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# Shifting Infrastructure Landscapes in a Circular Economy: An Institutional Work Analysis of the Water and Energy Sector

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**Abstract:** Under pressure by the transition towards a circular economy, the infrastructure landscape is changing. Using Institutional Work as an analytical lens, this article analyses the work actors do to change and adapt institutional structures. In this process of restructuring, the research shows that there are four dominant types of institutional work: Enabling, Constructing Identities, Constructing Normative Networks, and Changing Normative Associations. The increasing fragmentation of infrastructure as well as the increasing connections made between different flows forces organisations to readjust their internal institutions as well as those that guide their interactions with their surroundings such as other organisational actors as well as citizens. Circularity requires a restructuring of infrastructure governance in order to adapt to the increasing flux caused by decentralised technologies and the need for integration of different systems. Additionally, the actors associated with energy and water infrastructure are responding accordingly.

**Keywords:** circular economy; infrastructure; institutional work; new sanitation; decentralised infrastructure; water; energy

## 1. Introduction

The increasing pressure on the worlds resources has led to the propagation of the concept of the circular economy, which can be defined as: "A regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops." [1]. When expanding the concept to a more spatial perspective necessary for planning circular cities and regions, it becomes clear that infrastructure is crucial as it is the spatial connection between flows and places. The circular city or region therefore requires a revaluation of the way infrastructure is implemented and governed as it forces a revaluation of the optimal scales upon which resources should be managed. From the review of Kirchherr et al. [2], it becomes clear that academic research has primarily focussed on technical and economic strategies for closing resource loops: New technologies of production, new business models, etc. However, when translating the concept to the spatial level, it becomes apparent that there are big limitations in the planning and governance of these new systems. The introduction of all types of new decentralised technologies has caused a shift in the governance of infrastructures. Traditional infrastructure planning and management had already fragmentised [3] through the introduction of new technologies and new societal demands. In addition, the ambition to make circular and sustainable systems on an ever-smaller level exacerbates this development with the introduction of decentralised technologies such as solar panels and halophyte filters. This means that there is a necessity to rethink the governance of large scale infrastructure systems [4,5] as the upscaling of new technologies creates new challenges [6]. The introduction of new innovations has led to a shift of the relation between consumers, producers, providers, and public organisations [7–9].

The mechanisms and actions underlying this shift still need further exploration and this will be the main focus of this article.

This research looks at the current shifts taking place in the infrastructure management within the Netherlands. Traditionally, the Dutch are known for their large engineering solutions to common problems. The introduction of new decentralised technologies in the circular economy provides new challenges in the planning and governance of infrastructure in the country as it forces infrastructure providers to reassess their relation with other actors. Thus, the Netherlands is a particular interesting case as there is a clear friction between the traditional and successful top down approach and the new cooperative approaches that go together with the new infrastructural innovations of the circular economy. While the governance of infrastructure systems is contextually distinct, this case study provides interesting results for other contexts as global cities, regions, and countries struggle with the balance between centralised and decentralised infrastructures and the shifting relations between citizens, governments, and businesses.

The paper studies the development within both the energy and the water sector with an ambition to find similarities but also differences in their development. As the sectors are very broad, the case study in the Netherlands will, in particular, focus on distributed energy distribution and wastewater treatment systems as these play a key role in developing a circular system. Additionally, these subsystems are infrastructures where there is a potential for interaction between the sectors because energy can be, or in a circular system should be, extracted from water and heat can be extracted from energy production to warm water. Institutional Work theory [10,11] is used to identify the different strategies actors use to either create, maintain or disrupt institutional patterns associated with infrastructure planning. The comparison between the rapidly decentralising energy sector and the more conservative water sector leads to interesting perspectives on the future directions of infrastructure planning and management, and how the dynamic between actors and institutions pushes these sectors in particular directions. It provides insight on the impact of the circular economy on infrastructure systems and how actors navigate within this dynamic.

This paper starts with a literature review of contextual changes around decentralised infrastructures in both the energy and water sector. It then introduces Institutional Work as the theoretical framework. After the methodology has been described, the results are presented. These results are further discussed in the discussion and Conclusion Section at the end.

## 2. Literature Review: Decentralised Energy and Water Infrastructures

New innovations and circular thinking have brought a great dynamic in the energy and water infrastructure sector. This section will discuss the recent developments as described in academic literature for both the energy and the water sector. It aims to show the challenges as well as the opportunities that the introduction of new, decentralised systems bring in both sectors. The first paragraph in each domain discusses energy, and the second presents the findings for water.

### *2.1. Technological Context*

Through rapid technological progress, decentralised energy infrastructures such as solar panels experienced a strong decline in costs over the last decades [12]. This has made these new technologies increasingly competitive with traditional centralised technologies such as traditional power plants. Combined with other factors such as perceived environmental benefit and increased knowledge as motivation, an increase in the private uptake of these energy innovations has been perceived [13–15]. Yet, a big barrier from a system perspective is the resource availability [16–18]. The fluctuations in the availability of sun or wind make renewable sources unreliable and increase the spikes in energy availability. However, current development in storage and micro grids are thought to have great potential in overcoming this barrier [19–21]. Both of them also have a direct influence on the required capacity of the central system. Smarter storage means less demand on the main grid. Additionally,

the introduction of smart meters and the Internet of Things (enabling communication between devices) might enable an optimal management of demand and supply on every moment of the day [22].

