Joint Research Programme
BTO 2023.071| December 2023

# Socio-technological legitimation of water related reuse

Joint Research Programme

# Colophon

## Socio-technological legitimation of water related reuse

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# Managementsamenvatting

## *Succesvolle socio-technologische legitimeringstrategieën voor water gerelateerd hergebruik*

**Auteurs** Sandra Sikkema en Katja Barendse

Institutioneel vertrouwen en wet- en regelgeving kunnen bijdragen aan de socio-technologische legitimering van nieuwe technologieën voor water gerelateerd hergebruik. In deze studie zijn 12 legitimeringsstrategieën geïdentificeerd die dit institutioneel vertrouwen kunnen versterken. Ook is het kader van wettelijke verplichtingen voor water gerelateerd hergebruik beschreven. De geïdentificeerde succesvolle legitimeringsstrategieën beschrijven de acties die kunnen worden ondernomen om de acceptatie en adoptie van water gerelateerd hergebruik te vergroten. Bijvoorbeeld de creatie van ambassadeurs binnen de watersector door kwaliteitsresultaten van monitoringprocedures en meetsystemen te delen. Een samenspel van de met elkaar verbonden strategieën werkt het krachtigst.


*Legitimeringsstrategieën voor vier soorten legitimiteit voor de implementatie van technologieën voor water gerelateerd hergebruik: pragmatisch, normatief, cognitief en regulatief*

**Belang: circulaire wateroplossingen opschalen met aandacht voor sociale integratie**

In de transitie naar de circulaire economie worden veelbelovende technologieën ontwikkeld voor het hergebruik van water en de daarin aanwezige voedingsstoffen en energie. Een van de belangrijkste uitdagingen is het opschalen van circulaire wateroplossingen met aandacht voor maatschappelijke integratie en wettelijke verplichtingen. Hoe kunnen we dergelijke oplossingen socio-technologisch legitimeren op basis van ondersteunende regelgeving en institutioneel vertrouwen? Institutioneel vertrouwen beschrijft in deze context twee dingen: 1) het vertrouwen van burgers in organisaties en 2) het vertrouwen van medewerkers van organisaties in de nieuwe technologieën voor water gerelateerd hergebruik.

**Aanpak: academische literatuurstudie, interviews, project team discussie, eindgebruiker workshop**

Via een analyse van literatuur, voorgaande KWR projectresultaten en Europese en nationale regelgeving is vastgesteld welke factoren belangrijk zijn voor institutioneel vertrouwen, wettelijke verplichtingen en legitimeringsstrategieën. Interviews met experts gaven inzicht in het kader van wet- en regelgeving voor water gerelateerd hergebruik. Een project team discussie bood reflectie

op de bevindingen van institutioneel vertrouwen en wet- en regelgeving en analyse van legitimerings-strategieën. Een workshop met WiCE-partners in de rol als eindgebruikers discussieerde de resultaten en legitimeringsstrategieën.

**Resultaten: legitimeringsstrategieën voor de adoptie van water gerelateerd hergebruik**

Institutioneel vertrouwen wordt primair gevormd door risicoperceptie, acceptatie van de modus operandi, onderliggende attitudes, affectieve reacties, invloed van anderen, publieke betrokkenheid, communicatie door de organisatie over hergebruik van water, media-informatie, persoonlijke ervaring en geobserveerde prestaties. Deze elementen (zie figuur) beïnvloeden het institutioneel vertrouwen van burgers en bepalen de publieke acceptatie en adoptie van water gerelateerd hergebruik. Het vertrouwen van medewerkers in technologieën voor water gerelateerd hergebruik beïnvloedt het maatschappelijke vertrouwen.

Binnen het kader van wet- en regelgeving voor water gerelateerd hergebruik vallen onder meer: de Europese verordening inzake het hergebruik van water, het voorstel tot herziening van de richtlijn stedelijk afvalwater, de vereiste einde-afvalstatus voor teruggewonnen producten en het Kiwa Watermerk. Dit regelgevend kader is al meer ondersteunend geworden voor water gerelateerd hergebruik, maar er is nog veel behoefte aan verbetering: niet alleen aan juridische veranderingen die waterhergebruik toestaan, maar ook aanmoedigen en stimuleren waar dat passend is. Subsidiëring van innovaties voor waterhergebruik en het verplicht stellen van het terugwinnen van in water aanwezige hulpbronnen in de nationale wetgeving kunnen water gerelateerd hergebruik bevorderen.

De legitimeringsstrategieën zijn van toepassing op de vier soorten legitimiteit: pragmatisch, normatief, cognitief en regulatief. De vier soorten legitimiteit zijn gelinkt aan de eerder gedefinieerde factoren en strategieën voor de legitimering van water gerelateerd hergebruik. De strategieën zijn met elkaar verbonden en versterken elkaar. Het samenspel van meerdere strategieën is krachtig.

**Implementatie: legitimeringsstrategieën voor water gerelateerd hergebruik toepassen**

De legitimiteit van nieuwe technologieën versterken is een delicaat proces. Het legitimeringsproces is breder dan alleen de acceptatie van een nieuwe technologie. De verschillende niveaus van legitimiteit beïnvloeden en versterken elkaar. Zo kan de regulatieve legitimiteit versterken als is aangetoond dat er bereidheid is om water en de daarin aanwezige voedingsstoffen opnieuw te gebruiken.

Tijdens de workshop met WiCE-partners zijn meerdere helpende legitimeringsstrategieën benoemd voor de adoptie van water gerelateerd hergebruik. WiCE-partners benadrukten dat het met name voor de eigen medewerkers van drinkwaterbedrijven helpend is om strenge kwaliteits- en monitoringprocedures te delen en meetsystemen te ontwikkelen om de kwaliteit te waarborgen. De eigen medewerkers zijn namelijk vaak het meest kritisch over nieuwe technologieën voor water gerelateerd hergebruik. Het delen van de meetgegevens helpt om aan te tonen dat de technologieën werken en veilig zijn om te gebruiken. Zo is het mogelijk ambassadeurs binnen de watersector te creëren voor water gerelateerd hergebruik. Het is aangetoond dat het nuttig is voor de adoptie van water gerelateerd hergebruik om eerst de medewerkers van de betrokken bedrijven bij het proces van water gerelateerd hergebruik te betrekken, zodat zij een positieve boodschap naar de maatschappij kunnen overbrengen.

Er loopt al vervolgonderzoek om meerdere niveaus van waterhergebruik te verkennen en legitimeringsstrategieën te testen.

**Rapport**

Dit onderzoek is beschreven in *Socio-technological legitimation of water related reuse* (BTO-2023.071).

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# Contents

# 1 Introduction

## 1.1 Problem statement

Shaping our future entails the exploration of new sources for water, nutrients and energy. Water related reuse is one of the possible ways for finding new sources. In the transition to the circular economy (CE), promising technologies are being developed to reuse water and its embedded resources such as nutrients and energy. One of the key challenges is to further upscale circular water solutions while addressing societal integration and legal obligations.

Previous and ongoing research at KWR (e.g. in BTO WiCE) highlighted a number of required conditions, such as: a) innovative, effective and economically viable technologies that are sustainable at system level, b) circular business models and cross-sectoral integration across the value chain; and c) societal integration through inclusive innovation, engaging stakeholders, public acceptance, and an adapted governance framework. From experience with WiCE pilots (e.g. SuperLocal and Brainport Smart District) we see a particular need of our water sector partners to address societal integration and legal obligations. For that reason, this exploratory project takes a novel perspective of socio-technical legitimation of water-related reuse, by focusing on two central elements: institutional trust and supportive regulations.

This research uses the definition of legitimation as described by Suchman: “the generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions” (Suchman, 1995, p. 574). The socio-technical part is the interplay between actors, technologies and institutions in a system (Fuenfschilling & Binz 2018). Public acceptance of and trust in water related reuse and the related governing organisations is linked to the legitimation of new technologies. Although the importance of institutional trust has been acknowledged, how and in what way institutional trust affects legitimation is still underexposed in relation to water in the CE. The same accounts for how the legal obligations and regulations affect the legitimation of water related reuse. As an example, the required end-of-waste status for recovered products has been identified as a main legal barrier in reuse. This is in particular relevant for EU regulations and efforts to include circularity in the revisions of several directives.

## 1.2 Objective and research questions

The objective of this project is to explore the institutional trust and regulatory obligations that define the socio-technological legitimation of water-related reuse. With that information, legitimation strategies can be determined that can build and reinforce institutional trust and help to shape legal changes for supportive regulatory obligations. The aspired impact of this project is providing the water sector with narratives around the benefits of circular water technologies, strengthening societal acceptance. It shares the most promising successful conditions for the socio-technological legitimation of water-related reuse.

The main research questions are:

1 How does institutional trust affect public acceptance and the adoption of water-related reuse?
2 What are the current regulatory obligations and what legal changes are needed in favour of water-related reuse?
3 Which legitimation strategies can enhance societal acceptance of water-related reuse?

With water-related reuse is meant not only water reuse, but the recovery of embedded resources in wastewater, as nutrients and materials, recovering energy from wastewater, like biogas, and reusing the treated wastewater for new applications, for example crop irrigation, groundwater replenishment or drinking water production.

## 1.3 Methodology

The project builds on the integrated science approach for water reuse at KWR (Dingemans et al, 2020), connects our work on WiCE Governance (e.g. SENSE project) and public acceptance (Smith et al, 2018) to the concept of technology legitimation (Binz et al, 2016) and inclusive innovation (Hoffecker, 2021), and expands it with new knowledge on legal issues relevant for WiCE.

To explore institutional trust a review of academic literature and WiCE projects was performed, and a project team discussion session was held, all to the define the elements that constitute institutional trust. The project team consisted of ten KWR experts with disciplines varying from water quality to ecohydrology, all with expert knowledge on water related reuse. To explore the regulatory obligations, European and national regulations (e.g. H2020) were reviewed and experts from AquaMinerals, University Utrecht, Cranfield University were interviewed. Also in the project team discussion session the framework for regulatory obligations was determined. To explore the socio-technical legitimation strategies review of academic literature and expert knowledge assessment by the project team was performed. The application of the research results was discussed and enriched in an end-user workshop with BTO-WiCE partners in the water sector.

The results from the interviews with experts are cited as I-1, I-2 and I-3. The contributions of the project team discussion are cited as TD. And the end-user workshop with colleagues and WiCE partners in the water sector to discuss the results and evaluate the legitimation strategies is cited as WS.

## 1.4 Readers guide

Chapter 2 describes the way institutional trust affects the acceptance and legitimation of water-related reuse. It outlines the acceptance and perception of water-related reuse and the elements and forms of institutional trust. Chapter 3 outlines the laws and regulations that surround water related reuse. It touches upon the current laws and regulations and possible legislative changes in favour of water related reuse. Chapter 4 shows the strategies that can be used to legitimize the process of water-related reuse. It delves into the strategies that can create institutional trust and discusses which strategies can help to shape legal changes for supportive regulatory obligations in favour of water-related reuse. It discusses how strategies can be applied to increase institutional trust and form laws and regulations to legitimize water reuse and recovery of its embedded resources. Chapter 5 presents the conclusions of this project.

