Workshop for Developing Evaluation Metrics to Advance a National Water Resource Resource Recovery Facility Test Bed Network

May 16-17, 2016

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- My job this morning is to quickly update you on the Metrics Workshop that proceeded our workshop today.

The Organizing Committee

James Mihelcic (*evaluation metrics workshop chair)* Department of Civil & Environmental Engineering University of South Florida
Aaron Fisher Technology and Innovation Manager, Water Environment Research Foundation (WERF)
Adriane Koenig Oak Ridge Institute for Science and Education Research Participant, assigned to Environmental Protection Agency Office of Science and Technology
Jeff Moeller Director of Water Technologies at the Water Environment Research Foundation (WERF)
Mark Philbrick Waste-to-Energy Coordinator, Bioenergy Technologies Office, Department of Energy
Jason Ren (*structures workshop chair*), Environmental Engineering, University of Colorado Boulder
Bob Rose Policy Analyst for EPA Office of Water, Water Policy Staff
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Seth Snyder Water Initiative Leader, Argonne National Laboratory
Jason Turgeon Physical Scientist, Energy and Climate Unit, Environmental Protection Agency, Region 1

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Metrics Workshop Background

- May 16-17, 2016
- 59 stakeholders participated from geographically diverse regions representing academia, municipalities, technology vendors, federal government, and nongovernmental organizations.
- Several stakeholders were also managers of existing or planned testbeds.

Our ***workshop's primary objective*** was to:

define several key metrics that every new technology (or process) evaluated at the national test bed network that impacts the operations of a water resource recovery facility should measure and report.

What is a metric?

- **Metric**—"Defines the unit of measurement or how the indicator is being measured" (OECD 2011a). *Example: Using the first definition, an example metric would be [**grams Hg (of mercury)/Kwh (of energy input**)].*
- *The description illustrates the metric in the latter sense—specifying exactly how one arrives at the measure—**so that any two individuals in different institutions would come up with the same number.***

Table / 1.3

Characteristics and Intentions of Effective [redacted] Metrics

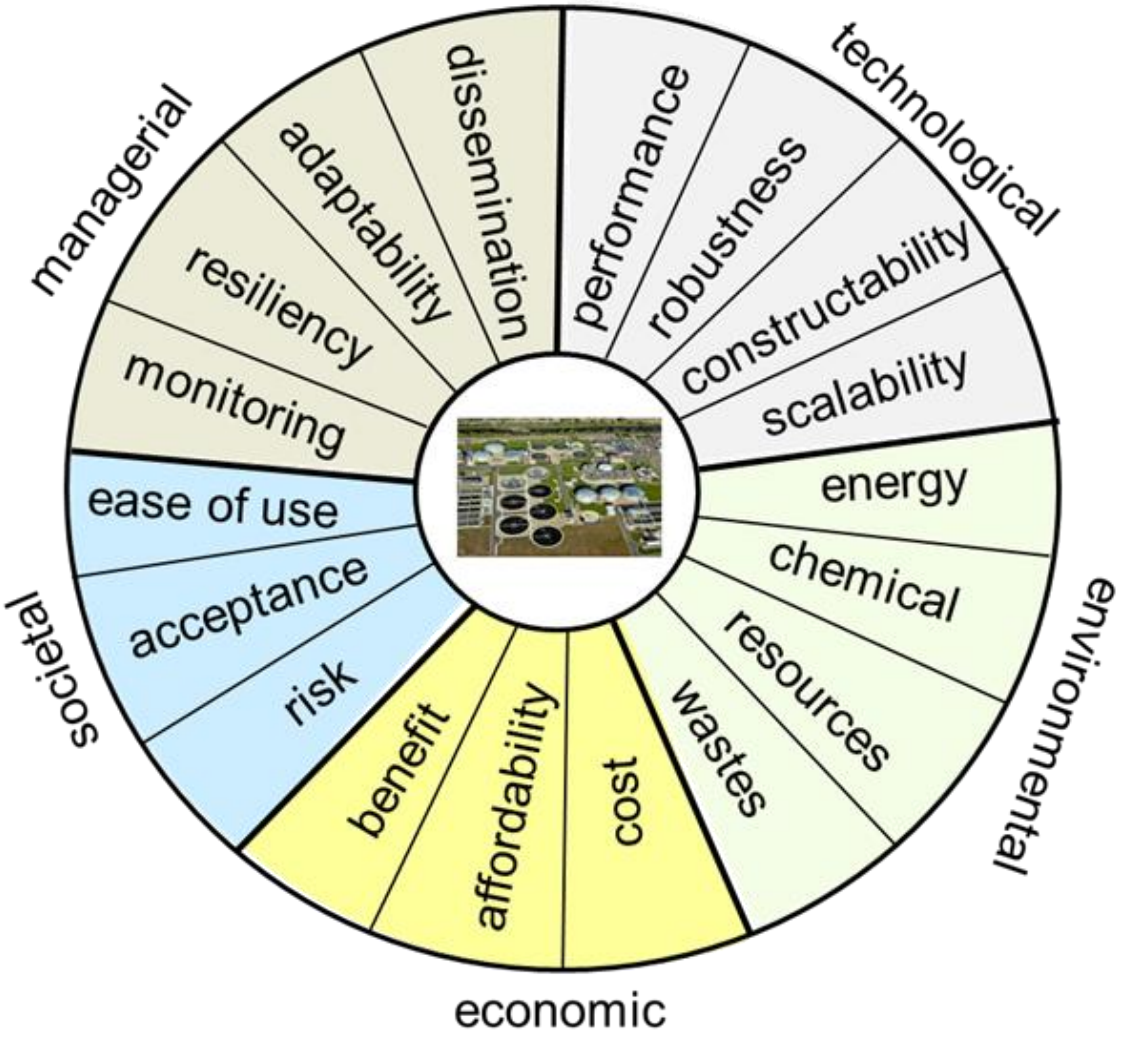
Relevant
Easy to understand by all stakeholders
Reliable
Quantifiable
Based on accessible data