The diverse innovation of technologies in the water sector range from decentralised wastewater treatment by halophyte filters [23], to using membrane filters for extracting medicinal residues in hospital wastewater [24] or extracting phosphates from the sewage system [25]. Decentralised techniques within the field of water extraction, recycling, and treatment can be separated into two types: Natural and mechanical [26]. The first uses natural elements such as filtration through sand filters or plant roots. The second uses machines. An example is the installation of vacuum systems for waste water. The main barriers for natural techniques are time and space. Both of which are required in large quantities [27,28]. This means they are mainly suitable for rural locations. Mechanical techniques are more suitable for urban areas, but they have higher financial costs in construction, implementation, and maintenance [29]. While decentralised techniques can do almost everything centralised systems can [30], they are more limited in utilizing economies of scale and therefore often more expensive [29]. In addition decentralised techniques often lead to a higher concentration in the central system requiring this latter system to also adapt [31]. However, these higher concentrations do offer other opportunities for efficiency in extracting energy and resources from waste water [32].

### *2.2. Economic Context*

Next to the capabilities of technology, economic factors influence the choice for decentralised infrastructures. Issues such as the cost of purchase, of usage, and maintenance, and the expected relative gains play a crucial role [33]. Additionally, while decentralised energy technologies have drastically reduced in cost over the last decades, the potential for creating economies of scale (concerning both production and consumption) remain a barrier for the development and upscaling [34–37]. Additionally, on the consumption side, decentralised technologies are more expensive to purchase as the costs are divided among fewer people. In response to this, smart ways of purchasing through citizen collectives or housing and energy corporations have aimed to mitigate some of these effects [38]. Related to these aspects is that as a consequence of increased usage of decentralised systems, the centralised infrastructure becomes more expensive as the cost are spread over fewer consumers. The last one connected to the central infrastructure that pays a heavy price if no additional legislation is put into place. Therefore, issues of equity and social justice play an important role in ensuring that the costs are not unequally distributed among particular groups.

Looking at the water sector, there is a strong difference in the economic rationale for moving towards decentralised systems in countries such as the Netherlands. Water has such a low price-point that there are no savings to be made by organising it in a decentralised manner. However, in countries with economic or physical water scarcity and lower densities, such as Australia, the economic cost/benefit ratio is a lot more favourable to decentralised systems [30]. Interestingly a strong increase in population can also be of influence on the economic attractiveness of decentralised infrastructures [39,40] as the central system cannot cope any more with peak demand. In addition, a population decline could also be potentially harmful to the economic viability of the centralised system as there will not be enough run-through of flows to keep the system clean and healthy [41]. In addition, the population density plays an important role. The lower the population density, the more competitive decentralised systems become as there are fewer people to divide the cost of the large infrastructure. Additionally, the privatisation of water infrastructure has a big impact on the economic competitiveness of decentralised infrastructures [42,43] as it generally seems to have led to a more expensive system for consumers. A key difference between energy provision and water provision is that the latter is, by nature, monopolistic within a defined spatial area. Not all water is the same in quality and it is impossible to run water from different providers through the pipes at the same time. In energy, the sources of the electrons might be different, but the quality of each electron is the same. If the cost for the consumers of the centralised system would increase, it will become more attractive for individuals or collectives to organise their own systems [44,45].

### 2.3. Social Cultural Institutional Context

Technological innovations should fit social cultural practices within a local context. Wrong usage of technologies leads to a reduction of the effectiveness of this technology. In addition, the provision of information alone does not seem to be enough to impact energy practices of consumers on the long term [46]. Over the last two decades new vertical ties have been created between citizens and energy providers that have led to different patterns of interaction. The consumer is no longer just the consumer of the service, but through decentralised technologies has also become a producer [47]. As has been shown [48], the institutional status of the citizens as a prosumer or co-owner also influences energy consumption behaviour. In addition, there has been an increase in horizontal ties as citizens have been able to develop energy cooperatives. However, innovations such smart monitoring, smart grids, and energy cooperatives are often difficult to implement as citizens value their autonomy and privacy concerning their energy practices [20]. Interestingly, in their analysis of the German energy transition, Fuchs and Hinderer [49] conclude that its success was determined by the general societal aversion of nuclear energy combined with the aversion of citizens' dependency of large energy co-operations. Decentralised technologies were seen by citizens as well as municipal and regional governments as an effective instrument to break the oligarchy of energy companies and democratise the energy system. A shared ideal within a large coalition seems to be very important for the large-scale adaptation of decentralised technologies. There are, of course, also factors that support keeping a centralised system in place. Centralised systems are often lower in cost, especially for those that are not able to afford the upfront investment cost [13]. In addition, they additionally require less actions from individual households as they are predominantly managed by a larger organisation that makes most technical and investment decisions [50].

