INNOVATIVE ENERGY MANAGEMENT PLATFORM FOR WATER AND WASTE WATER UTILITIES

by

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ABSTRACT

Water has become an issue of national security for most countries of the world. Water is a natural resource, fundamental to life, livelihood, food security and sustainable development. It is also a scarce resource. India has more than 17% of the world's population, but has only 4% of world's renewable water resources with 2.6% of world's land area. With the growing population, managing the demand and supply for the water utilities is going to be a challenge. It is necessary to reduce the operating expenses along with energy consumption to maintain the right balance between quantity and quality. It is important to have a public sector and private sector participation in addressing the supply and demand gap by improving the energy efficiency, technology penetration for recycling spent water, adopting advanced Instrumentation and Communication Technology.

This paper aims to address the various methods of energy efficiency and cost cutting methods to efficiently manage the water utilities and also the need for an innovative software platform for energy management. Wipro's innovative software platform and advances in smart metering helps in dealing the issues effectively in water and waste water systems thereby improving energy efficiency and quality in real-time. The set of services which will be offered by the platform includes energy optimization, smart monitoring of parameters, predictive controls, advanced analytics and reporting. Wipro's software platform aims to provide:

- Continuous monitoring - Use of smart metering to pick up and transfer critical operating and quality parameters to take quick decisions for an effective change or alteration in the operating conditions, which helps the operation and maintenance team to improve the operational efficiency and maintenance practices, improve quality and meet regulatory standards.
- Analytics - The plant level advanced data acquisition layer and platform level energy intelligence layer helps to trigger innovative modeling and optimization.
- Reports - The reports generated is designed to help the Operations team take the right decision and for the stake holders to plan and strategize.

INTRODUCTION

There is strong link between water and energy in municipal water generation and distribution systems. Monetary savings through water and energy are possible through technical and managerial interventions in water and wastewater systems, providing consumers with quality water using a minimum of energy. Efficiency in the provision of water and energy is one of the few cost-effective options available for meeting growing demands for vital services such as electricity, water and wastewater treatment. In addition to direct savings in water and energy, efficiency improvements in municipal water utilities generate impressive reductions in operating costs and often improve services.

The integral relationship between water and energy is not widely understood or sufficiently exploited through coordinated, holistic efficiency approaches. The water-energy relationship is based on the reality that treating water for human consumption and moving treated water to the consumer is an extremely energy intensive undertaking. The cost has surely not gone down with the ever increasing cost of producing energy itself hence every liter of water that passes through a system represents a significant energy cost. The relative energy importance of the different

steps depends on factors like the topography between the water source and its destination (especially elevation change), distance from the bulk water supply, and the integrity of the primary mains (supply pipes) and secondary mains (distribution pipes).

In India energy is usually the highest cost associated with water supply. Water supply and wastewater treatment are also infrastructure-intensive, requiring expensive pumping, treatment, and conveyance systems. Water access can be expanded much more quickly and inexpensively through efficiency than new infrastructure, deferring the need for additional infrastructure investment. Also, water and wastewater investment decisions that neglect energy efficiency have a domino effect that increase investments in other sectors such as power plants, investments to extract and transport the additional fuel and the environmental costs associated with air emissions and declining water and hydrocarbon reserves. A development agenda that maximizes the capacity of existing infrastructure through efficiency before encouraging new construction is the most cost-effective and sustainable way to meet the growing need for clean water. By incorporating efficiency into existing and planned infrastructure systems, costs can be controlled, service delivery can be improved and access expanded without necessarily adding to the cost of the service.

NEED FOR PUBLIC AND PRIVATE SECTOR PARTICIPATION

The key benefit of public-private partnerships for municipal water and wastewater systems is better reach, efficiency and cost. Such savings can be derived from a number of areas such as chemicals, equipment, power, sludge, etc. International case studies shows that with more than three decades of operating, maintaining, servicing and managing water and wastewater utilities, private operators have the expertise to effectively utilize and maximize these facilities along with the initiatives of the public sector, there is going to be reductions in consumption which will help municipalities generate savings. Effective opportunities exist for the private players in India to explore opportunities to improve the delivery of services in the water supply and waste water treatment plants joining in hands with Public Utilities. There can be effective mechanisms which can be formulated to make it effective.

