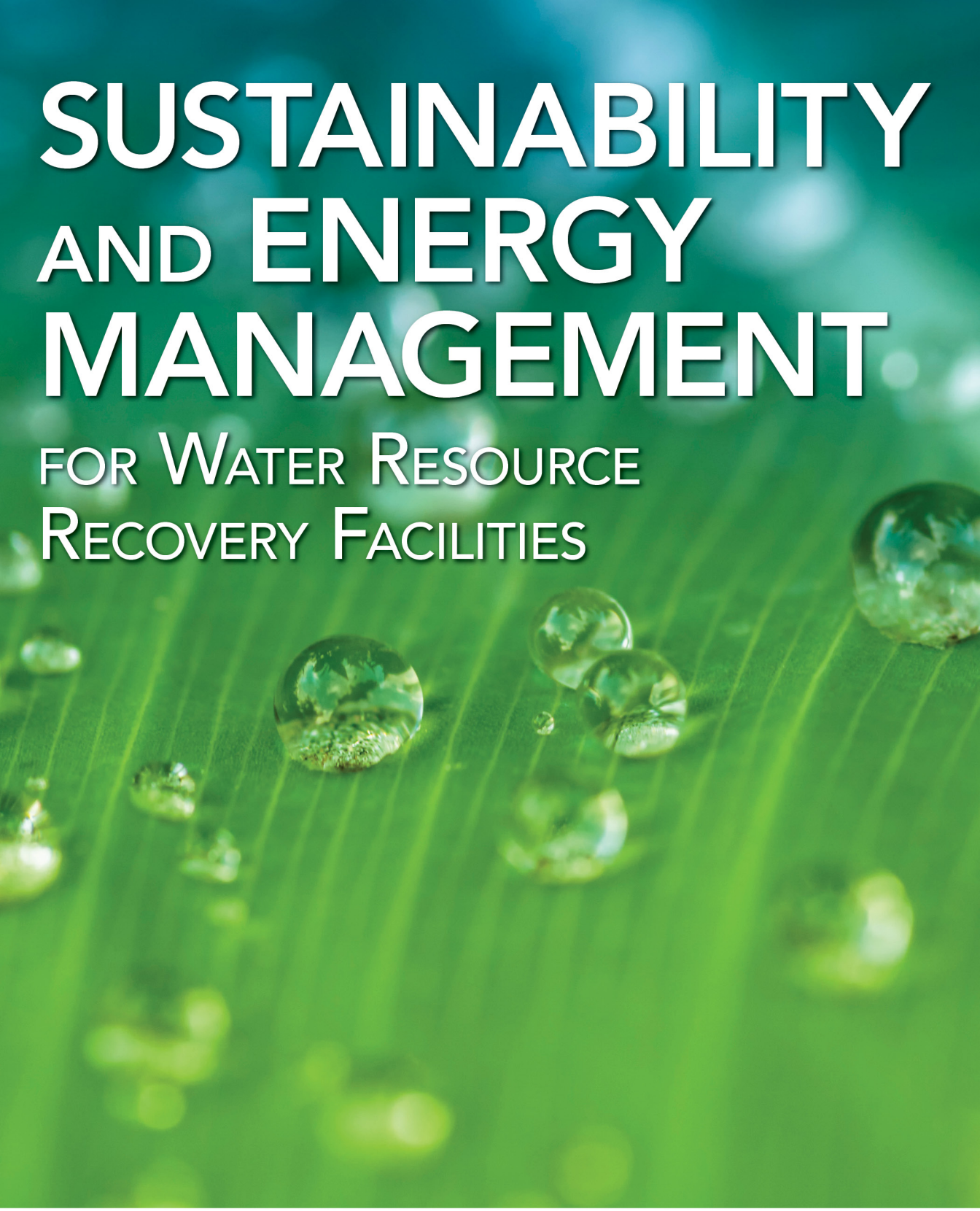
SUSTAINABILITY AND ENERGY MANAGEMENT

FOR WATER RESOURCE RECOVERY FACILITIES



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Sustainability and Energy Management for Water Resource Recovery Facilities

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1.0 INTRODUCTION

Energy savings and sustainable design deserve special attention to be sure water resource recovery facilities (WRRFs) have long-term adaptability and resilience to global climate change, volatile energy prices, and other predictable change scenarios. Municipal WRRFs in the United States use approximately 30.2 bil. kWh/yr, or approximately 0.8% of total electricity use in the United States (EPRI, 2013). Yet, of the approximately 14,780 WRRFs in the United States, only approximately 1268 (8.4%) include anaerobic digestion (which offers the potential to recovery chemical energy) and beneficially use this energy on site for production of power and/or heat (WEF, 2013).

