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RESEARCH ARTICLE

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Sustainability transitions in Los Angeles' water system: the ambivalent role of incumbents in urban experimentation

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ABSTRACT

Growing urban populations, climate change, drought, and ageing infrastructures increase pressure on water delivery. This prompts the search for innovations, with incumbents increasingly attempting to enable and steer 'experimental' approaches. Historically, incumbents were assumed to be largely resistant to potentially disruptive innovations. However, their strategic orientations may be changing due to the urgency of sustainability challenges leading to increased experimentation. This change raises a question about how incumbents influence experiments in particular directions while neglecting or discouraging others. This research centers on the 'La Kretz Innovation Campus', and three experiments therein, partly established by the incumbent water utility in Los Angeles. It explores how creating an internal 'protective space' for experimentation generates struggles over institutional changes necessary for such experiments to thrive. Conceptualizing 'incumbent-enabled experimentation' as a set of practices nested within novel institutional, organizational, and political arrangements reveals the internal tensions incumbents face when seeking more sustainable directions.

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1. Introduction

Los Angeles' water system is a case where the 'triple exposure' to climatic changes, regulatory constraints, and shifting socio-political attitudes necessitate rethinking water delivery (Hughes et al., 2013). Many technical solutions are proposed for the city's water infrastructures, such as shifting from dependence on remote conveyance systems to increased wastewater recycling. Simultaneously, actors, including utilities, traditionally thought of as 'incumbents' (see Table 1 for definitions of important terms), invest in and support forms of experimentation to speed up technological advancements, test new policies, and meet sustainability targets.

Experimentation is seen as an approach to potentiate sustainability 'transitions' (i.e. systematic shifts to more sustainable systems) and contribute to reconfiguring urban socio-technical systems (Farrelly & Brown, 2011). Initiatives such as urban living labs and cleantech incubators have proliferated globally in recent years (Madsen & Hansen, 2019). They have become a key part of climate change governance (Bulkeley & Broto, 2013). Early conceptualizations of experimentation focused on the 'protective spaces' and 'support structures' necessary to allow innovations to mature or scale-up (Smith & Raven, 2012). Recently, scholars have seen experimentation operating on a continuum beyond distinct niches and regimes. Instead, experimentation displays various degrees of institutionalization and local embeddedness (Van Welie et al., 2018). This encourages further attention on the spaces in which experiments are initiated, conducted or supported by actors with differing degrees of embeddedness in institutional structures.

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Table 1. Definitions of important terms used throughout the paper.

Term	Definition
Incumbent	Powerful companies, utilities, or other actors who 'mainly have competencies related to the current technological regime' (Smink et. al., 2015, *p*. 87), and who 'are assumed to strategically enact their interest' (Späth et al., 2016, *p*. 4)
Incumbency	Incumbency can be understood in relation to a status and position of power (and by extension mastery of key resources and processes) at a given time, which confers (a) privileged agency over the current workings and fate of established systems, and (b) exposure to potential overthrow or defeat, but (c) may also be leveraged to influence and shape transition efforts (Turnheim & Sovacool, 2020, *p*. 183)
Experimentation	An inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity (Sengers et al., 2019, *p*. 161)
Incumbent-enabled experimentation	Experimentation encouraged or facilitated by incumbents with a liminal character: they are not entirely external to an incumbent, nor are they internal (i.e. heavily controlled), due to this and their embeddedness they face certain opportunities and limitations

Furthermore, given the increased engagement in experimentation from a wider range of actors (i.e. incumbents such as utilities), more attention is needed to the role of incumbency and incumbents in experimentation (Grin, 2020). Current literature typically underestimates the role of incumbents as enablers of experimentation, as they assume incumbents to be resistant to change. Recent contributions have called for a more nuanced understanding of how incumbents support and enable experimentation (Turnheim & Sovacool, 2020; Ampe et al., 2021) and have begun to explore the relation between the two conceptually (Grin, 2020). However, few empirical studies address how and why incumbents initiate experiments and how incumbency shapes experimental practices. Therefore, this paper examines 'incumbent-enabled experimentation' and unpacks the opportunities and limitations of this type of experimentation concerning its influence on broader sustainability transitions in Los Angeles' water systems. Specifically, the paper focuses on the experimental spaces enabled by the city's water and energy utility, the Los Angeles Department of Water and Power (DWP), and analyses the relationship of such experimentation to dominant institutional structures (Scott, 2013).

The paper has two key objectives; (1) to explore and examine how incumbents are experimenting with urban water infrastructure innovations and (2) to examine how such experimentation is enabled (and limited) by incumbents, organizational structures, institutional settings and other place-specific factors. We review the theoretical perspectives on urban experimentation and the role of incumbencies (section 2). We develop an analytical framework to understand the 'embedding' of incumbent-enabled experimentation and reflect on our methodological approach (section 3). Hereafter we analyze experimentation in the institutional context of Los Angeles (LA) and the influence of an incumbent (section 4). We conclude with a discussion (section 5).

2. Theoretical background

2.1 Urban experimentation

Conventionally, transition theories such as the multi-level perspective (MLP) and strategic niche management (SNM) argued that experimentation occurred in protective spaces (niches) and facilitated 'transitions' in infrastructure systems (Geels & Schot, 2007). Niches make space for developing and using innovative and promising technologies through experimentation. The aim of niches is to learn about the innovation's desirability and enhance their further development and rate of application (Kemp et al., 1998).

Here, experimentation allows innovations to overthrow dominant socio-technical 'regimes' (i.e. networks of artefacts, actors, and institutions with stability and path-dependence) (Kemp et al., 1998; Smith et al., 2010). These understandings have been refined through evolving conceptualizations of the role of experiments (see Sengers et al., 2016) and growing attention to the geography of transitions (Truffer et al., 2015; Hansen & Coenen, 2015). However, in practice, experimentation seldom takes place solely at a 'niche' level; therefore, the

distinction between niche and regime is rarely clear-cut in transition processes. Instead, experimentation displays various degrees of institutionalization and local embeddedness (Van Welie et al., 2018). This demands a more fluid understanding of how incumbents and incumbencies influence socio-technical transitions.

