International Desalination Association®

CONNECTIONS

January / February 2017

Connecting People and Ideas to Water Solutions

Inside

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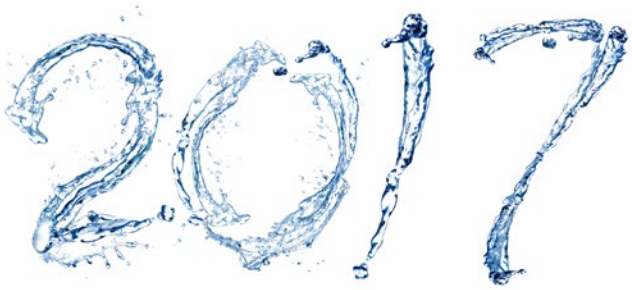
The Experts Speak: Views, Trends and More



Welcome to the January/February issue of *IDA Connections*. This issue contains industry insights, information about innovations and technical developments, and perspectives from several members of our IDA community as well as timely information we hope you find valuable.

IDA Director and Secretary Neil Palmer offers some thought-provoking views about **the need to de-politicize desalination**, which provides the only new source of fresh water on the planet.

Then, following up on our coverage of the IDA Energy & Environment Forum in Miami, we're pleased to include a technical article from IDA Director and Dean of the IDA Academy Leon Awerbuch about the **potential of geothermal desalination** – another strategy to cut energy requirements and reduce the carbon footprint of desalination.

This issue also includes one of our most popular features, our annual **Industry Leaders Round-up** in which highly respected members of our community share their thoughts about the opportunities and challenges in the coming year.

We are also introducing a **new column that will highlight trends** that are shaping the future of water treatment. First up in this series is an article by Gil Hurwitz of Water Planet discussing the **role of artificial intelligence-based solutions**, which are poised to follow developments that we regularly encounter in other parts of our lives.

Francisco Virgili, Head of Data Analysis at Global Water Intelligence contributes the first in a **series of articles focusing on Latin American countries** as we begin the run-up to our eagerly anticipated World Congress in São Paulo, Brazil.

We invite you to **meet the Technical Program Chairpersons** who are working overtime to ensure the success of our technical sessions.

We also welcome **news from the IDA Young Leaders** and are pleased to present a preview of the upcoming **Global Water Summit**, which IDA is pleased to once again co-sponsor.

And finally, we would like to take this opportunity to **encourage all eligible IDA members to cast their ballot in the voting on the proposed Constitutional amendments**. Your vote really can make a difference in the future of our Association! Voting closes on March 13, 2017. ■

message

from the Secretary General

Patricia Burke

Celebrating Connections

One of the most important aspects of going through our most recent strategic planning process was gaining a better understanding about what makes IDA relevant to our members, what sets it apart from other organizations that compete for mindshare, time and dollars.

A theme that emerged during our research was that of connections – the value that IDA brings in terms of helping members forge valuable connections with the leaders in our industry, all over the world. These connections happen in a variety of ways, from face-to-face meetings at our World Congress and other IDA events to information exchange in our Academy courses or sessions that we organize at other industry happenings. Connections made in our Mentor Program can be deep and truly life-changing. Our library of proceedings and technical articles also connect people with ideas in a very different but also? very important way.

We don't often talk about the connections that our staff have made with each of you through the years. However, two of our most tenured staff members have recently celebrated milestones at the Association, with Nancy Pagels now working with us for 11 years and Darlene Seta celebrating her 20th anniversary of service to the Association and to our members. Karen Zilinek, our Director of Operations, will soon celebrate five years, and Michele Pszenny our office and membership services administrator, has already surpassed the five-year mark. Patti Gorman, who works hard behind the scenes on paper management, Academy and other responsibilities, has been with us for a number of years, first as a temporary member of staff during World Congresses and other events, and as a full-time member of our family for the past three years. And while she is not an employee, Ann Seamonds, who is responsible for managing our external communications programs and is editor of *IDA Connections*, will have been part of the IDA team for nine years this spring, bringing a valuable outside perspective to our Association.

Since 1973, IDA's membership and leadership has represented a diverse yet loyal universe of professionals from all over the globe. Today our membership comprises scientists, end-users, engineers, consultants and researchers from governments, corporations and academia. We serve more than 2,600 core members in 60 countries and reach an additional 4,000 affiliate members. Our reach is even broader through our association with the United Nations as part of a growing international network of non-governmental organizations (NGOs).

Each IDA member brings his or her distinctive experience and skills to our Association as well as to the desalination and water reuse community at large. This diversity makes us strong and creates the perfect environment for cross-pollinating the knowledge base of our industry every time one member connects with another.

It has been my pleasure to get to know many of you during my tenure as Secretary General, and I look forward to connecting with you and meeting many new colleagues as we plan for our World Congress and beyond. I also invite you to share your story about the connections you have made as part of the IDA community in our newsletter or our social media channels. I'm sure that your words will spark inspiration.

As always, I welcome your feedback at paburke@idadesal.org ■

De-politicizing Desalination

By Neil Palmer

"Desalination is an expensive and speculative option that could drain resources away from … other more practical solutions." So wrote Adam Scow, California Director of Food and Water Watch in the International Water Association (IWA) newsletter "The Source" published in December 2016.

This emotive and inaccurate bleat has been repeated many times during the California drought, influencing public opinion and demeaning the exceptionally clever reverse osmosis desalination technology developed in (of all places) California from the late 1950s. Reverse osmosis is the workhorse of seawater desalination the world over, benefitting hundreds of millions of people who would otherwise have little or no water.

The IWA newsletter article edited by Jonathan Andrews posed a question: "when is desalination the right choice?" A panel of experts including Scow and fellow activist Heather Cooley from the Pacific Institute were joined by industry heavies including IDA President Emilio Gabbrielli, IDA First Vice President Shannon McCarthy and IDA Director Michel Canet.

The title of the article seems to presuppose that desalination is somehow evil. A later, more emotive, question from Andrews confirmed my suspicion: "How can desalination best mitigate and address the high energy, cost, and toxic effluent from membrane problems?"

However, I was heartened by the quality of the industry responses to the questions, rebuffing the more nonsensical assertions of the activists. They included easy to understand examples (this one from Denys Neymon, Executive Vice President, Suez): "…daily energy consumption to supply desalinated water to a family of four is the equivalent to ironing clothes for one hour or using a laptop for a day".

The following week, an article on the Carlsbad Desalination Plant appeared in Water Deeply, a web-based publication from the stable of News Deeply. Founded in New York in 2012, News Deeply is dedicated to in-depth, factual news sources on specific topics as an alternative to politically slanted stories from mainstream media. The article, written by Mark Muir from the San Diego Water Authority, reflected on the benefits to the region following one year's operation of the plant. That Carlsbad has been completed (despite every attempt by activists to stop it) and is operating without the dire environmental consequences forecast by activists is testament to the triumph of science and common sense over emotionalism and fear-mongering.

As the planet moves towards diminishing fresh water resources and greater demand, my wish is for balanced discussion on the merits of better desalination technology based on science rather than fear. I hope people from the industry are emboldened to take opportunities to speak and write confidently promoting desalination, thus helping its de-politicization.

After all, most of the fresh water on earth originates from energy intensive natural desalination of seawater, the energy for which comes from a nuclear reaction – the sun.

Neil Palmer is an IDA Director and former CEO, National Centre of Excellence in Desalination Australia. He can be reached at neil.palmer@murdoch.edu.au ■

Industry Leaders Round-up: Desalination and Water Reuse – What Does the Future Hold?

