Guidance for marketing residuals from the water sector

turning residuals into resources

Powered by AquaMinerals and Allied Waters, The Netherlands

Version August 2026

Calcite Pellets

Liquid CO_2

Struvite

Ammonium Sulphate

Caleyda

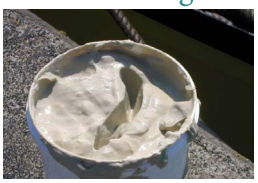
Biomethane

Cellulose

Kaumera

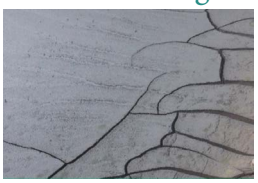
Alum Sludge

Lime Sludge



Ferric Sludge

Activated Carbon Sludge



Filter Sand

PREFACE

Turning residuals into resources, that's the central motto of our paper. We are passionate about enabling the conditions for recovery, reuse or upcycling residuals from the water sector. In our approach we combine economic value and sustainability objectives. This paper touches upon the various factors to consider in this business, based on our multi-year experience. It will be helpful for those who wish to develop long term value creation: moving beyond waste disposal to long-term value creation. By all means, innovation is a pillar to successful development of an upcycling business. And here is where we seek further international cooperation, working towards mutual benefits in a circular economy.

For more information, feel free to contact us at
info@aquaminerals.com or secretariatAW@alliedwaters.com.

About us

AquaMinerals (AquaMinerals BV) creates value chains for residuals that are generated by the Dutch and Belgian water industry. We create economic value and sustainability value from the current and expected resources.
Allied Waters (Allied Waters - Driving the circular economy) enables the implementation of innovative solutions, where the circular economy is our framework.
Both AquaMinerals and Allied Waters share strong values: market focus, innovation, societal entrepreneurship and collaboration.

Winner of the Best Practice Award 2025
WRC - South-Africa: Water efficient sanitation
and non-sewered sanitation

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Winner of the Best Practice Award 2023
KWR - The Netherlands: HerCauWer,
phosphate removal by upcycled ferric sludge

Winner of the Best Practice Award 2027

Who's next?

1. Scope and objectives

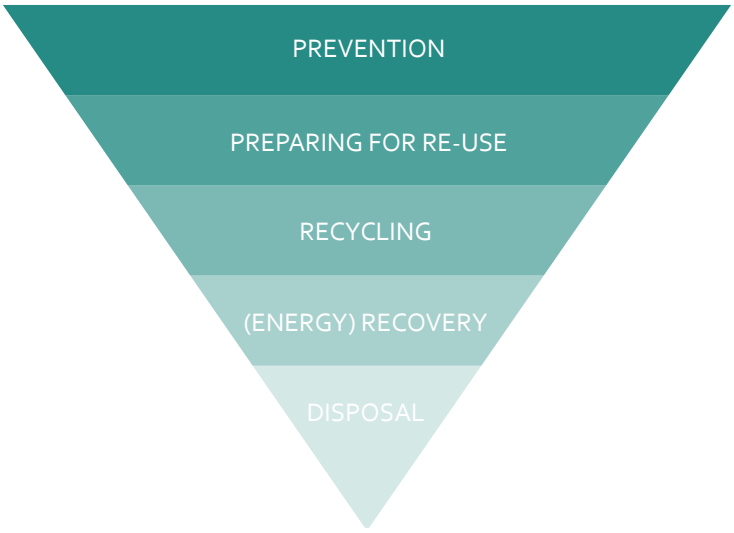
Residuals from water treatment processes

Water treatment processes are designed to achieve the water quality to an agreed standard. Inevitably, certain residuals are generated along the way, either on a continuous basis or part of a regular replacement program. The table below shows examples of such residuals for the main water flows. This paper covers residuals originating from all segments, i.e. drinking water, wastewater and industrial water. We focus on proven product market combinations, i.e. applications which are beyond the R&D phase. Obviously, R&D is a key factor in developing new applications!

