SUMMARY REPORT

INSTITUTIONAL COMPLEXITY

Navigating diverse perspectives in the adoption of on-site water reuse

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San Francisco, California, USA

Pursuing sustainable alternative water systems

Alternative water systems, such as onsite water reuse, are increasingly explored as a supplement for conventional water and wastewater infrastructure. With the development of new technology, practitioners are encountering both social and institutional hurdles to adopting these technologies beyond the pilot or demonstration scale. Some examples from recent work in San Francisco include perceived competition between centralized and decentralized configurations [1,2], the cost to build, monitor, operate, and maintain systems [1–3], and the transition from a performance-based to a risk-based regulatory framework [1,4]. Overcoming each of these hurdles requires coordination across diverse groups of stakeholders to mitigate institutional complexity. This report summarizes a recent academic study that investigates how institutional complexity exists as a sustainability transition occurs in the adoption of onsite water reuse.

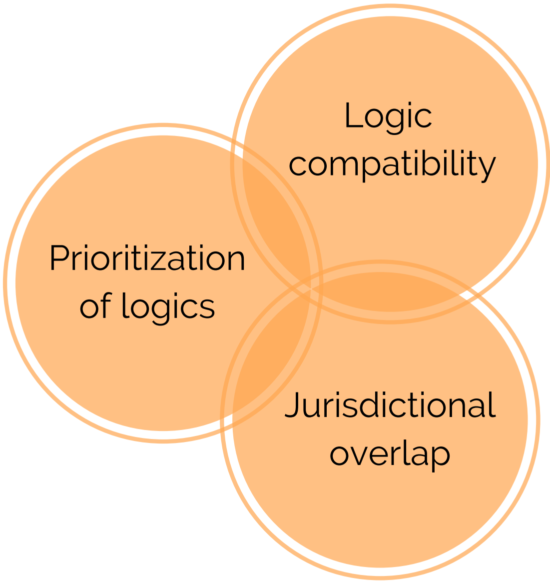

Figure 1. Factors that make up institutional complexity [6].

Complexity is inevitable

In engineering, complexity is usually discussed in relation to the number of interdependencies that exist within a system; the more interdependencies and variables, the greater the complexity. In the same way, 'institutional complexity' also exists in the social aspects of new technologies. Institutional complexity represents the amount of potential incompatibility between disciplinary approaches (sometimes referred to as 'logics' [5]) in a transition process. Almost all transition processes will encounter one or multiple types of institutional complexity , without necessarily resulting in a failed transition. A critical takeaway for stakeholders is to realize the different aspects of institutional complexity in order to encourage successful diffusion of alternative water systems.

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Factors affecting institutional complexity

Institutional complexity is represented by three different components, including logic compatibility, prioritization of logics, and jurisdictional overlap [6] (see figure 1). **Logic compatibility** relates to the alignment of priorities and activities of different actor groups. For example, developers might prioritize the financial feasibility of onsite reuse, while a regulator might focus on limiting risk to human health. While each logic might take a different approach, the weight of one logic might take precedence over another, representing a **prioritization of logics**. For example, a regulatory agency's priorities might carry more weight in a transition because they oversee the permitting and monitoring of onsite water reuse systems. This prioritization relates to the roles and responsibilities held by each organization. The overlap between these roles creates a **jurisdictional overlap**; the greater the overlap, the more potential for institutional complexity.

Case Study: San Francisco

San Francisco (SF) has recently adopted an on-site water reuse program [7] as a way to diversify its existing water portfolio. The adoption of onsite reuse has taken place at the local level with the adoption of Article 12C, a requirement of onsite water reuse for new developments over a certain threshold, with implications for surrounding areas with the adoption of SB 966 [8], and nationally with the establishment of the National Blue Ribbon Commission for On-site Non-potable Water Systems. This transition across the different scales of adoption can be categorized by different phases of adoption, shown in figure 2. We interviewed key stakeholders involved with the onsite reuse programs and specific projects in San Francisco and the Silicon Valley region to understand what type of institutional complexity existed and how various practitioners were able to mitigate it.

Based on the three components of institutional complexity (fig. 1), we found that San Francisco experienced high institutional complexity as the city program (Article 12C) was implemented. As the local program matured, institutional complexity was successfully mitigated by several actor groups that clarified jurisdictional boundaries and framed the adoption of reuse through storylines that are relatable to practitioners from different logics. For example, lowering potable water demand increases sustainability and climate resiliency [9].

How does institutional complexity affect the adoption of onsite water reuse?

The case of San Francisco sheds light on how other cities might be able to navigate institutional complexity as they look to adopt onsite water reuse. Three major takeaways include:

1) Anticipate complexity. When developing a new program at a city or regional level, complexity needs to be anticipated, especially in the early development phases. Encountering institutional complexity does not indicate a program is destined for failure; in fact, it is a normal part of the transition process. Instead of resisting complexity, it is more beneficial to identify the sources of contestation (fig. 1) and develop a long-term strategy to:

- Find common ground between competing logics
- (Re)define jurisdictional boundaries
- Develop a clear prioritization of objectives

2) Intermediaries are key for bridging institutional complexity. In San Francisco, key intermediaries were in the local utility, sustainability consultant firms, and companies responsible for operating onsite water reuse systems, to name a few. What helps the transition process is that intermediaries are able to translate between the different logics, helping with messaging for the program's overall priorities. For example, onsite reuse helps the increase local and regional resiliency, while helping developers meet sustainability certification requirements (e.g. LEED, LBC) [10].

3) Creating an enabling environment around the on-site water program helps navigate institutional complexity. While the number of engaged stakeholders might increase the potential for complexity, it also encourages participation that strengthens the overall uptake of onsite water reuse. For example the development of a risk-based regulatory framework [11] by various actors proved key in streamlining and simplifying the monitoring requirements for on-site water reuse systems. This in turn helped address the risk aversion expressed by some regulatory actors and provided developers and engineers with more flexibility in implementation, helping mitigate some of the increased costs for permitting and monitoring of systems.

Figure 2. Phases within a transition pathway for innovative technology.

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