For our first issue of 2017, IDA Connections posed three questions to leaders in our industry:

- What do you see as the major developments that are shaping our industry?
- What are the key opportunities and challenges that we will face in 2017?
- What do you think are the most exciting innovations (technology, business practices, business models, etc.) that we can look forward to – either those already on the drawing board or those still in concept stage?

Following are insights from six respected leaders from around the world and various parts of the desalination and water reuse industry.

Emilio Gabbrielli, President of IDA and Director, Overseas Business Development, Global Sales Water Treatment for Toray

Major Developments

The fall in the price of oil is significantly affecting our industry and is probably the key element shaping it at the moment. The major reshaping of the water scenario taking place in Saudi Arabia, the largest customer of desalination, is a clear indication of this. This market will remain one of the most important ones for our industry, but the financial pressures will be creating a more sustainable environment for business, which will be better for all in the long run.

Key Opportunities and Challenges

I have long believed that one of the key opportunities is a world becoming more and more aware of climate change and committing to deal with it, as shown by the Paris Agreement that focuses on greenhouse gases emissions mitigation and adaptation. Desalination and reuse become an intrinsic part of the resilience necessary to secure our water supplies, while reducing the carbon footprint of the technology has made it better than other traditional solutions like long-distance transfers. We still face a challenge in convincing some decision-makers of the real benefits of our industry in this context and need to work diligently to dispel myths and misconceptions that still affect choices. Each of us must play a part in continuing to educate stakeholders and advocate for appropriate use of desalination and water reuse to address the world's water needs.

Most Exciting Innovations

One major development that can be seen in many parts is the expansion of the use of renewable energy for desalination, even if still small as a percentage of total installed capacity. The fact that the push to develop and expand desalination based on renewable energy has not lost steam after the oil price crashed is a good indication that this push is here to stay as part of our society's path to sustainability. The widely expected rapid fall in the cost to store energy during the next 10 years will be very significant for our industry as it will allow smoother and more continuous operations of wind and solar based applications.

Shawn Meyer-Steele, IDA Director, Founder and Managing Director of H2OPROFESSIONALS

Major Developments

The water treatment industry has made a real shift toward wastewater reuse on both the macro and micro scale across the industrial, municipal and private sector levels. We are also seeing a significant increase in planning and actual use of renewables for water treatment projects. What's really exciting is that both of these shifts are being driven by a greater appreciation of limited natural resources and improved economics, not just policy.

Key Opportunities and Challenges

Unfortunately, at least through early 2017 we are seeing international market uncertainty which can cause project delays. There is also a shift in the US and some parts of Europe to protectionist policies, which could lead to price increases in multinational business projects that

constitute a large part of our industry. We could also face additional challenges if there is a continuation of the signals of retreat on multinational agreements governing environmental policies.

Most Exciting Innovations

There are a number of technology and business innovators that are bringing very exciting products to the industry, some of which we at H2Oprofessionals are fortunate enough to be involved with.

One is offering full scale integrated solar/battery microgrids under power purchase agreements to desalination plant operators. One has commercialized adaptive learning control systems and novel membranes with increasing durability and reduced operating for produced/waste water. Another has commercialized new treatment processes for municipal wastewater treatment that reduce electrical operating costs by up to 90%. And yet another has developed a low-pressure vacuum desalination process that can treat brackish and seawater to potable water and salt (ZLD) at a fraction of the cost of traditional desalination coupled with crystallizers/evaporators.

Our industry is alive with innovation driven by the dynamics of population growth pressures, dwindling resources and an increased attention to both.

Maurice NEO, IDA Director, Director of the Industry Development Department (IDD) in PUB, Singapore's National Water Agency

Major Developments

The desalination and water reuse industry will see stronger demand as weather patterns change and governments look to non-conventional and climate resilient sources of water. However, relative to conventional water, desalination and water reuse are more expensive due to their energy footprint. So the key is to look at technology developments to improve energy efficiency and lower corresponding cost.

PUB is currently undertaking a trial with Evoqua on electrochemical desalination, which aims to half the energy requirements of SWRO desalination. Other exciting research that is ongoing in Singapore covers the gamut from aquaporins to biomimicry and use of solar panels.

Besides affordable technology, another key development that will make desalination and water reuse successful is right-pricing water. The cost of water must reflect its true value, so that consumers understand how much water is worth and operators can recover their costs.

The third development concerns water reuse. In this regard, though technology is able to deliver good water, public acceptance is paramount; it is imperative for the authorities to communicate better.

Key Opportunities and Challenges

"Wastewater" is an under-utilized resource in many parts of the world. In Singapore, we have termed it as "used water," to highlight its value as a resource, and like Singapore, many cities have the opportunity to realize the full potential of used water and make water reuse more pervasive. However, the challenges related to water reuse are (i) the collection of every used drop, which requires a comprehensive sewer network, (ii) tight regulations on what is allowed to be discharged into the sewer, and (iii) public communication. These are not insurmountable challenges though, and together with tight management over water quality, utilities can enhance the confidence that the population has for this non-conventional water source.

Another key opportunity that we see is the trend of using smart solutions to address water loss in the distribution network. From India to China, "smart cities" have become a buzzword. But smart solutions will need capital investment, which only utilities practicing adequate recovery of costs would be able to afford sustainably. Hence, correct water pricing provides the means for utilities to embrace this opportunity.

In facing these key challenges, the sharing of best practices can help ease the steep learning curve. Platforms like IDA are very helpful in this regard. This year, PUB will also hold a utility-focused event to facilitate knowledge sharing, and we look forward to welcoming utility leaders to the Singapore International Water Week (SIWW) *Spotlight 2017* from *17-19 July* to discuss these and other issues.

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Insights from Industry Leaders

Most Exciting Innovations

Osmotic power generation, also known as blue energy, is an exciting development. In this regard, PUB has plans to co-locate our desalination and NEWater (high-grade reclaimed water) plants to harness salinity differences between seawater brine and NEWater brine.

But technology alone will not be sufficient; an effective water management framework is equally important. One governance model that can be considered is the management of water by a sole agency, which will allow authorities to apply systems thinking for more effective water management. Such a model will allow authorities to harness the synergies between different parts of the water loop, enable trade-offs and strengthen overall outcomes.

Another exciting area is the convergence of technology and behavioral science, using technology to influence consumer behavior. For instance, PUB is looking into the use of smart water meters and appliances to drive water consumption down, with the desired goal of managing overall water demand. This approach goes beyond hard science, and looks promising.

Paddy Padmanathan, CEO, ACWA Power

Major Developments

While the focus must remain on reducing energy intensity in desalinating sea water and in treating waste water to reduce cost and carbon emission, without doubt the two major developments that will shape our industry is (1) the use of renewable energy and (2) the understanding of the value proposition offered by a circular economy. In the case of the former, renewable energy is now cost competitive compared to fossil fuels particularly across the geography where desalination is used; the arid sun belt and of course renewable energy has no fuel cost volatility and is in keeping with our commitment to decarbonizing all human activity. In the case of the latter with the recognition of the value of keeping resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service as opposed to the traditional linear economy of make, use and dispose, from design of the membrane fabric itself all the way to the thousands of other components we use will need to be rethought injecting a new level of vibrancy to our industry.