While energy plays an important part in people's daily lives, water is surrounded by much more complex social cultural values. Drinking water is associated with personal and public health, with nature, and is—more than energy—considered a public good [51]. For instance, reusing waste water is often considered scary and dirty [39,52,53]. This means that the adoption of decentralised infrastructures is strongly influenced by cultural values. For example, the practice of going to the toilet is surrounded by taboos and social norms around privacy and hygiene. Flush toilets have become the norm in many societies because of the "flush and forget" principle that enables users to not avoid the confrontation with feces [50]. Urine separation toilets, which require people to sit, or compost toilets, which do not have a flushing system, enact feelings of aversion as they are considered inconvenient, dirty, or even a step back in the progress of society.

Interestingly, both proponents as well as opponents of decentralised techniques use health and environmental risks as an argument [39,54,55]. Proponents argue that decentralised systems are less vulnerable to energy failure caused by extreme weather events. Because they work close to the source and quite often work with natural systems, there is less risk of severe groundwater pollution in case they overflow. To the contrary, opponents state that the risks are greater because of poor unprofessional maintenance, and insufficient monitoring and control on the quality. Among other things, this would arguably lead to an increase of risks to the environmental quality [56]. On the other hand, decentralised or hybrid systems might better able to cope with increasing pressure from higher standards. Historically decentralised systems have been perceived as being environmentally more sustainable [57–59]. However, this is dependent on which aspects and scale they are perceived. Additionally, while the perception of sustainability might support the adoption of decentralised technologies, there are social and cultural norms that are more difficult to adapt.

### 2.4. Legal/Policy Institutional Context

National and EU regulations seem to have played an important role in the upscaling of decentralised energy technologies. The liberalisation of the energy market in particular was a crucial step towards the direction away from traditional governmental energy provision [47]. It opened up the traditionally closed monopolistic public networks and changed the citizen from a receiver of energy to a customer

with a freedom of choice [20,60]. The introduction of feed-in tariffs facilitated change in the citizen from a consumer to a prosumer as he/she was now able to sell excess energy to the energy provider and made it possible for prosumers to budget with more certainty about the generated income. It also stimulated the establishment of energy collectives that were focussed on producing energy [20].

Another example of the importance of the legal/policy institutional context is the role $CO_2$ taxation. Direct taxation on $CO_2$ has proven to be a highly effective measure in stimulating the uptake of sustainable decentralised energy systems and a reduction in $CO_2$ emissions in several initiatives in Germany, Sweden, and Poland [22]. One of the main reasons for this is that the taxation hits the large industrial consumers of energy

Developments in the water sector around environmental and health and safety regulation have in some cases led to more favourable conditions for decentralised systems. For instance, stricter regulation on the temperature of water transferred to the sewage system or natural environment would make it more attractive for industry to adopt localised decentralised water systems that would extract energy and resources. Stricter norms for micropollutants such as medicine residues, could also be a stimulus for innovation in decentralised systems as the concentrations are likely to be higher at the sources such as hospitals [26,61]. One of the main issues associated with the introduction of new decentralised water systems is the issue of control and responsibility. Who is responsible for checking the water quality of decentralised systems and who is responsible to solve the problems when something goes wrong [56]?

An important change in Australia was the privatisation of water infrastructure [56]. Formerly, government-controlled infrastructure providers were forced to reorganise as private companies. Combined with the reduction of subsidies, they had no choice but to bill their clients the full price of drinking water and waste water management. Consumers were thus faced with a strong increase in their utilities costs. This incentivised the uptake of decentralised systems as the cost benefit calculation had completely changed. Thus, the political preference for liberalising markets and privatising utilities companies is a contextual factor that can have a strong influence on the attractiveness of decentralised solutions. In a country such as the Netherlands, this is less likely to happen with water as it was put in law (2004) that water should remain in the public domain.

## 3. Theoretical Framework: Institutional Work

Institutional work has been defined as "the purposive action of individuals and organizations aimed at creating, maintaining, and disrupting institutions" [11]. The ambition of the approach is to overcome the predominantly static approach to institutions where they are conceptualised as structures in which agents act. Institutions can be defined as the formal and informal norms and rules that structure and reproduce patterns of human action and practices [62–64]. In institutional work, actions by actors are guided by the institutional structures in which they are embedded, but at the same time, they also influence the structures around them by their actions [62]. Institutions are not static, but dynamic and dialectic. The shift towards a circular system and the introduction of new infrastructures creates a dynamic in which actors can have a transformative impact on the institutions themselves and have to respond to the institutional changes outside of their influence. Crucial is that their interaction with institutions need not happen through deliberate action but it occurs even when actors are not aware of it [10]. This is one of the key differences with institutional entrepreneurship literature that focusses on actors' deliberate actions. Lawrence and Suddaby [10] criticised institutional entrepreneurship for being too disconnected with the sociological perspective on institutions, and consequently, for being too focussed on formalised institutions (governments and regulations) as the primary fields of intervention by these entrepreneurs.

Research on Institutional Work has gained momentum over the last decade in a wide variety of fields. For instance, Labelle and Rouleau [65] have applied the framework to the risk management in hospitals and how collective practices have institutionalised new patterns of working with health risks. Additionally, within the context of hospitals, Radaelli et al. [66] focused on the institutional work of managers in implementing radical innovations. Cruz et al. [67] analysed how mechanisms of

institutional work enable NGO's working in extreme operating environments, such as post-earthquake countries, to increase social capital and institutional resilience.