Sengers et al. (2019) propose an overarching definition of experimentation: 'an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity' (pp.161). In urban contexts, experiments may be more fluid and processual, characterized by multiplicity rather than singular well-planned and consensus-oriented learning processes (Hodson et al., 2017; Raven et al., 2019). Urban experiments encompass diverse and coexisting innovations, governance arrangements and understandings of sustainability. Similarly, our paper focuses on the broader process of experimentation and how these processes are governed and enabled contextually.

Urban experimentation comprises a continuum of different practices, ranging from attempts to observe the effects of a given intervention to co-creative, open-ended processes of attempting to prototype and manifest desirable urban futures (Ansell & Bartenberger, 2016; Torrens & von Wirth, 2021). Likewise, experiments come in many shapes and goals, such as research and development (R&D) departments within institutions, pilot projects (c.f. Vreugdenhil et al., 2010) and urban living labs (c.f. Von Wirth et al., 2019). Moreover, scholars have documented the proliferation of different forms of urban experimentation (c.f. Evans, 2011; Karvonen & Van Heur, 2014; Evans et al., 2018) and argued that this multiplicity is potentially generative of new urban infrastructure governance arrangements (Hodson et al., 2017). Rather than assuming what kinds of experiments are taking place, it is worth investigating how particular actors understand and practice experimentation in context and to what effect.

Urban experimentation, therefore, has become a 'critical means through which governing is accomplished' (Bulkeley & Broto, 2013, p. 372). It is increasingly promoted by actors traditionally understood to be 'incumbents' (e.g. dominant companies, utilities) (Grin, 2020), opening questions about their intentions towards experimentation. Hence, urban experimentation is no longer conceived solely as a bottom-up strategy by alternative networks and actors but an institutionally nested and locally embedded form of governance. Attention has turned to how institutional arrangements (regulative, normative, and cultural-cognitive elements) shape experimentation (Smith et al., 2010; Raven et al., 2019). Drawing on thinkers such as Scott (2013), these efforts show how pervasive and stable structures shape experimentation. While institutional structures influence experimentation, experiments' potential impact *on* institutional conditions is less well studied (Fuenfschilling et al., 2019; Hodson et al., 2017; Savini & Bertolini, 2019), suggesting the need to examine incumbents' efforts surrounding experimentation more closely.

2.2 Incumbency and urban experimentation

Transition studies is undergoing a shift towards more nuanced and ambivalent conceptualizations of the influence of powerful actors. Smink et al. (2015) define *incumbents* as 'firms that mainly have competencies related to the current technological regime, and that (financially) benefit from the way things are organized' (p.87). This concept focuses on private entities that may try to influence ongoing transition processes in a particular direction, e.g. maintaining the status quo. While the term has predominantly been used to refer to how private actors have/yield competencies concerning dominant technologies and innovations processes, researchers are increasingly thinking through *incumbency* in contexts such as local governments and utilities central to the way things are organized (Ngar-yin Mah et al., 2017; Betsill & Stevis, 2016). Here, notions of *incumbency* have highlighted the unevenness in how agency is distributed and wielded (c.f, Stirling, 2019), for example, not solely over technological developments, but over 'policy innovations' that influence broader energy regimes (Betsill & Stevis, 2016).

Until recently, the role of incumbents in experimentation lacked nuance. A common perception of incumbents is that they rarely introduce radical innovations that would displace their own privileged positions, instead tending to solidify their positions with relatively incremental innovations (Chandy & Tellis, 2000). Thus, despite incumbents increasing interest in experimentation, incumbents are primarily portrayed as 'villains' who resist and slow down transitions (Turnheim & Sovacool, 2020). Much depends on the broader institutional context. The 'free market innovations' view suggests incumbents innovate when faced with

competition from smaller firms (Chandy & Tellis, 2000). For monopolies, such as DWP, this competition is precluded, yet they face both 'challenges' (e.g. environmental regulations) and 'challengers' (e.g. new coalitions of actors). Moreover, monopolistic incumbents must adapt to changing contexts, for instance, new policies, regulations, and societal demands. For organizations such as DWP, while *incumbency* emerges from their monopoly position (e.g. its sole position as a quasi-commercial water provider), it is less clear how such *incumbencies* materialize at the interface between technological development and broader institutional change.

We thus assume that incumbents themselves are innovating and significantly influence innovation's development (Smink et al., 2015), albeit in very particular directions. Some scholars have focused on the positive role incumbents play in transitions (Ampe et al., 2021) and show that incumbents can mobilize financial, political, and organizational capacities to guide experimental practice in specific directions (Turnheim & Sovacool, 2020). Considering the institutional embeddedness of experimentation and the growing involvement of incumbents in experimentation (Grin, 2020), this perspective highlights incumbents' agency, both implicitly and explicitly, in either initiating or shaping ongoing experimental approaches.

Incumbents' apparent ambivalent relationship to experimentation deserves critical scrutiny. As incumbents generally favor some form of stability, they sometimes resist the most promising and radical innovations when they perceive them as threats. Strategies to deter or prevent experimentation can involve influencing the institutional environment by formulating stringent technical standards (Smink et al., 2015). Incumbents can selectively support experiments that have the potential to alter their practices, technologies, and methods of operation. Incumbents often realize this through design, i.e. new R&D processes, or by selection, such as providing selective policy and financial support to construct and mainstream protective spaces (Ampe et al., 2021; Smith & Raven, 2012). Incumbents can also encourage pilot projects or facilitate urban living labs, where their role and influence are highly context-specific (Vreugdenhil et al., 2010; Fuenfschilling et al., 2019). Thus, it remains an empirical question of what 'form' of experimentation is taking place and an analytical question whether such forms of *incumbent-enabled experimentation* have transformative potential.

2.3 Incumbent-enabled experimentation: opportunities and limitations

A more nuanced understanding of incumbents' role requires revisiting their engagement in experimentation. Grin (2020) suggests that the main challenge for experimentation undertaken by incumbents is to benefit from the proximity to incumbencies while maintaining the potential to be disruptive and rethink 'normal' practices. Embeddedness in (or selection by) incumbencies thus poses both opportunities and limitations.

Opportunities may include relevant knowledge, skills and capabilities, missions or guiding rules, geographical areas or scales and access to appropriate social and political networks (Turnheim & Geels, 2019). Opportunities related to network ties, such as vertical linkages, may help convert successful experiments into broader changes in socio-technical systems (Bai et al., 2009). Moreover, vertical linkages help to overcome institutional barriers (Irvine & Bai, 2019), such as a conservative, risk-averse and techno-rationalist operating cultures within utilities (Farrelly & Brown, 2011). Horizontal linkages (between experiments or organizations) may enable shared visions of change and sustainability, and enable new coalitions to emerge (Irvine & Bai, 2019). Often for experiments to produce systematic change, their insights/results should be assembled and refined collectively (Farrelly & Brown, 2011).