Key Opportunities and Challenges

While the opportunities around the concept of Circular Economy will take a while to develop, more immediately in 2017, the biggest opportunity is to start implementing a few projects integrating renewable energy with well tried and tested desalination process as well as new ones such as forward osmosis to show the cost effectiveness of the solution not to mention the significant positive impact on carbon intensity. The most significant challenge the industry will face is not the lack of clarity on where the real implementation ready projects will emerge both for desalination and for waste water reuse level treatment but with cyber security.

Most Exciting Innovations

The most exciting innovations are centered on two areas. One is the value to be extracted by integrating big data, internet of things and the massive commuting power available at miniscule cost all the way from design through to construction and operation and maintenance of plants. The second is the cost reduction we will be able to drive though by using newly discovered materials such as graphene, which is 200 times stronger than the strongest steel and conducts heat and electricity very efficiently and is displaying some very promising properties for membrane applications.

Devesh Sharma, Managing Director, Aquatech International

Major Developments

We are in a golden age of technology in our industry with a variety of new ideas and offerings in this space. Among the major developments are the accelerating need to tackle tougher waters; to recycle more, discharge less, or not at all – and to do so by pushing the

envelope with regards to economics. We also continue to see the push to further reduce energy consumption and increase recovery and reliability, and maximize uptime.

Key Opportunities and Challenges

The opportunity lies within addressing the challenge of holistically solving complex water problems. Although many new technologies are emerging, there is rarely one silver bullet technology or unit operation that will completely solve a particular water challenge. One must have the skills to integrate the required technologies – sometimes new, sometimes old, and most of the time a mix of both – to completely address a water problem. This may require a mix of equipment / process technology, chemical treatment, as well as automation / diagnostics.

Most Exciting Innovations

I believe our industry will benefit greatly by embracing the concept of integrated total water management solutions, which result in improved economics (cost per gallon) as well as smaller water and energy footprint. This is possible by integrating the various technology and knowhow outlined above to offer a holistic approach to solve complex water challenges.

Rick Stover, IDA Director, Chief Consultant, GP Water LLC

Major Developments

The major drivers for current and continued growth of desalination and water reuse are the decreased availability of cheap fresh water resources and the increased demand for fresh water. The water industry is meeting this demand by treating more challenging sources to higher levels of quality with greater reliability while reducing costs.

Key Opportunities and Challenges

One of the biggest challenges is the fact that, in most of the world, water is not priced according to its value and often even less than what it costs to produce and deliver it. This means water treatment is often not profitable, and this, in turn, undermines investment in the water industry and limits growth and innovation.

Scarcity has driven up the price of water in some regions, leading to innovations that have benefited everyone. An example is seawater reverse osmosis energy recovery devices that were initially developed in the Caribbean Islands and the Canary Islands, areas with both limited water availability and high energy prices, and these devices are now used on seven continents. Increased water demand and reduced availability will eventually drive up prices in other regions, increasing opportunities for investors and entrepreneurs.

Most Exciting Innovations

Thankfully, innovation continues to occur in all the areas listed: technology, business practices and business models. The three developments that are the most exciting to me are:

- the "productization" of water technology where increasingly complex water systems are being turned into standard appliance-like devices,
- the expanding application of membrane technologies, especially into brine concentration and wastewater applications that used to be the exclusive domain of evaporators, digesters or chemical processes, and
- increasingly intelligent monitoring and control systems that are enabling integration of multiple treatment steps, automating and optimizing operations, and ultimately improving reliability. ■

Geothermal Desalination: The Potential for Clean and Affordable New Water Solutions

By Leon Awerbuch, President IDCA; Dr. Victor Van der Mast, COO Supreme Energy; and Gerard Canton, Deputy General Manager, SIDEM/Veolia

As a follow up to "Reflections on IDA Energy & Environment Forum" in the November/December issue of IDA Connections, we are publishing a shortened version of a technical article presented at IDA's Forum as a part of "Sustainable Use of Renewable Energy in Desalination."

Geothermal energy is a source of renewable energy, and the oceans are a major alternative source of water. We know that desalination is a proven technology to produce clean water from the seas and brackish waters, and by water reuse and recycling. Desalination, however, is relatively energy-intensive, and sustainable energy systems urgently need to be developed to reduce energy consumption and environmental impact. Geothermal sources have the potential to serve as excellent heat sources for thermal desalination processes. Since thermal desalination processes require relatively large quantities of heat sources and the lowest electrical energy requirements in range of .9 kWh to 1.5 kWh per cubic meter of distilled water, geothermal based energy source represents a feasible, sustainable and environmentally friendly option.

Geothermal energy provides a clean energy supply for desalination plants, and geothermal desalination represents one of the solutions of the Global Clean Water Desalination Alliance (GCWDA) –"H2O minus CO2".

Geothermal Energy Association (GEA) data shows that a total of 18 new geothermal power plants came online in 2015, adding about 313 MW of new capacity to electricity grids globally. The global market is at about 13.3 GW of operating capacity as of January 2016, spread across 24 countries.

This year the global geothermal market was developing about 12.5 GW of planned capacity spread across 82 countries. Based on current data, the global geothermal industry is expected to reach about 18.4 GW by 2021. If all countries follow through on their geothermal power development goals and targets, the global market could reach 32 GW by the early 2030s.

The United Nations and the International Renewable Energy Association (IRENA) have pledged a five-fold growth in the installed capacity for geothermal power generation and at least two-fold growth for geothermal heating by 2030 compared to 2014 levels.

Communities and governments around the world have tapped only 6 to 7% of the total global potential for geothermal power based on current geologic knowledge and technology. There are vast untapped resources that could provide baseload renewable energy to grids and desalination across the globe.

Geothermal electricity generation is currently used in 24 countries, while geothermal heating is in use in 70 countries. This compares to desalination operating now in over 150 countries around the world.

Geothermal power is a sustainable, renewable source of energy because the heat extraction is small compared with the Earth's heat content. The greenhouse gas emissions of geothermal electric stations are on average 45 grams of carbon dioxide per kilowatt-hour of electricity, or less than 5 percent of that of conventional coal-fired plants.

The types of conventional geothermal power technologies are dry steam, flash and binary. In dry steam plants, naturally occurring high-pressure steam shoots up from the dry steam reservoir and is used to run the turbines that power the generator. In flash plants, steam is separated from high-pressure and high-temperature geothermal fluids (hot water and steam). The steam is delivered to a turbine that powers a generator. The liquid (condensed from the steam after passing through the turbine) and remaining geothermal water are injected back into the reservoir. In binary or ORC (i.e., Organic Rankine Cycle) plants, the heat is transferred from the hot water to an organic working fluid that has a boiling point lower than the boiling point of water. The working fluid is vaporized to run the turbine. The geothermal water is never allowed to reach the atmosphere – 100% is injected back into the reservoir. In all systems, the injected fluid is never allowed to mix with the shallow groundwater system.

Figure 1: Geothermal Power Operating and Developing Capacity by Developing Region

Note: The figure above compares current installed geothermal capacity to "announced developing capacity." Data for North America does not include the United States in this report. Source: GEA

Flash and dry steam technologies continue to be the most prevalent and the most developed. Flash technologies, including double and triple flash, make up a little less than two-thirds of the global producing megawatts (58%), while dry steam is about a quarter (25%) and binary is a remaining 16%. The binary turbine market, which can generate electricity from lower temperature fields, is only about two decades old. Many lower temperature resources are just beginning to be identified, explored and developed.

Geothermal Solution Low enthalpy (t>60°C) geothermal energy can effectively drive a sea or brackish water desalination unit to produce fresh water for drinking and/or irrigation. Since a geothermal plant, whether used for power generation or for space heating or other applications, has large quantities of available heat at low cost, the most cost effective method for seawater desalination is to provide directly geothermal heat to a MED (multi effect distillation) plant.

