The Climate Registry

Water-Energy Greenhouse Gas Technical Brief

Key Issues for the Development of the Water-Energy Greenhouse Gas Guidance

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Acknowledgments

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Background

The Climate Registry (TCR) is a non-profit organization governed by a board of directors composed of government representatives from states, provinces, territories and Native Sovereign Nations from across North America. TCR operates a voluntary entity-wide greenhouse gas (GHG) reporting program which includes a General Reporting Protocol (GRP) and General Verification Protocol (GVP). The initial versions of the GRP and GVP were developed in 2007 and are maintained through a consensus-based process that involves TCR's directors, members, and public stakeholders. TCR also develops sector-specific guidance to supplement these documents. Currently, customized guidance is available for local governments, and the electric power, public transit, and oil and gas production and exploration sectors.

This technical brief provides recommendations for and explores the challenges and opportunities associated with the development of a methodology to allow SCE business customers to account for GHG emissions embedded in water in a consistent and comparable manner. It will form the basis of transparent and scalable optional GHG intensity metrics for water purveyors to provide to their customers so they can better quantify GHG emissions attributed to the water they consume.

Large water consumers and the water and wastewater industries across North America would additionally benefit from entity-wide reporting guidance designed to address the quantitative relationship of the water-energy GHG emissions (WEG) associated with the collection, production, transport, treatment and delivery of potable water, also known as the water use cycle. Organizations interested in contributing to such a resource are encouraged to contact TCR at policy@theclimateregistry.org.

Purpose and Organization

Climate change, the current drought in the western U.S., and the rising cost of energy and water are driving the need to develop reliable WEG reporting guidance for Southern California water users, suppliers and treatment organizations. For instance, the California Department of Water Resources (DWR) lists 20 different roadmap objectives in its California Water Plan Update 2013 Strategic Plan. More specifically, roadmap objective 9 promotes reducing the carbon footprint in water systems and water leaks, including objective action 9.6, that "DWR, the State Water Resources Control Board (SWRCB), and other state agencies should work with non-governmental carbon registries to develop standardized methodologies and protocols to enable the collection of accurate and comparable data on embedded energy and carbon in water systems" (California DWR, 2013a).

FIGURE 1: Map of Hydrologic Regions

Source: Department of Water Resources, CWP 2013

This technical brief identifies key reporting and verification issues that should be considered in the development of WEG guidance for SCE customers, in addition to recommendations for incorporating these issues in a comprehensive GHG accounting methodology. Issues and recommendations are based on activities in Southern California, where water-energy relationships are some of the best defined.[1] Most of SCE's business customer base is within the South Coast Hydrologic Region so additional emphasis was placed on WEG issues within that hydrologic basin during the literature review and subsequent analysis.

This technical brief contains the following key elements:

- Overview of the Southern California water sector, including the size, components, representative challenges, and interrelations of its WEG nexus;
- High level literature review, including a review of published studies that have estimated energy intensity[2] and the associated carbon intensity[3] of the water use cycle in California;
- Preliminary guidance content, including scope, boundary definitions, and an example calculation methodology; and,
- Key guidance considerations, to be need to addressed and resolved.

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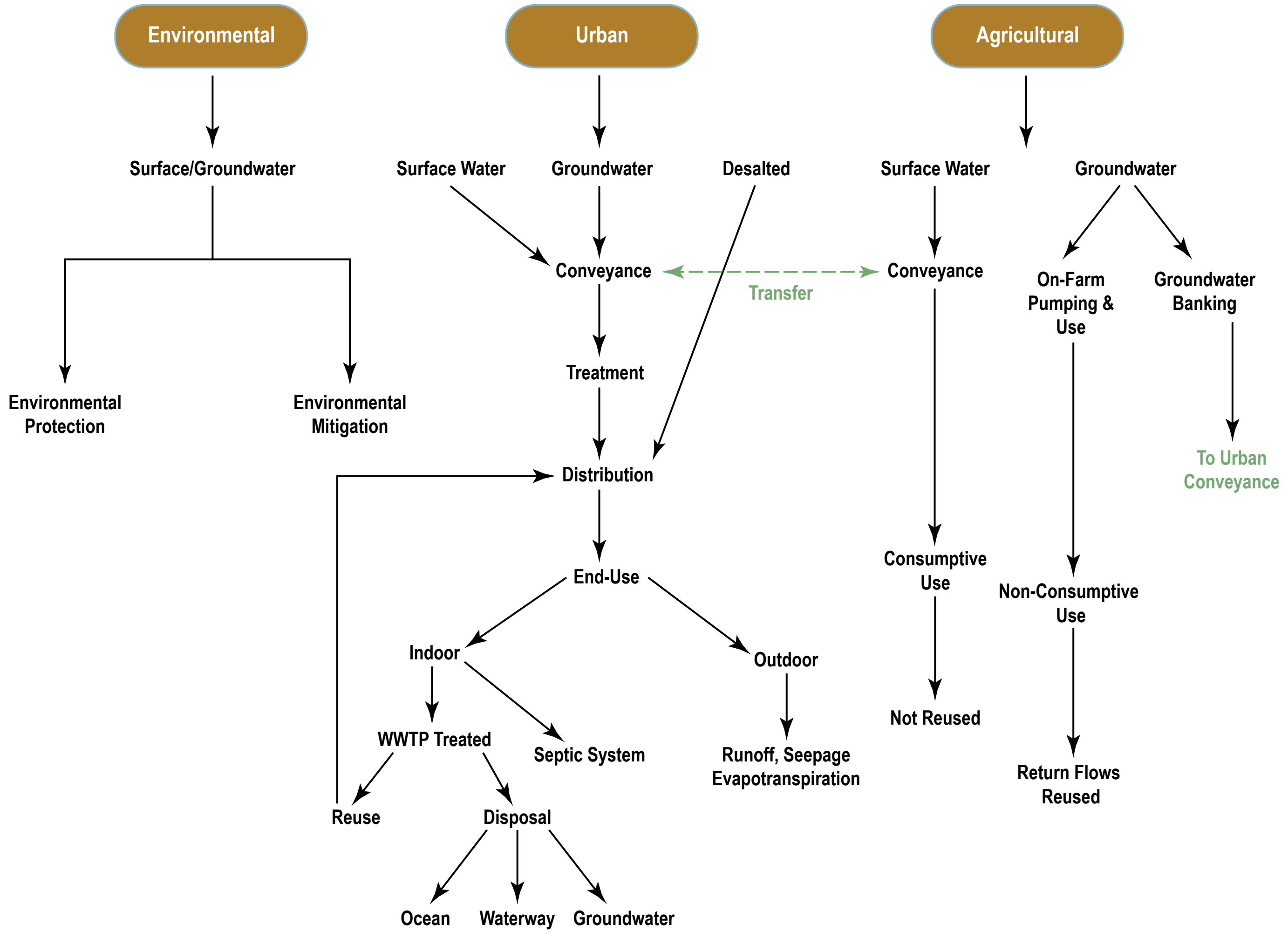
[1] California is broken up into ten distinct hydrologic regions as defined by the California Department of Water Resources (DWR). Five hydrologic regions are at least partially in Southern California. These are all of the South Coast, the Colorado River regions, and portions of the Central Coast, Tulare Lake, and South Lahontan regions.

