Application of Big Data for Energy Management: Questionnaire

Stantec is leading a research project for The Water Research Foundation entitled: "Application of Big Data for Energy Management in Water Utilities" (WRF #4798).

Progress has been made over the last decades in data technologies for improved data analysis and management, which have been incorporated into water and wastewater facility operation and planning. The tools for data processing in the water industry have evolved from sensor-based knowledge to more recent optimization-based data mining techniques and to new approaches based on big data including predictive analytics that allow for actionable real-time system control. This contemporary research project aims to provide utilities with guidance on advanced big data analytics for automated data collection and achieving energy efficiency and cost-effective operations.

This questionnaire, as one of the tasks for this project, will collect information on the current practice, opportunities and challenges related to data acquisition, data analytics, display and other data management strategies for energy optimization and management.

Please complete the following questionnaire by **April 15, 2020**. Your input is extremely valuable for the project as the information collected will highlight the critical needs in advancing big data and data management practices at water and wastewater utilities.

If you have any questions about the project or the questionnaire, please contact Dr. **Carla Cherchi** at carla.cherchi@stantec.com or at (626)-568-6009.

All information information received will be used strictly for academic research purposes and under no circumstances will your organization be identified with any of the information provided, unless permission is given at the end of the questionnaire.

Contact information

- Name of Respondent:_____
- Title:_____
- Utility Name:_____
- Email Address: _____
- Phone Number:_____

SECTION 1: Energy Information of the Utility

Q#1 - Please describe the services your utility provides (Please select all that apply):

- ☐ Drinking water
- ☐ Wastewater
- ☐ Water reuse
- ☐ Water transmission
- ☐ Stormwater
- ☐ Other (Please specify):_____

Q#2 - Provide the following information regarding your water system, if applicable:

- Total customers served (including residential, industrial, commercial users):_____
- Annual average water demand (MGD):_____
- Number of water treatment plants:_____
- Number of distribution pump stations:_____
- Reporting year for the information above:_____

Q#3 - Provide the following information regarding your wastewater system, if applicable:

- Population equivalent:_____
- Number of wastewater treatment plants:_____
- Annual average wastewater flow (MGD):_____
- Reporting year for the information above:_____

Q#4 - Please complete the table below with the approximate breakdown of energy use, energy cost and demand for each operation category that applies to your agency:

Note: Use "N/A" if the data is not available; Use "Not Applicable" if the option does not apply to your utility

Parameter	Drinking water[1]	Wastewater and/or water reuse[2]
Annual energy cost ($)		
Annual cost of energy purchased in spot market ($)		
Annual energy use (GWh) - Total		
Annual energy use (GWh) – Purchased (Total)		
Annual energy use (GWh) – Purchased (On spot market)		
Annual energy use (GWh) – Self-supplied		
Average peak demand (MW)		
Annual thermal demand (MMBtu)		
Reporting year for the information above		

[1] Includes raw water pumping, treatment and distribution, transmission including any minor ancillary use (e.g., offices, HVAC, etc.)

[2] Includes wastewater collection, pumping and treatment and water reuse, including any minor ancillary use (e.g., offices, HVAC, etc.)

Q#5 - Provide the following information regarding your energy generation and storage capacity:

- Total existing/installed electricity generation capacity (MW):_____
- Percentage of total electricity generation capacity exported to the grid or other users (%):_____
- Percentage of total electricity generation capacity used on-site (%):_____

Provide the breakdown of your energy storage/generation source capacity (nominal) and the average contribution to your daily energy portfolio:

Energy source	Percentage (%)	Nominal Capacity (MW)
Biogas		
Solar		
Wind		
Hydropower (lake/river)		
In-conduit hydropower		
Energy Storage		
Others		

SECTION 2: Data Acquisition Practice

Q#6 – Both energy and non-energy related data should be collected for energy management. What type of data do you collect, and how frequently, for energy management purposes at your utility?