Day 1 - Monday Morning

- Three keynote talks provided perspective of appropriate metrics from: 1) a utility perspective, 2) considerations of energy and small to large facilities, and 3) how to integrate energy and a sustainability framework into metric selection.
- The three keynote talks were following by a six-person panel that provided utility and federal perspectives on appropriate metrics for assessing treatment and resource recovery technologies.

Framework to organize thinking about sustainability that would inform the evaluation of activities or technologies

(preprinted with permission from Dr. Qiong Zhang, University of South Florida)



Monday Afternoon & Tuesday

Breakout Sessions……. And input from the larger group

Charge Question 1a: What will we be able to achieve with a common set of metrics?

1. facilitate dissemination of information
2. simplify interpretation of data
3. enable transparent comparison of technologies and process through standardized measurements
4. establish the legitimacy of test data

Charge Question 1b: what is an appropriate set of common metrics that should be measured across a national test bed network and reported for all technologies that impact the performance of a wastewater resource recovery and treatment technologies

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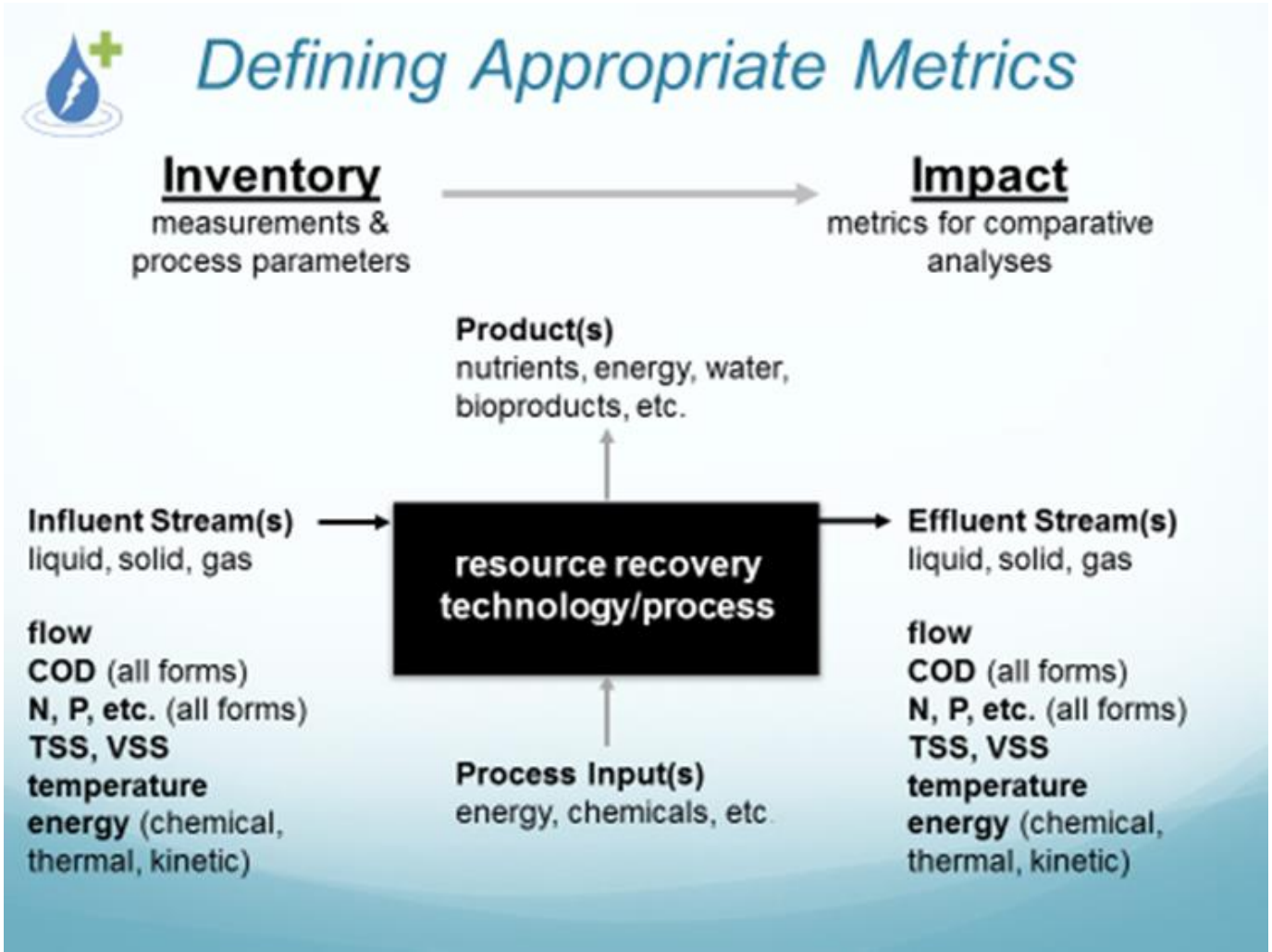
Categories identified:

1) mass balance (material and energy)
2) economic
3) risk
4) management/operations
5) regulatory (*)