# 2 Institutional trust

This chapter identifies the relationship between the societal acceptance of water-related reuse and institutional trust. It defines the elements that constitute institutional trust and discusses the two different forms. The chapter starts with an overview of acceptance, and continues with specifying the elements that form institutional trust.

## 2.1 Sociopolitical, process and product acceptance

Multiple levels of societal acceptance are at play when implementing a new technology. Van Aalderen (2021) categorised these in: socio-political, process, and product acceptance. Each level addresses outlines factors that influence the acceptance at that level. Barendse & Brouwer (2022) tailored these factors to water related reuse.
Socio-Political Acceptance is the broadest and most general level of acceptance. It is viewed as the acceptance of water reuse as an interesting solution to the societal issue of water scarcity. The drinking water customer is addressed in the role of a citizen in society. Factors such as the citizen "experiencing water scarcity" and having "concern for the environment" play a significant role in socio-political acceptance (Barendse & Brouwer 2022).
Process Acceptance is the acceptance of the way drinking water customers are approached for a transition to water reuse. It involves questions about who is involved and how reused water is produced. The drinking water customer is addressed in the role of a customer of a specific drinking water company in a defined supply area. An important predictor within process acceptance is if the customer has "knowledge of water reuse". A better understanding of the water cycle and water chain leads to a more positive attitude towards water reuse. The factor of "institutional trust" of the customer is essential within this form of acceptance. Institutional trust is the trust that the public has in the involved parties, such as the government, science, and (drinking water company) experts.
Product Acceptance is the acceptance of water reuse for personal use or consumption of water. It defines the drinking water customer in their role as an end-user of water reuse. An important factor influencing acceptance at this level is "personal contact": the degree of contact with the water. Multiple studies show that acceptance of water reuse decreases as the user's contact with the water increases. This means that people will more readily accept water reuse for watering the garden than for use in the shower or kitchen. Another factor that influences product acceptance is "organoleptic properties": what can be perceived by the senses (smell, sight, taste). Organoleptic changes (and attitudes about them) can affect feelings of disgust or acceptance of water reuse. The acceptance of drinking purified reused water increases when the organoleptic properties do not or minimally differ from the "regular" water that the end-user was accustomed to (Table 1).

*Table 1. Factors that influence water reuse acceptance, divided into three levels (Barendse & Brouwer 2022)*

| Socio-political acceptance | Process acceptance | Product acceptance |
|---|---|---|
| Concerns about the environment | Institutional trust | Personal touch (usage) |
| Perceived water scarcity | Knowledge about water reuse | Personal touch (sources) |
| | Perceived fairness | Organoleptic properties |
| | Knowledge about the water cycle | Emotional reactions |
| | Framing and information provision | Kiss by nature |
| | Timing of the communication | Perception of health risks |
| | Discourse frame | Water treatment |
| | Experience with alternative sources | Concerns about the costs |
| | (De)centralized source of pollution | Experienced advantages |
| | Social norms | |
| | False Consensus Effect | |

### 2.1.1 Acceptance of water related reuse

In the next sub-chapter (0), the elements of institutional trust are described. To first give an idea of the current status of acceptance of new technologies regarding water related reuse, the results of a few studies focusing on that are described here.

The results of multiple studies investigating the acceptance of water related reuse practices appear to give a positive image. One of the studies is a European project called Nextgen, that works on understanding and supporting the shift towards a circular economy in the water and wastewater sector across Europe. In one of their deliverables (Nextgen D4.2, 2022) they studied the responses to recycled water and nutrient recovery within three countries: Spain, the UK and the Netherlands. The study entailed three large-scale surveys of the general public regarding water reuse for drinking purposes and nutrients recovery to grow food. The results show that supports appears high in all three countries. In the Netherlands (n=751), 75% of respondents supported, or strongly supported the use of recycled water for drinking and the use of recovered nutrients to grow food.

Judge et al. (2021) show that acceptance is generally high for products made from materials regained from wastewater, like plant pots or table tops made from recovered cellulose. Positive emotions to the product were linked to higher acceptability of products made from wastewater, and higher intentions to purchase these products. Not all people had the same level of acceptability towards these products, but people with biospheric values, meaning concern for nature and the environment, had more positive emotions and generally higher intentions to purchase the products (Judge et al. 2021).

When looking at the public acceptance of water reuse for drinking water, a small study suggests that the group opposing to that practice is relatively small. A recent KWR study researching the public perception of water reuse in four focus groups found that participants were generally quite positive to neutral about reusing water, however, the amount of people in the study was limited and therefore not representative (Barendse & Brouwer, 2022). The number of people opposing to water reuse was small (6 out of 25 participants). During the focus group, in which information was provided and concerns discussed, opposition decreased and the number of proponents increased. This acceptance was evident not only in what the participants said, but also in their behavior. When they were offered a glass of recycled water, 24 of the 25 participants drank it. The results of the focus groups suggest that the general spontaneous perception about water reuse in the Netherlands is neutral to positive.

Barendse & Brouwer (2022) investigated the differences of acceptance between the client perspectives (Figure 1) (Brouwer et al, 2019). On the basis of a questionnaire, no major differences between the client perspectives were observed about the general acceptance of recycled water. The questionnaire shows that in all four groups there were always three participants (strongly) in favour of reused water as drinking water. However, the group with the quality & health concerned-perspective is the only group with two major opponents of reused water as drinking water. The groups with the down to earth & confident-perspective and aware & committed-perspective no longer had any opponents and the group with the egalitarian & solidary-perspective had one opponent.


*Figure 1. Client perspectives (Brouwer et al. 2015 cited in Barendse & Brouwer, 2022*

## 2.2 Elements of institutional trust

Barendse & Brouwer (2022) show that institutional trust is essential for the process acceptance of the transition to water reuse. In the literature, institutional trust and trust are often intertwined or very closely related to each other. In this paragraph, results on the trust factor are sometimes borrowed and extrapolated to institutional trust. Studies show that more trust is very important for the acceptance of new technologies, and leads to an increase in the likelihood of acceptance of a given technology (Brouwer et al. 2015; Smith et al. 2018; Goodwin et al. 2018; Fielding et al. 2019). Trust in authorities associated with water reuse is shown to be one of the factors for acceptance of water from alternative sources (Dolnicar et al. 2011; Brouwer et al. 2015). In the following ten sections, factors that relate to and build institutional trust are explained.

### 2.2.1 Risk perception

Studies describing institutional trust have multiple views on the relationship between risk perception, institutional trust and the acceptance of water reuse (as described in e.g., Eiser et al. 2002; Fielding et al., 2019; Goodwin et al. 2018; Smith et al., 2018). One model on the relationship between risk perception, trust and the acceptance of water reuse is the causal view model. In the causal view, trust is seen as a driver; more trust leads to perceiving less risk, which leads to an increase in the likelihood of acceptance of a given technology (Figure 2) (Eiser et al., 2002). The risk perception is a mediating element between trust and the acceptance of water reuse (Fielding et al., 2019). Lower risk perceptions are related to higher acceptance of water reuse, and vice versa, higher risk perceptions are related to lower acceptance (Fielding et al. 2019). The original causal model of Eiser et al. (2002) is not specifically about institutional trust but about trust in general, but it is relevant enough and can be tailored specifically to the relation between institutional trust, risk perception, and acceptance water related reuse technologies.


*Figure 2. Causal view model (adapted from Eiser et al. 2002)*

Other studies suggest instead that risk perception affects institutional trust (Fielding et al., 2019; Goodwin et al. 2018; Smith et al., 2018). Higher risk perception leads to lower institutional trust and lower risk perception leads to higher institutional trust. As citizens have more access to information and knowledge about risks, they demand more control of their government (Brouwer et al. 2019). In response, governments try to control these risks with standards and procedures so not to lose legitimacy. Beck (1992) describes that these standards do not guarantee safety, as they conceal uncertainties hidden behind the risks, and therefore give a false certainty (Brouwer et al. 2019). When a risk occurs, the government cannot really explain the standards, as only specialists can, resulting in citizens with even less trust in the government and specialist knowledge, creating more fear of risks in society (Brouwer et al. 2019). Next to an objective measurable risk, there is a perceived risk, which differs per context and per person (Brouwer et al. 2019). The risk perception of people establishes with an interaction of culture, norms, values, knowledge, emotion, beliefs and intuition (Brouwer et al. 2019). Risk perceptions of the public depend on the trust the public has in knowledge institutes and risk regulatory bodies, i.e. institutional trust (Poortinga & Pidgeon, 2005 as cited in Brouwer et al. 2019). More institutional trust leads to perceiving less risk and less trust leads to perceiving more risks (Smith et al. 2018), leading to a reciprocal relationship (Figure 3).


*Figure 3. Interaction between risk perception and institutional trust*

### 2.2.2 Acceptance modus operandi

In yet another model, the associationist view, trust is not a driver of acceptance, but affected by the likelihood of acceptance of the modus operandi, which means the acceptance of how the organisation operates (Figure 4). Research supporting the ascensionist model is increasing (Eiser et al. 2002; Brouwer et al. 2015). In the associationist model, the likelihood of acceptance determines how risk perceptions and trust are interpreted (Smith et al., 2018). “Judgments on the acceptance of a certain activity or new technology precede the related risk perception and trust in (regulating) institutions” (Eiser et al. 2002 as cited in Brouwer et al. 2015, p. 25).

### 2.2.3 Underlying attitudes

The likelihood of acceptance of a technology, like water related reuse, is to some degree predetermined by underlying attitudes (Eiser et al., 2002; Smith et al., 2018). Underlying attitudes exist of two elements: beliefs (descriptions of people, objects, and events) and values (consisting of favorable or unfavorable ratings) (Benoit, 2015). Underlying attitudes can be positive or negative towards acceptance of water related reuse. The underlying attitudes affect how people interpret risk perceptions and trust, like risk related information and the capabilities and motivations of governing institutes (Smith et al. 2018).

### 2.2.4 Affective reactions

The underlying attitudes are linked with the experiential system and affective, emotional reactions (Eiser et al., 2002; Smith et al., 2018). For shaping the acceptance of a new technology, the experiential system, which is based on associations, images and affective reactions is more important than the analytical system, which is based on evidence, reasoning and logic (Connor & Siegrist, 2010). Positive emotional reactions towards water reuse predict lower risk perceptions and higher acceptance of water reuse, and negative emotional reactions predict higher risk perceptions and lower acceptance (Fielding et al., 2019; Judge et al. 2021). An example of a negative emotional reaction is the ‘yuck factor’, a response of disgust with the reused water. These affective emotional reactions predetermine the underlying attitudes, which in turn affect the likelihood of acceptance of water reuse and how risk perceptions and trust are interpretated (Smith et al., 2018). Therefore, trust may be (indirectly) shaped by pre-cognitive emotional affective reactions (Smith et al., 2018).

### 2.2.5 Influence from other people

Wider societal contexts, trends and processes (Smith et al., 2018) and the perception of how much others support water reuse (Fielding et al., 2019) influence the acceptance of water reuse through narrative, discourse and social norms. “The influence a person feels from other people” can reinforce or counterbalance an individual’s own level of support (Smith et al., 2018: 47).