Why should geothermal energy be preferred in a desalination process?

Geothermal energy can be used for desalination due to following advantages:

1. Geothermal energy sources have a high capacity factor, which provides a stable and reliable heat supply ensuring stability of thermal desalination and hybrid desalination processes. Geothermal energy provides heat supply 24 hours a day, 365 days a year, ensuring the stability of the thermal processes of desalination.
2. Geothermal production technology (extraction of hot water from underground aquifers) is mature. It is unaffected by the seasonal changes and weather fluctuations.
3. Typical geothermal source temperatures are in the range of 70–90 °C in most parts of the world, which are ideal for low temperature MED desalination. High grade sources above 100 °C can be used for power generation and other process heat applications.
4. Geothermal desalination is cost-effective, and simultaneous power and water production is possible.
5. Geothermal desalination is environmentally friendly because it is the only renewable energy used in the process with no emissions of air pollutants and greenhouse gasses related to fossil fuels.
6. Geothermal desalination saves imported fossil fuels, which can be used for other purposes improving local energy security and environmental sustainability.
7. Geothermal sources have relatively lower surface area or land requirements per unit (MW) of all renewable energy sources (for example, 20 MWth-10 X10 m well size), and energy demand can be matched from the smallest to the largest energy consuming utilities.
8. MED technology is well demonstrated in sizes up to 15 MIGD and GOR of 11, with consumption of electric energy as low as .9 kWh/m^3.
9. Production of desalinated water can be arranged from geothermal fluid or by coupling with seawater or brackish water application.
10. Coupling between geothermal resources and MED can be arranged with flashing or heat exchange pipeline loop.

Geothermal desalination of geothermal resources using its own energy was initially demonstrated by Bechtel implementing a pilot plant program of VTE system for the US Bureau of Reclamation in Imperial Valley California in 1975. It has also been successfully demonstrated on the island of Kimolos, Greece through a project supported by the European Commission.

In contrast to geothermal power, the use of geothermal energy specifically for desalination is a relatively unexplored topic, with only a few studies done. The earliest work seems to be that of Awerbuch et al. [3] and [4], who in 1976 proposed and analyzed a novel patent process for the production of power and water from geothermal brines.

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A process isolates the power plant components from the corrosive soluble gases and scale-forming by a process similar to steam transformer of typical MED by exposing the turbine only to pure steam, generated by transferring heat from flashed geothermal vapor to distilled water. This is shown schematically in Figure 2. The pure steam is fed to the high-pressure ports of the turbine; additional motive steam is generated by flashing the distilled water to lower pressure to the intermediate pressure ports of the turbine.

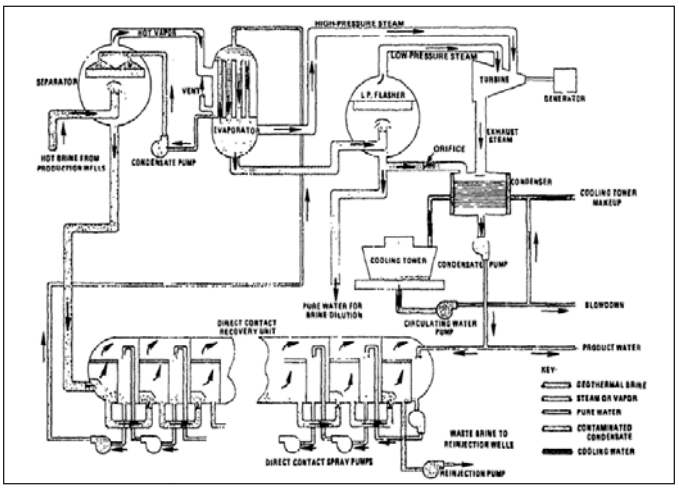

Figure 2: Geothermal Energy Recovery Process

One of the novel features of the Awerbuch invention is the preheating of condensed turbine exhaust in the Direct Contact Recovery Unit at the bottom of Figure 2. The condensate is sprayed into one side of a chamber where it contacts hot vapor generated on the other side of a partial wall in the same chamber. The contacting action raises the temperature of the condensate a few degrees in each stage. The condensate is pumped into successively hotter chambers (stages), moving from right to left in Figure 2, finally leaving the Direct Contact Recovery Unit at an elevated temperature. The hot vapor required for this process is generated spontaneously by the flashing of the geothermal brine, which flows in the opposite direction (from left to right in the figure). As the brine moves from state to stage, each one at a successively lower pressure, a portion of it flashes into steam which, in turn, condenses on the distillate sprayed into that stage.

As many in readers will readily notice, the multi-stage flashing and direct contact condensation heat recovery from the hot brine is similar to recently developing process of Thermal Purification Technology Limited. The surplus condensate from the power plant condenser is the distillate product water obtained from geothermal desalination.

This brings us to a discussion of use of geothermal thermal energy in a combination with seawater desalination plants particularly with well-established MED process. The lower temperature geothermal resources have significantly larger availability around the world and particularly in many islands. A 2015 report from NREL [7] stated that, based on geothermal resource assessment estimates by the U.S. Geological Survey (USGS), the total resource capacity for identified hydrothermal systems having a mean reservoir temperature between 50°C and 90°C is over 9,800 MWth.

Multi-effect distillation (MED) is, in our opinion, the most important large-scale evaporative process offering significant potential for water cost reduction. Particularly MED and MED-NF has great potential with thermal renewable energy like thermal solar both concentrated or low temperature, geothermal, solar ponds or alternative nuclear energy. The major potential advantage of the MED process is the ability to operate at relatively low temperatures and produce a significantly higher Gain Output Ratio (GOR) more than 15 kilograms of the product per kilogram of steam, where MSF limits GOR to 11.

Regarding the energy consumption in thermal plants, we have two parameters of efficiency. We need heat and electricity. The first parameter is the amount of produced water per unit of steam, called gain-output ratio. That historically was about 8 kilograms of water per kilogram of steam coming from the power plant. Today, we already have plants exceeding a ratio of 11. The second parameter in thermal desalination plants is electric power consumption, which for MED is about .9 to 1.5 kWhr/m3 per ton of water processed.

As a matter of fact, in January 2014, Veolia/Sidem won Az-Zour North Phase 1 IWPP - 1550 MW +107 MIGD, an EPC contract to build a desalination plant in Kuwait with a daily production capacity of 486,400 cubic meters of water. The plant is MED-TVC with 10 x 10.84 MIGD units in total 107 MIGD. But most important is the ability to lower the process power consumption to 0.9 kWh/m^3 with GOR 11, meaning that 1 ton of steam generates 11 ton

of desalinated water. The key here is that the energy for the desalination plant is provided by backpressure steam from combine cycle power plant typically at 2.7 bars.

The lower the pressure of the steam we can use for the desalination and the higher GOR, the less geothermal energy is needed, and the cost of developing geothermal resource is lower. Additionally, less energy needs to be rejected form desalination system. The MED process operates only with top brine temperature at 64 °C to 75 °C depending on the salinity of the seawater to avoid scale deposition on heat transfer surfaces. Therefore, the energy supply can be at a low temperature in the form of hot water or hot brine at less than 90 °C or steam at low .35 bars pressure. Moreover, electrical energy is required only for running the process pumps, at less than 1.4 kWh/m3. To minimize cost and energy required for desalination, we proposed an advanced very high efficiency hybrid MED-NF with Nanofiltration membranes, which are softening feed to high temperature effects. The coupling from energy source of hot water or brine is done through a flashing loop by transporting hot 90 °C water from the geothermal area to the MED desalination plant on the coast via a water pipeline.