Limitations of incumbent-enabled experimentation relate to political and institutional structures, such as the workplace culture and the organizational routines and procedures. Incumbents often focus on incremental innovations that may optimize existing practices without disrupting them. This is because radical innovations require developing new routines that are difficult, costly, and risky (Chandy & Tellis, 2000).

A growing concern is the power incumbents hold to alter innovations (Turnheim & Sovacool, 2020). Incumbents can use their power to formulate stringent technical standards (Smink et al., 2015) to deter innovations. Conversely, they may also use their knowledge of costumers/consumers' habits to push for innovation they perceive as necessary (Chandy & Tellis, 2000).

Thus, researchers have found that actors strategically 'select' specific experiments to nurture while excluding others (Savini & Bertolini, 2019). Incumbents' therefore seemingly have considerable influence on broader transitions through their impact on experimentation.

As such, what we here term *incumbent-enabled experimentation* has a distinctive liminal quality that requires context-specific attention. We do this by using an 'institutional lens' (Scott, 2013) to investigate empirically how experimentation is enabled by incumbents such as utilities in a particular institutional context. In sum, we assume there is a significant gap in understanding how institutionally embedded incumbents initiate and shape experimentation and 'work' to change institutional structures and cultures through experimentation (Smink et al., 2015). In the following, we therefore develop a framework for analyzing experimentation initiated by incumbents within multiple institutional dynamics and aim to show how a much more expanded view of experimentation is necessary.

3. The case of Los Angeles's water system

Los Angeles has a Mediterranean climate, highly seasonal precipitation patterns and has faced recurrent droughts in recent years. Historically, LA approached water supply challenges through energy-intensive water imports from rivers and aqueducts within and beyond California. Since the 1980s, however, there have been significant shifts in LA's water systems, especially concerning the city's water supply and governance (Pincetl et al., 2019). Water conservation has become a significant part of water supply planning. A state-wide mandate to cut urban water use by 25% in 2015 forced LA to consider water conservation strategies. Recently, alternative water sourcing through wastewater recycling and groundwater recharge has been explored (One Water LA, 2018). This shift from modernist-era imported water systems is supported by discourses surrounding increasing the diversity of water supply and increasing (re)use of 'local' water sources/technologies (Pincetl et al., 2019).

Researchers have identified three main drivers for these changes (Hughes et al., 2013). First, climatic fluctuations and droughts have made water supplies more unpredictable. Second, regulatory actions have affected availability, e.g. restricted water deliveries from the Los Angeles Aqueduct and the State Water Project. Lastly, broader political narratives and attitudes have shifted through rising environmental awareness. For example, the Mayor of LA, Eric Garcetti, has established sustainability goals in his *Sustainable City Plan* sub-titled as the 'Green New Deal', including sourcing 70% of water locally and recycling 100% of all wastewaters for beneficial reuse by 2035 (Garcetti, 2019). In response to such broadrer drivers and constraints, there has been a proliferation of 'natural' and technical experiments such as tree planting campaigns and local water conservation innovations (Pincetl et al., 2019).

The institutional context of water delivery in LA offers unique insights into enabling and developing experimentation. DWP delivers water (and electricity) as a proprietary department, meaning the City government has considerable influence over DWP concerning policy development and strategy. Moreover, DWP is solely responsible for water distribution infrastructures and providing water to LA residents (LADWP, 2015). Therefore, it heavily influences which water innovations become available and maintains an institutional relation with many experiments and innovations. Research on 'incumbent utilities' has indeed highlighted how the ability to establish/prevent strategic alliances is a key means by which incumbency materializes (Betsill & Stevis, 2016).

Generally, local experts suggest organizations such as DWP are taking a more adaptive and experimental approach to water delivery (Hughes et al., 2013; Pincetl et al., 2019; Meilinger & Monstadt, 2022). Fueling this turn to more experimental and 'adaptive' approaches are both external and internal pressures. External pressures include increasingly stringent environmental regulations such as surrounding imported water sources (e.g. dust control in the Owen's Valley) or river restoration (e.g. the LA River). Internal pressures include increasing water supply infrastructure sustainability while maximizing or repurposing existing technical artifacts and capital investments (Meilinger & Monstadt, 2022). One example, the case study of this paper, is the La Kretz Innovation Campus ('the campus') (LACI, 2016). Thus, DWP represents a potentially insightful case of a (monopolistic) incumbent utility pursuing experimentation.

4. Analytical approach and research design

4.1 Analyzing incumbent-enabled experiments

Previous research emphasizes how incumbent networks differ based on context (Raven et al., 2019). Therefore, we analyze how experimentation is 'enabled' in the case of the campus based on (1) the background/contextual drivers of water policies/discourses in LA, (2) the selection procedures of the campus, and (3) the specific support structures surrounding the operation of experimental organizations partnered with the campus. Our concern is to understand how incumbent organizations (i.e. DWP) influence experimentation through selection procedures and (selective) support structures, potentially enabling specific experiments and hampering others (Savini & Bertolini, 2019). We address this question by deploying an institutional lens to analyze how incumbent structures influence such forms of experimentation.

Following Raven et al. (2019), we adopt Scott's (2013) categorization of regulative, normative, and cultural-cognitive elements of institutional structures (Table 2). We assume these elements (in)directly influence the design and success of experimentation (Raven et al., 2019). While an institutional lens allows us to analyze the influence incumbents and incumbent structures have *on* experimentation, we also consider how incumbent-enabled experimentation influences back upon institutional arrangements through the mediation of an incumbent. Thus, we examine the interaction between institutional arrangements, incumbents, and incumbent-enabled experimentation (Figure 1). In this framework, institutional arrangements influence and shape incumbencies and vice versa. However, incumbencies are distinct from institutional arrangements in that they are persistent tendencies, uneven capacities, and forms of 'privileged agency', as discussed above.