Charge Question 1b: what is an appropriate set of common metrics that should be measured across a national test bed network and reported for all technologies that impact the performance of a wastewater resource recovery and treatment technologies (figure courtesy of Dr. Jeremy Guest, University of Illinois)



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Mass Balance (Material and Energy)

- COD, N, P mass balance to inform nutrient recovery, GHG emissions, energy balances
  - kg valuable product recovered / m3 treated water
  - kg product recovered/kg product removed
- Intensification
  - (mass removed or recovered) / reactor size - time
- Energy
  - kWh/(kg or m3 recovered)
  - CO2 Footprint (geographical and time of day differences)
  - O2/kg mass recovered or removed

Charge Question 1b: what is an appropriate set of common metrics that should be measured across a national test bed network and reported for all technologies that impact the performance of a wastewater resource recovery and treatment technologies

Economic

- Physical footprint
- Life cycle cost
- $/(kg or m3 recovered or kWh produced)

Regulatory

- Toxicity assays
- Emerging chemical removal

Charge Question 1b: what is an appropriate set of common metrics that should be measured across a national test bed network and reported for all technologies that impact the performance of a wastewater resource recovery and treatment technologies

Risk

- Scalability
- Resiliency
- Ease of Integration with existing infrastructure
- Cost Uncertainty
- Seasonal Performance

Management/Operations

- Staffing requirements (includes hours)
- Education/Certification Requirements

Charge Question 2a:
How might metrics change across different levels of testbeds?