The heat for the MED unit can be supplied from geothermal brine. The hot brine will be sent to a flash chamber and will generate the required steam to the MED unit. From the flash chamber, the colder brine will be reinjected to the geothermal field to recover heat.

In order to improve the overall specific energy consumption, a Nanofiltration (NF) unit has been added to treat the feed water to the hot group of effects. The NF unit will remove all the sulfates dissolved in the feed, allowing operation of the MED at a top brine temperature of almost 80 °C without scaling problems.

We have designed a full size commercial unit of a 25,000 m3/day with 20 effects desalination plant with thermal energy consumption of 137.6 kJ/kg or GOR=16.25. Even without NF, we could achieve GOR of 13.8, never before achieved without thermocompression TVC with heat input at 90 °C. The exciting possibility for desalination is the fact that, with such high efficiency with low temperature, the energy easily can be provided by geothermal energy without the need for energy or battery storage, and assure 24 hours' continuous based load operation. NF- softened feed is being blended with preheated seawater make-up at rate of about 30% of the total feed introduced only to high temperature effects of MED. We believe that a solution combining low temperature geothermal energy with low temperature MED or hybrid MED-NF will be competitive in comparison with PV-RO and will avoid challenges with the intermittent supply of solar energy.

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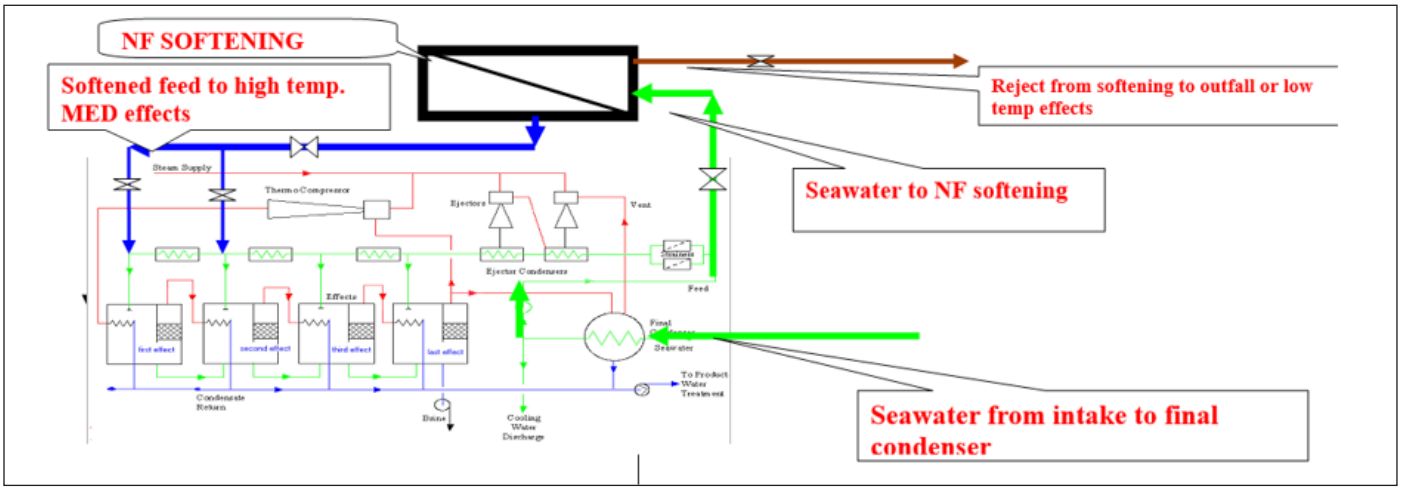

Figure 3: Process for partial blending of softened feed to high temperature effects of MED

IDA IS PLEASED TO INTRODUCE THIS NEW SECTION **HIGHLIGHTING TRENDS THAT ARE SHAPING OUR INDUSTRY.**

How Artificial Intelligence Is Redefining the Water Industry

By Gil Hurwitz, Ph.D., Water Planet

Over the past half-century, there have been tremendous advancements in the efficiency and scale of conventional desalination technologies. In 2015, more than 18,000 global desalination plants were in operation, providing more than 23 billion gallons per day of potable drinking water in 150 different countries, according to the *IDA Desalination Yearbook 2015–2016*. Yet, fresh drinking water remains one of the Earth's most precious commodities. Millions still struggle to find safe, clean drinking water and global factors, such as climate change, population growth, and industrial pollution, are expected to intensify the situation in the years to come.

Although conservation efforts and policy initiatives are critical, technological advancements will be needed to assure that supply keeps up with demand. Reverse osmosis (RO) desalination is the largest contributing technology, which accounts for 60 percent of the global capacity, and is expected to grow in the coming years, according to the International Renewable Energy Agency's *"Water Desalination Using Renewable Energy: Technology Brief"* (2012). This increase is due to significant improvements made in RO membrane quality, pre-treatment, and energy recovery, which have driven down the cost of RO desalination dramatically. However, cost reductions have begun to plateau, and the process is still dogged by high-energy consumption and performance instability.

In our technologically-advanced age, it is counterintuitive that water treatment operators and engineers are still required as the first line of defense to combat complex natural and dynamic system disruptions. Even well-trained, experienced plant personnel require days to process data, analyze trends, and prescribe operational changes needed at any given time. Such delays in response time can lead to compromised effluent water quality, decreased throughput, and increased costs. However, artificial intelligence can play a pivotal role in making society's current desalination infrastructure more cost-effective, energy efficient and, ultimately, better equipped to self-adapt and self-optimize to the inevitable variability of process conditions.

For example, seasonal variability in feed water quality can have catastrophic effects on conventional membrane desalination systems. The severe fouling caused by offshore algal blooms and red tide events has become a serious factor in limiting the applicability of membrane filtration for ocean desalination. Technological advances have improved the intrinsic performance of NF and RO membranes at the bench, but process technology is still lacking to ensure their protection in the field.

Yet where optimization of traditional engineering practices has left off, advancements in computer automation and control will pick up. We have reached a point where improvements in the economics of complex computational processing has allowed artificial intelligence (AI), or machine learning, to take over as the future of the water industry.