4.2 Research design and methodology

We adopt a case study approach (Creswell et al., 2007). We identified the 'La Kretz Innovation Campus' as an insightful case study through desk review and preliminary interviews. The campus, self-styled as a 'cleantech incubator', was opened in 2015 in the Arts District of downtown Los Angeles. DWP owns the campus, and a non-profit organization, Los Angeles Cleantech Incubator (LACI), operates it.

The campus is a distinct type of experimental space in that the broader project is managed and initiated by an incumbent who selects and supports external experiments (i.e. start-ups and innovative technologies). Therefore, the case is distinguishable from conventional R&D but encompasses many other types and features of experimentation found with pilot or demonstration projects. The innovations within the campus benefit from protections through connections to DWP. Therefore, the campus is a 'protective space'. However, each experiment within the campus is distinct (i.e. working towards a different sustainability goal, such as

Table 2. Institutional dimensions which may influence how incumbents engage with experimentation (adapted from Raven et al., 2019).

	Description	What to look for	Potential influence on incumbent-enabled experimentation
Regulative	Rules and processes with formalized authority can set rules for, monitor and sanction activities.	References to policy frameworks, agendas and incentive schemes, or formalized collaboration frameworks.	• Technical standards (Smink et al., 2015); • Regulations (e.g. water quality); • Vertical network ties (Bai et al., 2009); • Inspections and sanctions
Normative	Values and norms specifying what goals and visions are important and prescribing how they should be accomplished.	Evidence of prioritizations for water experiments, through which means, and whose involvement.	• Shared visions of change and sustainability (Kemp et al., 1998)
Cultural-cognitive	Shared conceptions and frames through which meaning is given and interpreted.	Common conceptions of sustainable experiments and their influence on and relation to broader systems.	• Conservative, risk-averse and techno-rationalist operating culture among utilities (Farrelly & Brown, 2011)

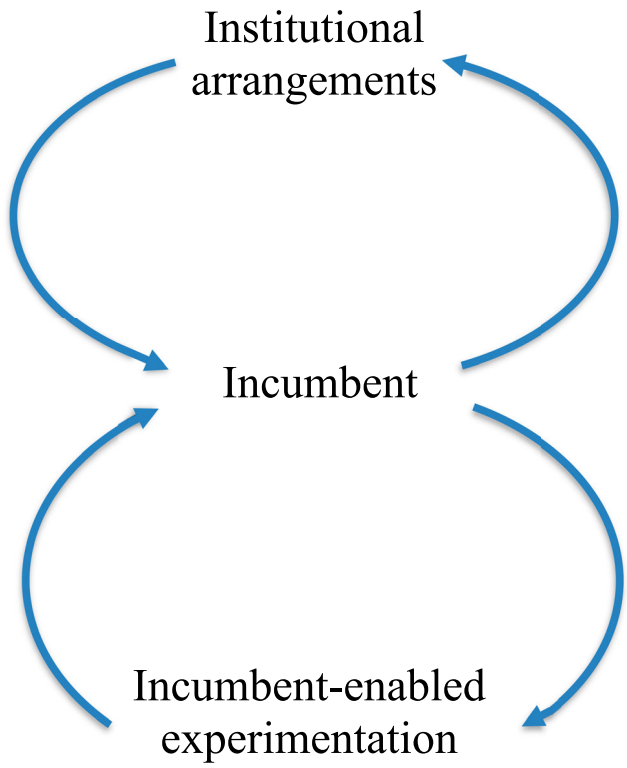

Figure 1. Analytical framework.

water conservation, water recycling or energy preservation) and therefore the campus is not *strategically* pushing transofrmations in one direction. The campus is perceived as a 'flagship' of the utility's overall approach to experimentation. Therefore, we approach the campus itself as a critical example of an incumbent-enabled experimental space, which can provide insights into the relations between incumbent-enabled experimentation and sustainability transitions at an urban scale.

Additionally, we focus on individual experiments within the campus. Following site visits and conversations with managers, we focused on three individual organizations and their respective innovations: *Rain Systems*, *Saya Life*, and *Advantageous Systems*. These organization have all been with LACI roughly since its inception and therefore were assumed to be insightful cases concerning the opportunities and limitations of the campus. Moreover, the innovations promoted by these organizations all commonly relate to water: water conservation, water recycling or water education. Thus, they are highly representative of organizations/experiments associated with the campus. We added a fourth experiment with a similar focus (*Greywater Corps*), not situated within the campus, to test the validity of our findings. This organization is likewise located in LA; however not involved in any of DWP's programs.

After a desk review of experimentation in the water sector in LA, primary data was collected from November 2019 to January 2020 through 16 semi-structured interviews (Appendix I). The respondents were asked questions about sustainability challenges in LA, the role and impact of incumbent-enabled experimentation and the opportunities and limitations of such experimentation. Furthermore, we analyzed previous research, policy documents, and government and planning reports to triangulate and complement the interviews.

5. Findings

5.1 Experimental spaces and experiments in Los Angeles

5.1.1 The proliferation of water experimentation in Los Angeles

Based on a desk review, we found experimentation in LA's water sector is not restricted to a particular actor. Major water agencies implicated in the water management in Los Angeles, including DWP, LA Sanitation, and the Metropolitan Water District (MWD), have all instituted experimental programs or policies. MWD, as a regional water supplier in Southern California, tests innovative technologies at a water recycling demonstration plant called the 'Regional Recycled Water Advanced Purification Center' (MWD, 2020). Multiple organizations experiment with conservation and efficiency projects and initiatives through funding programs. Such projects range from improving landscape water efficiency to leak-detection software and innovative greywater systems (MWD, 2020). DWP's main funding program stimulating experimentation is the *Technical Assistance Program* (TAP) which provides financial incentives for custom water conservation projects.

Such actors enroll many actors in their experiments. For instance, DWP has partnered with various city departments and external stakeholders (such as NGO's) to develop experimental projects. For example, DWP, various city departments, and the NGO 'TreePeople' collaborated to create the 'StormCatcher' Project. This project has created retrofitted pilot homes with cisterns and rain gardens to demonstrate stormwater capture systems, reducing demands on the central network (TreePeople, 2020). Besides stimulating technological innovation, DWP stimulates social innovations through 'pitching programs' where NGO's and non-profits can pitch ideas to qualify for funding. Thus, *partnering* and *funding programs* are common ways in which experimentation is encouraged in LA's water sector.