Segment	Examples of residuals	Remarks
Drinking water	Sludges from coagulants (ferric or aluminum salts), lime pellets, lime sludge, sand/gravel replacements	Type and quantity strongly related to the water source: surface water, groundwater, bank filtrate, sea water
Wastewater	Biosolids, fats, screenings, struvite, liquid CO_2, biogas, cellulose fibers	Hygienic quality is a key issue
Industrial water	Depending on the type of industrial water	

Turning residuals into resources

The waste hierarchy as defined by e.g. the EU gives guidance to managing residuals. Upcycling residuals from water treatment processes is part of the domains reuse – recycle – recover, depending on the type of residual and the upcycling path of interest. Successful upcycling requires appropriate efforts in a professional manner.
Goal of this paper is to provide inspiration and guidance while setting up an organization dedicated to upcycling residuals from the water sector.



Source: Waste hierarchy | Epthinktank | European Parliament

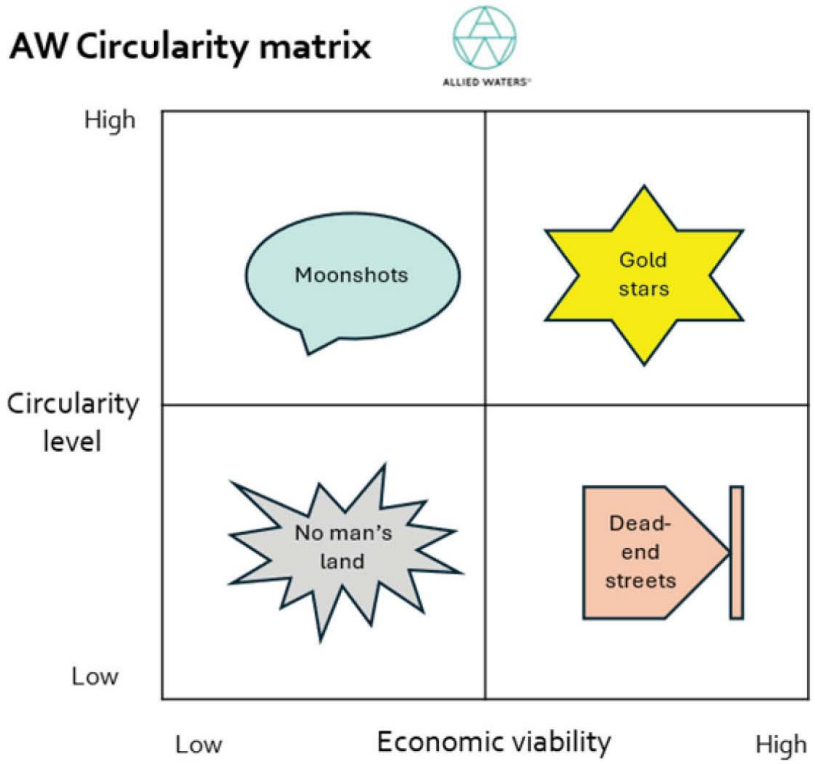
2. Towards a circular economy

Circular economy

The UN SDGs (Sustainable Development Goals) are a strong reference point for sustainability driven initiatives overall. How to introduce new sustainable solutions successfully? In practice economics are key in most cases. This is why we frame our activities in the context of the circular economy: it's about both a green planet and economics. Already for more than a decade the European Commission promotes the circular economy concept, aiming for sustainability, competitiveness and resilience to global geopolitical developments.
How do we define a circular economy? According to ISO 59004:2024 – Circular economy — Vocabulary, principles and guidance for implementation: "The long term vision of a circular economy is, by design, to provide appropriate solutions for the reduced, efficient and effective use of resources, and to prevent harmful releases, losses and environmental degradation when meeting social needs".

Circularity matrix

The dual approach – sustainability and economics – is reflected in our Circularity matrix. Essentially this is the counterpart of the famous BCG matrix, which just reflects conventional economics.