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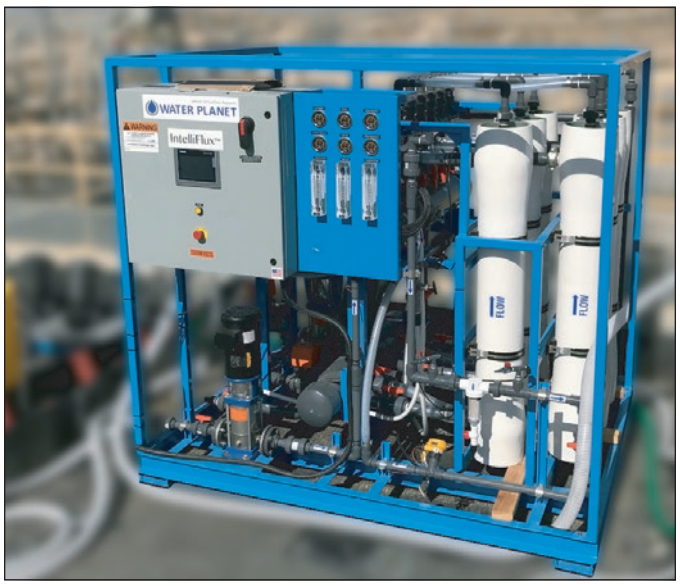
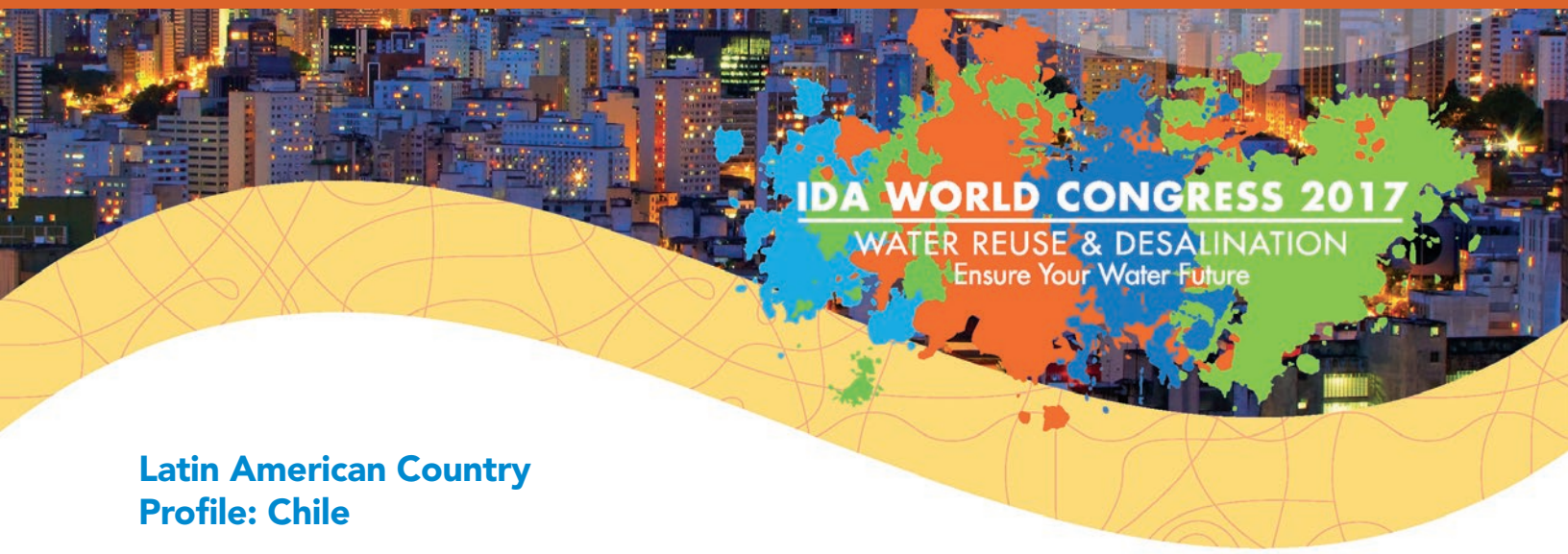


Water Planet PolyCera® Membranes powered by IntelliFlux®



Latin American Country Profile: Chile

By Francisco Virgili, Global Water Intelligence

As we lead up to the highly anticipated 2017 IDA World Congress, we are pleased to share profiles of selected Latin American countries presented by Global Water Intelligence.

Chile is a well-established desalination market in Latin America with an interesting history driven largely by industrial desalination projects primarily for the mining sector, which has seen a string of investment in previous years in the form of several large-scale projects, such as Copiapó, Escondida, and Candelaria.

However, in addition to mining, two often-cited themes – water scarcity and drought – are at play. These two issues are bolstering prospects for the construction of desalination plants that will help offset a severe reduction in mining operations and curtailed plans for desalination in the mining sector as that industry deals with the sting of low commodity prices.

Much of the Northern half of the country, including areas such as Atacama, Antofagasta, and Coquimbo, has an arid or semi-arid climate, which compounded with the severe multi-year drought that has been affecting large areas of the country, has severely stressed water resources, even as consumption is set to increase by 10% in 2017 compared to 2016.

These factors influenced the decision to include several desalination projects in the country's 2015 Drought Plan, which outlines proposed short- and long-term solutions to the ongoing problem. Private utilities, for example Aguas Chañar (together with the Empresa Concesionaria de Servicios Sanitarios, ECONSSA) and Aguas del Altiplano, currently have plans to deliver large desalination projects in their service areas, the former relying on support from the central government initiative and the latter using independent resources.

Another interesting factor in play in this market is the competition between municipal and industrial users, particularly within the context of stressed water resources. Chile has been pursuing an update to its 1981 Water Code, which recently passed through the lower house of the legislature and under proposed reforms would shift towards prioritizing water allocations for human consumption and accounting for environmental issues. By limiting the ownership of water rights by mining companies, these reforms could further stimulate demand for desalination in the industrial market by forcing heavy water users to rely on alternative water sources.

In terms of the mining industry, as future mining operations or expansions are put on hold or cancelled altogether, desalination projects have been postponed indefinitely or at least until the market picks up, or in some cases, have been combined into more centralized treatment for several nearby mines. The most concrete example of this has been the Goldcorp and Teck Resources 50/50 joint venture "NuevaUnión", which aims

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to reduce costs by streamline mining operations and infrastructure, including desalination, water transmission, and wastewater disposal. A significant factor in the rebound of this market will be rallying commodities prices and the uptick in mining activities, which CODELCO, the Chilean national mining company, believes could start slowly recovering as soon as this year.

Globally, water reuse is also becoming an increasing popular topic, particularly projects that involve advanced treatment technologies such as reverse osmosis. The Chilean reuse market is still nascent, but is prompting more serious discussions, particularly when presented with, for example, the significant amount of treated effluent that is discharged to the ocean in coastal areas. The legal framework surrounding reuse is not clearly defined and debate is continuing particularly on the ownership of treated wastewater effluent, how much it is worth, and who can sell it for profit, all of which will affect the logistics of the market.

Francisco Virgili is Head of Data Analysis at Global Water Intelligence. He can be reached at fv@globalwaterintel.com.
For information about the upcoming Global Water Summit and its strands on Latin America, please visit http://www.watermeetsmoney.com/ ■

SWRO BOOT Project Participants Sought for Chilean Desalination Project

As IDA Connections goes to press, Water Desalination Report (WDR) is reporting that SWRO BOOT project participants are being sought for a desalination project in Chile.

Asset Chile has been retained by Corporación Nacional del Cobre de Chile (Codelco), the state-owned copper mining company, to conduct a competitive process to select a developer for a seawater desalination facility for its Radomiro Tomic Sulfides Project. The desal project will be located 155 km (97 mi) north of Antofagasta, near Tocopilla, and will be developed on a standalone basis to support the increased production at the Radomiro Tomic Mine.

Initially, the SWRO plant will have a production capacity of 54,430 m^3/d (14.4 MGD), with a potential build-out capacity of 145,150 m^3/d (38.3 MGD).The project is scheduled for commercial operation in 2021.

Interested companies may request additional information to enable the preparation of an expression of interest (EOI), including the EOI submittal date, at cws@assetchile.com.

For details, please see the February 6, 2017 edition of WDR. Excerpt published with permission of WDR. ■

ABES Joins Roster of Brazilian Supporters

As announced in the November/December issue of *IDA Connections*, ABES, the Brazilian Association of Sanitary and Environmental Engineering (ABES), is a strategic partner for the 2017 IDA World Congress.