IMPROVING ENERGY EFFICIENCY

The energy efficiency in water and waste water utilities are addressed in three areas such as pumping, leakage and pressure management and effective monitoring and control.

Pumping Systems

One of the most critical elements to improve water and wastewater system efficiency is to optimize energy consumption by the pumping systems. Optimizing the system includes improvements such as matching the pump to requirements, optimizing the distribution piping, eliminating unnecessary valves, controlling pump speed where appropriate, and institutionalizing improved O&M practices. Some of the top priority options are as below:

- Improve Pump System Efficiency
- Optimizing the pumping power with respect to the waste water characteristics such as BOD, SS and nutrient levels
- Replace inefficient (and often over-sized) pumps with efficient, properly sized ones.
- Effective capacity regulation by ON/OFF or Install variable speed drives
- Regular preventative maintenance and adopting condition based monitoring techniques
- Energy efficient motors

The pumping system should be analyzed to identify the opportunities for improvements. A common problem in water supply and wastewater treatment pumping systems is the selection of pumps which are often too large for the needs of the system. All pumps have a best efficiency point (BEP)—the flow rate at which the pump operates with the lowest energy intensity (volume moved per kWh)—and a pump operating at a flow rate significantly lower than its BEP is wasting a lot of energy and wearing out more quickly. Besides switching to a smaller pump, other possible approaches are to trim the impeller (that is, to reduce the length of the blades that move the water), install a smaller impeller, reduce pump speed, and—for a Multi-stage pump—remove one or more stages. Aside from an

initial set of efficiency measures, it is critical to institute improvements in the routine operations and maintenance protocol.

Leak and pressure management

The phrase leak management is used here to embrace two basic activities, apart from repairing leaks, aimed at reducing water losses from a water supply or wastewater treatment system, leak reduction through pressure management and leak detection is also important. Real losses are the physical losses of water from the distribution system, including leakage and storage overflows. The principle behind pressure management is simply that decreasing water pressure in the network decreases the volume of water escaping through any existing hole or leak in the pipe. It is also beneficial because it allows the utility to equalize pressure within the network, allowing a greater number of people to be served with little or no increase in water input. Ideally the pressure reduction valves and associated equipment will be automated so that pressure can be automatically adjusted to account for fluctuations such as changing incoming pressure, and pressure can be reduced even further at night when demand is low. In situations where the buried pipes of the network have numerous leaks, pressure management is likely the most cost-effective way of reducing leakage, apart from major leaks that must be repaired.

Monitoring and control

There is a longstanding saying in business that “you can't manage what you don’t measure”. In water systems around the world, only about 35% of consumption and 50% of supply is metered, making it difficult to improve system performance. The basic steps for putting in place a successful monitoring and metering system are to:

- Create a system for water metering and monitoring if there is none, or expand and upgrade the existing system.
- Develop baselines and metrics for regular monitoring.
- Create targets and gauge success towards achieving them against baselines and benchmarks.
- Procure the proper measurement instrumentation.

Experience shows that it is cost effective to have a program to regularly replace water meters. This is because the working parts in a meter wear out over time, causing the meter to slow down and lose accuracy. In addition, older meters generally do not register water passing through the meter resulting from a leak on the property and resulting water loss becomes the liability of the municipality. The lists below summarize the parameters typically monitored in a regular monitoring protocol.

Pumping System

- Valves – inspect for leaks, clogs, or an open or closed stationary position.
- Flow – compare water flow rates in different parts of the system to help pinpoint leaks and other problem areas needing attention.
- Pressure – monitor working head and suction and delivery pressure (meter/kg-cm2), not only to identify leaks but to indicate whether there is excessive pumping, enabling pressure, and therefore service, to be kept constant. Monitor network pressure at the critical point in the distribution zone to ensure sufficient supply pressure.
- Rotating Speed – measure pump speed with a strobe light to determine whether a motor is operating at optimal efficiency.
- Power Consumption – an increase indicates a loss of pump efficiency
- Volume of Water – pumped per day

Electrical System

- Motors – under different flow conditions, measure operating parameters such as input power (to indicate whether motor operating at optimal efficiency), the current upon start-up and while running, frequency, and speed.
- Power Factors
- Operating Loads – peak and off-peak
- Energy Consumption – track and analyze electricity bills.