Data Category	Example Data	Frequency of Collection/ Granularity (e.g. monthly, daily)	Used for Energy Management Decisions? (Y/N)
Energy billings	Bills (electric, natural gas, steam, diesel)		
	Tariff structures and rates (e.g., TOU/TOD)		
	Demand charges		
	Power factors, or other component of energy used in billing		
Energy data	Energy/power consumption of equipment (process related)		
	Energy/power consumption of equipment (not process related)		
	Energy sub-metered data		
	Motor amperage		
	Power generation of power sources on-site		
	Energy stored on site		
Power quality data	Breakers		
	Harmonics		
Process data	Flows (raw water, treated water, intermediate flows, sludge flows, inter-stage volumes pumped, airflows, etc.)		
	Pressures (suction and discharge), head, pump speed		
	Storage volumes, reservoirs and tank levels and operating limits		
Operational data	Process control parameters and set points		
	Pump start/stop cycles, runtime, rotation and pump status		
	Pumping combination configurations and efficiencies		
	Hydraulic modeling results		
Asset data	Asset inventory		
	Process or distribution system configuration		
	Pump curves and efficiency curves		
	Equipment nameplate information		

Data Category	Example Data	Frequency of Collection/ Granularity (e.g. monthly, daily)	Used for Energy Management Decisions? (Y/N)
	Equipment maintenance records and repair history		
	Testing performance (e.g., oil tests, infrared rests, and motor testing)		
	Maintenance work order system tracking		
	Asset management data		
Water quality data	Field water quality data		
	Laboratory water quality data		
Enterprise data	Regulatory data		
	Customer information and accounts and customer sales data		
	Financial information and budgets		
	Cost of replacement new (CRN) insurance valuations		
	GHG emissions data		
	Number of violations or emergency events		
Others	Statistics on the utility and its network		
	Weather data and seasonal data		
	Previous utility energy reports		

Q#7 – Sub-metering of energy consumption data has also been proven to be invaluable in understanding the details of facility energy usage and assist in energy/cost optimization and management of assets and processes. Do you have energy submetering at any of your facilities?

- ○ Yes, we have energy submetering in place
- ○ No, but we are planning on implementing energy sub-metering in the near term
- ○ No, we do not have energy sub-metering
- ○ Other (Please specify):_____

Please provide the following information below related to your submetering practice (if applicable):

- Assets/processes submetered:_____
- Total number of submetering points:_____
- Energy submetering size cutoff for equipment (hp):_____
- Describe the type of energy submetering infrastructure used:_____
- Do you have a plan for submetering instrument calibration and validation? (Y/N):_____
- Briefly describe your plan for submetering instrument calibration and validation:

  _____

Q#8 – What are the main challenges that you currently experience or have experienced regarding data acquisition equipment and practices and that may limit your opportunities to rely on big data solutions? (Please select all that apply)

- ☐ Data incompleteness and data gaps
- ☐ Data accuracy issues and quality issues
- ☐ Lack connection of the data collection equipment to SCADA or historians
- ☐ Errors or offsets from non-calibrated instrumentation
- ☐ Discrepancy in the collection and recording time frequencies, resolution and status
- ☐ Lack of protocols for selection of data acquisition frequency and data reconciliation/synchronization
- ☐ Lack of integration of data acquired from different sources stored in different locations
- ☐ Lack of integration between resolved and unresolved data sets
- ☐ Lack of data validation protocols
- ☐ Lack of staff and resources to maintain and operate a metered system, to identify data challenges and to QA/QC datasets
- ☐ Other (Please specify):_____

Please provide examples on the strategies you used to overcome some of these data acquisition challenges that have improved your energy management activities.

Q#9- Please describe your current data storage practices for data that you collect to make energy management decisions.

