electricity with biomass by 2030.

Production in chains and networks

The increasing complexity of our society demands a multidisciplinary, broad-spectrum approach. This approach transcends wastewater management. Partnering in chains increases the quality and flexibility of our services. Regional water authorities and provincial and municipal authorities have very promising options to work with partners to close cycles even further.

Sustainability

Society continues to set increasingly high standards on sustainability and the safety of products and chains. And the living environment is also vitally important. Governmental authorities are focusing more and more on sustainability. Companies that take the initiative in these areas deliver added value and give themselves a competitive advantage. Big changes are in store for both the system and our culture.

Climate change

Climate change is driving dramatic fluctuations in weather patterns. Long dry spells alternate with periods of torrential rains. Many places are suffering from shortages of drinking water. Agricultural lands are drying out or becoming infertile. Even the flora, fauna and crops themselves are changing. We have to be ready to cope with negative effects of these changes. Examples include hydraulic stress on overburdened rainwater collection systems and the increase in the number of discharges of diluted wastewater into surface waters and the soil. We must have the right response ready for events like these.

Transparency and objective information

Customers and private individuals demand more and more from companies; they must have a broad perspective on sustainability, safety and the effects of their products. Successful companies are fully transparent. They clearly communicate the values they do and do not supply. Companies are continually looking for options to improve the quality and safety of their products.

Dynamic local society

Many are concerned about whether in our global society, the supply of raw materials and products is really secure. A countermovement is emerging at the local level. Residents, municipalities and energy companies are investing in local energy networks, working together to transition to green towns and cities. In this movement, water is a binding force. The capture and use of rainwater remain important in restructuring older communities and creating new ones.

Focus on restructuring

Many experts predict that the economic crisis in Europe will be followed by an extended period of modest economic growth. Focus is shifting towards economic and social restructuring, both nationally and locally. This restructuring can be seen in many areas. Government organisations are refocusing on their tasks. The housing market is also in the midst of sweeping changes. Government expenditures will be dropping sharply in the coming decades. At every turn, we are being told we will have to do more with less. Combined solutions are smart and economical.

Annex 3: Methods and project organisation

Our method

Workgroups and project group

In 2010, regional water authorities and municipalities produced a global vision of wastewater management in 2030. They then further detailed this vision in three separate workgroups. Regional water authorities, municipalities, wastewater management partners and knowledge institutions were all represented in these workgroups. The entire process was overseen by a project group.

Development of vision

The three themes are raw materials, energy and water. We used information from a number of sources. the vision document Interconnecting Water, the Climate Agreement, the Phosphate Agreement, the energy factory and the raw materials plant. This resulted in a great number of opportunities and question marks. Knowledge institutions researched them in a series of 10 studies. After review by the project group, we used the results of these studies in the development of this vision. Representatives of regional water authorities, municipalities, industry and research institutes all reflected on this vision together in the final project meeting.

Action lines

We then produced a summary of the action lines that can lead to the realization of the vision. The project group played an active role in this process. Where possible, we used the results of the external studies.

Action programme

A special roadmap team is currently drafting an action programme and implementation plan based on the vision and action lines. This team is also investigating financing options.

Composition of the project group and workgroups

Project Group

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UNIE VAN WATERSCHAPPEN

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Association of Regional Water Authorities, Association of Netherlands Municipalities, AgentschapNL and DNV

UNIE VAN WATERSCHAPPEN

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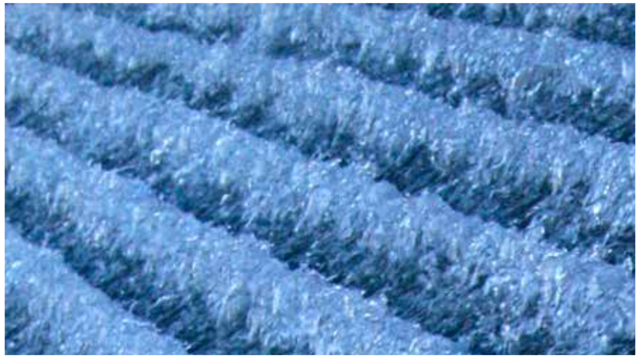

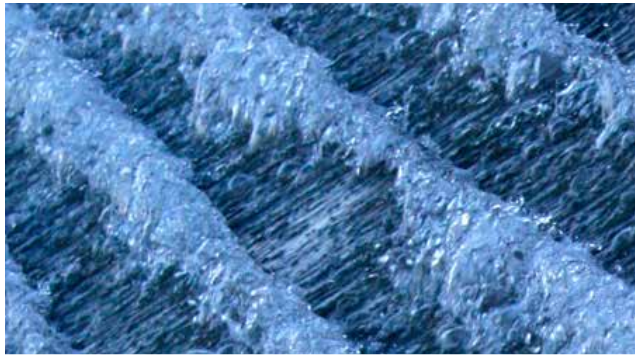

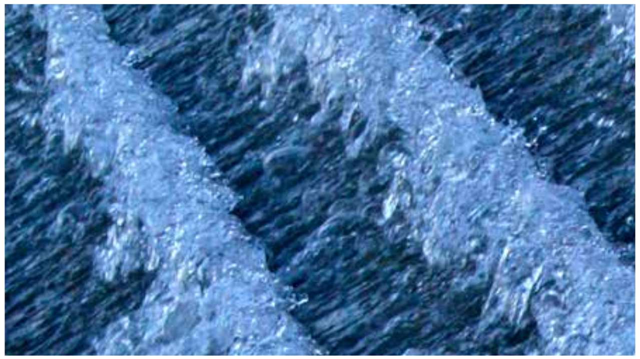

Worldwide wastewater management is in transition!

This report is a translation of the vision on wastewater management in the Netherlands to 2030. It is the final product of a thorough investigation and represents the shared vision of the Dutch regional water authorities and municipalities.

Wastewater management is a field that is in a strong state of flux worldwide. It is a field in transition, a transition that will bring sweeping changes in every aspect of wastewater management. These changes mean big challenges, but also big opportunities for more sustainable and economically viable approaches and perspectives.

With this report we hope to contribute to this challenging transition and to share our inspiration and ideas with our colleagues abroad.

Roadmap
Wastewater management