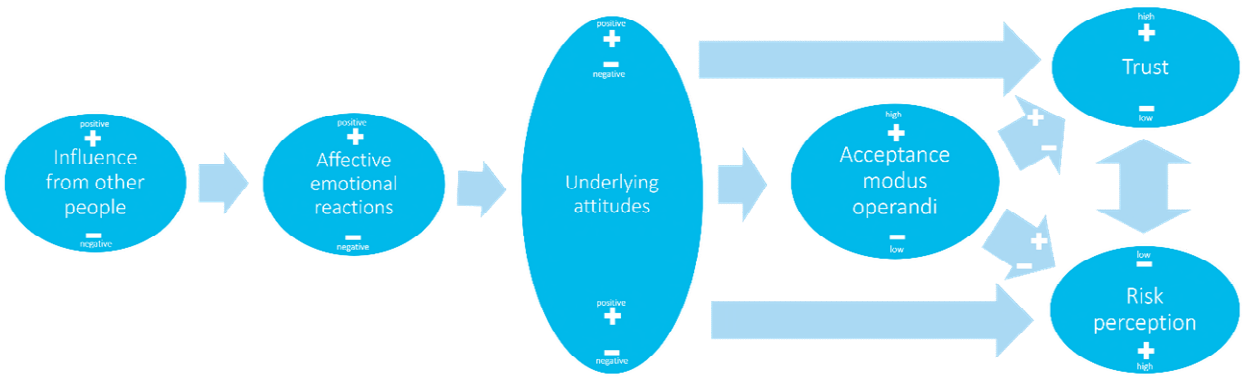


*Figure 4. Associationist view model (adapted from Eiser et al. 2002 with Brouwer et al. 2015; Smith et al. 2018)*

### 2.2.6 Public engagement

Since influence from other people has shown to be a factor determining trust, public engagement is important to build trust. Early and adequate public engagement is linked to higher support for water reuse projects and recommended to help build public trust; water reuse regulations and guidelines also support this (Goodwin et al., 2018). When a well-organised comprehensive communication process is established long before water-reuse project plans are made and continued throughout the project, trust between water reuse organisations and stakeholders is maximised (Goodwin et al., 2018).

### 2.2.7 Communication provision

The contribution of providing knowledge or different kinds of messaging to increase acceptance of water reuse tends to be small but is still present (Smith et al., 2018). For instance, the receptivity of people regarding video messaging seems to be higher for information about the general context and management practices of water-reuse schemes than for information about the water treatment processes (Goodwin et al., 2018). More specifically, after receiving information in the form of video messaging, people show an increase in trust in authorities to manage water-reuse schemes (Goodwin et al., 2018). The impact of this kind of messaging is more pronounced for decreasing perceptions of risk and for increasing trust in management (Goodwin et al., 2018).

### 2.2.8 Media information

Information provided by media, about the performance and functioning of water organisations, tends to leave impressions that affect the trust of the public (Brouwer et al. 2015). Negative events are seen as more important by the public and can even be trust-destroying. Reported positive events can be trust building, but leave less deep impressions.

### 2.2.9 Personal experience

The personal experience of the consumer affects their trust in an organisation involved in water reuse (Brouwer et al. 2015). The personal experience is affected by potential incidents that the consumer has experienced in the past. For instance, incidents of failure have long-lasting consequences on the consumer's trust (Brouwer et al. 2015). User involvement can determine the personal experience. Through public involvement the consumer can have positive experiences of trustworthy and open organisations.

### 2.2.10 Perceived performance

Public trust in water reuse organisations is influenced by their performance perceived through the eyes of the consumer (Brouwer et al. 2015). For example, how consumers perceive the quality and supply of the provided water. The perceived performance influences the perceived competence and therefore trust in water reuse organisations (Brouwer et al. 2015). It is only when the quality or quantity of water changes, or when tariffs become unreasonable that consumers will think about their trust.

### 2.2.11 Conclusion

Concluding, there are different perspectives on the elements that constitute the institutional trust of the public in organisations involved in water reuse. From one perspective, the elements that constitute institutional trust are affective, emotional reactions, underlying attitudes and the likelihood of the acceptance of the given technology. Other studies highlight that societal contexts, trends and processes and more specifically narrative, discourse and social norms, and the influences of other people are important. It has been shown that early and adequate public engagement while receiving information in a well-organised comprehensive communication process long before and throughout the project contributes to building public institutional trust in organisations managing water reuse systems. Communication, information, experience and perceived performance influence the trust in organisations as well. Together, this sums up ten elements that influence the public trust in organisations (Figure 5).

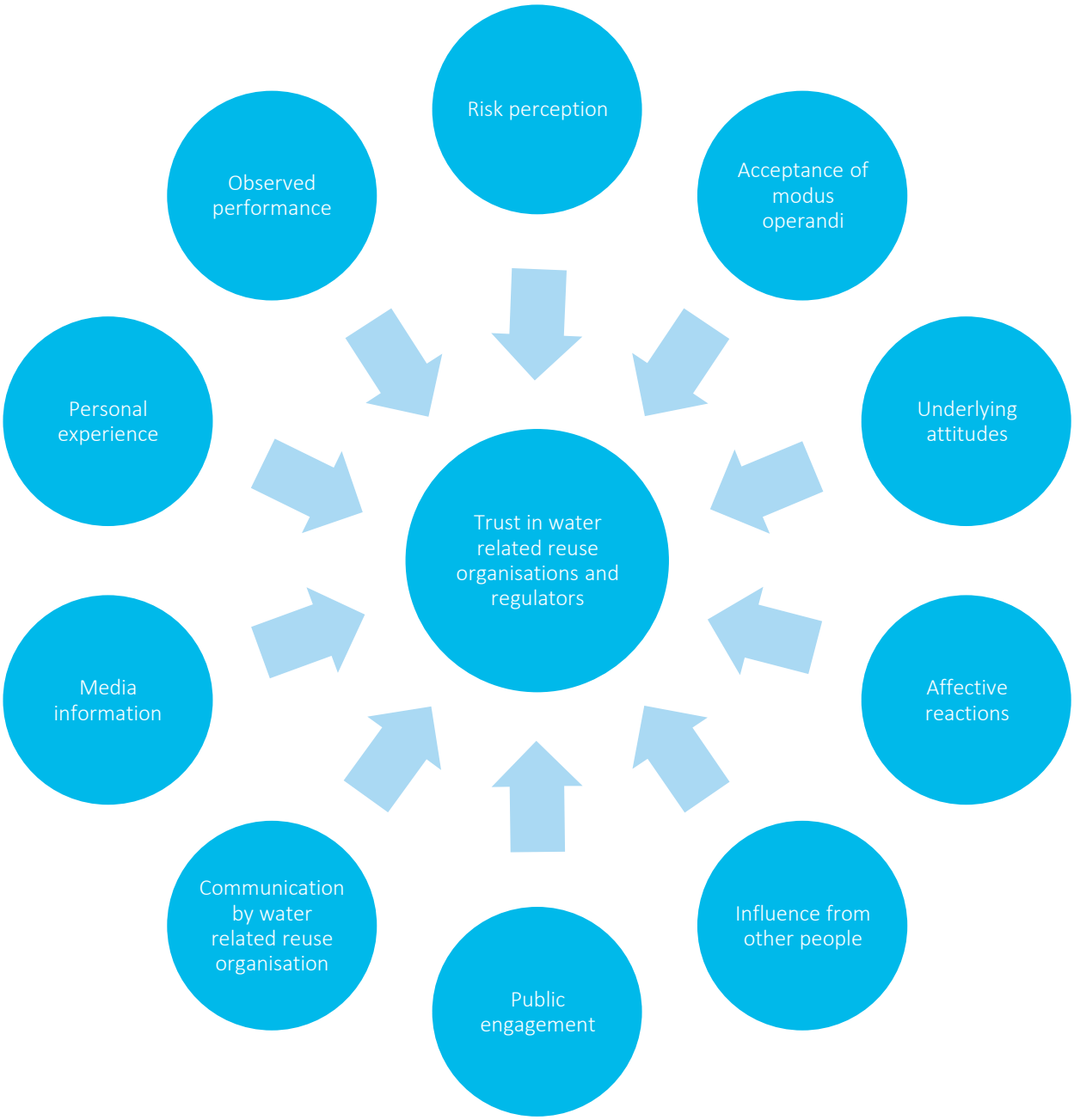


*Figure 5. Elements that constitute public institutional trust in organisations involved in water related reuse (Adapted from Brouwer et al. 2015)*

## 2.3 Forms of institutional trust

Building on the elements that constitute institutional trust, it can be explored what different forms of institutional trust are at play. It is not only relevant to look at the public opinion and their trust in organisations, but also at the trust of employees at the organisations themselves. It is not that relevant in this research to look at the trust of employees in their management or organisation. Most relevant for the specific focus of this research is the trust of employees in new technologies for water related reuse.

1 the trust of the public in the governing institutions, for instance involved parties in water-related reuse, such as the government, science, and drinking water company experts (Barendse & Brouwer 2022);
2 the trust of employees and experts working at the involved parties and governing institutions, like the institutions managing water-related reuse, with a specific focus on their trust in in water-related reuse technologies.

### 2.3.1 Institutional trust of citizens

One of the elements that can influence the institutional trust is the perceived performance of the organization through the eye of the customer; e.g. how consumers perceive the quality and supply of the provided water. Customer satisfaction of Dutch citizens in terms of drinking water quality and services provided by drinking water companies is high (Vewin, 2022). Clients rated drinking water companies services with an 8,1 and the quality of drinking water with an 8,7 in 2019 (Vewin, 2022). Satisfaction with company services and quality of the drinking water builds trust in the drinking water companies. Studies show that the trust of citizens in drinking water companies is high (Brouwer et al. 2019). This trust is further strengthened by trust in other regulatory bodies, the general policy and regulations. Compared to various governing institutions, clients rate their trust drinking water companies the highest (Brouwer et al. 2019) (Figure 6).

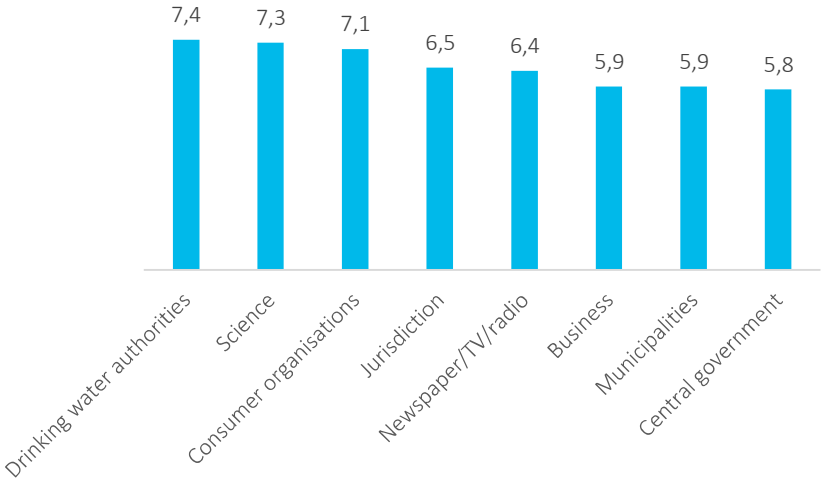


*Figure 6. Trust of citizens in governing authorities (Adapted from Brouwer et al. 2019)*

The trust of the public in institutions and governing authorities affects the legitimation of water related reuse practices by influencing the acceptance of new technologies. As has been shown, when the trust of the public in organisations managing water related reuse is high, it predicts high public acceptance of these practices and a higher chance for the adoption of water-related reuse. “Consumers with a higher level of trust in their public water suppliers also have a higher attitude towards planned potable reuse water” (Barnes et al. 2023. p. 11).