Integrating a socio-geographical perspective with the institutional work theory, Lawrence and Dover [68] focus on the concept of place. Analysing housing projects for marginalised communities, they found that place contained, mediated, and complicated institutional work. The manner in which a place was incorporated determined the ontological essence of that place being either an enclosure, a signifier, or a practical object. Analysing the change occurring at Robben Island, the South African prison, most famous for the incarceration of Nelson Mandela, Cascio and Luthans [69] argue that the inmates generated the psychological capital necessary for disruptive institutional change. This has led to a change in the ontological essence of Robben Island through the changed practices of both the inmates and the prison regime. It moved from a highly oppressive regime to one with a more humane perspective in which, within the context of apartheid, prisoners and guards treated each other with respect.

Moving more into environmental policy, institutional work has been increasingly related to the concept of resilience. Beunen et al. [70] propagate institutional work as a conceptual tool to analyze the dynamic between adaptation and rigidity of governance systems. Beunen and Patterson [71] argue that it is important to incorporate non-purposive action into the analysis of institutional work in order to address the environmental conditions that are the consequences of everyday practices. They redefined the definition of institutional work given above: "as those actions through which actors attempt to, or in effect do, create, maintain, or disrupt institutional structures" [71]. In this way, also non-purposive action is taken along in the analysis. This article uses this broadened definition.

Institutional work has also, to a limited extend, moved into the main field of interest in this article: Infrastructure. In their research on potable water reuse in California, Binz et al. [72] argue that different types of institutional work plays a role in the different phases of technology legitimisation: Innovation, Diffusion, and Validation. More related to this article is the paper by Bergsma et al. [47] that uses institutional work to analyse how infrastructure planning organisations respond to the shifting institutional and social context in which roles and responsibilities have shifted into a polycentric governance system with a strong influence of external actors such as citizens, organisations, and companies. It combines institutional work with social systems boundaries to show that institutional work has been primarily done within the internal organisation to accommodate these contextual changes. The article explored uses this theoretical proposition to analyse not only the type of institutional work in the restructuring of energy and water infrastructure is taking place, but also whether it is directed at the internal environment, the transactional environment, or the external environment [73]. The internal environment is directly under control of the organisation or actor. The transactional environment is where an organisation interacts with other actors and can still exert influence in relation to others. Consequently, its power is relational and therefore it is likely different types of institutional work are employed. The external environment is where the organisation has very limited direct and indirect influence. Again, this is relational because national regulation could be in the external environment for a small enterprise, but for a large company it might still be in the transactional as they have easier access to decision-makers.

Figure 1 provides an overview of the conceptual framework that forms the basis of this research. As the actors involved in the water and energy sector are diverse and dynamic, this article speaks of an actor constellation. Following Scharpf [74], actor constellations are crucial to understanding the evolution of institutions. Yet, while Scharpf looks at specific key actors, our interpretation is broader to also include actors, such as citizens, that might not be aware that they are performing institutional work [11]. In relation to the issue of circularity and decentralised infrastructures, this means that the shift towards circularity and decentralised infrastructures is influencing the practices of the actors within the constellation. It brings the traditional modes of working, governing or managing, into conflict with these new realities. Additionally, the manner in which actors respond, consciously or unconsciously, by changing the institutions that guide their activities, is the particular focus of this article. The institutional restructuring taking place in infrastructure governance under influence of

the ambitions of circular development evokes actions that can be analysed and explored by using the institutional work framework.

