WSWC – WGA Energy-Water Nexus Workshop

April 2, 2013 – Denver, CO

The Workshop Scope, Goals and Outcomes

The Western States Water Council (WSWC) and the Western Governors' Association (WGA) co-sponsored a workshop on water and energy nexus topics pertinent to water and energy planners, and utility managers on April 2nd, 2013, in Denver, Colorado. The intended audience of the workshop was a diverse group of energy managers and interests, water district managers and interests, researchers, and environmental stakeholders from private, public and the academic sector. The purpose of the workshop was to present new information on water/energy research being conducted throughout the West and across the nation, that was thought to be helpful and informative to the attendees. The workshop was also intended as a forum for examining topics that the Council or WGA could review for emphasis when making recommendations to the western states' governors. For example, topics covered by the speakers and the breakout sessions included, but were not limited to: water used for energy extraction, different energy supply sources, renewable energy development, water use trends and emerging technologies, new tools for quantifying resource risk, innovations in data sharing, and programs for taking an integrated approach to energy and water resources for statewide water planning efforts.

The workshop was attended by approximately 60 people in person. An additional 10 attendees participated via webinar, for a total of approximately 70 attendees. The invited speakers addressed a wide range of topics, and were able to provide a significant update on the status of water-energy nexus research being conducted. A latter portion of the workshop was reserved for breakout sessions, where attendees would be able to answer questions (either provided to begin discussion or self-selected), and give feedback on what they'd heard during the presentations. These were moderated and directed by group moderators, who summarized the groups' discussions and "reported back" on the results to the other attendees at the end of the workshop.

Speaker Summaries

The workshop began with remarks from Tony Willardson, Executive Director of the WSWC. He welcomed the workshop participants and explained the origin of the workshop and its intended scope and goals. Tom Iseman, the Water Policy Program Manager at WGA, also made remarks on his agency's interest in and support of ongoing water and energy nexus research being conducted. He anticipated hearing more about these efforts, and then hearing the thoughts of the participants during the workshop breakout sessions. Tom then introduced the keynote speaker for the workshop, Commissioner Jim Tarpey.

Commissioner Jim Tarpey, Colorado Public Utilities Commission – Energy and Policy Perspectives on Water in the West

Jim Tarpey began by discussing the regulatory process for the Colorado Public Utility Commission (PUC) and its relationship to other major utilities. He reviewed the statutes within Colorado that relate to public utilities, and the two specific statutes that would relate to water and energy nexus

topics. One observation of interest presented by Commissioner Tarpey was that the Colorado PUC is recognized under Colorado's state constitution, as opposed to creation by statute, which gives them the ability to address issues akin to the state legislature. If the state legislature leaves a perceived gap in addressing an emerging issue, the PUC can work to fill those gaps. Commissioner Tarpey described the traditional approach of the PUC for evaluating proposed energy projects, indicating that a cost/benefit approach was used where least economic cost was typically the main criteria that led to new projects. This process was used until the mid-nineties. At that time, Colorado PUC began looking at projects with a new approach that viewed energy development from a portfolio perspective, and considered a wider variety of factors for new development. The Colorado PUC now considers such things as 1) whether the project promotes the development of rural economies; 2) whether the project minimizes water use; 3) whether the project diversifies Colorado's energy portfolio; 4) whether the project reduces the impact of volatile energy pricing; and 5) whether the project improves Colorado's natural environment. Commissioner Tarpey emphasized that debate amongst the interested parties is a good thing, and that the Colorado PUC would like more entities to become involved in the planning process.

Brad Nickell, Western Electric Coordinating Council (WECC) – Incorporating Water into Long-Range Electricity Transmission Planning