REUSE AND RECYCLING OF TREATED WASTE WATER

As the demand for water grows, more water is extracted, treated, and transported sometimes over great distances which can require a lot of energy. If the local source of water is ground water, the level of ground water becomes lower as more water is removed and this increases the energy required to pump the water to the surface. Recycling water on site or nearby reduces the energy needed to move water longer distances or pump water from deep within an aquifer. Tailoring water quality to a specific water use also reduces the energy needed to treat water. The water quality required to flush a toilet is less stringent than the water quality needed for drinking water and requires less energy to achieve. Using recycled water that is of lower quality for uses that don't require high quality water saves energy and money by reducing treatment requirements.

Treated waste water can be used for non-potable (not for drinking) purposes, such as agriculture, landscape, public parks, and golf course irrigation. Other non-potable applications include cooling water for power plants and oil refineries, industrial process water for such facilities as paper mills and carpet dyers, toilet flushing, dust control, construction activities, concrete mixing, and artificial lakes.

Some of the other areas include recharging ground water aquifers and augmenting surface water reservoirs with recycled water. In ground water recharge aspects, recycled water can be spread or injected into ground water aquifers to augment ground water supplies, and to prevent salt water intrusion in coastal areas.

ADVANCED INSTRUMENTATION AND CONTROL TECHNOLOGY

Automation in a water supply or wastewater treatment system monitors—and if sophisticated enough, also controls—various system components for optimal system performance and efficiency. Automation varies in complexity but it always has at its core sensors that measure operational and quality system parameters. The most basic and inexpensive form of automation consists of standalone devices that act on the information from the sensor to perform simple actions only at the site where they are placed, such as an automatic shut-off valve responding to water level indicator. Next in line of complexity is telemetry, which automatically measures and transmits measurements from sensing devices located throughout the network to a central receiving station. Data acquired by the devices can be transmitted via radio, fiber optics or phone lines, and it is not uncommon for more than one form of communication to be used in a single system.

In the absence of control devices, telemetry requires an operator to analyze the input and act upon it. A control system not only monitors variables in the water distribution or wastewater treatment system, but it automatically maintains them at a desired range of values. A set of controlled devices, such as control valves, motors, pumps and fans, act in response to a set of controllers, such as an automatic power factor controller. The most common type of control automation used in water and wastewater systems is the Supervisory Control & Data Acquisition (SCADA) system. SCADA can remotely monitor and control in real time a large array of components spread over large geographic areas, while also providing performance information on individual sites. A properly designed SCADA system for water pumping saves time and money while improving service. Some of the many benefits include:

- Complete information on pumping operation provided in real time
- Pump operation adjusted automatically as needed to ensure reliable water supply
- The need for service personnel to visit sites for inspection, data collection or adjustments greatly reduced

- Alarms sent to the central control location in case of emergency
- Optimal pressure maintained in the water supply network, minimizing service interruptions and eliminating water hammers
- Electricity consumption reduced and pump productivity increased
- Troubleshooting facilitated
- Equipment life increased
- Reports generated automatically

WIPRO'S COMPETITIVE ASSESSMENT CAPABILITIES

The assessment of water utilities will be done by Wipro to have the better understanding of the following categories (refer table 1) of the Water and Waste water Process

- Knowledge management (contextualizing data and exposing it to key stockholders)
- Technology (selection of appropriate tools and effective deployment of water process optimization tools)
- Performance management (ability of the organization to measure its results to improve its businesses)