### 2.3.2 Employees trust in the water related reuse technologies

Whereas the first form of institutional trust describes the trust of citizens in governing authorities related to water reuse, the second focus is specifically on the trust of employees in water related reuse technologies. Meaning the people working at drinking water companies, water boards, regulatory agencies and other institutions involved in water related reuse. With this side step, the trust of employees in water related reuse technologies is investigated as employees' trust in water related reuse influences the legitimation of water related reuse practices in two ways:

First, employees are the best ambassadors for innovative sustainability initiatives, like reusing resources (Veleva et al. 2017; Barendse & Brouwer, 2022). The attitudes of employees towards water reuse practices can influence how other employees, public officials and the public perceive water reuse technologies (van Leeuwen & van Alphen, 2021). Their trust in water related reuse can have an effect on the trust of citizens in water reuse practices. Employees at drinking water companies, water boards or governing bodies are seen as experts, and their opinions are valued. By having fearful attitudes and mindset towards reusing and recycling wastewater they can negatively influence the public perspective and trust of water reuse (Barendse & Brouwer, 2022). It is of high importance to first focus on employees at water organisations and their trust in water reuse practices to enhance public acceptance.

Second, it is discussed that employees often (wrongly) think that citizens do not accept water-related reuse (TD). By having sceptical attitudes, they can create an unnecessary social barrier for the implementation of water-related reuse practices, as it can prohibit further implementation of water reuse technologies. Detailed knowledge about the procedures and related risk can be obstructive to trusting new technologies and accepting them. These perceptions can create prejudice of the experts, regarding how the public perceives water reuse technologies. Often the acceptance and trust of the public in water reuse is not as low as 'experts' or employees at water reuse organisations think. As has been shown in the focus group study in chapter 2.1.1 'Acceptance of water related reuse', the majority of the group was neutral to positive about water reuse practices and opposition decreased during the focus group (Barendse & Brouwer, 2022).

The trust of employees in water related reuse technologies affects the public acceptance. When employees' trust in water related reuse technologies is high, it can facilitate the adoption of water related reuse by the public (TD). In turn, by facilitating the acceptance and adoption of water related reuse, high trust of employees enhances the legitimation of water related reuse practices (TD). The influence of employees, as ambassadors, relates to the factor of 'influence of others' that builds institutional trust, as described in chapter 0.

Veleva et al. (2017) studying the transition to the circular economy by focussing on "zero waste" found that employee engagement and awareness is underdeveloped and could be enhanced to advance circular economy practices. Employee engagement is a critical strategy for implementing innovative sustainability approaches, like reuse (Veleva et al. 2017), and water related reuse practices (Barendse & Brouwer, 2022). According to Veleva et al. (2017), employee engagement is built by informing, educating, empowering and recognising (Figure 7). Employees can be informed, educated and empowered about water related reuse by organizing trainings or lectures about the (communication about the) circular economy, water reuse, or recovering embedded resources. Employees can be recognised for their efforts by supporting their efforts to reuse water. Focusing on these four indicators is a way to manage and facilitate enhancement of employee engagement on circular economy practices of organisations.

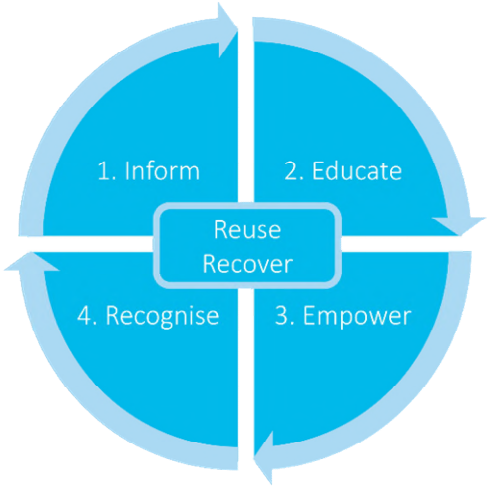


*Figure 7. Employee engagement (adapted from Veleva et al. 2017)*

# 3 Regulatory obligations

This chapter describes the regulatory obligations in the transition to the circular economy for promising technologies to reuse water and its embedded resources such as nutrients and energy. It includes the regulatory obligations for water reuse and water-related reuse, meaning regulations for the recovery of products from water.

## 3.1 European Water Reuse Regulation

The general basic rules of water reuse in the European Union (EU) are that reclaimed water quality is tailored according to the purpose of its use (to avoid unnecessary expenses) and that water reuse must be safe for human health and for the environment (EWA, June 2023). To fulfill those two basic rules, the quality of reclaimed water must meet certain standards. In the EU countries, these are 1) national standards for water reuse, 2) EU Regulation No. 2020/741 and 3) international ISO standards.

The new European Water Reuse Regulation was built on article 12 of the European Urban Waste Water Directive that states: where possible, urban wastewater will be further purified and reused (I-2). The extent to which the Water Reuse Regulation has made water reuse easier or harder is difficult to say and variable depending on the country it is being implemented in. It was meant to be supportive in creating a level playing field of the quality regulations. It did achieve that, created some aspects of clarity, but at the same time it is considered stringent and its implications are complicated (I-1; TD). The regulation facilitates water reuse since it has created a framework for safe water reuse, but is somewhat obstructive as it frustrates existing de facto reuse (TD).

Regulation 2020/741 on minimum requirements for water reuse for agricultural irrigation entered into force in June 2020 and has been applicable since June 26, 2023. The new rules are expected to encourage and facilitate water reuse in the EU. The regulation is mostly oriented towards water reuse in agriculture, but also allows EU member states to use reclaimed water for further uses such as industrial, amenity-related and environmental purposes (EWA, June 2023). Amenity-related can be public needs, for example, the irrigation of public areas, parks, etc. Water reuse for industry and public amenities should follow existing national regulations for these practices (I-1). The goals of the new water reuse regulation are to encourage circular approaches to water reuse and to address water scarcity and drought, while keeping it safe for human and environmental health (EWA, June 2023). The regulation sees urban wastewater as the source: domestic wastewater, run-off rainwater, and sometimes industrial water. This water is now discharged to and purified in sewage treatment plants and in most cases discharged into surface water. The regulation focuses on purifying and reusing this water for agricultural irrigation. The most important point of the regulation is: if water is to be recovered and supplied, then it must meet these quality standards at some point if it is used for agricultural purposes. The regulation presents three different categories:

a Products directly for human consumption. All food crops consumed raw where the edible part is in direct contact with reclaimed water and root crops consumed raw. For this category apply quite strict standards, which minimizes the public health risks.
b Products that still need to be processed before they are eaten by humans. Or food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk- or meat-producing animals.
c The same crop category as ‘b’, but with drip irrigation or other irrigation method that avoids direct contact with the edible part of the crop.
d Products for industrial, energy, seeded and floriculture (ornamental pumpkins, etc.) crops, and therefore not for consumption. Less strict standards apply to this (EU Regulation 2020/741).

The minimum requirements are subdivided into these four different reclaimed water quality classes and are specified for E.coli, BODs, TSS, turbidity and other components, like legionella (Figure 8).

(a) Minimum requirements for water quality

**Table 2 – Reclaimed water quality requirements for agricultural irrigation**

| Reclaimed water quality class | Indicative technology target | Quality requirements | | | | |
|---|---|---|---|---|---|---|
| | | *E. coli* (number/100 ml) | $BOD_5$ (mg/l) | TSS (mg/l) | Turbidity (NTU) | Other |
| A | Secondary treatment, filtration, and disinfection | ≤ 10 | ≤ 10 | ≤ 10 | ≤ 5 | *Legionella* spp.: < 1 000 cfu/l where there is a risk of aerosolisation<br>Intestinal nematodes (helminth eggs): ≤ 1 egg/l for irrigation of pastures or forage |
| B | Secondary treatment, and disinfection | ≤ 100 | In accordance with Directive 91/271/EEC (Annex I, Table 1) | In accordance with Directive 91/271/EEC (Annex I, Table 1) | - | |
| C | Secondary treatment, and disinfection | ≤ 1 000 | | | - | |
| D | Secondary treatment, and disinfection | ≤ 10 000 | | | - | |

*Figure 8. The minimum quality requirements of the reclaimed water for agricultural irrigation (Water Reuse Regulation 2020/741)*

### 3.1.1 Deployment of regulation in the Netherlands

Regulation 2020/741 on minimum requirements for water reuse for agricultural irrigation is an invitation for water reuse, but it is not a requirement. It is an incentive for the Member States; they must ensure that they meet the standards if they are not already compliant. Regionally, it must be examined whether the regulations adds to the current situation. The regulation itself applies directly; it does not have to be implemented, but it needs to be embedded in existing laws and regulations. In the Netherlands, that has happened by transposing it in the Environment and Planning Act (Omgevingswet) (I-2). The regulation leaves several choices to the Member States. One of them is to designate areas where water reuse is not allowed. In the Netherlands, water reuse will not take place in groundwater protection areas and in drinking water extraction areas, as the risks are perceived to be too big for that. This decision has been established in the law, in a General Administrative Order (Algemene maatregel van bestuur, AMvB) (I-2). The regulation is considered vague about the division of responsibilities; how it should be executed and who should execute it (I-2; TD). For instance, aspects as figuring out which institutions are responsible for the permitting and the risk management have been more complicated for some countries than others (I-1). There are considered to be many gaps around monitoring and specific parameters that must be considered, for instance regarding the responsibility of overseeing the plans on risk management (I-1; TD).

The reuse of treated wastewater in agriculture requires a permit, a risk management plan, and monitoring. The Ministry of Infrastructure and Water Management (I&W) gave the Provinces the competent authority to grant these permits, assess the risk management plan and carry out inspections. The implementation of this lies with the Environmental Services (Omgevingsdiensten) (Stowa meeting, 2023). Water boards can apply for these permits and supply the retreated wastewater, but other institutions or individuals can apply for these permits as well. Every authority that is going to do this needs the water boards for the supply of the retreated wastewater. The risk management plans have to be established by the exploiting party, the one who applies for the permit, in which all the risks for health and environment should be taken into account. Witteveen & Bos have published the Instrument Risk Management Plan for the Reuse of WWTP Effluent for Agriculture (Handreiking risicobeheersplan voor hergebruik van RWZI effluent voor de landbouw). This is available at Informatiepunt Leefomgeving (IPLO.nl) (Stowa meeting, 2023). The RIVM has been evaluating the minimum values of substances allowed, which will be published early 2024 in an report entitled 'Reuse of urban wastewater in agriculture: towards an assessment framework' (Hergebruik stedelijk afvalwater in de landbouw: op weg naar een toetsingskader) (IPLO, 2023).