ABES is non-governmental organization founded in 1966 with the purpose of developing and improving activities related to sanitary engineering and the environment, stimulating social awareness and actions that could meet conservation demands as well as environmental and life quality improvements within Brazilian society. Its goals are to develop and improve activities related to water, sanitation and environmental engineering, to promote social awareness and act to increase Brazil's quality of life.

Over its 47-year existence, ABES has actively participated in crucial political moments in Brazil's environmental sanitation sector, in which it holds a prominent position as a technical benchmark. In addition to its international prestige, the association commands a great deal of institutional respect. ABES has projected itself by dealing with subjects concerning social and economic development, most precisely as the latter are linked to public sanitation policies. Its prompt interventions have always been made at relevant moments, always dealing with facts that instigated its professional awareness and sense of ethics.

ABES has 27 State Chapters (same number of states in Brazil), and over 400 professionals work as volunteers all over the country, as directors and counselors. ABES has approximately 10.000 individual and corporate members. It is represented at the most significant councils

and forums of the Brazilian Environmental and Sanitation Sector such as CONAMA – National Council for the Environment, CNRH – National Council for Water Resources, and CEMA – State Environmental Councils.

As a strategic supporter, ABES will actively participate in the Congress with initiatives such as email marketing and disseminating news to their colleagues that will greatly boost the ability to attract participants from Brazil to this Congress and bring the maximum benefit to the country. ■

Online Registration Now Open

Registration is now open for the 2017 IDA World Congress. Take advantage of our early bird discounts by registering now through June 30, 2017.

In addition to the early discount savings, all IDA members are eligible for a member discount – offering the best registration value when coupled with the early bird discount.

To register online, visit http://wc.idadesal.org/registration/

IDA is also offering a special registration package for delegates from Brazil. Click here to take advantage of this offer https://www.eiseverywhere.com/ereg/index.php?eventid=210760&

Please feel free to share these links with colleagues, and be sure to regularly check the World Congress website, wc.idadesal.org, for updates and more World Congress news. ■

Become a Sponsor/Exhibitor Today

The IDA World Congress is the ideal place to showcase your products and services, promote your brand and establish important business-building connections at this premier water reuse and desalination event. Take advantage of extensive global media coverage, maximize your visibility on the show floor of the Congress as an exhibitor and benefit from the promotion before, during and after the Congress as a sponsor. Visit the IDA World Congress website, wc.idadesal.org, for more information. ■

Meet the Technical Program Chairs

IDA is pleased to introduce the four Technical Program Chairpersons who are instrumental in developing and managing the program for our 2017 World Congress.

Mr. Miguel Angel Sanz

IDA Director and Director of Strategic Development of SUEZ Treatment Infrastructure, France

Miguel Angel Sanz is Director of Strategic Development of SUEZ, Treatment Solutions. He has 32 years of professional experience in desalination as well as in the drinking water and wastewater fields.

He joined the Degrémont group in 1983 in Spain, where he led the Project Department. From 1992 to 2002, he was Technical and Project Director for the Spanish subsidiary. From 2002 to 2006, he was Desalination Manager and Deputy Technical Director for Degrémont group. From 2006 to 2009, he was Director of Business Development in Degrémont Iberia, and from 2009 to 2014 he was Director of Development and Innovation of Degrémont, based in France. As of January1, 2015, Degrémont and all companies of the group became SUEZ.

Mr. Sanz has been a member of the IDA Board of Directors since 2009, and currently serves as Chairman of the 2017 World Congress Technical Program Committee as well as a member of Affiliates Committee. Mr. Sanz received his Industrial Engineer degree in 1981 from Bilbao High Technical School of Engineers.

Mr. Guillaume Clairet

IDA Director and Chief Operating Officer, H_2O Innovation Inc., Canada

Guillaume Clairet is the Executive Vice President of H_2O Innovation, a leading company in water treatment related technologies. Mr. Clairet started his career in the water industry as a research associate for the National Institute of Scientific Research (INRS) where he conducted several studies on the contamination of ground water from military training activities. He joined H_2O Innovation in 2003 when the company was still at the start-up stage. He played a key role in the company's rapid growth, holding positions of increasing responsibility including Project Manager, Sales Manager and International Business Development Director.

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Mr. Clairet received a Physics Engineering Degree from Laval University in Quebec, Canada and he completed a Master in Business Administration (MBA) at the University of San Diego, USA. He has been a member of the Board of Directors of the International Desalination Association since 2011 and he is a member of WEF, AWWA and AMTA. He is also a registered Professional Engineer in the Province of Quebec, Canada.

Mr. Juan Miguel Pinto

IDA Director and Sales Manager, Desalination Americas for Energy Recovery, USA

Juan Miguel Pinto currently holds the position of Sales Manager, Desalination Americas for Energy Recovery Inc. (ERI). He has been involved in the water industry for more than 10 years. He joined ERI in 2004 and he played key roles through various Departments such as R/D, Engineering, Project Management and Sales. He has authored and co-authored over nine international publications.

Mr. Pinto serves on the Board of Directors of the International Desalination Association (IDA), as well as La Asociatión Latino Americana de Desalación y Reuso (ALADYR). Additionally, he served on the Board of Directors of the Caribbean Desalination Association (CARIBDA) in 2012.

Mr. Pinto received an Industrial Engineering Degree from Universidad Católica Andres Bello in Caracas, Venezuela. He also received a Certification in Master in Business Administration (MBA) and Project Management from the University of California at Berkeley.

Renato Giani Ramos

Latin America Commercial Director, Dow Water & Process Solutions, Brazil

Renato Ramos is currently responsible for Desalinization and Reuse Chamber in Brazil Sanitary Engineering Association (ABES). He holds the role of Commercial Director for Dow Water and Process Solutions in Latin America. Possessing more than 20 years of experience in the water market, he earned a degree in Civil Engineering from the University of Campinas and earned a Master Degree in Water and Wastewater Treatment from the University of São Paulo. He also holds an Executive MBA.

Members of the Technical Program Committee are:

Dr. Ahmed Al-Arifi	KSA
Professor Gary Amy	USA
Mr. Antonio Casanas	Spain
Professor Maria Kennedy	The Netherlands
Professor In S. Kim	Korea
Mr. Shawn Meyer-Steele	USA
Mr. Roberto Olivares	Mexico
Mr. Harry Seah	Singapore
Mr. Nikolay Voutchkov	France

The **Advisory Committee** includes Mr. Leon Awerbuch, USA, and Dr. Emilio Gabbrielli, Brazil.

Technical Program Update

The Technical Program Committee has reviewed 350+ abstracts that were submitted for consideration for presentation in the World Congress Technical Program. IDA announces that 323 abstracts have been accepted and moving on to writing manuscripts for (Podium) Oral or Digital Poster presentations.

Notifications were sent at the end of January to all authors. IDA wishes to thank all those who submitted abstracts for consideration.

Please note the list of upcoming important dates related to presentations in the Technical Program.

First draft manuscripts of accepted abstracts due	March 15, 2017
Presenter co-authors listings: profiles completed in IDA database website	March 15, 2017
Draft manuscripts review process	April - May
Second announcement (available)	April
Final manuscripts and copyright agreements due	June
Presenters register for Congress	June 30, 2017
Notification of presentation assignments (Podium Oral or Digital Poster)	June/July
Advance Program available	July
Presenter introduction final edits (database bio profile)	August
Draft PowerPoint presentations review process	August / September
Welcome to the Congress (check-in)	October

Trendwatch

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For example, AI technology can be used to improve the desalination process by optimizing supplemental equipment surrounding the desalination membrane. One self-adaptive flux enhancement and recovery control technology by Water Planet, Inc. appears to be the first application of AI as an active, real-time control platform in the water industry. *IntelliFlux™* technology monitors key operating parameters, performs real-time data analytics and makes predictions about when and what future maintenance actions will be required for upstream ultrafiltration pretreatment systems. In doing so, it provides the ability for the pretreatment filter to adapt to high fouling events buffering against the effects of these events on downstream membranes — ultimately, maximizing production while minimizing cost.