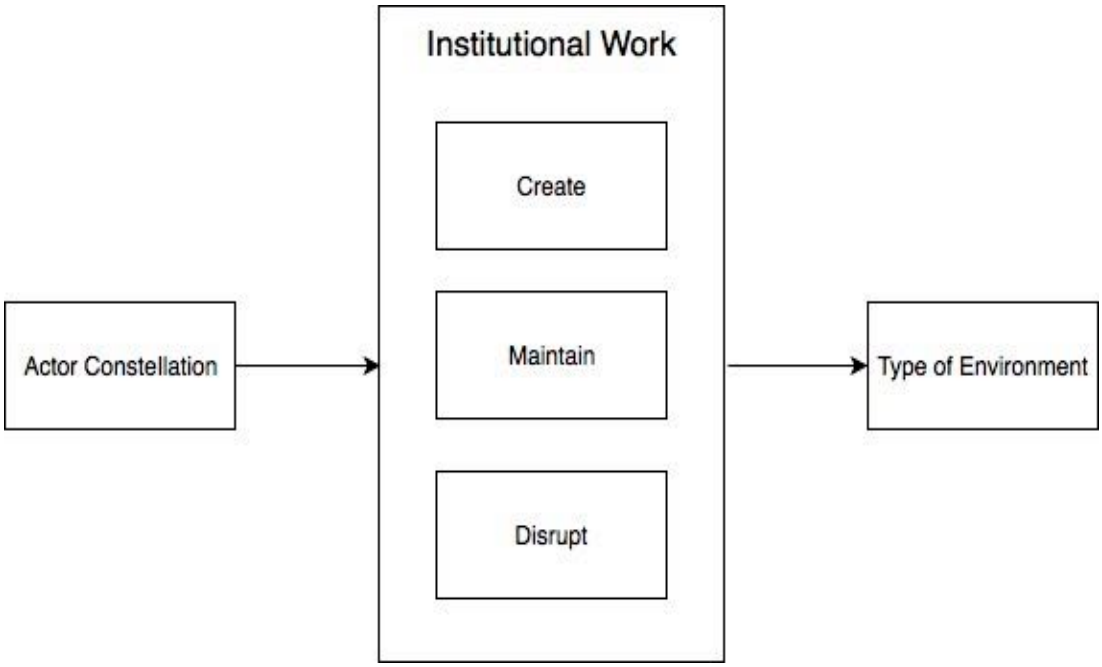


**Figure 1.** Conceptual Framework.

## 4. Methodology

To understand the institutional work in the water and energy infrastructure leading to or preventing change, this research interviewed 25 respondents from the actor constellations surrounding these fields. They had a broad range of backgrounds in order to get a proper perspective. The academic experts and water research institute employees were interviewed because of their broad overview of the fields. The Water Board Officials and the Water Service Providers were interviewed because they could reflect from a socio-political and technical perspective, respectively. The Municipality officials were interviewed because they are responsible for the circularity implementation in different municipal project and could provide information about the spatial and institutional implications of implementing new circular infrastructures. New innovative businesses provided valuable information about the opportunities and challenges of implementing new innovations from a business side. Additionally, the same is true for the citizens whose information clearly showed the dynamics between different actors within the sectors. The housing organisations are key actors in the upscaling of new technologies, especially in the larger urban areas of the country. Table 1 gives an overview of the anonymised respondents in their occupational category.

**Table 1.** Interviewees.

| Occupation | Number |
|---|---|
| Water Board Official | 3 |
| Academic Experts | 4 |
| Water service provider | 3 |
| Municipality officials—Planning and Environment | 2 |
| Energy Infrastructure provider | 2 |
| Water Research Institutes | 2 |
| Housing Organisations/Developers | 2 |
| Small Businesses new technologies | 4 |
| Innovative Citizen builders | 3 |

In the interviews the respondents were asked to reflect on new developments in their sectors and important changes that might or might not occur. The interviews followed a semi-structured interview script. They were not asked specifically for different types of institutional work. This would have steered the interviews too much. Rather, their responses were later coded according to the list of institutional work variables derived from Lawrence and Suddaby [11]. Whenever an interviewer made a remark about an action it was coded. If it fitted the institutional work variable as operationalized in Table 2, then the quote was coded accordingly. The coding was done by the author in Atlas.ti.

**Table 2.** Types of Institutional work.

| Institutional Work | Type | Definition |
|---|---|---|
| Creating strategies | Advocacy | The mobilization of political and regulatory support through direct and deliberate techniques of social suasion |
| | Defining | The construction of rule systems that confer status or identity, define boundaries of membership or create status hierarchies within a field |
| | Vesting | The creation of rule structures that confer property rights |
| | Constructing identities | Defining the relationship between an actor and the field in which that actor operates |
| | Changing normative associations | Re-making the connections between sets of practices and the moral and cultural foundations for those practices |
| | Constructing normative networks | Constructing of interorganizational connections through which practices become normatively sanctioned and which form the relevant peer group with respect to compliance, monitoring and evaluation |
| | Mimicry | Associating new practices with existing sets of taken-for-granted practices technologies and rules in order to ease adoption. |
| | Theorising | The development and specification of abstract categories and the elaboration of chains of cause and effect |
| | Educating | The educating of actors in skills and knowledge necessary to support the new institution |
| Maintaining strategies | Enabling work | The creation of rules that facilitate, supplement and support institutions, such as the creation of authorizing agents or diverting resources |
| | Policing | Ensuring compliance through enforcement, auditing and monitoring |
| | Deterring | Establishing coercive barriers to institutional change |
| | Valourizing and demonizing | Providing for public consumption positive and negative examples that illustrates the normative foundations of an institution |
| | Mythologizing | Preserving the normative underpinnings of an institution by creating and sustaining myths regarding its history |
| | Embedding and routinizing | Actively infusing the normative foundations of an institution into the participants' day to day routines and organizational practices |
| Disrupting strategies | Disconnecting sanctions | Working through state apparatus to disconnect rewards and sanctions from some set of practices, technologies or rules |
| | Disassociating moral foundations | Disassociating the practice, rule or technology from its moral foundation as appropriate within a specific cultural context |
| | Undermining assumptions and beliefs | Decreasing the perceived risks of innovation and differentiation by undermining core assumptions and beliefs |

The limitations of using this theoretical framework as an approach is that it limits the researchers to the categories described above. However, it has been applied in a broad range of research and is the result of a comprehensive overview of Institutional Work literature [11]. It also focuses on the actions

of actors and therefore provides less of a discussion of broader institutional structures such as the capitalist system or social-economical class inequalities. While also being very important, an article forces to limit and focus the research and therefore this articles choses to limit the analysis on circularity and infrastructure from an Institutional Work perspective

## 5. Results

After coding, it has become clear that there are only a few of the institutional work categories from Table 2 that were actually extensively discussed by more than the interviewees. The dominant types are Enabling, Constructing Identities, Constructing Normative Networks, and Changing Normative Associations. These will be discussed in this result section in relation to their focus on the internal environment, the transactional or the external environment. The results indications are primarily working in redefining their internal environment through changing practices engrained in their functioning over the last decades. Additionally, at the same time, it is clear that organisations are increasingly searching for ways to interact with other actors and to create networks around circular innovations and new infrastructures.