Brad Nickell began his presentation by describing the organization of WECC, from the utility level to sub-regional to the interconnection level. The Transmission Expansion Planning Policy Committee (TEPPC) is the governing body of the planning community within WECC, and is charged with building infrastructure such that the system works now and well into the future. This includes compliance monitoring and enforcement when necessary, as well as managing the planning process and standard development, which are brought through various committees. WECC is focused on public policy directives that influence the energy industry, and pulls together state and federal policy for this sector. WECC has the capability to help coordinate the aggregation and dissemination of datasets that are important to long-range transmission planning. They also provide a forum for facilitation and discussion between stakeholders. Water has always been an issue for energy generation planning, but had never been incorporated as a specific modeling parameter until now. Mr. Nickell discussed the scenarios that WECC was reviewing for the coming decade, into 2022. He estimated that 60% of WECC's portfolio at that time would use water for cooling processes and that, even though this was still a relatively small piece of the "water use pie," it was important because energy generation is one of the fastest growing consumers of water. WECC conducts long-range planning and this is where the new water data from a study by Sandia National Lab would be applied. Models show that there is an incremental increase in water usage, and importantly, places where they are running into water availability limitations are in renewable energy zones and major gas-trading hubs. Their models also look at different cooling technologies such as wet versus dry, and what kinds of tradeoffs that result in terms of geography and climate. Mr. Nickell discussed the opportunities presented by WECC's collaboration with Sandia to evaluate water supply sources and cost to develop those sources. Some of the data have been incorporated, while some are still too politically sensitive to ingest into models. He indicated there is a need to take advantage of these collaborative opportunities and leverage them, such that there is increased confidence and reliability in their long-range planning models.

Paul, Faeth, CNA Corporation – Policy Analysis for the Energy-Water Nexus at the Electric Reliability Council of Texas (ERCOT)

Paul Faeth first discussed what kind of entity CNA is, and its role in water and energy planning for ERCOT. CNA is a private, non-profit company that conducts research studies, including work on the energy-water and climate nexus. The study presented at the workshop was funded by a regulatory assistance project focused on helping public utility commissions address water issues. CNA evaluates the results of these studies and has the ability to incorporate water into them. CNA models included 19 different energy generation options and a wide variety of policy scenarios, which were extrapolated out to a 30-year horizon, given fixed costs for certain model parameters (capital and fuel costs). The results from the models will be published in May or June of 2013. A site specific example, the population in Texas is estimated to grow by 4 million people every 10 years, and power demand is project to increase up to 73%. Projections also suggest that wind costs will decrease by 25% over the same timeframe, but CNA models look at both the decrease and no decrease in wind cost scenarios. They also incorporate other policy issues such as a carbon tax or cap. Mr. Faeth presented the baseline scenario as well as several other permutations of the CNA models for the ERCOT region to show what effects these might have on water withdrawals and on carbon dioxide emissions. The takeaway message from the models is that a decrease in the cost of wind would result in a baseline scenario that is favorable to both water consumption and carbon emissions.

Vince Tidwell, Sandia National Laboratory – Energy and Water in the Western and Texas Interconnects

Vince Tidwell, the principal investigator for a major water-energy nexus project funded by the Department of Energy, presented some background information on their study. He discussed the project's goals and how they were working with WECC and ERCOT to supply comprehensive data for their long-range transmission planning (a horizon of 20 years). He presented data on the water consumption factors for various electricity generating technologies, and gave an example of the spatial water consumption factors for coal facility water use (i.e. how local climate can impact water use by the same energy generation technology). He also discussed the climate component of the study. This portion evaluates climate variability, drought scenarios and changes in water demand. This portion also looks at the vulnerability of power generation systems due to lowered lake levels and thermal effluent temperatures. Results indicate that a single year drought (using the drought of record – 2011) would not significantly alter operations, but that multiple year droughts would have some impact on Texas' energy generation. The effluent limitation analysis suggested that operations would be very near their thermal limits in future summers. Mr. Tidwell also presented on a series of water availability metrics that were developed by his research team and a volunteer team of water experts. The metrics included different water supply sources (appropriated and un-appropriated surface water, potable and brackish groundwater, and wastewater reuse), as well as current and future water demand trends. Much of the data was taken from state water agencies via direct interaction or from online sources. These metrics, as well as associated cost for development, were aggregated to an 8-digit hydrologic unit code (HUC) scale to provide a more comprehensive and comparable dataset on water availability and cost across the West. When comparing new water supply sources to the projected change in demand by sector, it was found that just developing un-appropriated water supply sources would not be sufficient to meet

demand, but that use of the entire water supply portfolio would meet water demand in most locations. Mr. Tidwell summarized several other facets of the study efforts, including a metric for environmental limitations to water supply development, water for fuel extraction, an energy for water provision calculator, and a water data exchange where the Sandia data would be able to provide their results and access the latest planning data available from state agencies.