- ☐ Manual logbooks
- ☐ Electronic logbooks
- ☐ SQL Database
- ☐ Data Historian
- ☐ Internal servers
- ☐ SCADA
- ☐ Oracle
- ☐ Third party cloud-based servers
- ☐ Other (please specify):_____

Please briefly describe the limitations of your data storage practice for your energy management activities (e.g., integration of different datasets stored at multiple locations, communication issues among different systems, data access authority, etc.)

If your data is stored in multiple locations, please provide your plan/strategy to integrate the different datasets at one centralized location, if any.

SECTION 3: Big Data Tools and Analytics

Note: **Big data analytics include data mining (search of patterns and relationships in data), predictive analytics (forecasting models), machine and deep learning (algorithms analyzing large data sets), and artificial intelligence*.

Q#10 – Which of the following energy management activities at your utility benefit or would benefit the most from the use of big data analytics and related infrastructure? (Please select all that apply)

- ☐ Energy and/or cost optimization of pumping systems
- ☐ Energy and/or cost optimization of aeration processes and aeration blowers
- ☐ Energy and/or cost optimization of pre-treatment and primary treatment processes
- ☐ Energy and/or cost optimization of other secondary treatment processes
- ☐ Energy and/or cost optimization of chemical feed pumps
- ☐ Energy and/or cost optimization of sludge handling processes
- ☐ Energy and/or cost optimization of on-site distributed energy generation
- ☐ Energy and/or cost optimization of energy storage systems
- ☐ Energy demand management
- ☐ Establish dynamic baseline performance
- ☐ Integrated process evaluation
- ☐ Process control and automation
- ☐ Offline simulations of system or asset energy performance
- ☐ Internal or external energy benchmarking
- ☐ Decision making for capital investments
- ☐ Proactive identification of preventive actions
- ☐ Troubleshooting, response time and maintenance planning
- ☐ Asset management decisions impacting energy management
- ☐ Other (Please specify):_____

Q#11 - Do you currently use or plan to use any in-house developed or commercial off-the-shelf solutions (e.g., OT/IT interface, database, data storage, data analytics software, optimizer, energy dashboard, etc.) for operational energy efficiency and energy cost reduction?

- ○ Yes, we use in-house developed data management solutions
- ○ Yes, we use commercial off-the-shelf data management solutions
- ○ No, but we plan to develop data management solutions in-house
- ○ No, we plan to procure commercial off-the-shelf data management solutions
- ○ No, we explored the feasibility of installing data management solutions, but we decided not to implement them
- ○ No, we don't intend to use any data management solutions

If you are using equipment, commercial off-the-shelf or in-house data management solutions, please provide the following information in the table below and describe if these equipment or solution have functionalities that are based on big data approaches:

Name (Equipment, solution, technology, software, tool)	**Function/Application for or in support of energy management** (Data managment, system control, data storage, etc.)	**Does the solution include a big data analytic approach? (Y/N)**	**Briefly explain the details of the big data analytic approach**

SECTION 4: Data Display for Business Intelligence

Q#12 - What key performance indicators (KPIs) do you use for operational energy use assessment and benchmarking?

KPIs used for pumping system performance *(e.g., Wire-to-water efficiency (%), Pump energy indicator (kWh/MG/ft),* Specific energy (kWh/MG), etc.)

KPIs used for wastewater treatment process performance (e.g., MWh/year, kWh/MG of influent pumped, kWh/kg of BOD_5 removed, etc.)