Explanation

- **Gold stars:** the reflection of the motto 'sustainability and economics going hand in hand'
- **Moonshots:** highly circular, however need additional drivers and/or creative thinking in order to become economical
- **Dead end streets:** any ongoing business lacking a sustainability/circularity perspective; unfortunately the major part of our present economy
- **No man's land:** to be avoided for obvious reasons

The philosophy behind the concept of a circular economy is great. Now the question is, how to make it happen? How to move moonshots to gold stars? Like in a conventional economy, market pull is a powerful mechanism to get things moving. In our approach we stimulate market pull across a combination of different tracks:

- Upcycling residuals from the water sector, matching supply and demand
- Creating value (USP) based on a truly sustainable profile
- Saving costs in the value chain, including social cost-benefit analysis
- Rethinking the business model, if appropriate
- Acquiring co-funding through dedicated investments, grants or tax benefits

How do the water industry and the market benefit?

The governance of residuals management can be organized in different ways, i.e. on a public, private or public/ private basis. Whatever way is preferred it is crucial to emphasize the gains for both the water industry (source) and market (clients). Having a balanced set of benefits provides the best guarantee of long-term success.

Benefits for the water industry

- Unburdening
- Efficiency, lowest cost
- Contribution to sustainability
- Drive to innovation
- Resilience: less dependency on chemicals purchase
- Standardization of contracts

Benefits for the market

- Professional organization
- One point of entry
- Security of supply
- Quality control
- Contribution to sustainability
- Standardization of contracts

3. Business concept

Marketing residuals

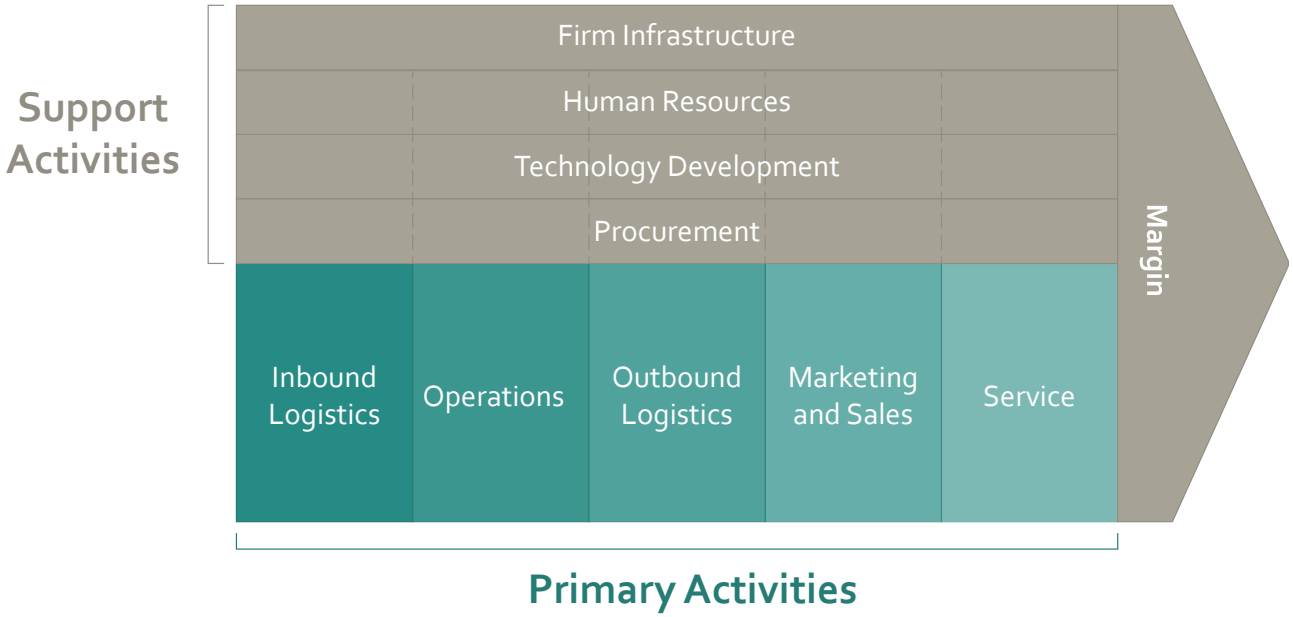
Upcycling residuals deals with marketing materials which are a side stream of the main process. All elements of a conventional product value chain apply, i.e. matching supply and demand, timely deliveries, supplies according to quality specifications, supply security and more.

