

***Process control strategies for dynamic efficiency modeling:  
From unit to whole-plant***

The main aim of this timely workshop is to bring together stakeholders from the research & development and the implementation & application side to discuss the state-of-the-art as well as the future of performance and energy and resource efficiency optimization by using models to improve the design of advanced process control strategies. The goal is also to bring the energy discussions to the necessary dynamic level by introducing available dynamic modeling and simulation tools as well as specific requirements, gaps, best practices and common pitfalls.

The cost of energy and resources for wastewater treatment is increasing while stringent treatment requirements are becoming more and more widespread and the pressure on public infrastructure budgets is steadily increasing. There is a general consensus that conventional wastewater treatment and water resource recovery processes are energy and resource intensive. Consequently, optimization of energy usage and resource consumption via process intensification approaches has become the focal point of many water resource and recovery facilities (WRRFs).

Typically, energy efficiencies are discussed from a steady-state perspective whereas in fact the main opportunities for improvements lie in dealing with the inherent dynamics of a WRRF. An apparent limitation of equilibrium modeling is the disregard of the different time-constants of the various unit operations and processes assembled in a treatment plant. Moreover, energy consumption is just one of the components of overall power and energy costs; hence power, its dynamics, and all the charges associated thereto must be included for realistic modeling and evaluation of process control strategies.

Real-time control (RTC) can be seen as the synonym for dealing with the dynamics of a system in the most adequate way. To this end, RTC of unit processes in wastewater treatment has emerged as one of the most important approaches for energy efficiency and treatment cost reduction. Significant effort (also covered in the WWTmod 2012 aeration and the WWTmod 2014 energy workshops) has been invested on energy optimization via steady-state analysis. In spite of these steady-state tools being capable of providing process information for full plant optimization and energy efficiency, little work has been done on evaluating saving potentials in a dynamic way. The tools required are dynamic simulators combining process models with more detailed and fully dynamic equipment models.

The next step is to add more detailed controller models to facilitate the development of better real-time control strategies. Supported by dynamic modeling and simulation, there has been a big thrust in understanding and developing process control strategies to manage energy and resource consumption. However, modeling of RTC strategies for the challenging field of wastewater treatment and water resource recovery are still being investigated by experts from around the world. We seek to instigate a conversation over the state-of-the-art with the ultimate aim to create a road map for the next two-year cycle, i.e. to report at WWTmod 2018.

**Expected discussions and results**

We envision a lively discussion over the topics of 1) best practices of modeling control strategies with a special focus on resource and energy efficiency 2) capabilities of currently available models to simulate selected systems 3) existing limitations, knowledge gaps, and typical pitfalls 4) future directions and field data needs.

We expect to exchange ideas and share information on the integrated modeling of treatment processes, equipment, and control strategies, capture recent developments in energy cost optimization, and discuss process control strategies dealing with multi-criteria targets. This should enable stakeholders (i.e., utilities, consultants, academics) to get a better idea on available tools to streamline controller designs and facilitate the implementation process. A critical summary of the discussion and recommendations will be summarized in a white paper.

### Workshop set-up

To engage all attendees from the outset and encouraged by the past experiences of the core team, the workshop organizers have decided to conduct the workshop in a format that is different from the conventional practice. We believe that the WWTmod seminar attracts highly motivated individuals with a high experience level on the relevant topical areas, allowing a more interactive workshop setup rather than the typical presenter-listener format.

There will be no formal speakers in this workshop rather it will have a team of *Instigators* who are tasked with starting and guiding the course of discussion. All other workshop attendees will be equal *Contributors* who will be asked to come prepared with few slides containing their main ideas and thoughts that could add value to the topic and possible discussion. Workshop attendees will be asked to submit their slides at least 2 weeks before the conference so that instigators can review and prepare their team and discussion ideas. To have more directed discussions we will group instigator-contributors around pre-selected lists of keywords. The Instigators will draft the road map that will be produced from this workshop. Target is a submittal to WS&T.

### Chairs

*Pusker Regmi* (Brown and Caldwell, USA)

*Lluís Corominas* (Institut Català de Recerca de l'Aigua, Spain)

### Instigators

Diego Rosso	UC Irvine (Lead Instigator)
Pusker Regmi	Brown and Caldwell
Lluís Corominas	Institut Català de Recerca de l'Aigua
Leiv Rieger	inCTRL Solutions
Guillermo Baquerizo	IRSTEA
Jose Porro	Cobalt Water Global

### Contributors

Bernhard Wett	ARAConsult
Jens Alex	IFAK
Sergio Beltran	CEIT
Roger Samso	IRSTEA
Gerardo Aguilera	Suez-Env
Ed Becker	ARCADIS
Miguel Mauricio Iglesias	USC
Leon Downing	CH2M
Marc-André Labelle	École Polytechnique de Montréal
Joaquim Comas	LEQUIA – UdG
Ignasi Rodríguez-Roda	LEQUIA – UdG

### Targeted Attendance

- Utility managers focused on learning innovative modeling tools and evaluating opportunities for implementing energy/resource efficient and cost effective solutions
- Consulting engineers working towards developing process control strategies to solve their clients pressing needs for treatment intensification
- Academics who are engaged in the research and development of innovative processes, algorithms, and models for enhanced performance and efficiency

### Programme

Time	Topic	Instigators
09:45 - 09:50	<b>Welcome</b>	Regmi & Corominas
09:50 - 10:00	<b>Introduction:</b> Motivation, scope & objectives; Present workshop structure, presenters etc.	Rosso
10:00 - 10:45	<b>Topic #1:</b> Why do we need to model dynamically? <i>A discussion of targets, boundaries and time constants</i>	Rieger & Regmi
10:45 - 11:15	Coffee break	
11:15 - 12:00	<b>Topic #2:</b> How do we take energy optimization to the next (dynamic) level? <i>Process level and/or equipment level From unit processes to whole plant Integration of units with different time-constants</i>	Regmi & Corominas
12:00 - 12:45	<b>Topic #3</b> How to deal with multi-criteria optimization using mathematical modelling and artificial intelligence techniques? <i>Water quality vs. energy cost vs. operational cost vs. capital cost vs. personnel cost vs. operational problems (i.e. sludge settling and GHG emission risks)</i>	Rosso & Baquerizo
12:45 - 13:45	Lunch break	
13:45 - 14:30	<b>Topic #4:</b> What are the data needs for equipment modeling? <i>What additional data is required? Ideal frequency of data harvest? Data quantity and quality?</i>	Porro & Regmi
14:30 - 15:15	<b>Topic #5:</b> Who can top my best failure story? <i>Don't repeat that one: a collection of pitfalls</i>	Corominas & Rieger
15:15 - 15:45	Coffee break	
15:45 - 16:30	<b>Topic #6:</b> Why does it still fail? <i>From design to implementation to incentives</i>	Rosso All instigators
16:30 - 17:15	<b>Summary and Wrap -up</b> <i>Conclusions / Future action items / Reports and papers</i>	Regmi & Corominas All instigators