Jeanine Jones, California Department of Water Resources – Ongoing Energy/Water Research in California

Jeanine Jones highlighted California's long history of planning for energy and water. In the past, these were not coordinated efforts, but the acknowledgement of climate change impacts resulted in new initiatives to force coordination between the resource planning agencies. State legislation was passed in 2006 that mandated reduction in greenhouse gas (GHG) emissions; in particular, the 2005 Governors' executive order to create a climate action team (CAT), resulted in the creation in a number of "kittens," – subcommittees named RCAT and WETCAT. California became very interested in embedded energy because of a discussion about how much was needed for the movement, treatment and use of water in the state. This high energy use is exacerbated by climate change due to an increase in water demand, and also the energy demand for other parts of the water supply and use cycle, such as groundwater pumping. Snowpack is projected to decline at mid-elevations, which also increases vulnerability. California's Department of Water Resources is the largest energy consumer in the state. Ms. Jones discussed the Public Interest Energy Research (PIER) Program, highlighting their significant contribution to the research surrounding water-energy nexus topics, and indicating that they have been replaced with a new program known as the Electric Program Investment Charge (EPIC). She then discussed some of the new requirements for formal planning within the state for energy and water development, including recommended actions addressing water use efficiency, water recycling, water system energy efficiency, reuse of urban runoff, increased renewable energy production and a public goods charge for water. Ms. Jones also highlighted some of the benefits of state interagency research coordination, such as reduced duplication of effort, standardization of global climate models and emissions storylines used for state planning programs, and facilitation of program implementation.

Eric Evenson, US Geological Survey (USGS) – Federal Perspectives on the Nexus: A Water/Energy Partnership

Eric Evenson began his presentation by pointing out that water and energy are two parts of a three-legged stool, which also includes food production. He suggested that agricultural production should be included when discussing the nexus. USGS would like to better understand the fluxes of material between each, but it would require a level of detail for water use data that is not currently possessed. He discussed USGS' efforts to quantify how much water is used by the thermoelectric power generation sector, including both withdrawals and uses, categorized by fuel type and cooling technology employed. USGS is working with the Energy Information Administration (EIA) to address recommendations made by the Government Accountability Office (GAO) concerning these trends. These efforts also include developing a process to involve stakeholders to improve data collection and dissemination. Their current research elucidates patterns related to withdrawal amounts and cooling type that vary by geography. The East Coast is dominated by a pattern of once-through cooling, while

saline water use dominates along coastal areas, and closed loop plants are more prevalent in the West. The overall budget for plants in the continental U.S. is dominated by once-through cooling. However, from a consumptive use standpoint, cooling towers have the greatest consumptive use, with recirculating ponds playing a lesser role.

Doug Larson, Western Interstate Energy Board (WIEB) – Water and the Western Interstate Energy Board

Doug Larson began his presentation by describing the role that WIEB plays in energy planning for the West. They are planning for load growth, and the West has some of the best solar, wind and geothermal energy potential. He also discussed the role of coal, which is inexpensive but in decline. Many coal plants are faced with major retrofits in order to comply with air quality regulations. With regard to water, a lessening of coal as energy generation fuel will reduce water needs in the West. Natural gas is more flexible, and can be located in urban areas with transportation infrastructure. It is also more easily ramped up and ramped down. Mr. Larson also discussed new generation capacity that will be coming online in the next decade, stating that the portfolio presented is a result of a mix of variables that include cost, state policy and resource flexibility. Renewable energy is also expected to increase, most of which is driven by state renewable portfolio standards (RPS) requirements. Within the solar arena, the two available options vary with respect to water resources – photo-voltaic (PV) solar requires very little water, while concentrated solar power (CSP) uses more. A technology to look into with respect to the water sector would be dry-cooled CSP technology. Mr. Larson indicated that the electric sector could benefit greatly if better water information were available.