Guiding principles

Like in any business, one of the first steps is to design a business plan which covers available volumes of materials, markets, alternative routes ('competition'), legal issues, entrance barriers, promotion and resources required including any investments in physical assets.
Given 4-5 different streams of residuals and a range of possible applications the question arises what is a proper way of getting organized. Different perspectives regarding residuals from the drinking water sector include:

a. Supplier's collective: water suppliers who offer their residuals through one channel; this is the Dutch-Flemish model of AquaMinerals
b. Buyer's collective: typically organized through a central purchasing organization, for in stance applied to industrial commodities
c. Private enterprise: a dedicated private broker taking care of the supply chain, the model applied in France (Accueil - Seitiss)
d. An open platform: e.g. an online marketplace for matching supply and demand

Connected to the options a) to d) many factors have to be considered such as the business strength, the level of shareholder commitment, allocation of revenues, time to market and the impact of competition law. By all means, the economic viability is a common factor for all options. For inspiration, Annex A provides a value proposition according to the Canvas format for AquaMinerals.



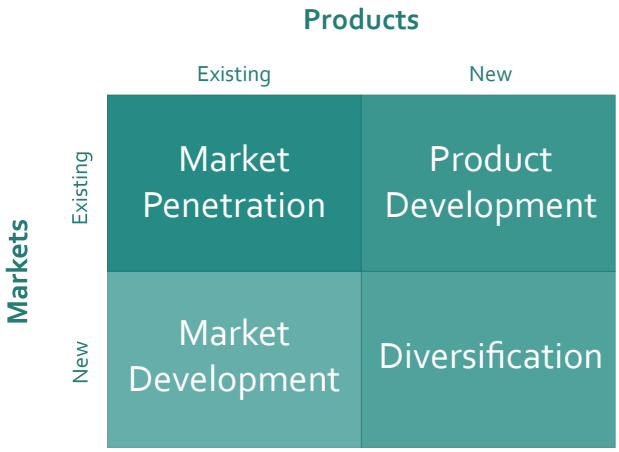
4. Innovation is key

Continuous search for new pathways

In the early nineties the predecessor of AquaMinerals was established and ever since the upcycling of residuals from the water sector has been practiced in The Netherlands and neighboring countries. A gamma of applications has been developed throughout these years. An appealing example is represented by lime pellets, a by-product of central pellet softening at drinking water plants. Initially the pellets ended up in relatively low value products, i.e. bricks and other construction materials. New applications have been developed. From soil improvement to additive in the steel, feed, glass, paper and carpet industry. And nowadays a portion of the materials is even used in cosmetics replacing microplastics! And it pays out. Initially the net value of the pellets was negative, however in 2015 the breakeven point was reached, and since that moment the pellets have a net positive value (ch. 6).
These developments do not come for free, they are based on continuous efforts in R&D and market development.

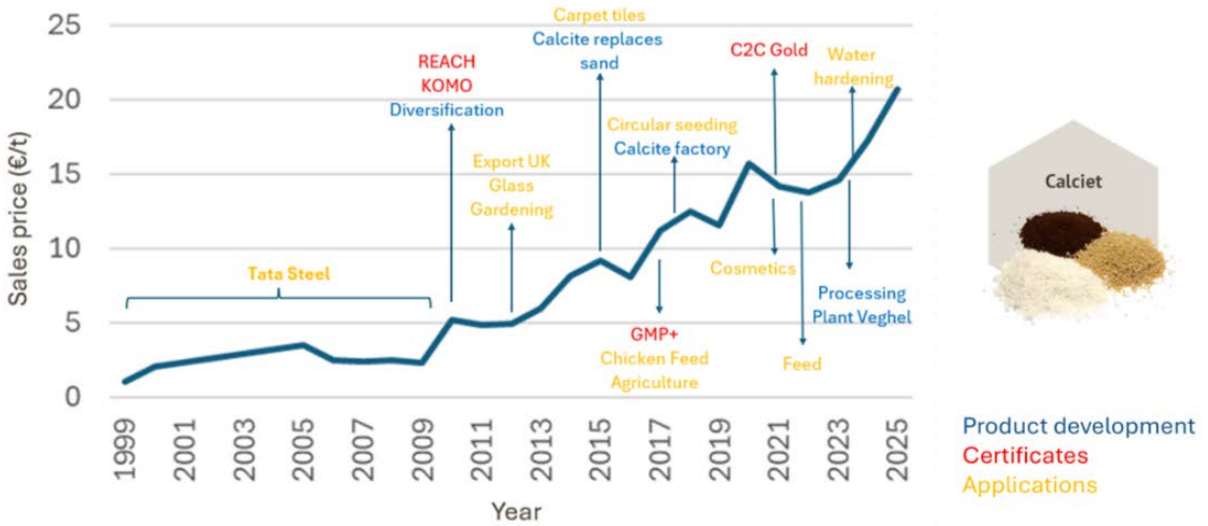
Getting the innovation process organized