The umbrella of *sustainability* covers long-term provisions for resilient facilities to manage a wider range of stressors, and treatment process adaptability to accommodate changing regulations. Sustainability in this context refers to the ability to continue operating without causing immediate or long-term harm to the environment, society, or depleting natural resources. In the accounting sense, this means planning for the future by making annual financial investments that seek to minimize the total life cycle cost of a WRRF across its full life and avoid deferring costs and negative effects to future generations. The concept of sustainability has also expanded to include indirect effects to the greater community, and consider local industry partnerships and social justice issues. Optimizing the sustainability of a WRRF requires

systems thinking and a willingness to make change. Using strong leadership, cultural buy-in, and an understanding of the best technical practices described in this publication, utility managers can make a big difference.

Public expectations of today's wastewater utility have changed in recent years and are likely to continue to evolve. There is greater emphasis on making appropriate long-term investments for the future and a lower overall *life cycle cost*. This includes an increased expectation to prioritize sustainability of operations and maintenance. These changes are congruent with a shift toward resource recovery and the expectation for more readily realizable benefits to be derived from WRRF projects.

The focus now is on planning and designing facilities that are less costly to operate and maintain over the facility's full life cycle and more resilient to near-term and long-term change. New facilities are expected to have significantly reduced energy consumption, modern automated equipment with less downtime, cost less to operate and maintain, be more resilient to weather extremes, require less chemical inputs, and be able to offer marketable products through resource recovery. These trends are driving facility managers to better balance utility finances through improved control over operating energy and chemical use, and through creation of new revenue sources.

We are also witnessing an increased public expectation for wastewater utilities to establish defined goals that reduce negative aspects and improve the benefits of wastewater infrastructure for future generations. Accordingly, the public expects greater community engagement in planning public infrastructure projects, more attention to *equity and social justice* with respect to facility siting and other neighborhood effects, inclusion of public amenities, and overall more transparency and justification in decisions made by local government. Leadership, vision, transparency, long-term view, fairness, and collaboration are skills needed in this arena. Now is the time for utilities managers to relish the opportunity to engage with the public and spotlight the important work done at WRRFs.

When commencing an initial review of sustainability and/or energy management for WRRFs, the first step is to establish the boundaries for the analysis. This includes setting economic parameters, environmental analyses, and/or geographic/community boundaries. Boundaries will be influenced by the context and culture of the organization, typical approaches used for decision-making, and the current stage of the project. For example, will the evaluation be limited to the immediate project site or a larger campus managed by the same owner? Is the owner interested in applying external frameworks to seek awards (e.g., Leadership in Energy Environmental Design [LEED], Envision, BREEAM®), obtain grant/loan funds, or to simply facilitate communication? Context and boundary decisions dictate final outcomes so it is important to do this early and get input from decision-makers.

This publication addresses energy and sustainability of operations at WRRFs, with a focus on facilities in the United States and Canada but includes strategies, tools, and references that are globally applicable. The best practices described here draw from examples in which optimization of constrained resources within a defined system has achieved the best set of long-term benefits. The spatial boundaries are generally the property line and/or the immediately affected neighborhood near the WRRF. However, indirect effects of facility operations are also discussed regarding the embodied energy of construction materials and greenhouse gases associated with these materials and imports/exports of the facility. *Embodied energy* is the non-renewable energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport, and product delivery to the construction site; measured in gigajoules per unit weight or per unit area. *Greenhouse gases* (GHGs) include the collection of gases both naturally occurring and human-made (e.g., carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, and other compounds), which absorb infrared radiation and contribute to the atmospheric greenhouse effect.

Regarding service life, evaluation of energy and sustainability spans the full expected life of a WRRF, which may range from 30 to 100 years or longer; with 20 to 30 years typically used as the horizon for alternatives analysis and facility planning. Considerations across the project life (i.e., during planning, design, construction, bidding, and operation) are described herein. Guidance for improving energy and sustainability at WRRFs is constantly evolving. Please also see the "References" and "Suggested Readings" sections at the end of this publication.

2.0 SUSTAINABILITY FRAMEWORKS

A number of frameworks for integrating sustainability concepts into projects have been developed in the last two decades. Table 1 provides a summary of sustainability frameworks and related references relevant to the wastewater industry. The choice of which framework is most appropriate for a given project depends on the overall project goals, geographic location, intended use of the installed facility, and owner preferences. Regardless of which tool is used to help integrate sustainability into a project, the project team should anticipate that there will be tradeoffs between competing objectives during each phase and plan ahead as to how objectives will be prioritized and the resulting facility optimized. These tradeoffs are themselves a function of previous decisions about economic, environmental, and community boundaries.