Richard Belt, Xcel Energy – Long-Term Water Strategies for Energy Utilities

Richard Belt presented on water and energy nexus issues related to a local energy utility, reminding the audience that all water issues are inherently local. He reviewed the projected breakdown of uses for the state of Colorado in 2050, pointing out that, of the 3% projected to be used by self-supplied industries, only 50% was used by thermoelectric energy generation. There are many strategies that can employed by local energy providers concerning water supply. Xcel uses a “little bit of everything” approach to diversifying its water portfolio. These strategies include the procurement of direct flow water rights/storage, self-supplied or contract supply, native basin and trans-basin diversions, and recycled wastewater. Xcel focuses on supply integration and on maximizing supply flexibility. They are also focused on increasing their engagement with stakeholders and water providers. Some strategies employed with regard to drought include cooperative agreements with both the municipal and the agricultural sectors. These can consist of contracts, trades ,“unique” arrangements, interruptible supply, and use of recharge credits. Mr. Belt presented on Xcel’s water stewardship program, which addresses plant process improvements and greater incorporation of water reuse. It also includes reviewing new technologies surrounding water use, such as combine-cycle gas generation, hybrid cooling, wastewater recycling, incorporating renewables into their portfolio, and demand side management.

Jordan Macknick, National Renewable Energy Laboratory (NREL) – Energy Production and Water Use Trends

Jordan Macknick began his presentation with a visual review of historic water withdrawals by sector from 1950 – 2005. The graph presented illustrated the dramatic rise in withdrawals for the energy sector over that time span. Energy-water nexus research conducted at NREL has been to quantify both the operational water consumption and the operational water withdrawals necessary for each of the major subgroups of energy generation technologies. NREL has also conducted research on the implications of generating electricity based on various combinations of energy types, from an energy portfolio that had a heavy coal composition, including carbon capture and sequestration, to that with a phase-out of coal to a higher percentage of renewable technologies. This evaluation also broke the projected water use down by 18 different regions across the US. A life cycle analysis (LCA) of water use by major groupings of energy generation was also presented. LCA takes a "cradle to grave" look at the costs or impacts of a specific technology or policy. Mr. Macknick discussed specifically the water use of shale gas extraction during hydraulic fracturing, explaining its variability, but generally less than what is required for operations. He presented a comparison of shale gas wastewater management trends, which indicate that there is a trend away from surface water discharge in Pennsylvania, while that trend is reversed in Colorado. He summarized his talk with a restatement of national trends toward a more constant rate of withdrawal over the past 30 years, and by suggesting that these withdrawals and uses may change depending on various regional factors and the fuel systems and cooling systems chosen.

Jessica Shi, Electric Power Research Institute (EPRI) – Innovative Water Saving Technologies for the Electric Power Sector

Jessica Shi began her presentation by discussing the role EPRI plays in sponsoring innovative technology development through their Water Conservation Program. She provided background information for, and a breakdown on, the membership of EPRI. The Water Conservation Program was initiated in 2011, and seeks to develop "out of the box," game-changing cooling and water treatment ideas with a high potential for water conservation. Their first collaborative round resulted in 114 proposals and several white papers, solicited from national and global collaborators and from all EPRI sectors (environment, nuclear, generation and power distribution unit). Ms. Shi provided several examples of project proposals that had the potential to save significant quantities of water that were currently under investigation. These ranged from the effects of reducing condensing temperature on steam turbines to increase efficiency, to heat absorption by nanoparticles added into a coolant during the cooling phase of energy production. Several other potential projects were presented that dealt with hybrid dry/wet cooling, reverse osmosis membrane self-cleaning techniques, and the integration of membrane distillation and use of degraded water supply sources to decrease the use of potable water. Ms. Shi also discussed the details of an upcoming joint solicitation that will be issued by the National Science Foundation (NSF) and EPRI, before summarizing their joint efforts to date.