### *5.1. Enabling Work*

The interviewees discuss the necessity for enabling or facilitating new decentralised technologies and new experiments. There is a general perspective by interviewees that the business case for these new decentralised circular technologies is weak. This is especially the case for the new water technologies. There seems to be no economic incentive for changing the current system. However, as an academic expert (interviewee 9) phrases it: "Everybody [in the water sector] shouts, it is not possible and it is futile because water is already so cheap and so reliable. It is a perfect product. But when you look from it from a technological perspective, then you say: water neutrality? Why not?". Thus, the drive for decentralised water technologies seems to be primarily driven by the desire to accommodate new technologies.

In the energy sector, things seem to be different as there are several decentralised technologies that are cost effective and are being widely adopted. As there is a large normative urgency to enable an energy transition, all actors seem to focus on enabling this transition using decentralised technologies such as solar panels and windmills. However, for circular development, energy is one of the main currencies that enable the linking of different technologies. Additionally, water techniques that remove energy (often in the form of heat or biogas) are crucial in the wider perspective of the transition towards a circular society. As a water service official (interviewee 25) argues: "if you extract energy from waste water, you have to be close to the energy user ... Because else it becomes low level heat and a large loss of heat along the way". The interviewees indicate that governments, infrastructure providers, and service providers all accommodate experimentation with new decentralised technologies. As one official from the energy infrastructure provider (interviewee 6) brings forward: "we are an electricity network. And that network will not stay as it is. Will we even have a [central] network? ... And we assume that if you act as if you want to keep everything as it is, you will eventually lose your relevance. You will be too late to see what you can do with your organisation and what your role is [in this changed landscape]." This quote also illustrates the focus on enabling work in the transactional environment. It is in interaction with other actors that experiments are undertaken. The cross-sectional nature of circular development of course also necessitates the cooperation between different parties. Decentralised thermal water solutions are difficult to enable without the cooperation of energy and construction/housing companies. They need to be located in a house and they need to be connected to energy infrastructure and/or energy consumption such as the room heaters. However, enabling work also focuses on the internal context as new institutional rules are created that enable new initiatives to come from the organisation itself. This is especially clear in the case of the water company and the energy infrastructure company. However, this becomes even more apparent in the next paragraph of constructing new identities.

### *5.2. Constructing Identities*

The shift towards a circular system requires especially large-scale organisations such as municipalities and infrastructure providers to develop an approach that integrates different departments. As a representative of the municipality (interviewee 2) states: "yes and that [circular development] impacts the manner in which we organise ourselves. Because we also have different elements . . . And how do you arrange that you keep looking at the long term." Long term planning and circularity need to be mainstreamed into the organisation in order to have different departments work towards a circular future.

A waterboard delegate (interviewee 11) adds: "[that opens space] for other parties yes. Why should the government organise something which we can and would like to do? But many of our board members argue: it is our legal obligation and therefore we have to do it. They think that executing the law is more important than serving society." There seems to be a lot of work done, or identified as needing to be done, on changing the mindset within the organisation. Circularity requires the placement of the normative responsibility towards society above the limited responsibility towards the regulatory mandate.

A representative from the energy infrastructure provider (interviewee 6) argues that they are becoming more of a network organisation. As the decentralised nature of circular and sustainable solutions they need to interact and work together with local actors. This means that they themselves can no longer design a centralised grid and implement it, but that they need to accommodate new initiatives and enable a local organisation to develop around these new technologies. The new identities actors within the infrastructure providers are working towards seem to relate to a transformation towards a network organisation. They move from being a provider to being an enabler. Related to this is the third prominent institutional work of constructing normative networks.

### *5.3. Constructing Normative Networks*

Most interviewees argue that the shift towards a circular economy or a circular water and energy system is only achieved through the alignment of multiple actors. As a municipal representative states (interviewee 2): "So we mapped the linear system . . . And decided on the basis of economic and ecological indicators what the most important value chains were... We had this research done by a consortium and for me that illustrates that you need all different kinds of perspectives to look at circularity. You cannot do it from one perspective." Circularity needs different perspectives and different partners. This is why there is a lot of work in creating normative networks, i.e., establishing co-operations with likeminded parties. Another example is the organisation Amsterdam Rainproof, which was established by the water company Waternet and the municipality of Amsterdam. As a water company official (interviewee 25) states: "For our water treatment we primarily use technology so that is something we can do ourselves. However, our main challenge now is to innovate outside our own gate. That starts with Amsterdam Rainproof where you say the sewage system can take on 2 cm of rain an hour and we are now confronted with rain periods of 7 and 8 cm an hour. So we need different parties. Now we work with a consortium of 24 partners, for example Dakdokters [a green roof company], housing associations, and municipal services responsible for public space. But it requires more psychology as people have to invest for something that they do not experience, or that only happens every few years. It is a challenge to convince them." Thus, circularity creates an interdependence between different actors across different fields.