- Breakout groups recognized that metrics measured may change across different geographical locations (climate, size)
- Metrics measured at one testbed tier level may not be translatable to other testbed tier levels.
- It may be easier to obtain economic or socio-economic metrics at the larger scale tier testbeds.
- Evaluation of some managerial and societal measures of feasibility and sustainability may be subjective and will reflect existing plant design and operating philosophy.

Charge Question 2 b:
What is the proper framework that would allow new metrics to be included in the future?

- Not discussed in depth by any of the four breakout groups.
- There seemed to be a general consensus that flexibility is important to the framework to allow for new metrics to be included in the future.

Charge Question #3: What is most effective method to store data generated during testing.

- Require a standard data management plan that addresses how data is stored.
- Some usable formats for mentioned were raw data, metadata, and synthesized data.
- Data should be easily combined with other data for comparative analysis and be able to be independently analyzed.
- Data could be more than numerical metrics and could include fact sheets, videos, links to videos, and other data visualization tools.
- Data security is important to prevent an outside party from entering the data storage system and manipulating existing data.
- There should be a plan to share data from test failures as well as test successes.

Charge Question 4a:
Who needs to have access to the data?

- End users: the public, research community, government agencies, funding organizations that include technology vendors and developers, venture capitalists, consultants, regulators, educators, professional organizations (e.g., WEF, WERF), utilities and their operators, and other testbeds in the network.
- What might cause restrictions in access to data? for example, will access to data be linked to financial support of a testbed or particular test, how would intellectual property considerations impact data access, and will users of the data pay for access.
- Data should be available to smaller utilities who may not have financial resources.

Charge Question 4a:
Who needs to have access to the data?

- Potential risks include: 1) labels of performance are likely to have long-term impacts on perceptions of a particular technology or process, and 2) as our understanding of technologies evolves, our ability to optimize and control them will mature and improve.
- Information on capital costs/risks is critical for decision makers but less certain and relevant at the bench-scale and more quantifiable for pilot- and full-scale test bed studies.

Charge Question 4b: What is the most effective way to share information after a pilot is over to ensure wide dissemination and public access?

- Data management plans are an effective way to share information to ensure wide dissemination and public access.
- It may be important to separate public (open) data and private data, which may be more secure.
- Examples include: 1) user-friendly clearing house with a searchable/filterable database, 2) multi-access portal, cloud storage, 3) development of common data fields, and 4) leveraging social networking platforms.
- It was recommended also that there are examples on data sharing to learn from; for example, the stormwater BMP database and two-page fact sheets developed for other technology evaluations

Charge Question 4b: What is the most effective way to share information after a pilot is over to ensure wide dissemination and public access?

Questions raised by breakout groups:

- Perhaps the WERF LIFT program has addressed some issues related to data sharing and intellectual property.
- what is a reasonable expectation of data-sharing if a technology supplier is utilizing a testbed and benefiting from the claim of testbed validation?
- how might intellectual property considerations impact data access?
- is it possible to have standardized agreements by testbed tiers because universities and utilities have different requirements for academic freedom / public information?
- It was also noted that there may be a conflict with a goal that testbeds would provide a safe place to fail, but how this would integrate with a requirement that all data must be shared.

Where are we now…

We have a draft report, and this summer will prepare a final report and associated manuscript for dissemination

What is a metric?

- **Goal**—what is specifically sought to be achieved. The goal is determined through the use of measured indicators. *Example: Reducing mercury emissions from electric utility steam generating units.*
- **Indicator**—"A summary measure that provides information on the state of, or change in, a system" (OECD 2011b), that is, what is being measured. *Example: Mass of mercury emitted per heat energy input, for example, pounds per gigawatt hours.*
- **Metric**—"Defines the unit of measurement or how the indicator is being measured" (OECD 2011a). *Example: Using the first definition, an example metric would be [**grams Hg (of mercury)/Kwh (of energy input**)]. The description below illustrates the metric in the latter sense—specifying exactly how one arrives at the measure—so that any two individuals in different institutions would come up with the same number.*