Our review suggested that 'cleantech incubation' has also recently emerged as a prominent form of experimentation, as exemplified by the campus. The campus hosts different experimental start-ups and is 'a place where entrepreneurs, engineers, professionals and policymakers can collaborate, promote and support the development of clean technologies and LA's green economy' (LACI, 2016, p. 7). In close collaboration with the city council, DWP established the campus and 'owns' the space. It, therefore, can be characterized as a public-private partnership, or as interviewee 1 described it, a 'sweetheart deal' where LACI as operator puts any revenues generated from the organizations into cleantech development. This partnership goes beyond traditional incubators by providing organizations with entry points to experiment within DWP's infrastructures.

5.1.2 The 'enabling' of water experiments within incumbent structures

The organizations hosted within the campus maintain close relationships with DWP through various 'partnering agreements'. These relationships are essential for how the incumbent enables experimentation, allowing for explicit and implicit selection of which type of organizations join. In this section, we describe such relations for our three focal organizations.

The campus selects organizations wishing to join through various partnerning programs. These include a two-year '*Incubation Program*', which costs a 1.5%–3% equity stake as revenue to LACI. Enrollment provides support through advice and mentoring, investment support, market access and visibility, pilot funding and access to the campus facilities, including its 'prototype center'. More established companies can apply for the one-year '*Market access program*' at the cost of a 0.5% – 1.5% equity stake, which supports pilots and investors to scale cleantech innovations. Additionally, there are two free programs. The 12-month '*Innovators Program*' offers early-stage cleantech start-ups a 'light-touch' network access program. The 10-week '*Founders Business Accelerator*' helps underrepresented start-up organizations in low-income neighborhoods increase their community, social and environmental impact. Additionally, sponsor/partner companies work as standalone cleantech companies and rent office space at the campus.

We focused on three organizations within the campus and one outside (Table 3). *Rain Systems* and *Saya Life* are both in the incubation program and were founded upon joining the campus. *Rain Systems* develops water conservation strategies, predominantly through a hydrogel installation machine. This technology implants hydrogel into existing turf, reducing irrigation and potentially cutting water consumption by up

Table 3. Characteristics of the experiments analyzed.

	Rain Systems	Saya Life	Advantageous Systems	Greywater Corps
Type of innovation / experiment	Water conservation	Water conservation & preventing water risks	Water conservation/ recycling	Water conservation/ recycling & education
Relationship to LACI	Incubation Program	Incubation Program	Sponsor	None
Founding date	2016	2016	2008	2009
Joining date	2016	2016	2016	n/a
Purpose	Reduce water usage and cost by reducing the need for irrigation by injecting hydrogel in soil	Prevent water-related losses, safe water and reduce cost through monitoring water and detecting leaks	Purify and recycle water cheaply by treating it with magnetic nanoparticle	Reduce water usage and reuse water through eco-friendly greywater systems
Technology	Hydrogel installation machine	'Smart' water metering	Water purification system	Greywater system
Level of technology	High-tech	High-tech	High-tech	Low-tech
Number of employees	2–10	2–10	10–20	2–10

to 50% (Rain Systems, 2020). *Saya Life* develops a submetering AI platform, which provides water monitoring and leak detection, preventing catastrophic failures (Saya Life, 2019). At the time of fieldwork, both experiments were tested in pilot projects. *Advantageous Systems* (AS) is a 'sponsor company' experimenting with magnetic nanoparticle water treatment technology. This water purification system is a new technique to recycle water while reducing electricity demand, reducing water purification costs (ADS, 2021). The one organization without a relation to the campus, *Greywater Corps*, builds systems that recapture grey waters (from bathtubs and showers) and develop gravity-based systems to irrigate gardens (Greywater Corps, 2021). It is important to acknowledge that while the severity of the challenges faced by DWP and LA are high, these experiments are relatively small in both scale and scope.

5.2 Institutional arrangements' influence on incumbents and incumbent-enabled experimentation in LA

While the organizations have different partnering processes with the campus, DWP is a fundamental part of the complex institutional arrangements and processes that comprise the socio-technical water infrastructures in LA and experimentation. Thus, the following section analyzes how regulative, normative, and cultural cognitive aspects influence experimentation (Table 4).

Concerning the *regulative dimension*, sustainability goals, policies, and dominant regulations in LA's water sector firmly embed experimentation. This dimension includes sustainability goals such as the *LAPlan*, and the *Urban Water Management Plan* of DWP (LADWP, 2016). Indirect regulations contribute to this form of experimentation. For example, a new building ordinance was passed in 2016 stating that new buildings in LA should be designed to reduce potable water use by 20% and be 'greywater ready', meaning greywater and blackwater are plumbed separately (LADBS, 2017; Quinn, 2016). Thus, there is an envisaged regulatory order to such experimentation. Once specific cleantech innovations are 'tested' and demonstrate their viability, there is an expectation that DWP can incorporate them in its practices or that strategies and technologies can be streamlined to guide the development processes.

Interviewees from DWP emphasized a clear expected sequencing to such experimentation (i.e. chosen paths) where rebates or further support/incentives would be provided to help secure markets for preferred innovations that do not yet have economies of scale. This expectation firmly situates experimentation within established regulations and infrastructural decision-making processes. For example, one expected pathway for experiments to be upscaled was through the 'Steering Committees for the Greater Los Angeles County Region Integrated Regional Water Management Plan', a committee, including members from DWP, for each sub-

Table 4. LA's institutional environment and the mediation possible through the campus.

Dimension	Examples	Mediation through the campus
Regulative	• Public-private partnerships between DWP and the La Kretz Innovation Campus; • City-level sustainable water management plans defining key areas for experimentation; • City-level agencies' policies, regulations, rebates, incentives, and research funding.	Influence in structuring experimental spaces and setting expectations for what is pursued.
Normative	• Explicit focus on sustainability within water management; • DWP's power to shape experimental spaces and experiments through its monopoly position; • Emphasis on technological innovation; • Maintenance of DWP's public character.	Values and norms guiding experimental spaces, mainly decided by the City and City-level Agencies focus on achieving sustainability through technology.
Cultural-cognitive	• Innovation 'ecosystem' where technological entrepreneurship is rewarded; • Residents expectation that water is cheap and innovations will maintain culturally significant practices (e.g. irrigated lawns)	Shared expectations of technological innovation through entrepreneurial ecosystem. Driven by start-ups and focused on establishing patents and for-profit innovation.

region in LA County which promotes and approves more efficient, collaborative and effective water resource management. Conversely, interviews with organizations in the campus highlighted how such roadblocks often served as a deterrent for certain organizations to apply for support from the campus. Nevertheless, some 'successes' in regulative change were evident such as greywater reuse which has shifted from 'illegal' status to a legitimate one, predominantly through demonstrations by bottom-up innovations, including through the campus.