Robert Goldstein, Electric Power Research Institute (EPRI) – WaterPRISM: Water Availability and Resource Risk Management

Robert Goldstein presented on WaterPrism, a new decision support framework for managing water resource risk. Drivers for the development of the WaterPrism tool include electric power reliance on water resources, the need to manage environmental, regulatory, reputational and financial risks, and

the need to establish a roadmap to sustainability given the complexities of water/energy systems. The design of the software includes data on the available surface water and groundwater storage for a given watershed, as well as population, demand, and land use data. The combination of these supports a regional water balance that compares the projected water demand with the available water. The tool's functionality has been demonstrated by two pilots in the Green River Watershed in Kentucky, and the Muskingum River Watershed in Ohio. The datasets required for the runs were gathered and some demand management strategies were incorporated into the scenarios. The interface has the ability to show the savings of each strategy over a business-as-usual (BAU) baseline. It can also show the impact of decommissioning power plants that are less water efficient and conversion to other energy generation supply sources such as natural gas. WaterPrism allows the modeler to look at scenarios as they are evolving, and provides localized, fine resolution decision support.

Sara Larsen, Western States Water Council (WSWC), WaDE: A Water Data Exchange for Energy/Water Utility Planners

Sara Larsen first described the water/energy nexus work being conducted by Sandia National Laboratory, emphasizing the difficulty that the Labs had gaining access to and aggregating state water data. At the same time, the WGA and WSWC began discussing the possibility of sharing data between the states. State water planning data contains flow records for streamgages, water supply budgets, estimates of use, physical and legal availability and allocation data. These data collection efforts and estimates reflect local knowledge. States want their data to be published, so they agreed to initiate the Water Data Exchange (WaDE) project as a means to do so. WaDE's goal is to enable the states to start sharing water data with each other, the public and with federal agencies, while also encouraging federal partners to adopt standardized data schemas and publish relevant datasets using web services. Ms. Larsen explained how the WaDE framework was distributed so that the data remain at the state hosts' sites instead of transferring databases back and forth. Data are returned in an interoperable format using XML and REST-based web services. It will provide important water planning data estimates. Some data are gathered by the states, some are not, but the schema is something that the states can work toward. The states will continually be asked to answer national and regional questions about water availability and uses in the future. Participation in WaDE allows the states to be proactive about publishing their data to a variety of partners.

Nathan Morris, Nebraska Department of Natural Resources, INSIGHT: Integrated Water Resource Tools

Nathan Morris presented on Nebraska's new INSIGHT program, which is short for Integrated Network of Scientific Information and Geo-Hydrologic Tools. He described the purview of the Nebraska Department of Natural Resources as overseeing surface water rights, while the natural resource districts that cover the state administer groundwater. INSIGHT will integrate a variety of data and provide a centralized comprehensive set of records to support management decisions for Nebraska and broader efforts. The final product will use a mapping format, which will make the information easy to access by the public and other stakeholders. These will benefit by having access to data about water uses, demands and available supply. INSIGHT information is integrated and published used three primary mechanisms: the data management framework, the web-mapping framework and a web interface for

data viewing and retrieval. The viewing interface will be a combination of looking at information for each basin of interest, including pictures and a summary of the water supply sources and uses, as well as a timeline of that supply and use over many years for a longer perspective. INSIGHT is undergoing testing, and will likely be complete in July of 2013.

Breakout Session Summaries

After the presentations, the attendees were subdivided into groups for a breakout/discussion section to be held in an adjacent room. Each group had a moderator assigned to them and was given four questions to get their discussion going. If none of the questions were of interest to the group, they could propose a question and answer that instead.

Yellow Group – Questions and Answers

Yellow group was moderated by Tom Iseman of the WGA. His group selected three questions to answer. Question One: What data are still needed for energy and/or water planning? The group expressed the need for water availability data that is inter-seasonal, spatial and for a variety of water supply sources, including definitions of water availability related to physical, legal, political, social and environmental factors. It was suggested that some of this data is available, but that they need to be more timely and comparable between areas or regions. This may include cost information about the water, and could encompass a life-cycle analysis of different sources and their impacts on other sectors. Some regions have more pressing issues related to water availability than others. Question Two: How does energy development planning in your region impact the water sector? For some group members, a concern is the movement of water from the agricultural sector to the energy sector. There is a need to consider feedback loops, and the local economic and demographic changes caused by this transfer of use. There is a need to determine the amount of water used for new technologies of energy extraction and if there is a trend toward increasing use. Question Three: How is lack of data (for either energy or water activities) a constraint to good planning? This depends on the state doing the planning. A question was posed about what the drivers are for starting to include certain types of data into a planning process. This could be either a crisis or a proactive approach to a perceived emerging issue. Sometimes it's not a lack of data that is the problem but a lack of being able to find the data. They need to be centralized, comparable, and easily accessed.