Innovation is a key driver for increasing market impact. By evaluating over 100 innovation projects over the past decade we learnt about the critical success factors: which projects succeeded, and which failed. Projects across the different segments of the Ansoff diagram. And we used this experience to further improve the success rate of new innovation projects.



Circularity League®

Worldwide massive efforts are put in R&D focused on resource recovery, developing new materials and processes to enable recycling ang reuse. That's great! Still, in many cases it's a long way to practical application. This is not unique for upcycling business, the step from promising R&D result to practical use is challenging in any sector. So we need a catalyst to cross this gap.
This is the idea behind the Circularity League®, recently launched by us. The ultimate goal is speeding up the implementation of viable upcycling processes, i.e. we focus on development projects which lead to implementation within 2 years. International members of the Circularity League contribute to the funding and jointly decide about implementation projects; read further at [Allied Waters - Circularity League®.]



5. Main material streams

In practice: quality and availability of materials

For each individual case a representative sample must be analyzed: generic parameters (physical appearance, color, main components, moisture), impurities (e.g. trace metals), parameters related to the intended use and/or legal requirements. Another key question is about availability of materials including volumes, time pattern if any and storage facilities.

Residuals from drinking water processes

As a general rule, the type and volume of residuals from the production of drinking water is strongly related to the raw water source used. Regarding the solid residuals generated on a continuous basis for common fresh water sources:

- Surface water: ferric or alum sludges from the coagulation/flocculation stage, powdered activated carbon (optionally added into this stage), lime sludges or pellets from softening processes.
- Groundwater and bank filtrate: sludges containing natural ferric from the aeration stage, lime sludges or lime pellets from softening processes.

Certain materials become available on a project basis, e.g. replacement of sand, anthracite, granular activated carbon and/or gravel in filters. Further, on top of these solids also residual liquid streams may have to be handled. This may apply when membrane filtration (nanofiltration, reverse osmosis) of ion exchange processes are included in the treatment line. These streams require a tailored approach.

	Water treatment stage	Common solids treatment steps	Examples of possible applications
Ferric sludge	Coagulation	Thickening, dewatering, drying	Absorbent in air/water/soil (compounds containing sulphur, phosphate, arsenic), construction materials, reuse as coagulant
Ferric sludge	Aeration	Thickening, dewatering, drying	Idem
Alum sludge	Coagulation	Thickening, dewatering, drying	Construction materials, reuse as coagulant
Lime sludge	Typically combined	Thickening, dewatering	Soil improvement
Lime pellets	Pellet softening	Thickening, dewatering	Cascading to wastewater plants
Sand and gravel	Filtration		Road works, anti-slip measures (in cold climate areas)

Residuals from sewage treatment

Typically, municipal wastewater is composed of a mix of wastewater from households, from industries and rainwater, all strongly varying in time and location, which results in an overall wide range of quality. Essentially the sewage treatment process is relatively uniform:

- Prescreening and fat removal
- Primary clarification
- Biotreatment: active sludge or granular sludge
- Secondary clarification

Next, sludge from the primary clarification and biological surplus sludge are processed in a separate sludge line. Additional steps may include advanced treatment for removal of e.g. nutrients or trace organics. Within this window there is a huge variety of (bio)technological options.

Surplus sludge represents the largest volume and hence is the key to a paradigm shift: how to recover valuables and make those suitable for any beneficial use? Anaerobic digestion is a classic: production biogas from sludge. Over the past decades massive research has been dedicated to enable further recovery, reuse or upcycling. Gradually, a number of these developments have resulted in successful market introduction. An overall key factor for the application potential is the hygienic quality of materials.

