Executive **Summary**

WATER ENVIRONMENT & REUSE FOUNDATION WE&RF

Examining process intensification at water resource recovery facilities

State of Knowledge and Workshop Report: Intensification of Resource Recovery (IR^2) Forum (TIRR1R15)

The Central Issue

Process intensification is a standard term used in engineering, which can be applied broadly. For instance, wastewater treatment intensification could be defined as any system that significantly outperforms conventional designs. That enhanced performance may include increased resource recovery capabilities. New approaches are needed to intensify treatment of wastewater within existing infrastructure because sustainable increases to wastewater treatment capacity and capability are necessary.

Context and Background

In 2015 a group of scientists, engineers, entrepreneurs, and other wastewater professionals gathered to accelerate, develop, demonstrate, and further implement innovative technologies to enhance recovery of water, nutrients, energy, heat, and other valuable products at water resource recovery facilities at reduced costs. Over 30 new technology developers shared their innovations with nearly 150 leading experts and practitioners from utilities, consulting firms, universities, regulators, and other areas of the industry. Technologies examined included:

- Dewaterability impacts of biological phosphorus removal – Technologies that reduce the negative impacts on dewaterability of biosolids.
- Biosolids to fuel – Using pyrolysis or hydrothermal processes to directly produce fuels from biosolids.
- Intensification of mainstream biologic nutrient removal – Technologies that reduce aeration costs for nutrient removal or provide a higher biomass inventory in a smaller footprint.
- Carbon diversion – Using enhanced primary treatment, filtration, or high rate systems to increase carbon resource recovery.
- Digestion enhancements – Technologies that increase digestion biogas yields, including thermal hydroloysis, pretreatment, and co-digestion.

The Department of Energy Technology Readiness Level Scale

The Department of Energy Technology Readiness Level Scale's nine levels describe the progression from basic research to commercial deployment.

Technology Readiness Level	Description
1	Basic research: Basic principles observed.
2	Applied research: Initial practical applications identified.
3	Critical function: Studies and initial laboratory measurements to validate analytical predictions of separate elements of the technology.
4	Laboratory testing/validation of alpha prototype component/process: Design, development, and lab testing of technological components.
5	Laboratory testing of integrated/semi-integrated system: Component and/or process validation in relevant environment.
6	Prototype system verified: System/process prototype demonstration in an operational environment.
7	Integrated pilot system demonstrated: Demonstration of an actual system prototype in a relevant environment.
8	System incorporated in commercial design: Pre-commercial demonstration.
9	System proven and ready for full commercial deployment: Actual system proven.

Findings and Conclusions

There are numerous possibilities for process intensification of resource recovery. Those possibilities include new technologies that have been successfully applied by early adopters. These three elements can further facilitate early adoption:

1. The value of innovation.
2. The potential for resource recovery.
3. The need for dedicated funding for research, as well as the long-term return from investment in research.

All of this information should be provided to community leaders, policymakers, and decision makers. This research report provides an independent literature review and state of knowledge of the technologies described above. It presents the possibilities for process intensification of resource recovery that are available through new technologies and identifies critical research or demonstration needs.

Management and Policy Implications

This report presents numerous possibilities for process intensification of resource recovery which are available through new technologies that have been successfully applied by early adopters.

Early adoption of new processes and technologies that outperform conventional designs can significantly improve the performance of water resource recovery facilities within existing infrastructure.

A few of the esteemed participants at the 2015 Intensification of Resource Recovery Forum.

Related WERF Research

Project Title	Research Focus
Assessment of Technology Advancements for Future Energy Reduction (ENER7C13b)	Provides an assessment of emerging technologies for energy recovery and their potential.
Towards a Renewable Future: Assessing Resource Recovery as a Viable Treatment Alternative (NTRY1R12)	Reviews extractive nutrient recovery technologies with an emphasis on bridging the knowledge gap faced by utilities when considering nutrient recovery for nutrient management.

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