Table 1: Wipro's Capabilities

Area	Details
Process	§ Established standardized process to track results of programs on a regular basis § Business processes are standardized, auditable and transparent across all functional groups
Knowledge management	§ Information from the utility bill is directly transferred to a software application § Collect energy data using plant automation system (PLC, SCADA, DCS etc-) § Real – time and historical data easily accessible to decision makers § Energy data is measured in real time § Scorecard for normalizing and benchmarking performance across different plant
Performance management Technology	§ Technology currently implemented to manage energy: § Energy management / Intelligence § Carbon management § Dashboard / Alert / Event Management § Analytics § Simulation and Modeling § Reporting tools

The tools allow companies to collect critical data from production line, process, and plant utilities. Leverage the collected data to contextualize real – time data events and make optimal decisions based on historical trends.

ADVANCED SOFTWARE PLATFORM FOR ENERGY MANAGEMENT

Wipro's Energy Management platform for water utilities effectively manage energy, predict overall energy use and emissions, add advanced energy and process analytics layer over and above the present automation for optimal energy consumption across the process areas. This helps the water utilities to grow and profit by optimizing energy and minimizing environmental impact. The designed solutions empower an end-to-end energy and environmental process to help water utilities to improve efficiency.

Wipro Eco Energy makes the water utilities to manage energy and achieve a high level of operational and financial success by influencing them in their strategic actions, improving the organizational capabilities and enabling energy efficiency technologies. The targeted task, actions, capabilities and the solution enablers are described in the table 2 below:

Table 2: Wipro's targeted task and solution enablers

Wipro's targeted task	Initiated actions	Penetrated capabilities	Wipro solution enablers
§ Reduce costs in water utilities operations	§ Optimize/align waste water processes to support water utilities' energy goals § Helping in creating / improving collaboration across treatment units	§ Making standardized processes to monitor energy and carbon data across the water utilities § Establishing control limits to monitor energy and carbon data in real – time. § Making real – time and historical energy data easily accessible to key decision makers § Creating methodology for normalizing and benchmarking performance across different water utilities § Establishing a process to quantify the benefits of energy and carbon management initiatives § Sustenance of energy savings	§ Energy management tool § Carbon management tool § Data Historians § Dash boards § Analytics § Simulation and modeling § Reporting tools

Wipro's structured energy management procedures and methodology helps water utilities to use their energy efficiently in their processes to make real – time decisions for optimizing energy, meeting the regulatory quality parameters such as BOD, SS, ammonia, Nitrogen etc-, Based on our experience Wipro believes that energy management is not about energy consumption through the utility bill, but about rational and informed consideration of energy in operational decision making. These enablers ensure that information is provided at the right time, in the right form and in front of right decision maker to enable smarter decision making.

CONCLUSION

Effective water and energy management program in water utilities improves efficiencies and reduces cost and still adhering to regulatory standards. This can be achieved by improving the system performance by implementing lean methodology for better operational practices, implementing energy optimization techniques, using advanced analytics and implementing energy management platform.

Wipro's software platform and smart metering helps in dealing with the issues described above effectively in water utilities. The energy efficiency and quality deviations can be addressed in real-time. The set of services which will be offered by this platform includes energy optimization, smart monitoring of parameters, effective predictive controls, advanced analytics and reporting. Thus Wipro's software platform aims to provide continuous monitoring of operating parameters, water quality and availability and also helps the water utilities to maintain the regulatory standards along with effective energy management program.

Wipro's initial findings in a few case studies show that there is a potential of about 20% to 25% energy cost savings while implementing an energy management platform in addition to retrofit and technological options.

As water energy demands and environmental needs grow, water recycling will play a greater role in our overall water supply. By working together to overcome obstacles, water recycling, along with water conservation and efficiency can help us to sustainably manage our vital water and waste water utilities.