AI can play a pivotal role in making our society's current water infrastructure more cost-effective, energy-efficient and, ultimately, better equipped to keep us all safe. The advanced mathematics used to optimally maintain a complex water treatment system cannot possibly be processed by humans in real-time; however, computers excel at rapid computing — around the clock and with perfect memory. It is with advanced computing and control philosophies that operators, engineers, and their companies will be able to make more informed decisions in a timely manner.

Creativity is not the strength of artificial intelligence, computers are only as smart as we make them, and human ingenuity will always be needed to shepherd industrial and municipal processes to meet the ever-growing and complex needs of future generations. Integrating AI into the water industry will be the first step in doing so by maximizing the potential of current technology while freeing up valuable time for experts to focus on these higher-level advancements.

Dr. Gil Hurwitz is a scientific director with Water Planet Inc., an award-winning global supplier of high-performance membrane-based water treatment solutions. He may be reached at gil@waterplanet.com. For more information, visit waterplanet.com. ■

YLP Spotlight

Invite Your Colleagues to Join IDA with New Member Special!

IDA encourages you to share our special membership offer with your friends and colleagues who may not have discovered the benefits of being part of our community.

New members can sign up by March 1, 2017 to receive four free months of IDA membership. Their membership would run through June 30, 2018.

Membership in IDA is your connection to the global desalination and water reuse community. All IDA members age 35 or under are eligible to participate for free in the IDA Young Leaders Program and take advantage of the many educational and networking opportunities that come with IDA membership such as the Channabasappa Memorial Scholarship and IDA Fellowship Program

Restrictions apply – please contact membership@idadesal.org.

For more information about individual membership, visit http://idadesal.org/membership/membership-benefits/#individual-membership. ■

IDA YLP Holds Networking Event at the 2017 Membrane Technology Conference & Exposition

During the 2017 Membrane Technology Conference & Exposition in Long Beach, California, the IDA Young Leaders Program (YLP) and AWWA/AMTA Young Professionals (YP) sponsored a young professionals networking event. The reception took place on Tuesday, February 14, 2017 from 6:30-8:00 PM at the Hyatt Regency Hotel, located next to the Long Beach Convention Center.

IDA's North American affiliate, the American Membrane Technology Association (AMTA), works to promote, advocate and advance the understanding and application of membrane technology to create safe, affordable and reliable water supplies, and to treat municipal, industrial, agricultural and waste waters for beneficial use. The American Water Works Association (AWWA) is the largest nonprofit, scientific and educational association dedicated to managing and treating water, the world's most important resource. With approximately 50,000 members, AWWA provides solutions to improve public health, protect the environment, strengthen the economy and enhance our quality of life.

The organizations jointly hold this annual conference to show how the latest developments in membrane technology can enhance water reliability and quality. Each year the conference reveals new directions in water and wastewater treatment technologies, desalting and membrane bioreactor applications.

Register to attend the conference and exposition at http://www.awwa.org/conferences-education/conferences/membrane-technology.aspx.

For more information, please contact Naomi Jones at Naomi.Jones@h2oinnovation.com. ■

Technical Corner (Cont.)

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Global Water Summit 2017: Intelligent Synergies

IDA is pleased to once again announce its support as a co-sponsor of the of the Global Water Summit 2017, which takes place April 24-25, 2017 at the Madrid Marriott Auditorium Hotel and Conference Center in Madrid, Spain.

As a co-sponsor, IDA will lend its name and support to help promote the event and co-chair sessions on desalination. In addition, IDA members will receive a 10% discount off the registration pricing.

As part of the cross-promotion agreement, GWI will promote the IDA World Congress 2017. The IDA-GWI agreement was established based on the mutual objectives such as: cross-marketing to address current issues in desalination and the wider water industry for an executive level audience.

Global Water Summit 2017: Intelligent Synergies will explore how intelligent synergies blending finance and technology can deliver solutions for both industries and utilities, from Latin America to China. The program is designed to help delegates better understand how connections at the edges of the water sector can provide fresh perspective on the roadblocks to growth. For example, the digital revolution means that utility business models are evolving. Data is empowering the customer and the developing world, disrupting the traditional dynamics of the water industry. Meanwhile, the age of the "smart" and "livable" city has made water an intimate bedfellow with other environmental services such as waste and energy.

Strands will focus on Latin America, the site of IDA's upcoming World Congress, with sessions on Catalyzing PPPs in Latin America and Wastewater Management for Latin American Megacities. Other sessions address digital strategies, privatization and more.

A popular highlight of the Summit is the Roundtable Networking session. This year's event offers more than 30 roundtables with four 20-minute rotations to facilitate connection-building.

Plenary sessions open each day's program and a ministerial panel, Global vs. Local: The Next Generation of Water Management, closes the conference. Day 1 speakers are Martin Ford, New York Times Bestselling author and winner of the 2015 Financial Times/McKinsey Business Book of the Year Award; and Sue Murphy, Chief Executive Officer, Water Corporation, Western Australia. The Day 2 plenary session features CEOs of six of the world's most important water businesses who will discuss the key issues for the future of the water sector.

This year's Global Awards Dinner celebrates excellence across the international water industry and features guest speaker Nassim Nicholas Taleb, former trader, risk specialist, and author.

IDA members are invited to take advantage of a special member rate. For more information, visit www.watermeetsmoney.com/ ■

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Calendar of Events

February 13-17, 2017
AMTA/AWWA 2017 Membrane Technology Conference & Expo
Long Beach, CA, USA
www.amtaorg.com

March 28-30, 2017
WSTA 12th Gulf Water Conference
Manama, Kingdom of Bahrain
www.gulfwaterconference.com

April 24-25, 2017
Global Water Summit 2017: Intelligent Synergies
Madrid, Spain
www.watermeetsmoney.com

May 16-18, 2017
Ozwater '17
Sydney, Australia
www.ozwater.org

May 25-26, 2017
CaribDA Two-Day Workshop
Punta Cana, Dominican Republic
www.caribda.com

September 3-7, 2017
EuroMed 2017
Tel Aviv, Israel
www.edsoc.com

October 15-20, 2017
IDA 2017 World Congress
Sao Paulo, Brazil
www.idadesal.org

October 23-25, 2017
WETEX 2017
Dubai World Trade Centre
Dubai, UAE
www.eventseye.com

October 31-November 3, 2017
Aquatech Amsterdam 2017
Amsterdam, The Netherlands
www.aquatechtrade.com/amsterdam

May 6-10, 2018
Desalination for the Environment, Clean Water and Energy
Nantes, France
www.edsoc.com

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Editorial Director
Patricia A. Burke
Editor
Ann Seamonds
Editorial Offices
International Desalination Association
P.O. Box 387
94 Central Street, Suite 200
Topsfield, MA 01983 USA
Tel: +1-978-887-0410
Fax: +1-978-887-0411
Editorial Inquiries
+1-978-764-5528
seamonds@seamonds.com

International Desalination Association
PO Box 387, Topsfield, MA 01983 USA
Website: www.idadesal.org
Email: info@idadesal.org