Additionally, respondent experience a change in the external environment that forces them to change their behaviour. There is a general feeling that there is political pressure to move into the direction of self-organising citizens. However, most interviewees nuance this movement as they expect that the potential for citizens to treat their own waste water is a lot lower than for those willing to produce their own energy. As a professor from the TU Delft (interviewee 8) states: "And that is the painful thing about the message by the current government of creating a participative or 'energetic' society. We will all do it ourselves. But it is of course a very, very specific group of citizens that is

able to do these things themselves." Thus, the question seems to be how to include all citizens into this new network of centralised and decentralised systems that is pushed by circular and sustainable ambitions. Seeing that there is an exclusionary process in the water system, a water board official (interviewee 16) responds: "I am working here in Amsterdam to include different groups . . . With Moroccan youths, with Ghanaian youths, with Surinam and Antillean youths who all live in this city and that all think: 'water board? Water? Why? What are you talking about?' But if you talk to them, you find out that there are a lot of associations which they can work with. That are relevant to them. That they find really interesting. But that is not done with one conversation. You need to develop an agenda; how are we going to have a dialogue together and what is the [intended] outcome of the dialogue." It is an important pitfall of a circular transition fuelled by new technologies and the self-organisational capacity of citizens. Not all citizens have the capacity or interest to organise every part of their lives themselves; from the energy they use, to the water they flush their toilet with. A lot of work that is put in these networks is also to find partnerships that can empower citizens without overburdening them. However, to create these normative networks, respondents argue that normative associations need to be changed as well.

### *5.4. Changing Normative Associations*

The necessity of changing normative associations around unsustainable practices is prominent in most interviews. However, it is often not work they do themselves. A water board member stated (interviewee 1): "Until two or three years ago, whenever someone mentioned climate change, there was always a journalist that said that it is not so serious. Now it is clear that the press sees that it is a real problem . . . So slowly everyone thinks we need to act."

It often seems that it is the other actors that need to change their normative associations and consequential practices as it is an obstruction to their perceived progress. A water expert (interviewee 7) discusses separating waste water: "Yes we should separate urine because it is technically useful in [circular] processing. Yes, but stop. Do people want that, are they going to use it . . . People do not want change so it will always be 'No' in first instance." Thus, to a large extent the motivation for experimenting is also to show and inform people that these new decentralised techniques do not always pose an extra burden. In this case there is also a lot of educating involved in changing these normative practices.

However, experimentation also requires a shift in the norms behind large infrastructure providers. As a professor from Utrecht University (interviewee 20) states: "yes and the idea that you start working from self-organisation means that you are experimenting and that you accept that not everything goes well. That is the risk you need to take." Thus, there is also the necessity to change normative association within the own organisation. There is a general awareness with the interviewees of the infrastructure provides both energy and water that there are still quite a lot of their employees that still work from the premise that they know best and that citizens should accept their 'optimal' solutions. The institutional work is done on changing the normative within the internal and transactional environment. Additionally, there is an external environment where normative associations need to change and to some extent are changing and that this is stated as an important reason for changing the practices of the organisation.

## 6. Discussion

### *6.1. Reflection on the Results from a Social System Boundaries Perspective*

The results show that the ambition of a circular and sustainable society is creating a new dynamic in the water and energy infrastructure sector. The analysis indicates four prime institutional work categories that are prominent in this institutional restructuring: Enabling, Constructing Identities, Constructing Normative Networks, and Changing Normative Associations. Taking a system boundaries perspective shows that most actors are focussing on the internal and transactional environment.

They do see changes, political and societal, in the external environment, such as circular ambitions and independent citizens, having consequences for their work. Interestingly, there are no external developments identified that are directly influencing the internal environment, such as rules and regulations that force organisations to change internally. Therefore, this is a different situation from the 1990's when under pressure from neo-liberal legislations, energy and water systems were separated into energy and water companies and infrastructure providers. Thus, the shifts that are taking place in the sector are not driven by external top-down pressures but from shifting normative perspectives around circularity and sustainability. Additionally, in general, these shifts are caused by responding to changes in the transactional sphere.

The transactional environment is where actors interact with each other. The strong focus on creating normative networks is illustrative that a large part of the institutional work is undertaken in this transactional environment. Circularity, perhaps even stronger than sustainability, requires the interaction between different systems and different organisations. It is not something that can be achieved by just an energy company, just a water company or just a citizen by his or herself. Infrastructure providers, building companies, housing associations, municipal departments, innovators, and citizens all need each other within the circular economy. However, the interviewees clearly identified that this is not easily achieved, especially on a structural basis. There is a lot of cooperation and ad hoc networks working on experiments, but a structural institutional change towards a network around circularity is still missing. At the same time, organisations are addressing this by working on the internal organisation through reconstructing their identities. Infrastructure providers and municipalities are restructuring and revisioning themselves as enablers. They are increasingly seeing themselves as networking organisations making new innovations possible and stimulating and facilitating other actors in their circular ambitions. This is a large change from the engineering dominated organisations providing centralised solutions to the masses. Additionally, the interviewees indicate that this internal shift is sometimes a real challenge as at a strategic level the necessity for change is usually accepted, but the other parts of the organisation are often less convinced of these changes to their daily practices.