	Water treatment stage	Processing	Examples of possible applications
Biomethane	Biogas upgrading	Sorption media for impurities, next separation of methane (CH_4) and CO_2	Feeding into gas networks
Liquid CO_2	Biogas upgrading	Idem	Feedstock to greenhouses
Struvite	Biosludge processing	Crystallization of magnesium ammonia phosphate	Fertilizer (additive)
Ammonium sulphate	Water from the sludge line	Stripping or membrane filtration	Fertilizer
Cellulose	Preclarification	Special separation step for catching cellulose fibers	Drain inhibitor asphalt, composites, sheet materials
Biopolymer: PHA	Biosludge processing	Cultivating PHA accumulating bacterial species from VFA feed (Volatile Fatty Acids)	Biodegradable coatings (early stage market)
Biopolymer: Kaumera	Biosludge processing	Extraction of the biopolymer from granular active sludge	Biodegradable coatings, binder (early stage market)

6. Identifying markets

Developing market traction

Which applications and markets can be developed for a certain volume of materials? Stable supply chains require multiple sources for a given end user. And following the same rationale, single markets for a given source material must be avoided.

The AquaMinerals Inspiration Book provides an interesting selection of applications for a range of materials.

For any application – material, key aspects include:

- Quality specifications
- Required packaging
- Volume per user, demand pattern over time
- Current value chain and relevant players
- Any corporate policies of end users
- Any special requirements
- Delivered price level

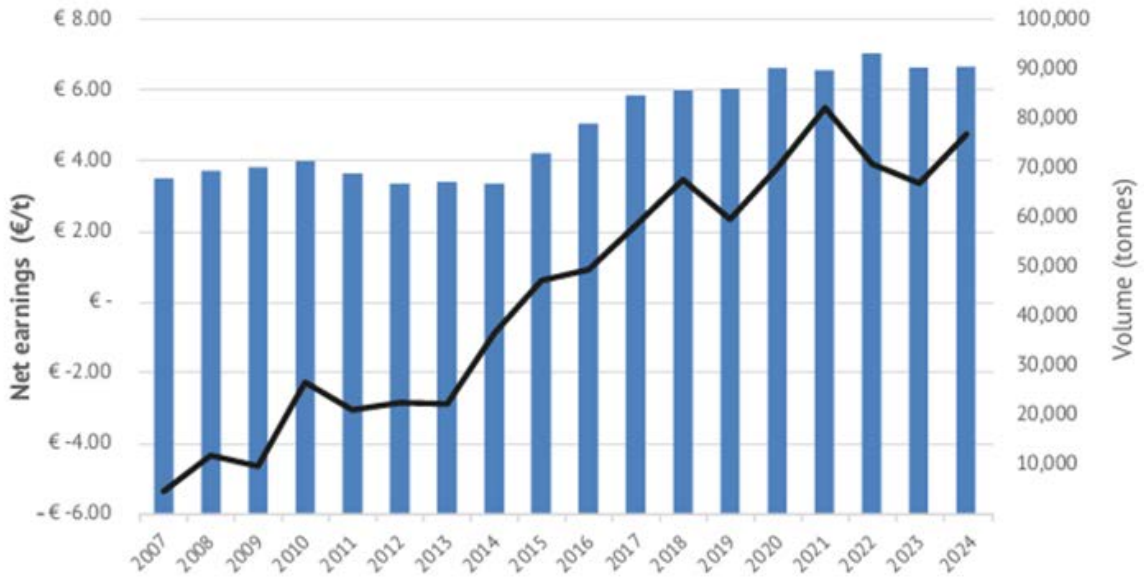
Matching supply and demand

Next, developing a plan is an iterative process:

- To what extent do supply – demand match (volumes and qualities, geography)?
- Which handling, storage and logistic services are needed?
- Finding subcontractors if and where needed
- Evaluating economics (cost – revenues), including logistic costs
- Organizing the commercial process (sales approach, promotional activities, supply agreements)

And keep in mind, each market segment – i.e. combination of source material and application – is a value chain!