REFERENCES

- http://wiproecoenergy.com/
- http://watergy.org/
- http://wrmin.nic.in/
- http://water-energy.lbl.gov/
- http://www.energymanagertraining.com/
- http://www.bee-india.nic.in/
- Wastewater Engineering: Treatment and Reuse Metcalf & Eddy, Inc., George Tchobanoglous, Franklin Burton, H. David Stensel
- Wipro EcoEnergy- Energy Management Platform reference documents

BIOGRAPHICAL DETAILS OF THE AUTHORS

Dr. Mohan Gunaratnam:

Dr. Mohan is experienced in the development and implementation of business strategies to access the UK and European water sectors. Dr. Mohan's central focus is in the area of process and energy management. Dr. Mohan has about 12 years of experience working for both private and public sector water clients. In his previous role, Dr. Mohan focused on the delivery of the strategies to commercialise product and services to municipal and industrial water clients in Europe. Dr. Mohan also has established technical skills and a passion for creative excellence. Dr. Mohan is a Chartered Chemical Engineer with a Doctorate in Process Engineering, having functional knowledge of the design and operation of the water industry assets and infrastructure. Dr. Mohan has worked as a technical expert, reviewer and contract supervisor on various European projects. Dr. Mohan has also presented at both national and international conferences. Dr. Mohan has developed novel tools for process and energy optimisation of water systems to enable alignment of operational resilience targets and business strategies. Dr. Mohan is passionate about the development of new markets and solutions within the field of water and energy management. Dr. Mohan has also recently completed an MBA programme that focused on leadership and strategy

I. Thanumoorthi:

Thanumoorthi graduated in Energy Technology from Anna University in 1996. From 1997 to 2009 he worked for TERI, in the field of Energy Management Consulting covering the Industries such as Power plants, Water utilities, Cement plants and other process industries. From 2009 he is working with Wipro EcoEnergy developing solutions covering industries such as Refineries, Water utilities, Iron & Steel in the area of energy management and coordinating with the software team to develop an Energy Implementation Technology Platform for the waste water sector and process industries. He has expertise in developing solutions in solar photovoltaic and solar thermal projects. Thanumoorthi has participated and led more than 300 different projects covering different industrial, manufacturing, municipal sectors and commercial complexes.

Antony Gerald:

Antony graduated in Energy Conservation and Management from Bharathidasan University in 2001 and has more than 11 years of experience in the field of Energy Consulting primarily in the areas of energy efficiency, demand side management, distributed generation, wastewater management and power plant conceptual design, modeling and simulation of combined cycle power plants, technical regulations and grid code operability of gas turbines. From 2011 he is working with Wipro EcoEnergy on solution development for water utilities and process industries in the area of energy management and coordinating with the software team to develop an Energy Implementation

Technology Platform for the waste water sector. Antony has participated and led more than 200 different projects covering different industrial, manufacturing and municipal sectors.

Wilson Dhanaraj:

Wilson Dhanaraj has over 15+ years of experience in the Beverages and Water Manufacturing industry, IT consulting and building industry Solutions. He has proven abilities in enhancing production process operations, optimizing resource and capacity utilization, improving productivity and operational efficiencies. Wilson is proficient in coordinating projects, Cost reduction, Efficiency improvement, conducting audits. He has expertise in IT consulting, in the areas of Business process mapping and activity value analysis in the Manufacturing and Supply Chain sectors. He has conducted assessments in providing water conservation measures and is currently the solution architect for the water platform at Wipro Eco Energy.

Mahesh K.S:

Mahesh has over 10+ years of experience in Strategy, Marketing, Business development and Consulting in IT, Manufacturing and Utilities industry. He holds an MBA degree from Asian Institute of Management, Manila and Bachelor of Engineering degree from Bangalore University. He has proven abilities in driving strategic projects, product & service marketing and business development across multiples practices. Mahesh's IT consulting experience includes Business blueprinting and process design in areas of Sales and Distribution. He has handled energy management projects covering assessments, resource optimization, capacity utilization, productivity improvements and operational efficiencies. He is currently driving business development for water practice at Wipro Eco Energy.

CERTIFICATE

The author(s) certify that the paper titled " **Innovative Energy Management Platform for Water and Waste Water Utilities** " and submitted for consideration for Conference on "India Water Week" to be held in New Delhi from 10-14 April 2012 is in original and has not been published or presented at any other forum.

Signature of Author(s)

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