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Water Microgrids: The Future of Water Infrastructure Resilience

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Abstract

Microgrids have recently come into vogue as a potential solution to address the increasing number of power outages caused by extreme weather events that impact our cities and communities. Such events – often precipitated by increasing global temperatures and climate change – have repercussions that expand beyond damages to a city's electric infrastructure. Water infrastructure is similarly vulnerable to extreme weather events, resulting in significant impacts to clean water distribution, wastewater treatment, and stormwater management. Given this similarity, and other value drivers to be outlined, this paper proposes leveraging concepts behind electricity microgrids to develop a unified framework for microgrid application to promote water resilience in the face of our changing climate.

Many parallels can be drawn between the electric grid and water infrastructure considering both are utilities that generate, store, and distribute an essential product that has been identified as a basic human right. Also similar to the electric grid, water infrastructure is aged and costly to redevelop. For both industries, microgrids are a potential solution that addresses aged infrastructure concerns while also being potentially more cost effective. In addition, by leveraging legacy infrastructural components while developing a new system within the system, microgrids provide redundancy, fortify vulnerabilities and secure the resource supply chain. This paper will investigate parallel components of electric and water infrastructure to provide a vision for future resilient water microgrids.

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1. Introduction

Electricity and water are critical resources of which our society depends; delivery reliability is expected and based on a traditional large-scale, centralized model. Despite being such precious resources, both have numerous delivery challenges, some of which are symptoms of the traditional utility model. An approach leveraged by electric utilities to mitigate these challenges is the development of microgrids that support existing infrastructure. Microgrids for the purposes of this paper can be defined as a grid within a grid – where all functions required for the larger network exist in a modified capacity for a smaller service area. Electricity microgrids are increasingly popular considering their relatively low capital and operational costs compared to redesigning the electric grid, their reliable performance and their ability to mitigate environmental impact. There are many benefits to utilizing energy microgrids many of which would also be realized if microgrid concepts were applied to water infrastructure.

1.1. Energy Microgrids as a model for Water Micronets

Envisioning our water supply networks as a grid, we can apply microgrid components to these networks to develop micronets (water micro networks) for water infrastructure. Like microgrids, micronets are small scale water systems built on top of the existing water supply network infrastructure. This is differentiated from the concept of decentralized water systems (such as decentralized wastewater treatment systems) which are completely segmented from existing legacy infrastructure.

In this paper we will investigate the various components of an electric microgrid and indicate the parallel benefits for water micronets, as outlined in below in Figure 1.

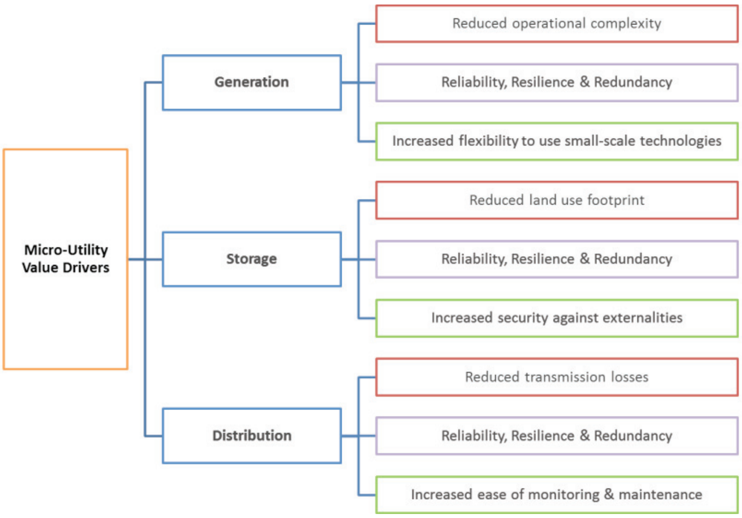

Fig. 1: Conceptual Unified Framework for Micro-Utility Value Drivers

There are three main areas that energy microgrids address: generation, storage and distribution. Each of these can be directly linked to a process that would be required of water micronets. The goal is to illustrate the value drivers of utility micro-infrastructure which prepares us to meet the stresses of future climate effects and increased utilization.

Considering the similarities in structure of water and energy infrastructure, we are proposing a unified framework for utility micro-infrastructure value drivers. By fully exploring these benefits, in the future, business cases can be