Business history lime pellets



7. Enabling and maintaining a value chain

From idea to operationalization

Developing a new value chain is often a complex and time-consuming process. It requires a combination of solving technical and chemical challenges, as well as operating within the legal and regulatory frameworks applicable to the specific chain. In addition, stakeholders must remain actively engaged throughout the process. Finally, the financial framework must be — and remain — acceptable for all parties involved. Fortunately, many valorization projects do reach this final stage, particularly where multiple parties in the chain have committed themselves to the intended development at an early stage.

However, this does not mean the work is finished. New value chains introduce new challenges, such as arranging financing, allocating risks, performing quality controls, and coordinating operational execution. Existing, traditional structures are often insufficient to address these challenges. In many cases, the new chains are even perceived as competitive by existing stakeholders and are actively resisted. It is therefore prudent to consider, already during the valorization process, how these new chains will be enabled. It is essential to involve all intended chain partners during the valorization phase and to agree in advance on how the aforementioned issues will be allocated and organized.

Maintaining a value chain

Maintaining these chains requires daily attention, comparable to what is needed for primary raw materials. This includes continuous attention to quality assurance (possibly in the form of certification), supply chain management, administrative handling (financial administration, environmental registers), procurement, sales, stakeholder management, and more. If these operational activities do not receive sustained attention, the chain will gradually deteriorate. More importantly, trust among customers will decline and may ultimately disappear.

Many of the activities described above are new, particularly for the parties involved. Embedding them within existing, traditional chains and organizations is often not an option, as these new chains require different competencies and frequently conflict with existing interests and stakeholders. As a result, new and dedicated governance and operational structures are often designed and implemented specifically for these chains. Which structure is 'best' strongly depends on the specific context, while learning from both successful and unsuccessful precedents will be instrumental.

8. Legal issues

The relevance of legal issues

Typically, legal issues are not a favorite topic for professionals working in business, process technology, science and innovation. However, in practice they are quite key! Bringing residual streams from the water sector to the market involves several legal aspects, primarily related to classification, product compliance, transport, and—where public entities are involved—market access. Properly considering these legal aspects early stage in the process of residuals marketing will pay out later on. Below we review the main aspects from a European perspective, where EU regulations provide the legal context. Obviously, as similar regulations apply in other parts of the world, the legal framework always must be reviewed for the local situation.

From waste to product status

Residuals from water treatment processes are classified as waste by default. This implies a negative value, strict regulatory controls, and handling by permitted waste operators, typically under gate-fee models. As a result, realising the economic and sustainability value of recovered resources requires moving beyond waste status.

Under the Waste Framework Directive 2008/98/EC, this can be achieved through:

- End-of-Waste (EoW): recovered materials cease to be waste once specific criteria are met
- By-products: production residues that are not waste if strict conditions are fulfilled

For recovered materials from wastewater treatment achieving the EoW status is the sole option; they cannot be classified as by-products. By contrast, certain residuals from drinking water production may qualify as by-products. In both cases, it must be demonstrated that there is a market, all legal requirements for the intended use are met, and the use is safe for humans and the environment. The latter aspect can be challenging, particularly for materials derived from urban wastewater.

REACH and product regulations

Once a material is no longer waste, it is considered a product and falls under the REACH Regulation. Registration is generally required, although an exemption exists for recovered substances already registered (Article 2(7)(d)). Depending on the application, additional rules and standards apply, such as the Fertilising Product Regulation for nutrients or CEN standards for building materials. Certification might be needed as well, for example GMP+ for application as feed or ISCC for green gas and biobased feedstocks.

Producer responsibility

Supplying a material to the market entails a responsibility for its quality and compliance. While water treatment processes are well controlled, additional quality assurance systems are often needed for recovered materials.

Transport

End-of-Waste materials and by-products can be transported as goods, provided all countries involved recognise their non-waste status. Waste transport, especially across borders, remains subject to the EU Waste Shipment Regulation.