## 3.2 Urban Wastewater Treatment Directive

A revision[1] has been proposed for the Urban Wastewater Treatment Directive (UWWTD) to increase energy neutrality in the water and wastewater sector and provide incentive for reusing water and recovery of phosphorus and biogas. It is facilitating water related reuse (TD) and is considered to be a step in the right direction towards the CE (Nextgen 7.6, 2023). The evaluation and proposal for revision of the UWWTD contains three main sets of challenges that are expected to reduce pollutants discharges even further (European Commission, 2022). The proposal for revision includes new requirements for microplastics and other micropollutants in line with the Circular Economy Action Plan, aims for the sector to become energy-neutral by 2040, and adds essential points for the energy-water nexus and nutrients recovery (NextGen 4.4, 2023).

### 3.2.1 Reusing water, recovering nitrogen and phosphorus

The proposal for revision states that the wastewater sector can increase circularity by increasing safe reuse of treated water and recovering nitrogen and phosphorus, and by reducing greenhouse gas emissions and energy consumption. These aims fall under the challenge of aligning with the European Green Deal (EGD). The EGD sets ambitious policy objectives for the European CE, to counter climate change and reduce environmental degradation. The wastewater directive needs additional efforts to be in alignment with these goals. Additionally, the proposal addresses the insufficient and uneven level of governance. The wastewater treatments operators greatly vary in performance and transparency. The 'polluter pays' principle is not sufficiently applied. Wastewater can be a rapid and reliable source for public health information if competent authorities for health and wastewater management are well coordinated. The proposal also targets the remaining pollution from urban sources, like smaller cities below 2000 p.e. (population equivalent), decentralized facilities and pollution from rainwater. The minimum requirements for treatment of pollutants are outdated due to technical progress and new pollutants like micro- and micro-pollutants have emerged, that can be harmful at very low concentration levels for the environment and for human health.

### 3.2.2 Biogas from sludge

The proposed revision is to provide incentives for recovering biogas from sludge, which is in line with the Circular Economy Action Plan. The Circular Economy Action Plan indicates that it is needed to better integrate the urban wastewater sector with the CE. One action is to accelerate the clean energy transition, for which wastewater treatment facilities have been identified as "go-to areas". The proposal for revision of the UWWTD states the objective to reach energy neutrality in the wastewater treatment sector by 2040. The practices of more experienced Member States show that this can be achieved by improving energy efficiency, notably by the production of biogas from sludge.

## 3.3 End-of-waste status

The waste status is seen as the most impeding factor for the recovery and reuse of embedded resources within wastewater (I-3; TD). All effluent of sewage treatment plants, is called 'waste' by law. One of the challenges is to give the rest-products the status of 'end of waste', so they are no longer considered waste by law. The process to get the 'end-of-waste' status takes a very long time. For struvite, the first product for which an end-of-waste status has been obtained, it took more than six years (I-3). Struvite must still meet many requirements. "The RIVM demands that the products are completely clean and has a 'zero-risk' policy, which leads to many (unnecessary) process steps to provide the product that meets these stringent requirements" (I-3). Currently, work is in progress to achieve the 'end-of-waste' status on cellulose and bioplastic (polyhydroxyalkanoate /PHA).

[1] On 26 October 2022, the Commission revised the Directive > the proposals will now be considered by the European Parliament and the Council in the ordinary legislative procedure. Once adopted, they will take effect progressively, with different targets for 2030, 2040, and 2050 – giving industry and authorities time to adapt and invest where necessary.

As of 2019, the Fertilising Products Regulation 2019/1009 has been revised and the end-of-life or waste status of substances has been reconsidered. The revised fertilizing products regulation is now extended and includes the conditions for making fertilizers available from organic or recycled materials, for example from (waste)water. Therefore, fertilising products containing or consisting of such recovered waste materials can access the internal market. For certain recovered wastes, such as struvite, biochar and ash-based products, a market demand for their use as fertilising products has been identified. “When these products comply with all the requirements of the regulation they should cease to be regarded as waste” (Regulation 2019/1009 p. 170/4). The revision is now in line with the development of the circular economy, provides an incentive for further use of recycled materials, allows for more resource-efficiency of nutrients, and reduces the dependency on nutrients from other countries. Products intended to improve plants’ nutrition efficiency are included in the revision as well (Regulation 2019/1009).

### 3.3.1 Experience

For the opening of a struvite plant in 2013/2014, for the production of struvite, there was much media attention. At the opening of this struvite plant, a little bit of the struvite product was put in a jar with which a number of press people visited people on the street (I-3). They explained that struvite is a slow secondary fertilizer, from human manure and asked questions as ‘what do you think about that and would you use it in your garden?’. The majority of people held the jar and was positive; comments ranged from, ‘it does not stink’, to ‘it looks nice’, and ‘I would use it in my garden’ (I-3). It shows that experiencing the product can help to make it more tangible. It can also help to show developers of new technologies how the public perceives the product and if acceptance is neutral or high.

### 3.3.2 Self-declaration

Since the process of obtaining the end-of-waste status is slow, the sector itself is now starting to declare themselves that their products have the end-of-waste status, a so-called self-declaration. For example, companies in the chemical industry that produce green chemistry and other things from secondary sources do this (I-3). More and more companies are saying: “I've done everything I can, I fully stand behind my product, I know it's safe and clean and has no impact on people, the environment and nature” (I-3). The companies are therefore overtaking the laws and regulations and declaring themselves that their product meets the requirements.

### 3.3.3 Lobbying

When obtaining the end-of-waste status for struvite, this self-declaration was deliberately not chosen, to be able to formally change the laws and regulations (I-3). There has been a lot of lobbying in the case of struvite. For example, by Vewin and the Union of Water Boards. There is now European legislation on secondary phosphate, focusing on struvite and other streams, partly because of lobbying to put that legislation on paper (I-3).

## 3.4 Kiwa watermark

Kiwa tests and certifies products that encounter drinking water that is used in industrial and domestic drinking water installations. Products that meet the requirements set by the Dutch government are provided with the Kiwa watermark (Kiwa, 2023). A Kiwa watermark is needed to use residual flows from drinking water in the treatment of wastewater, and vice versa. For example, if biogas is produced at a sewage treatment plant and the biogas is converted into green gas, CO2 can be captured and used in the drinking water industry for pH correction. That CO2 is clean, but a Kiwa Watermark must be arranged before it can be used. The certification process for that is considered to take quite a long time (I-3). Often because it is unknown, so it requires an extra measurement step. In the case of CO2, smell and taste tests must take place. The core businesses of water boards and drinking water companies are to manage surface water and to produce drinking water respectively. The extra business for the raw materials is quite complicated and does not feel like their core business, which makes it extra complicated (I-3).

## 3.5 Drinking Water Directive 2020/2184

When reclaimed water will be used for the production of potable water it should meet the requirements as written in the Drinking Water Directive. Article 7-10 of the Drinking Water Directive include risk-based approaches, assessment and management (Drinking Water Directive 2020/2184). Member States shall ensure that the supply, treatment and distribution of water intended for human consumption is subject to a risk-based approach that covers the whole supply chain from the catchment area, abstraction, treatment, storage and distribution of water to the point of compliance. The Drinking Water Directive states the requirements for 'water intended for human consumption': A) all water, either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes in both public and private premises, regardless of its origin and whether it is supplied from a distribution network, supplied from a tanker or put into bottles or containers, including spring waters; B) all water used in any food business for the manufacture, processing, preservation or marketing of products or substances intended for human consumption" (Drinking Water Directive 2020/2184, p. 14).

## 3.6 Legislative changes in favour of water-related reuse

### 3.6.1 Accelerate end-of-waste status

Speeding up the process to get the 'end of waste' status is considered to be the most important possible change in favour of reusing embedded resources (I-3; TD). Currently a project from Het Versnellingshuis, financed by the national government, is developing a route to get the 'end of waste' status as quickly as possible (I-3). The example of bioplastic (PHA) is taken, with the goal to create a blueprint for accelerating the process of achieving the 'end of waste' status. It is argued that by accelerating the process, other processes like investments of market parties can accelerate too (I-3). It is considered to be important for secondary processors of reflows to arrange this quickly, as they will otherwise not be able to continue with their businesses (I-3). It is argued to be helpful if the Fertilising Products Regulation focuses more on requirements for the end product, instead of the source of the product (TD).

### 3.6.2 Accelerate Kiwa watermark

As described in part 3.4, the certification process for the Kiwa watermark is considered to take quite a long time. It is argued that by accelerating the process of obtaining the Kiwa Watermark, water related reuse is facilitated (I-3). It is considered that it would then be easier to demonstrate that a product from wastewater is safe to reuse in drinking water production processes (I-3). For example, CO2 is a product from wastewater that can be reused in drinking water. It arises as a 'rest product' when biogas is converted into green gas. The CO2 can be used for pH correction in drinking water production. Reusing-chains within the sector is considered to be the highest possible prove that products from wastewater are safe (I-3). Specifically when the drinking water sector uses rest products from wastewater, as the Dutch drinking water is globally seen as the cleanest (I-3). It is therefore considered to be the highest achievable goal to reuse a resource from wastewater in the drinking water process. If this is demonstrated, it is expected that many more markets will be open to purchase wastewater products (I-3).

### 3.6.3 Mandatory recovery in national legislation

In the Netherlands it is not yet mandatory to recover resources from wastewater. It is argued that it would facilitate resource recovery if it would become mandatory to recover these resources (I-3). For example in Germany, it is already mandatory to recover phosphate, which has accelerated the implementation of these practices (I-3).

### 3.6.4 Subsidising

The national government is subsidising the energy transition, like the production of green gas, but it is argued that there is still far too little focus on the circular economy (I-3). Green gas and bioplastic can be produced at sewage treatment plants, but it is mentioned that there are almost no subsidies for it (I-3). It is therefore argued to be important for the national government to make a shift from the energy transition to the circular economy, and focus more subsidies on circular economy practices (I-3).

# 4 Legitimation strategies

This chapter identifies which legitimation strategies can be used for the socio-technological legitimation of water-related reuse. It delves into which strategies can create institutional trust and discusses which strategies can help to shape legal changes for supportive regulatory obligations in favour of water-related reuse.

## 4.1 Legitimacy framework

> Legitimacy
>
> *a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions (Suchman, 1995, p. 574).*

Since 1960, the concept of legitimacy has become widespread in literature. One of the prominent researchers in the field of managing legitimacy is Mark Suchman. In 1995, Suchman provided a synthesis of organizational legitimacy, analysed the strategic and institutional approaches of legitimacy and defined three types of legitimacy: pragmatic, moral, and cognitive. Building on the work of Suchman, Scott (2008) provided a distinction of regulative, normative and cultural-cognitive legitimacy. Harris-Lovett et al. (2015) continued with this framework and applied it to a well-known example of water reuse, identifying legitimation strategies that were performed. Binz et al. (2016) adapted the classification of Suchman and added the regulative legitimacy of Scott. Afghani et al. (2022) continued with these types of legitimacy and described them with four related questions that this researched adopted. Building on previous research, this project continues with the four categorisations of legitimacy: pragmatic, normative, cognitive and regulative legitimacy (Figure 9). These four legitimacy types are further explained in the next parts of this chapter.