The *normative dimension* is evident in how the campus actors converge around a distinct focus on sustainability and 'clean technology'. This direction mirrors city-level planning and strategy. Many plans, goals, and targets, such as those in the *LAPlan*, center on the responsibilities of city-level agencies (including DWP) to contribute to more sustainable water systems. A dominant focus found within the campus is on technological solutions, particularly high-tech. As one interviewee described, 'the utility is pushing for more local water, we need technology to help us get there.' (Interview 1). Thus, there is an implicit impetus to harness technological potential, exemplified also by the campus as a facility with a shared 'baseline' of technological apparatuses that innovations/innovators should access.

The recurrent reference in campus documents and materials to 'innovation ecosystem' is a distinct hallmark of the *cultural-cognitive* dimension. A goal of the campus is to connect individuals and organizations with 'other like-minded people'. Specifically, there is a shared belief in technological entrepreneurship in 'for-profit' expectations, qualities to be rewarded. One interviewee adds: 'If a for-profit technology company puts research and development into something, it is assumed that they must profit wildly for that innovation' (Interview 8). That assumption also fits into the broader spirit of entrepreneurialism in LA. However, many interviewees also shared common beliefs about which social attitudes and cultures should be challenged. Interviewee 4 describes: 'People do not value water in a way. There is the American dream of the house and the green lawn. It is intrinsically wrapped up in people's consciousness, this idea that you have to have a lawn to make it a home.'

5.3 Characterizing incumbent-enabled experimentation

As the previous sections show, experimentation, both nested within an incumbent-enabled space and broader institutional structures, can be understood as a tiered process influencing which forms/types of

experimentation are encouraged. Here, we characterize this as incumbent-enabled experimentation. Generally, the campus supports experiments whose objectives match DWP's priorities and broader *normative* goals. The primary focus of the experiments we examined is on high-tech innovations that address relatively narrow technical challenges. Such experiments must (1) serve core strategic objectives (e.g. water conservation) and (2) be economically feasible. As interviewee 2 described, 'It is not just about selling something that is about saving the world. The water cost savings is a powerful incentive.' There was an expectation among campus managers and partnering organizations of many 'failures'. As one interview described, 'for every 30 start-ups, only a handful of them will be something that gets implemented on a large scale' (Interview 5). Here, risk is limited by enabling many experiments rather than diversifying the experiments and innovation pathways explored.

We found that DWP influences experiments through less 'formal' means, beyond partnering arrangements and overarching goals. These included increasing LACI's investment capacity, providing baseline technological tools/equipment (e.g. a 'widget' and lab), training and mentoring, and networked connections. One interviewee explained: 'we provide the ecosystem where they can excel' (Interview 1). Additionally, DWP has a close relationship with LACI. DWP is a board observer at LACI, allowing DWP to follow and engage with the experiments within the campus. Thus, while the 'innovation ecosystem' is promoted as a core shared cultural-cognitive value, it underpins the wider influence of the incumbents upon experimentation.

While the campus is, in principle, open to a wide variety of potential actors, there are predominant tendencies reproduced through selection of participating partnering programs. The campus stimulates mainly high-tech, but nevertheless small-scale, entrepreneurial experimentation and innovations with for-profit start-ups; 'social' or 'soft' experiments are less prominent but still present in other DWP programs. Moreover, the institutional arrangements of water delivery in LA compound influence on experimentation. The regulatory order and need for a key sequencing (i.e. identified paths) for innovations is tied to an expectation that potential innovations will address existing regulatory drivers or constraints. That expectation may neglect wider learning that experimentation can facilitate beyond stated goals. As one interviewee described, the 'enabling' of experimentation 'builds the walls of the sandbox in which people can play' (Interview 1).

Thus, incumbent-enabled experiments have a liminal character: they are not entirely external to DWP nor an inherent challenge to their practices. Neither are they altogether 'internal', i.e. heavily controlled and limited. The findings show that incumbents such as DWP engage in processes of selective partnering and provide selective support. Therefore, they greatly influence what experimentation gets done and how (Savini & Bertolini, 2019). Thus, due to their unique position, the proponents of incumbent-enabled experiments must navigate the multiple interests around the 'shared' objectives, 'shared' understandings and incumbent-determined support structures. They do so under the influence of established institutional arrangements, working first to be selected, and then to thrive within the experimental spaces, with limited latitude to 'rock the boat'.

5.4 Opportunities and limitations of incumbent-enabled experimentation

5.4.1 Opportunities of incumbent-enabled experimentation

This liminal character of incumbent-enabled experimentation will likely influence its potential to drive change in socio-technical systems and the direction in which it develops. Hence, we examine if and how experiments benefit from the enabling conditions described in the previous sections. Firstly, we identified several common opportunities (Table 5).

Network factors relate to enhancing existing and creating new vertical and horizontal linkages. Enhancing *Vertical linkages* with governance actors implicated in regulation- and priority- setting (directly with DWP, and indirectly with actors such as the Mayor's office) are a strong incentive for organizationsto partner with the campus. The campus (and DWP) help partnered organizations find funding and connect to pilot projects (therefore forming coalitions of actors). For example, SayaLife's smart water meter partnered with the campus as a pilot project. Clear from interviews with DWP officials was that it was exploring routes to integrate the technology/actor organizationally. This finding corroborates other researchers who find that vertical linkages are an enabler of broader changes to socio-technical systems (Bai et al., 2009) and for overcoming

Table 5. Opportunities of incumbent-enabled experimentation within the La Kretz Innovation Campus.