Green Group – Questions and Answers

Green group was moderated by Vince Tidwell of Sandia National Lab. His group selected three questions to answer. Question One: Is there (enough) interaction between energy and water planners? The group used examples of water and energy groups working jointly on projects to demonstrate some instances of cooperative planning (i.e. Colorado Water Resources and Xcel Energy, Pacificorp, Manitoba Water Works and hydropower operations). The group looked for more opportunities for collaboration between the two resource groups, noting that many of these instances for cooperation were a result of environmental or endangered species concerns. Question Two: What are some of the most important energy/water models and data that are being used by energy/water resource planners? The group cited several instances where models were used to answer water/energy related questions, such as watershed models to prove up water rights, or decision support systems for evaluating new developments. Forecasts for streamflow and climate models are being incorporated into hydropower

operations and environmental regulation for use on different time frames. The group noted some gaps in modeling tools include a linkage between hydropower with broad power dispatch modeling, and with more variable renewable energy sources. There is also a lack of incorporation between each resource group (i.e. water only recently being integrated as a parameter or constraint to planning, energy use planned into water development, etc.). Question Three: What are some of the main issues with energy used for the water supply and consumption cycle? In many cases, a lack of good data is a primary constraint to identifying issues with energy used for water provision, despite energy cost being a significant factor in overall operating budgets. Using renewables to power water provision provides an outlet from the negative feedback loop created by increasing energy use for water provision.

Blue Group – Questions and Answers

Blue group was moderated by Tony Willardson of the WSWC. His group worked to address two their possible questions. Question One: Concerning water/energy efficiency and conservation, what are some of your strategies? The group specified several options for both energy and water demand side management strategies. Education and outreach were seen as very important to establishing more of a conservation ethic related to both resources. Some regions facing scarcity may need to mandate some level of water conservation, or simply adopt new water-related regulations (i.e., watering lawns only at night). It was suggested that pricing water in such a manner that encourages conservation was a very effective strategy. Question Two: What is your organization's vulnerability to extended drought? Energy providers are vulnerable to drought in terms of their water available for withdrawal for cooling at the facility, as well as by regulation of effluent temperatures. Energy producers do have options during a drought, which include paying agricultural irrigators to fallow their fields, or purchasing/leasing senior water rights. In this manner the agricultural sector acts as a buffer during extreme drought years. States also have the right to exert emergency measures for either sector in extreme cases of drought.

Red Group – Questions and Answers

Red group was moderated by Nathan Bracken of the WSWC. His group focused on one question that was of import to the group. How can energy planners take long-term drought or climate change into their planning? The group felt that energy planners needed to be proactive about addressing this issue. They would need to consider cross-boundary impacts, and the drivers of the drought/extreme weather. Group members desired to see agencies plan for the extremes of their forecasts instead of averages. This could include new approaches for determining what those extremes are. FERC relicensing processes could include and work to address climate change impacts. Increasing energy portfolios to include more drought resilient sources of energy (such wind, photo-voltaic solar, and small-hydro) was also an option. Multi-scale planning would be needed – working from local to regional to national levels. New technologies that conserve water should be fostered, while other cooling technologies that have more intensive water use could possibly be limited. Establishing a framework and encouraging the use of water markets could also provide additional flexibility in the face of a prolonged drought or climate change.

Conclusion

After the breakout/discussion session, the groups' moderators and the participants met back in the conference room to report on the answers to the questions they had discussed. Each moderator

explained their questions and answers to all other participants. Tony Willardson also discussed the “next steps” to be taken by the WSWC with regard to publishing the results of the current workshop, and the need for continuing a dialogue about energy and water in the future, with the possibility of conducting more workshops that built on the information gathered that day. He commented on the breadth and depth of the topics and research that had been presented by the speakers that day. He also noted that the breakouts had provided much needed insight and some excellent suggestions for further inquiry.