Energy performance of energy generation and storage processes (e.g., kWh produced/m^3 biogas, kWh generated/kWh consumed, % of energy offset from grid, etc)

Other KPIs categories used for assessing energy performance or energy cost related information (e.g. Load factor ratios, demand factor ratios, kWh (off-peak)/kWh (on-peak), $ spent off-peak/$ spent on-peak, etc.)***:***

Please list any additional KPIs that you are currently considering at your utility that are of relevance for energy management:

Q#13 – Do you have an energy dashboard to monitor your system's energy information and performance, and to make energy management decisions? (Please select all that applies)

- ○ Yes, we have an energy dashboard displaying information from the entire system
- ○ Yes, we have an energy dashboard displaying information from only a portion of the system
- ○ No, but we plan to procure or develop an energy dashboard in the near future
- ○ No, we don't intend to procure or develop an energy dashboard

Please provide additional information supporting or justifying the selection above (e.g., which part of the system is covered by the energy dashboard, customization of energy dashboard to various organizational levels, preference of in-house developed vs. commercial of the shelf dashboard, challenges and obstacles to the procurement of a dashboard, etc.):

Q#14 - List all the data and information your dashboard displays. If you do not have a dashboard, list what would you include in your potential/dashboard to assist your energy management decisions.

- ☐ Temporal, and historical, plant- or asset-level energy consumption profiles versus influent flows or other normalizing parameters
- ☐ Forecasted plant- or asset-level energy cost and consumption profiles based on predicted future system performance
- ☐ Outcomes of energy benchmarking with other utility assets or those of peer utilities
- ☐ Power quality monitoring parameters
- ☐ Correlations between process metrics, causes of inefficiencies and troubleshooting measures

- ☐ Alert and alarms to identify issues in real-time
- ☐ Outcomes after energy management interventions or improvements
- ☐ Time-of-day process information and its impact on operating costs
- ☐ Cost savings achieved in semi-real-time or real-time
- ☐ Cost incurred for no taking actions
- ☐ Other (please specify): _____

SECTION 5: Benefits and Challenges of Big Data Practices

Q#15 - List all the benefits achieved through your big data solutions and practices, if any, and provide a brief explanation of the benefit achieved.

- ☐ Cost savings:_____
- ☐ Energy savings: _____
- ☐ GHG emissions reduction:_____
- ☐ Improved demand management:_____
- ☐ Energy benchmarking opportunities: _____
- ☐ Improved uniformity of operations through automation:_____
- ☐ Improved troubleshooting, response time and maintenance planning: _____
- ☐ Improved knowledge on system operations: _____
- ☐ Improved asset performance visibility: _____
- ☐ Improved operations and performance of distributed energy resources:_____
- ☐ Extend service life of physical assets and delay specific investments: _____
- ☐ Improved workforce skills and reduced labor cost: _____
- ☐ Flexibility to change as the data management solution matures:_____
- ☐ Improve and accelerate the reporting process:_____
- ☐ Improved convergence of IT/OT:_____
- ☐ Improved communication to internal and external stakeholders:_____
- ☐ Assist organizations in preventing knowledge losses:_____
- ☐ Others (Please specify):_____
- ☐ We do not use any big data practice

Q#16 - List all the challenges of implementing data management solutions and big data approaches at your utility and provide the strategy that would help you overcoming these challenges.

- ☐ Unable to afford capital investments for big data management solutions
- ☐ Lack of an integrated data management approach, standards and procedures
- ☐ Concerns over integration of data solutions with existing infrastructure
- ☐ Concerns over reliance on third party solutions
- ☐ Data security concerns
- ☐ Cultural resistance to technological advancements and automation
- ☐ Lack of integrated effort within other departments in the organization
- ☐ Inadequate time or in-house expertise to develop or deploy big data solutions
- ☐ Others (Please specify):_____

Q#17 – What type of staff resources, operational skillsets and commitment do you need or wish to have available to develop and maintain the big data solutions in place at your utility?

SECTION 6: End of the Questionnaire

The information collected in this questionnaire will be included in a report published by the Water Research Foundation. Do you give permission to disclose the name of your Utility and the information collected in the final report?

- ○ Yes
- ○ No
- ○ Don't know, I will make a decision after reviewing the draft final report.

This concludes the Questionnaire.

We greatly appreciate your time in answering these questions.
For any questions regarding this questionnaire please contact
Dr. Carla Cherchi at **carla.cherchi@stantec.com**

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