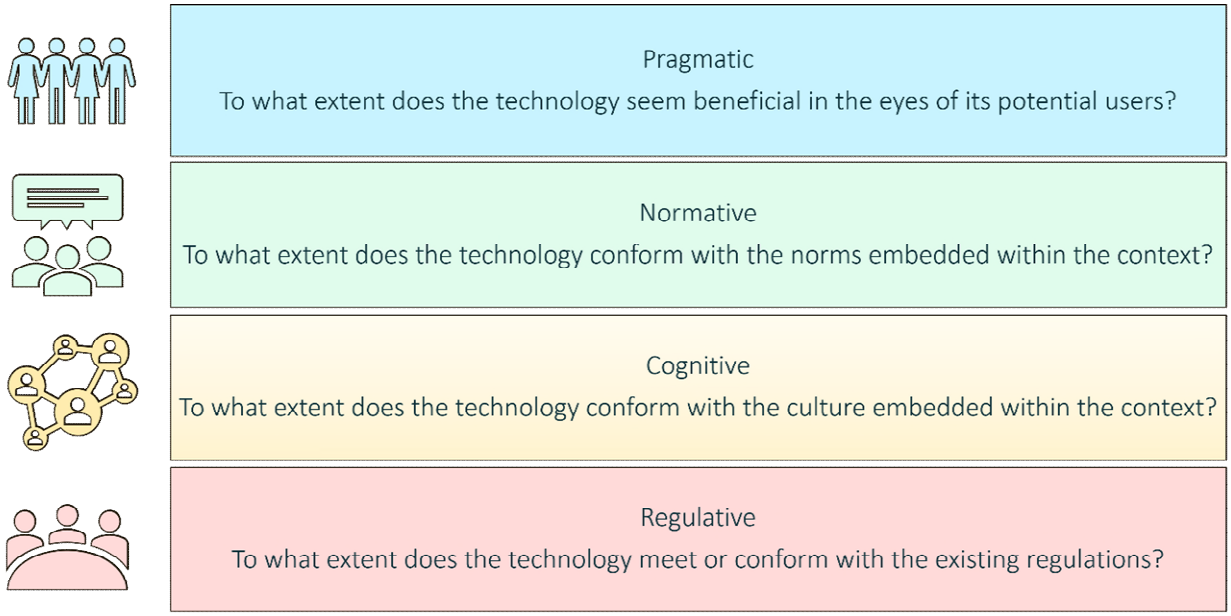


*Figure 9. Legitimacy types (Adapted from Afghani et al. 2022)*

Pragmatic legitimacy is described as to what extent the technology seems beneficial to the eyes of its potential users (Afghani et al. 2022). The basis for pragmatic legitimacy is personal evaluation (Binz et al. 2016). Normative legitimacy is described as to what extent the technology conforms with the norms embedded within the context of the innovation (Afghani et al. 2022). The basis for normative legitimacy is if the technology is morally governed (Binz et al. 2016). Cognitive legitimacy is described as to what extent the technology conforms with the culture embedded within the context (Afghani et al. 2022). The basis for cognitive legitimacy is if the technology is comprehensible and culturally supported (Binz et al. 2016). Regulative legitimacy is defined as to what extent the technology meets or conforms with the existing regulations (Afghani et al. 2022). The basis for regulative legitimacy is if the technology is legally sanctioned (Binz et al. 2016).

A discussion point is if legitimation happens as an organic process or if legitimation can be created because of applied strategies. The process of legitimation is a part of organic societal processes (I-1). Legitimation can be an undirected process since legitimatizing processes can happen without intervention or without action. However, legitimizing process can also happen with certain actions or strategies that can help the legitimation process (I-1).

When it comes to societal acceptance, it is important to realize that it is never static, and can be influenced by a whole range of (external) factors. For example, acceptance could suddenly decline due to technical failure, the emergence of local action groups, and the positioning of media. At the same time, this means that active work can be done to increase societal acceptance (Barendse et al. 2023). One example is the development of strategies like programs that allow people to see, smell, and taste reused water so they can learn its organoleptic properties. Regular tap water from different regions can also be offered so that people experience that the organoleptic properties of the current drinking water can also differ, but it is all clean and tasty, as with reused water (Barendse et al. 2023).

The multiple levels of legitimacy are all interrelated and affecting each other, which means that they can also amplify each other. The interplay of different legitimation strategies is powerful. Often the focus still lies on individual strategies. Yet the goal is to focus on the interplay of the strategies. For instance, the regulative legitimacy can strengthen if it can be demonstrated that there is a willingness to reuse water and its embedded resources. With the interplay of multiple legitimation strategies in different areas, legitimacy can be created.

## 4.2 Legitimation strategies

There are multiple authors that have used the legitimacy framework, and analysed the application of legitimation strategies. Most of these authors have used specific case studies and analysed which strategies were applied to create acceptance for new technologies of water related reuse. The results of two of these studies are described.

Harris-Lovett et al. (2015) used the four types of legitimacy as a lens through which they analysed the case of potable water reuse in California. They have analysed how the potable water reuse system of Orange County Water District (OCWD) in California established legitimacy, focusing particular interest on the strategies that OCWD applied to create legitimacy for the water reuse system they employed.

Analysing the case of OCWD, Harris-Lovett et al. (2015) found that OCWD had many traits contributing to the legitimacy portfolio and no traits detracting from the legitimacy portfolio. The strategies (with the corresponding legitimacy dimension) include the following. For pragmatic legitimacy, they applied targeted outreach and education campaigns (exchange), elicited feedback from community leaders (influence), and demonstrated the utility's trustworthiness (dispositional). For moral legitimacy they kept consistent track record of high water quality (consequential), had emergency intervention and quality monitoring plans (procedural), a state-of-the-art technology, sophisticated laboratory (structural), and the management was personally involved in outreach work (personal). For the cognitive legitimacy, they were serving visitors purified water from a tap (comprehensibility) and framed potable reuse as recycling, groundwater protection (taken-for grantedness).

When compared to the other potable water reuse projects in California, many had traits that detracted from the legitimacy portfolio, and few traits contributing to it. Examples of the strategies (with the corresponding legitimacy dimension) are the following. For pragmatic legitimacy, there were outreach campaigns to establish controlled potable reuse as an improvement over de facto reuse (exchange), however there was weak public involvement in planning and decision-making about potable reuse (influence), and little proof of the sector's "good character", despite branding efforts (dispositional). For moral legitimacy, there was a successful track record with indirect potable reuse systems in some places (consequential), but incomplete procedural standards for water reuse plants (procedural), there was research on infrastructure and technology development (structural), but a few knowledgeable spokespersons for potable reuse (personal). For the last, cognitive legitimacy, there was development of vocabulary that meshes with cognitive frames (comprehensibility), but inconsistent use of terminology (comprehensibility), yet potable reuse was related to the water cycle (taken-for- grantedness) (Harris-Lovett et al. 2015).

Binz et al. (2016) focused on technology legitimation and the institutional work that was performed for potable water reuse in California. They describe strategies for the enhancement of regulative legitimacy. Binz et al. (2016) describe that forms of institutional work that help to create technology legitimation are to to convince politicians, the public or investors of the need for innovation through personal communication, lobbying and meetings (advocacy). Institutional work that helps to create technology legitimation is also to create expert groups and committees associations that evaluate and certify the innovation (constructing normative networks) and meshing the innovation with daily life experiences, for instance, selling bottled recycled water alongside bottled spring water (mimicry). Other examples are creating scientific models and predictions, developing concepts and shared language that build a cognitive map (theorizing), public outreach campaigns and information materials, presentations, guided tours to production facilities (educating), giving awards to innovative projects and individuals (valorizing), underlining a place's history and experience with the innovation (mythologizing), or showing pictures of pristine water, playing children, etc. (imagery).

## 4.3 Adapted model

A simplified and adapted model is created for this research, by building on the legitimacy framework by Suchman (1995), Afghani et al. (2022), and Scott (2008) and the legitimation strategies described by Harris-Lovett et al. (2015) and the institutional work by Binz et al. (2016).

The first three types of legitimacy, the pragmatic, normative and cognitive legitimacy, are linked to the identified factors that build institutional trust, as described in chapter 0 and Figure 5 on page 13. The fourth type of legitimacy, the regulative legitimacy, connects to the factors that can create regulative legitimacy, as identified in interview I-3, and described in chapter 3.3 on page 18.

Legitimation strategies are added based on results from Barendse & Brouwer (2022), Brouwer et al. (2019) Goodwin et al. (2018), van Leeuwen & van Alphen (2021) and the interview I-3. The overview is a model that is simplified and adapted to this research, showing the legitimacy type, the identified factors for institutional trust and regulative legitimacy, and one legitimation strategy or a combination of multiple strategies (Figure 10).

In attachment I, an extended overview of the legitimacy strategies is shown (Table 2). In the extended table, the complete overview of legitimacy types and multiple strategies is shown, with their references. The legitimacy types are connected to the different levels of acceptance, as described in chapter 2.1 Sociopolitical, process and product acceptance.