Opportunities	Rain Systems	SayaLife	Advantageous Systems	Greywater Corps
Network factors				
Vertical linkages	✓	✓	✓	✓
Horizontal linkages	✓		✓	✓
Political and institutional factors				
Rules, regulations, policies				✓
Rebates and incentives	✓			
Legitimacy and representation			✓	
Economic and financial factors				
Investors/grants	✓		✓	
Pilot projects	✓	✓	✓	
Technological factors				
Technological compatibility	✓	✓	✓	
Personal and human-capital factors				
Skills	✓	✓	✓	
Motivation			✓	✓

institutional barriers (Irvine & Bai, 2019). Since DWP can influence which organizations enter the campus there is a tendency for benefital networks to form. For example, DWP have a 'first look at technologies' arrangement, allowing them to examine the innovations and assess potential future benefits. The utility thus indirectly helps initiate innovations with network potential and, in return, they expect these innovations to aid long-term sustainability goals: as one interviewee described it, 'it is all about the long-term economic propositions' (Interview 1). This is a less likely advantage for external organizations and experiments. Greywater Corps does indeed persue vertical linkages by, for example, attending conferences and connecting to policy makers, but in general it appears much more difficult to build and sustain those interlinkages, such as through 'shared understandings' surrounding the potential socio-economic benefits and 'fit' of innovations.

Furthermore, respondents reported that the campus provides partnered organizations with a 'professional appearance' and gives them a 'stamp of approval' as the organizations can meet clients in the conference rooms and carry the LACI name, for example. Conversely, because the organizations often carry the LACI name, LACI is more cautious with which organizations are accepted at the campus.

Horizontal linkages includes common vision(s) between organizations, local governments, and society, i.e. long-term sustainability visions (Irvine & Bai, 2019; Torrens et al., 2018). The three organizations interviewed highlighted horizontal connections with peer and sister companies as a key opportunity. Being connected to the campus and other groups/organizations facilitates knowledge exchange. For example organizations come together to practice pitches. ADS, for example, was found to have collaborated with multiple other organizations within the campus and mentors other organizations. Researchers have considered the interplay of multiple experiments as crucially important in understanding the reconfiguration of urban systems (Hodson et al., 2017). This interplay also emerged as an important theme in our research. The campus intentionally stimulates the assembling and interplay of multiple innovations and experiments. One interviewee describes this,

> Collectively, as these companies grow, change and band together, they can impact the legislation and the policies. What happens is that legislators will see that this technology is coming, and it will help the environment (Interview 1).

For external experimental organizations, this is once again less of a clear advantage. While external organizations can and do pursue similar horizontal opportunities through joining associations etc., this inevitably takes greater time and resources whereas the campus already assembles similar organisations that can potentially benefit each other.

Closely related are *institutional and political factors*. Firstly, The campus provides organizations with connections to broader political actors, creating channels to seek *legitimacy* and *representation.* One interviewee described this advantage: 'This is what is special about what we have with LADWP here in LACI. It is typically very difficult to cross those channels and have discussions [with government entitities]' (Interview 5). Other institutional and political opportunities include greater alignment between technological innovations and

policy programs such as rebates and incentives. For example, *Rain Systems* works with MWD providing rebates (cashback) to commercial parties using their services. Such alignment with laws, policies and programs can help create a secure market through purchase incentives (Irvine & Bai, 2019). Thus, linkages with DWP (and other actors) highly influence the success of individual experiments as they enable opportunities, such as decisions over who receives pilot projects. Conversely, external organizations are less likely to receive such benefits and primarily navigate city politics and governance independently. However, external organizations can collectively influence broader processes. For example, Greywater Corps and other organizations/non-profits were influential in streamlining LA's greywater system permit processes.

The third opportunity relates to *economic and financial factors*. Funding is available for organizations within the campus. For example, *Rain Systems* drew financial support from the MWD and the Mayor's office for pilot projects. Moreover, LACI has facilitated conneections between Rain Systems and actors such as the LA Unified School District and The City of LA Recreation Parks, resulting in pilot project funding. This is consistent with the observation that financial support and labelling projects as 'pilots' are key success factors in this sector (Farrelly & Brown, 2011). Generally, it appears much more difficult for external organizations to receive fuding, especially for smaller experimental projects. Partnering between private companies and NGOs is one strategy that can enhance funding opportunities for both internal and external organisations, but in general funding opportunities in the water sector are sparse due partly to how capital budgets are tightly tied to cost-recovery, and how funding available is more likely to go to means-tested solutions.

Lastly, there are opportunities concerning *personal and human-capital factors*. Partnering with the campus creates opportunities to develop personal and human-related skills. Mentoring and advice from more advanced organizations/innovations to younger ones stimulates skills development. A classic function of business incubators, which is nevertheless relevant in this context. External organizations can also develop personal skills. However, Greywatercorps highlighted previous bad experiences with advisors who were meant to build skills/knowledge within the company. To some extent, organizations within the Campus are protected from such experiences, as they are directly connected with key professionals in the water sector and benefit from the selection processes to enter the campus.

5.4.2 Limitations of incumbent-enabled experimentation

Incumbent-enabled experimentation faces many limitations related to similar factors as opportunities (Table 6). The most critical were found to be *political and institutional factors*. For example, interviewees highlighted DWP's (and other institutional actors') resistance to change. This was particularly highlighted by the external organisation. In particular, the organizations' entrenched procedural elements and operational culture were perceived as key barriers. One interviewee stated, 'they [government entities] are fearful of trying something new, and they [experimental organizations] always have something new.' (Interview 5). Previous literature highlights the lack of competence, workplace culture and resistance to change as challenges to the progress of experimentation (Bai et al., 2010).

Table 6. Limitations faced by incumbent-enabled experiments within the La Kretz Innovation Campus.

Limitations	Rain Systems	Saya Life	Advantageous Systems	Greywater Corps
Network factors				
Vertical mis-linkages	✓	✓	✓	✓
Horizontal mis-linkages				
Political and institutional factors				
Workplace culture			✓	
Rules, regulations, policies		✓		✓
Economic and financial factors				
Long procurement	✓		✓	
Money and pilot projects	✓		✓	✓
Technological factors				
Technological compatibility				
Personal and human-capital factors				
Lack of knowledge and skills	✓	✓		

Moreover, several interviewees identified the engineering-dominated culture focused on high-tech solutions as a limitation. They often referred to deficits regarding entrepreneurial aspects of initiatives. For experiments to progress, one interviewee explained how:

> You need big players to be on board with your product, and they are usually not on board because of financial reasons. Typically, we are talking about engineers and water scientists; they get on board because of the technology they are interested in (Interview 5).

Thus, prominent policies are focused on engineering solutions, downplaying low-tech or social innovation and experimentation.