### *6.2. Relating the Results to Literature*

In the movement towards a circular society, a new dynamic is created in the energy and water sector. In line with Giddens [62], there is an institutional restructuring in which changing institutions are forcing actors to change their practices and at the same time actors are, aware or unaware, changing institutional structures through their actions [11]. In this research, actors seem to be primarily focusing on their internal and interactional environments. The focus on changing normative associations, creating networks, and enabling actions shows that the technical barriers are not the prominent ones in the perspective of professionals and experts in the field. As identified by Balcombe [13], perceived environmental benefits are important in the uptake of new decentralized technologies and the results clearly show that actors realize this. Their focus on changing normative associations has a lot to do with creating awareness and support for the transition towards a circular water and energy sector that will include both centralized and decentralized infrastructures.

Circular development is also a process that requires experimentation and letting go of traditional methods of production and consumption [1,2]. (Semi) Governmental institutions such as Water Boards and Energy Infrastructure Providers are trying to facilitate this through enabling work as they are looking for linking resource flows. For instance, in the extraction of energy from water, essential for creating circular systems [75,76], the previously separated sectors of water and energy come together. There are no fixed practices and therefore these new innovations are approached with an experimental mindset. It is important to also be able to fail if learning is to happen [77].

The new connections between sectors necessitated by circular developments such as the connection of energy and water flows, combined with the introduction of decentralized infrastructures, has created a dynamic of creating new normative networks around the concept of circularity.

As identified by Graham and Marvin [3], the governance of infrastructure has increasingly fragmented. This means that actors are increasingly dependent on each other to achieve their ambitions of creating a circular society. It is clear from the results that actors are repositioning themselves in this dynamic of institutional restructuring [62] of infrastructure governance under the influence of the ambitions of circular urban development. From the research, it becomes apparent that the transformation towards a circular society requires not only the introduction of new technologies, but that it requires an institutional restructuring of how infrastructure is designed, managed, implemented, and governed.

### *6.3. Reflection on the Usage of Institutional Work*

The usage of institutional work as an analytical instrument provides the possibility to perceive the dynamics of institutional restructuring. It is not the question of whether institutional change has taken place or not, but what the work actors are doing in creating, maintaining, or disrupting institutions. That means this research could also highlight the direction towards which actors are working and the motivations behind their work. In this case we can see that organisations are driven by perceived changes in society and their own normative ambition of creating a circular economy. Thus, in line with Bergsma et al. [47], and Beunen and Patterson [71], this research benefits from using institutional work as a perspective. By combining it with a systems boundaries perspective, this research shows in which context the work takes place or responds to. Taking this a step further, there is a lot of potential in combining it with the multi-level perspective [78] to identify how actors, both niche and regime, work to create, maintain, or disrupt institutions that enable or inhibit larger scale societal transformations.

## 7. Conclusions

In the transition to a circular economy, it is clear that infrastructure plays a crucial role. It is the connection between flows and place, between different activities. With this introduction of new infrastructures there is a shift towards increasingly decentralised solutions. This is already very apparent in the energy sector with the introduction of solar panels and wind mills, but this transformation is also taking place within the water sector as new heat extraction and storage, decentralised sanitation systems and water filtration systems are being introduced and implemented. This research has tried to bring the analysis about the changes that are occurring or will occur, and its impacts on the institutional setting and governance, by taking an institutional work approach and interviewing a variety of stakeholders and experts in the water and energy infrastructure domain.

The analysis shows that there is currently a reorientation at the level of infrastructure network providers to use institutional restructuring to adapt to changes in the external environment. Most institutional work is aimed at the internal context by reconstructing their identity internally as there is a need to move from a providing company to an enabling organisation. This is also why there is a lot of enabling work identified that focuses on changing rules and regulations to enable new developments and initiatives. However, it is also about changing the normative associations within the organisation that they know what is best. New infrastructure innovations require more flexibility on the part of infrastructure provider employees that even though it might not be the optimal solution from an efficiency perspective, it is what people want and need in order to be more sustainable or more autonomous. This requires new ways of governance that empowers innovative organisations and citizens instead of the traditional provide, monitor, and sanction role infrastructure providers in the energy and water sector used to work from. In this new role, a lot of institutional work goes into the creation of new networks around the norms of circularity or sustainability. Transitions require partnerships and in the current phase of experimentation, new partners are crucial for learning and adapting.

As we are moving towards a more circular and sustainable society, the world of infrastructure provision is confronted with an increase in decentralised infrastructures introduced by new organisations, companies or citizens. This analysis showed how institutional restructuring is taking

place within the two domains and how new identities are being constructed that focus on enabling initiatives and new networks. The value of institutional work as an analytical tool is that it provides the opportunity to capture the dynamics of institutional restructuring. Circularity, perhaps even stronger than sustainability, requires the interaction between different systems and different organisations. It is not something that can be achieved by an energy company, a water company or a citizen by his or herself. Infrastructure providers, building companies, housing associations, municipal departments, innovators, and citizens all need each other within the circular economy. Circularity requires a restructuring of infrastructure governance in order to adapt to the increasing flux caused by decentralised technologies and the need for the integration of different systems.

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