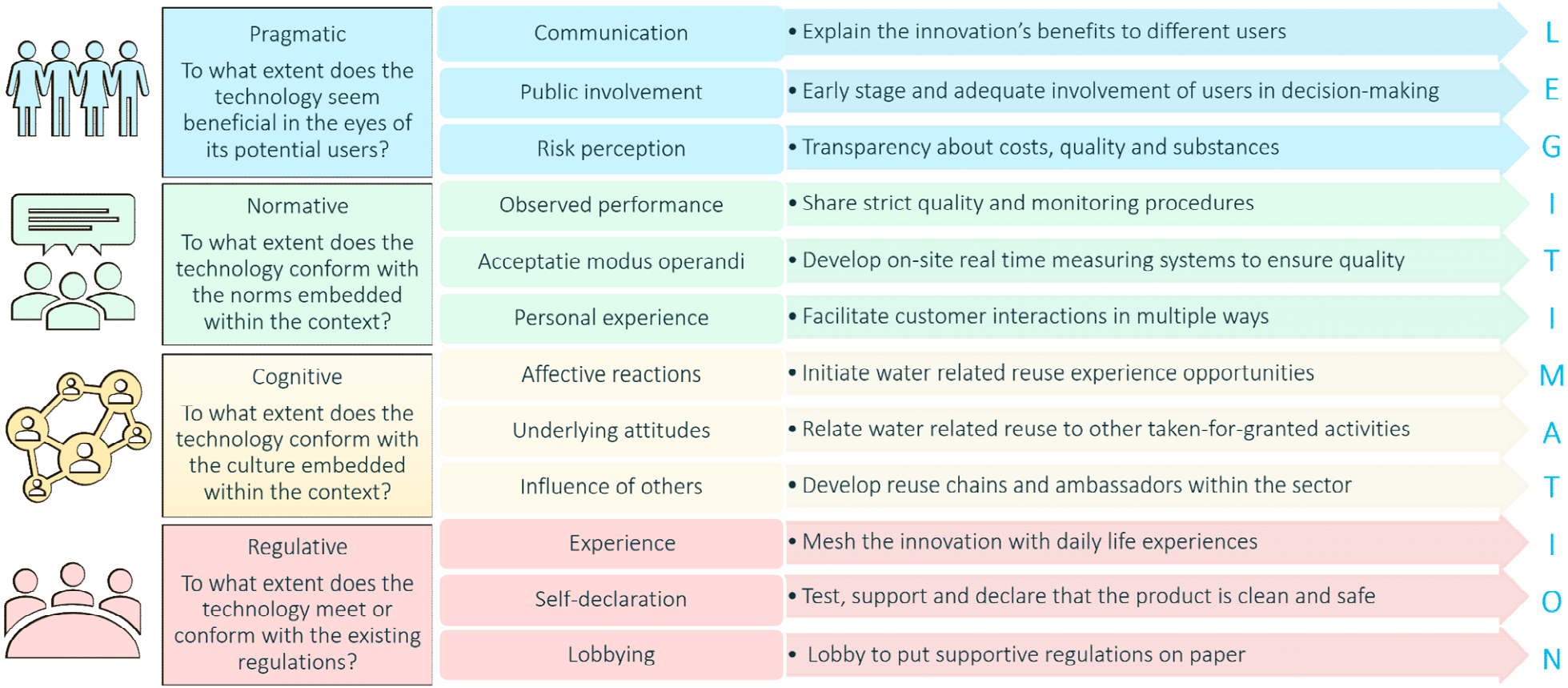


*Figure 10. Legitimacy types, identified factors and strategies combined*

## 4.4 Discussed strategies

In the end-user workshop with WiCE partners, multiple legitimation strategies were highlighted that were argued to be most helpful for the acceptance and adoption of water related reuse technologies (Figure 11).

WiCE partners highlighted that in particular for the own employees of drinking water authorities, it is helpful to share strict quality and monitoring procedures and develop on-site real time measuring systems to ensure quality. As the own employees are often most critical towards water related reuse technologies, sharing these data can be helpful to show it is safe to use. There is especially resistance in the water sector itself, to these kinds of developments. To adjust the idea of the colleagues in the sector with a technical background, it helps to show and demonstrate that the technology works (WS).

This relates to the strategy of creating ambassadors withing the water sector for water related reuse. It has been shown and argued to be helpful for the adoption of water related reuse to first include the employees of the companies involved in the process of water reuse, so that they can convey a positive message to the public.

Transparency about costs, quality and substances was mentioned as it is required to share this data as a drinking water authority, but that there are different levels in which this is possible. It was discussed that it is helpful to be transparent as it creates trust, but that it needs to be explored in what degree transparency is optimal. Due to the publicity around PFAS, trust in drinking water (companies) may decrease, which can be a risk of transparency (WS).

Relating water related reuse to other taken-for-granted activities was mainly mentioned in relation to de facto reuse. Meaning that explaining that water is now indirectly reused already helps to create understanding. For drinking water authorities using surface water, it might be relatively easier to convey this message and relate it to possibilities for direct reuse. For drinking water authorities that mainly use groundwater for the production of drinking water the transition might be harder (WS).

Finally it was mentioned that lobbying to put supportive regulations on paper does really help, but it was discussed that except for Vewin, water boards and provinces are not too close to national government. The question arose if there is enough lobbying power with the central government to influence the regulations (WS).

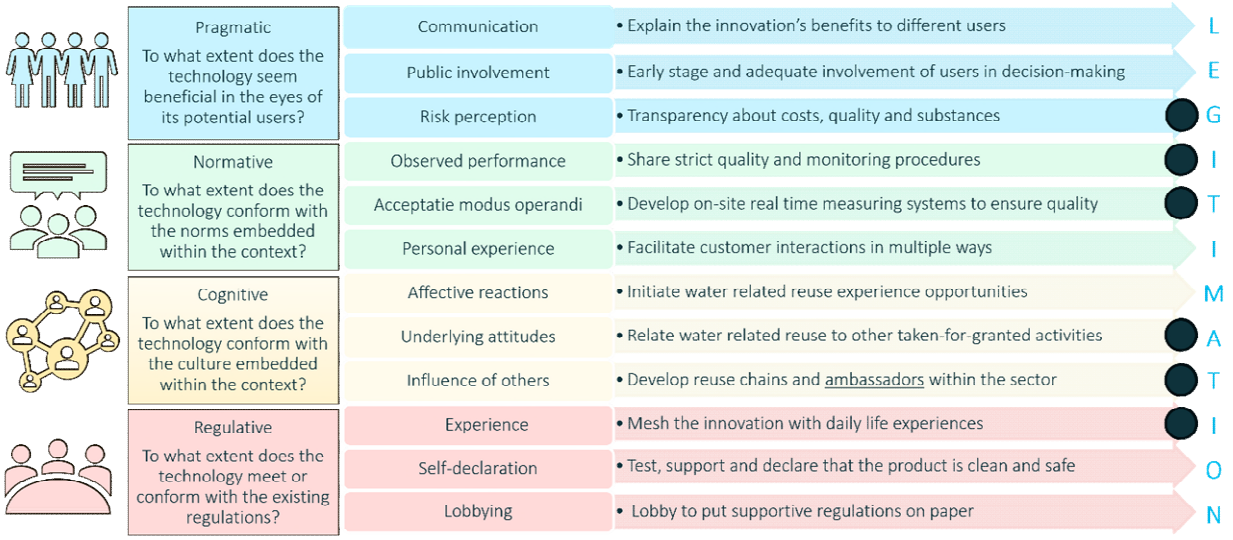


*Figure 11. Strategies argued to be helpful for the adoption of water related reuse*

# 5 Conclusion

The objective of this project was to explore the institutional trust and regulatory obligations that define the socio-technological legitimation of water-related reuse. With that information, legitimation strategies would be determined that can build and reinforce institutional trust and help to shape legal changes for supportive regulatory obligations. The aspired impact of this project is providing the water sector with narratives around the benefits of circular water technologies, strengthening societal acceptance. It shares the most promising successful conditions for the socio-technological legitimation of water-related reuse.

In conclusion, there are multiple elements that constitute two different forms of institutional trust: 1) trust of citizens in water related reuse organisations and 2) trust of employees at water related reuse organisations, meaning their trust in water related reuse technologies. The elements that constitute institutional trust are risk perception, acceptance of the modus operandi, underlying attitudes, affective reactions, influence from other people, public engagement, communication by the water related reuse organisation, media information, personal experience and observed performance. These elements influence the institutional trust of citizens and determine the public acceptance and adoption of water related reuse. The trust of employees in water related reuse technologies influences the trust of the public and adoption of these new innovations.

Supportive regulations for water related reuse are starting to become supportive but can definitely be enhanced. The framework of regulatory obligations for water related reuse is defined but not limited to the following regulations and directives: The European Water Reuse Regulation, the proposal for revision of the Urban Wastewater Treatment Directive, the required End-of-waste status for recovered products, and the Kiwa Watermark. The regulatory framework is starting to be supportive towards water related reuse but there is still much need for enhancement. There is a need for legal changes that not only allow water reuse to happen but also encourage and incentivise it where it is appropriate. Subsidising water reuse practices and making recovery of embedded resources mandatory in national legislation could favour water related reuse.

The legitimation strategies are all intertwined and connected, and the interplay is most powerful, as they can amplify each other. The legitimation strategies apply to the four types of legitimacy: pragmatic, normative, cognitive and regulative. For each of the four types of legitimacy, three previous defined factors and three strategies for the legitimation of water related reuse are matched. In the end-user workshop with WiCE partners, multiple legitimation strategies were highlighted that were argued to be most helpful for the acceptance and adoption of water related reuse technologies. Most significant were to demonstrate to colleagues with a technical background that the technology works and create ambassadors within the water sector.

The project has contributed to building long-term narratives around the benefits of circular water technologies so that it becomes ‘normalised’ and accepted in society. This is expected to benefit the water sector and the WiCE programme towards the wider adoption of technologies and systems premised on CE approaches.

In follow-up research, multiple levels of water reuse will be explored and legitimation strategies will be tested. The project results are expected to provide valuable input to follow-up research such as the Ultieme Waterfabriek, a major initiative of Dutch water authorities and water companies to demonstrate the production of drinking water from treated wastewater effluent (direct potable reuse); KWR is currently co-shaping the research agenda of this initiative. The Ultieme Waterfabriek investigates this at different levels: local, regional, national (legislation) and will test multiple legitimation strategies.

# 6 References

Afghani, N., Hamhaber, J., & Frijns, J. (2022). An Integrated Assessment Framework for Transition to Water Circularity. Sustainability, 14(14), 8533.

Barendse & Brouwer (2022) KWR BTO 2022.101 Perceptie waterhergebruik

Barendse, K., Brouwer, S., van Dijk, S., Schriks, M., (2023). Een verkenning van de acceptatie van waterhergebruik in Nederland. H20

Barnes, J. L., Krishen, A. S., & Hu, H. F. (2023). Public tap water perceptions and potable reuse acceptance: A cognitive dissonance theoretical understanding. Journal of Cleaner Production, 429, 139587.

Beck, U. (1992). Risk Society – Towards a New Modernity. SAGE publications: London.

Benoit, W. L. (2015). Accounts, excuses, and apologies: Image repair theory and research, Albany, State University of New York Press.

Binz, C., Harris-Lovett, S., Kiparsky, M., Sedlak, D. L., & Truffer, B. (2016). The thorny road to technology legitimation—Institutional work for potable water reuse in California. Technological Forecasting and Social Change, 103, 249-263. https://www.sciencedirect.com/science/article/pii/S0040162515002930

Brouwer, S., van den Berg, S., Nijhuis, N., Hofman, R., van Aalderen N., Fujita, Y., Bergsma, E., Sjerps, R., (2019). KWR BTO 2019.023 Risicoperceptie 402045/050

Brouwer, S., Maas, T., Smith, H., & Frijns, J. (2015). Trust in Water Reuse (D5.2). http://www.demoware.eu/en/results/deliverables/deliverable-d5-2-trust-in-reuse.pdf?msclkid=539630a3b67011ecbb247d8b2e7d71dd

Brouwer, S., Pieron, M., Sjerps, R., & Etty, T. (2019). Perspectives beyond the meter: A Q-study for modern segmentation of drinking water customers. *Water Policy, 21*(6), 1224-1238.

Connor, M., Siegrist, M., (2010). Factors influencing people's acceptance of gene technology: the role of knowledge, health expectations, naturalness, and social trust. Sci. Commun. 32 (4), 514e538 https://journals.sagepub.com/doi/10.1177/1075547009358919

Dingemans, M. M., Smeets, P. W., Medema, G., Frijns, J., Raat, K. J., van Wezel, A. P., & Bartholomeus, R. P. (2020). Responsible water reuse needs an interdisciplinary approach to balance risks and benefits. Water, 12(5), 1264.