Despite attempts to create space for experimenting, internal organizations mainly noted bureaucracy and regulations as a limitation, mainly due to the mismatch between the regulatory timelines and the financial support available. Both internal and external organizations investigated reported that receiving permits, funding, and pilot projects to test small-scale experiments in real-world settings typically took a long time and involved several regulatory hurdles, partly as a product of the risk-aversion described in the previous sections. For example, permits for greywater systems must go through health regulations, testing and approval, which can take up to one year. Such delays mean some companies struggle to finance their association with the campus. One interviewee described how, 'because of the length of time it takes to get contracts with giant city government like the city of LA, I am shifting to shorter sales cycles so that we can have some cash flow' (Interview 2).

Relatedly, interviewees expressed limitations due to a lack of experience in dealing with powerful actors, whether in government or infrastructure managers. *Network factors* and *human-capital factors* also pose a challenge for developing experiments. A lack of linkages, knowledge and skills can result in misinterpreting policy intentions at the local level (Bai et al., 2009). Thus, many factors related to the institutional arrangements of water delivery are limitations for incumbent-enabled experimentation but it is important to note that these limitations were also felt by the external organization interviewed who particularly mentioned the resistance to change.

6. Conclusion and discussion

This paper showed that incumbent-enabled experimentation faces intertwined opportunities and limitations due to its embeddedness and liminal character. The foremost opportunity is enhancing and creating vertical and horizontal network linkages. Through the campus, DWP and LACI stimulate the assembling and interplay between multiple innovations, start-ups and experimental practices. Therefore, such experimental spaces play a role in the LA water system transition that is both *indirect* and *collective*.

As our analysis shows, it is relevant to distinguish between the experimental spaces and specific experiments. Rather than a clear-cut R&D strategy or user-centered, open ecosystem living lab, the campus represents an internal tension *within* an incumbent itself. It both wishes to encourage experimentation (i.e. the 'space') but simultaneously maintains formal and informal control and influence over individual experiments (and their 'success'). This cautions against considering 'incumbents' as internally coherent and consistent actors. Instead, incumbents are complex arrangements of specific, often coexisting, goals and multiple institutionalized logics, cultures, and imperatives.

Our analysis uncovers the selective filtering and enabling that shapes incumbent-enabled experimentation. The findings highlight the need for more nuanced understanding of experimentation that considers the role of incumbencies beyond, but also including, the institutional settings of infrastructure delivery. Attending to place-specific politics, organizational cultures/structures (and internal power dynamics therein), and the specific support structures is essential to grasp the ambivalence and tensions which arise when incumbents encourage experimentation. Specifically, we uncovered a focus on small, predominantly high-tech, entrepreneurial experimentation within the campus, centered on economically feasible solutions to specific challenges. As an incumbent, DWP both filters and provides institutional legitimacy to such innovations. The 'disruptive potential' and 'uncertainties and ambiguities' (Sengers et al., 2019)

surrounding experimentation are reduced through this selective enabling, even when 'failure' of experiments is expected.

Critical questions concerning the 'closeness' (proximity to incumbents) of incumbent-enabled experimentation deserve more attention (c.f. Grin, 2020). The urgency of key sustainability challenges in cities such as LA is forcing actors such as utilities to bring experimentation 'close-by'. Partnering with experimental spaces involves closer connections with city-level decision-makers, regulators, finance sources, and the potential for further 'protections' once innovations reach maturity. Moreover, it gives innovations technical, economic and political 'legitimacy'. Conversely, closeness restricts the types of innovations encouraged, and narrows the disruptive impact upon entrenched institutional logics, organizational cultures, and existing regulatory boundaries. This finding shows the ambivalent position of incumbent-enabled experimentation and points to the need to explore such experimentation further.

While 'incubators' and 'accelerators' have long been common within industry, incubators focused on a loosely defined socio-technical challenge such as 'cleantech' are less common. Arguably, the La Kretz Innovation Campus is unique in its institutional position, explicitly seeking to address city-level sustainability goals. Incubators enabled by quasi-public utilities may display more complex, overlapping objectives, reflecting more complex operating structures. Very few in-depth studies exist of such incubators, and this article may serve as a useful basis for further research. This may include experimentation by other incumbents involved in the governance of urban systems. In general, there is a need for more in-depth analyses of incubators in different geospatial contexts (c.f. Ampe et al., 2021), including critical analyses of how various underlying operating and institutional structures influence innovation outcomes.

This paper has contributed to transitions and experimentation theory, furthering understanding on the influence and role of incumbents in urban water experimentation. First, we provided unique empirical insights into how incumbencies are enabling experimentation. We have further charactirzed and distinguished incument-enabled as a distinct form of experimentation, and developed a means to assess the opportunities and limitations of such innovations. This, we hope, contributes to the literature by providing a more nuanced perspective on urban sustainability transitions that moves beyond, and problematizes, dominant distinctions such as 'niche' and 'regime' in transitions research.

Secondly, we developed a framework for analyzing experimentation anchored by incumbents based on the embeddedness of experimentation within local institutional dynamics. Our contribution enhances understandings of 'incumbencies'. We suggest future research explore different types of incumbent-enabled experimentation, beyond 'cleantech' incubation and explore the 'gap' between the challenges faced by incumbents and their response in the form of experiments. Lastly, further research is necessary concerning the conflicting logics *between* different incumbencies and *within* incumbent-actors themselves. Much of the 'disruptive potential' of such experimentation may not solely lie in a linear progression of 'innovations' but rather the potential for internal conflicts to produce change.

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Appendix

1. List of respondents.

R1	DWP Official (Sustainability Projects)	**R9**	Former DWP Official (Environmental Affairs)
R2	Founder individual experiment 1	**R10**	DWP Official (Water Conservation)
R3	Founder individual experiment 2	**R11**	DWP Official (Water Conservation and Recycling Policy)
R4	Founder individual experiment 3	**R12**	LA Sanitation Official (Water Recycling Implementation)
R5	Founder individual experiment 4	**R13**	LA's Mayors Office of City Services Official (Infrastructure Policy)
R6	Director sustainable water non-profit	**R14**	DWP Official (Environmental Affairs)
R7	Director sustainability non-profit	**R15**	Metropolitan Water District Official (Resource Development)
R8	Founder sustainable water non-profit	**R16**	UCLA Official (California Center for Sustainable Communities)