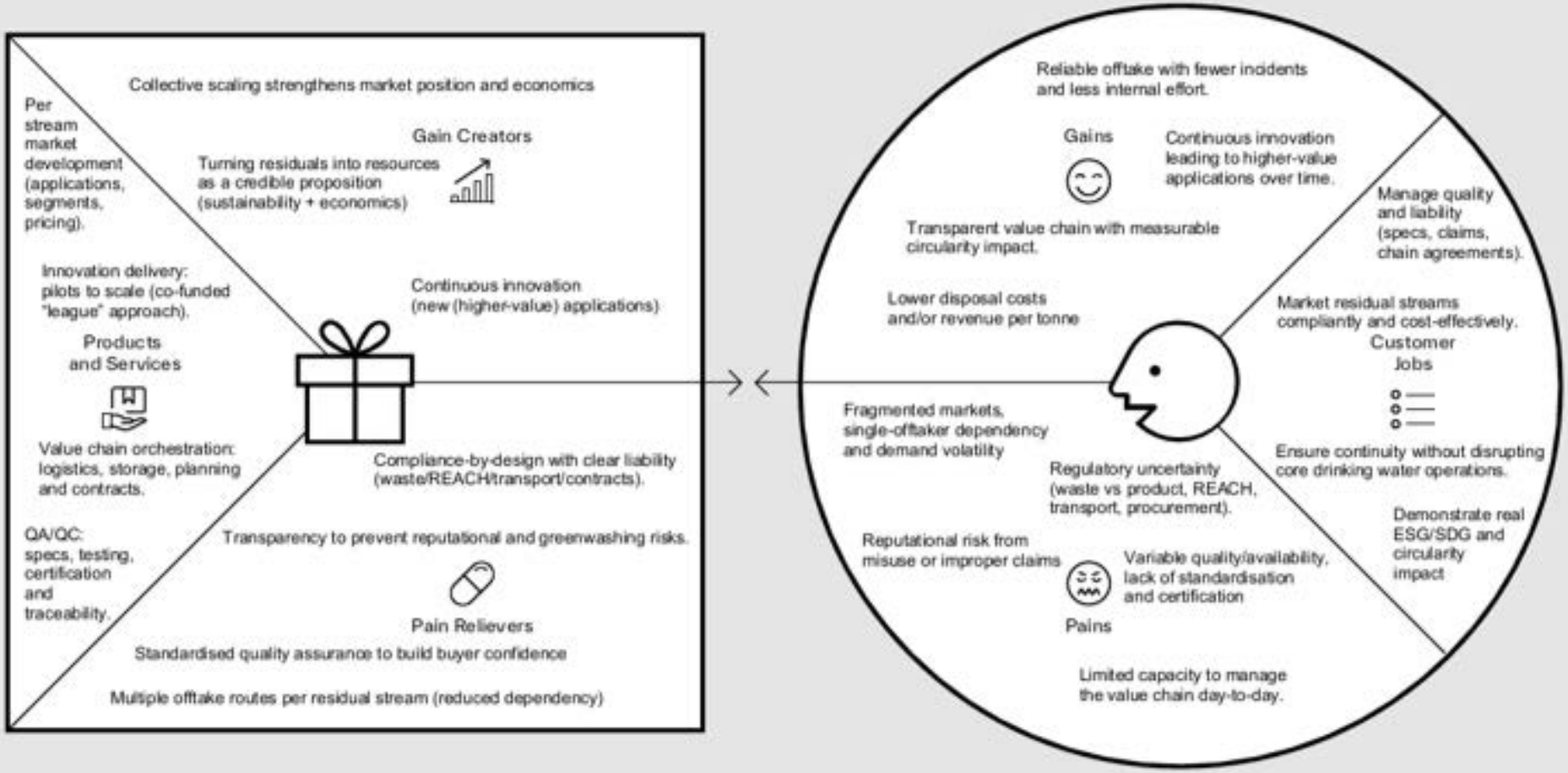
Tendering and market access

Public bodies subject to Directive 2014/24/EU on public procurement must apply tender procedures when procuring waste services. The sale of by-products and End-of-Waste materials is not subject to procurement rules, as it concerns placing products on the market. Nevertheless, national case law may impose transparency requirements and giving equal access.

The Value Proposition Canvas

Value Proposition:

Customer Segment:



Annex B: The value creation journey: The way up