Dolnicar, S., A. Hurlimann & B. Grün (2011). What affects public acceptance of recycled and desalinat ed water, Water Research, 45, pp. 933-943. doi:10.1016/j.watres.2010.09.030

Eiser, J., Miles, S., & Frewer, L. J. (2002). Trust, perceived risk, and attitudes toward food technologies. Journal of Applied Social Psychology, 32(11). https://doi.org/10.1111/j.1559-1816.2002.tb01871.x

European Union (2020) Drinking Water Directive 2020/2184 https://eur-lex.europa.eu/eli/dir/2020/2184/oj

European Commission, (2022) Proposal for a Directive concerning urban wastewater treatment (recast) https://environment.ec.europa.eu/topics/water/urban-wastewater_en#revision

Fielding, K. S., Dolnicar, S., & Schultz, T. (2019). Public acceptance of recycled water. In International Journal of Water Resources Development (Vol. 35, Issue 4). https://doi.org/10.1080/07900627.2017.1419125

Fuenfschilling, L., & Binz, C. (2018). Global socio-technical regimes. *Research policy*, *47*(4), 735-749.

Goodwin, D., Raffin, M., Jeffrey, P., & Smith, H. M. (2018). Informing public attitudes to non-potable water reuse – The impact of message framing. Water Research, 145. https://doi.org/10.1016/j.watres.2018.08.006

Harris-Lovett, S. R., Binz, C., Sedlak, D. L., Kiparsky, M., & Truffer, B. (2015). Beyond user acceptance: A legitimacy framework for potable water reuse in California. Environmental science & technology, 49(13), 7552-7561

Hessels, L.K, Van Alphen, H.J. & Frijns, J. (2018) BTO 2018.012 Toekomstvisies op de Circulaire Economie

Hoffecker, E. (2021). Understanding inclusive innovation processes in agricultural systems: A middle-range conceptual model. World Development 140, 105382.

IPLO (2023) Risicobeheerplan voor een waterhergebruik systeem, Informatiepunt Leefomgeving (iplo.nl) https://iplo.nl/thema/water/stedelijk-afvalwater/verordening-hergebruik-water/risicobeheerplan-waterhergebruiksysteem/

Judge, M., de Hoog, O., Perlaviciute, G. et al. (2021). From toilet to table: value-tailored messages influence emotional responses to wastewater products. Biotechnol Biofuels 14, 79 https://doi.org/10.1186/s13068-021-01931-z

Nextgen D4.2 (2022) Towards a next generation of water systems and services for the circular economy. Smith et al. Horizon2020 (H2020) NextGen 4.2, 2020 https://nextgenwater.eu/wp-content/uploads/2023/03/D4.2-Final-report-on-societal-acceptability.pdf

NextGen D4.4 (2023) Frijns, J., Smith, H. 2023 D4.4 Roadmap to addressing governance and societal challenges to support wider uptake of circular solutions in the water sector https://nextgenwater.eu/wp-content/uploads/2023/04/D4.4-Roadmap-to-support-uptake-of-circular-water-solutions-1.pdf

Nextgen D7.6 (2023) Final report D7.6 https://nextgenwater.eu/wp-content/uploads/2023/03/D7.6-NextGen-final-report.pdf

Poortinga, W. and N.F. Pidgeon (2005). Trust in Risk Regulation: Cause or Consequence of the Acceptability of GM Food? Risk Analysis, 25(1): 199-209.

Scott, R.W., (2008). Institutions and Organizations — Ideas and Interests. 3rd edition. Sage

Smith, H. M., Brouwer, S., Jeffrey, P., & Frijns, J. (2018). Public responses to water reuse–Understanding the evidence. Journal of Environmental Management, 207, 43-50.

Stowa meeting 2023 Bijeenkomst 'Hergebruik van stedelijk afvalwater voor irrigatie in land- en tuinbouw. Regels en uitvoering' 27 november 2023 https://www.stowa.nl/agenda/bijeenkomst-gebruik-van-stedelijk-afvalwater-voor-irrigatie-land-en-tuinbouw-regels-en-uitvoering

Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. Academy of management review, 20(3), 571-610. https://journals.aom.org/doi/abs/10.5465/AMR.1995.9508080331

van Aalderen, N. S., Salmon .; van Lidth de Jeude, M.; Kooijman, A.l.; Brouwer, S. (2021). Uitwerking handelingsperspectieven. Retrieved from https://www.warmingup.info/documenten/van-aalderen-et-al-2021-_uitwerking-handelingsperspectieven-warmteactoren_warmingup_t6mp2r1v1-1.pdf

Veleva, V., Bodkin, G., & Todorova, S. (2017). The need for better measurement and employee engagement to advance a circular economy: Lessons from Biogen's "zero waste" journey. Journal of cleaner production, 154, 517-529. https://www.sciencedirect.com/science/article/abs/pii/S0959652617306315

Vewin (2022) Kerngegevens drinkwater https://www.vewin.nl/SiteCollectionDocuments/Publicaties/Cijfers/Vewin-Kerngegevens-drinkwater-2022.pdf

# I Extended table legitimacy strategies

*Table 2. Legitimacy types with dimensions, definitions, related strategies, identified factors and levels of acceptance*
*(Adapted from [1]Harris-Lovett et al. 2015; [2]Barendse & Brouwer, 2022; [3]Brouwer et al. 2019; [4]van Leeuwen & van Alphen, 2021; [5]Goodwin et al. 2018; [6]Binz et al. 2016; [7]Van Aalderen et al. 2019, I-3)*

| Legitimacy | Dimension | Definition | Legitimation strategies | Identified factor | Acceptance level[7] |
|---|---|---|---|---|---|
| **Pragmatic legitimacy**[1] | 1.1 exchange[1] | Support for innovation based on its perceived value to the end user[1] | Public outreach campaigns, explaining the innovation's benefits to different user[1]; utilize positive international examples in communication and information sharing; provide a comprehensive analysis of societal costs and benefits[2]; establish a well-organised communication process before the project and continue throughout the project[5] | Communication | Product acceptance |
| | 1.2 influence[1] | Support of an implementing organization because it shared decision-making power with end users[1] | User involvement in planning and management, focus groups, surveys, user representatives in decision-making bodies[1]; ensure inclusivity and representation[2]; early and adequate public engagement[5] | Public involvement | Process acceptance |
| | 1.3 dispositional[1] | Support for an implementing organization based on a belief that the organization is acting in the end user's best interest, has "good character" [1] | Transparent information policies, cooperation with external evaluators and regulators, developing an "quality brand" for proponent utility[1]; provide transparency about costs of water reuse[2] and quality of and presence of non-natural substances in the drinking water[3] | Risk perception | Socio-political acceptance |
| **Normative legitimacy**[1] | 2.1 consequential[1] | Support based on evaluation of the implementing organization's accomplishments[1] and innovations' contribution to sustainability, protection of resources and tackling water scarcity[2] | Publicizing data indicating consistently high water quality, building a success story about innovation[1]; consider using international data if domestic data is limited[2]; Position water reuse as protective measure for biodiversity, environment, water scarcity, 'future optimism'[2]; communicate as fair method of water purification and distribution for future generations[2]; develop eco-labels for products irrigated with purified effluent[2] | Observed performance | Product acceptance |
| | 2.2 procedural-structural[1] | Support based on evaluation of the implementing organizations specific procedures and physical characteristics[1] | Adopting and sharing strict quality control and monitoring procedures, standardized emergency intervention plans and shut-off valves, professional training for operators[1] to build trust and confidence[2]; emphasize that effluent meets stringent health and quality standards and is safe for crop cultivation[2]; develop on-site and real-time measuring systems for irrigation that assess parameters to gauge water quality, ensuring water quality assurance and confidence in reuse[2] | Acceptance modus operandi | Process acceptance |
| | 2.4 personal[1] | Support based on an evaluation of an implementing manager's charisma[1] | Water utilities managers talking directly to the end users[1]; engage objective external inspectors and experts in communication efforts, facilitating interactions with customers through various means[2]; emphasize safety through transparent quality data and expert explanations of advanced techniques[2] | Personal experience | Process and product acceptance |

[1]Harris-Lovett et al. 2015; [2]Barendse & Brouwer, 2022; [3]Brouwer et al. 2019; [4]van Leeuwen & van Alphen, 2021; [5]Goodwin et al. 2018; [6]Binz et al. 2016; [7]Van Aalderen et al. 2019, [I-3]Interview I-3

| Legitimacy | Dimension | Definition | Legitimation strategies | Identified factor | Acceptance level[7] |
|---|---|---|---|---|---|
| **Cognitive legitimacy**[1] | 3.1 comprehensibility[1] | Support because an innovation meshes with the end user's daily life experiences and cognitive frames[1] | Organize water tastings, provide bottled recycled water, develop comprehensible vocabulary[1]; conduct research to identify the most suitable terminology for water reuse[2]; organize tours of water recycling facilities, citizen science, open days, view crops' growth[2]; emphasize that "new water" does not exist in the water cycle[2]; offer experience opportunities about recycled water in positive environments, as festivals, sporting events, or wellness settings[2] | Affective reactions | Product and process acceptance |
| | 3.2 taken-for-grantedness[1] | Support based on seeming inevitability, in which alternatives are "unthinkable" [1] | Relate potable reuse to other-taken-for granted activities (e.g., recycling) [1]; emphasize positive aspects water reuse, highlight health and quality adherence[2] Develop programs that allow people to experience recycled water through sight, smell, and taste, to familiarize them with its organoleptic properties next to regular tap water to show organoleptic properties are similar but can vary, but it is all clean and tastes good[2] | Underlying attitudes | Process acceptance |
| | 3.3 influence of others | Support based on the trust in the innovation and related organisations | Build on existing high level of public trust in drinking water companies[2]; focus on efforts in drinking water purification and control instead of (not exceeding) the quality standards[3]; first involve employees of water related reuse organizations in process to become ambassadors[2]; Develop reuse chains within the sector[I-3] | Influence of others | Socio-political and process acceptance |
| **Regulative legitimacy**[6] | 4.1 mimicry[6] | Associating new practices with existing sets of taken for-granted practices, technologies and rules[6] | Meshing the innovation with daily life experiences, e.g. selling bottled recycled water alongside bottled spring water[6]; provide video messaging information regarding the general context and management practices of water-reuse scheme[5] Use media attention positively for acceptance[I-3] | Experience | Product acceptance |
| | 4.2 constructing normative networks[6] | Constructing inter-organizational connections that normatively sanction practices, form the relevant peer group for compliance, monitoring and evaluation[6] | Creation of expert groups, committees, associations, advocacy groups or NGOs that evaluate and certify the innovation[6]; facilitate direct interactions between managers and stakeholders involved in the innovation[2]; test, support and declare the value and purity of product[I-3] | Self-declaration | Product acceptance |
| | 4.3 advocacy[6] | Mobilizing political and regulatory support through direct and deliberate techniques of mobilizing direct networks to decision-makers[6] | Convincing politicians, the public or investors of the need for an innovation through personal communication[6]; intern discussion, convincing arguments and political support at the municipal level over a long period of time[4] Lobby to put supporting laws and regulations on paper[I-3] | Lobbying | Socio-political acceptance |