[2] Energy Intensity (EI) is the total energy consumed in moving the water through the water use cycle and is typically measured in kilowatt hours per million gallons (kWh/MG).

[3] Carbon intensity is analogous to an emission factor and is typically measured in metric tons of carbon dioxide equivalent emissions (CO_2e) per unit of activity, which for water activity is typically per million gallons.

FIGURE 2: Simplified Schematic of the California Water Use Cycle



Overview of California's Water Sector

There are three types of water uses in California—environmental, agricultural, and urban. Environmental use accounts for about 50 percent of the water for environmental protection and mitigation (41.0 million gross acre-feet per year) and is mostly confined to the northernmost rivers of California and in coastal, delta, uplands fishery, and wetland management. Agriculture use, to help irrigate approximately nine million acres of farmland, accounts for approximately 40 percent (33.0 million gross acre-feet per year). Urban use accounts for approximately 10 percent (8.7 million gross acre-feet per year) (PPIC, 2014).

Figure 2 illustrates a simplified schematic for the California water use cycle based on the present state of California's heterogeneous and decentralized water management system. This decentralized system poses many challenges for developing consistent and comparable WEG reporting guidance.

In California, many water suppliers have primary or secondary water rights that have been in place for over 100 years. There are over 2,300 agencies that have jurisdiction over California's water (California DWR, 2013a). This estimate includes Federal, state and local regulatory bodies, as well as wholesale and retail water suppliers[4]. Water suppliers are generally categorized in the following groups:

- Large wholesalers;
- California Water Project (CWP) contractors[5];
- Small and medium wholesalers;
- Special district retailers;
- Municipal retailers;
- Investor-owned water retailers;
- Private water retailers;
- Irrigation districts; and,
- Publicly-owned treatment works (POTWs)[6].

Any of the above suppliers could be required under California law to report its long-term water management and conservation goals. For instance, California has identified 448 urban water suppliers that each serve over 3,000 urban connections or supply at least 3,000 acre-feet of urban water annually that must complete a state-mandated Urban Water Management Plan (UWMP)[7] (California DWR, 2012). A study by the Public Policy Institute of California (PPIC) estimates a total of 418 UWMP-eligible water utilities, which is composed of 373 retail agencies, 26 wholesale agencies, and 19 agencies with mixed retail and wholesale functions (Hanak, 2005). In this same study, the PPIC estimated that UWMP-eligible water agencies served at least 86 percent of California's population (Hanak, 2005).

Southern California Water Supply

For the remainder of this brief and for the WEG reporting guidance, only urban and agricultural water will be considered. Environmental water, as described above, is outside the scope of this work. As a result, urban and agricultural water account for 20 and 80 percent, respectively, of the water in California considered here (50 percent of total).

Urban Water

Residents and industry in Southern California rely mostly on imported water for their daily indoor and outdoor needs. This water comes primarily from six sources, including two imported and four local or regional sources, depending on the connection location and end-use:

- **Imported water from the Sierra Nevada** that is primarily transported to Southern California via aqueducts, canals and pipelines under the auspices of the State Water Project, the Federal Central Valley Project managed by the United States Bureau of Reclamation (USBR), and the Los Angeles Department of Water and Power (LADWP) Owen's Valley Los Angeles Aqueduct.
- **Imported water from the Colorado River** through a thoroughly managed program of aqueducts and pipelines prioritized in the 1931 Seven Party Agreement and operated and managed by the USBR. This agreement assigned a priority hierarchy to seven categories of users. First priority was given to the Palo Verde Irrigation District (California DWR, 2013b). In Southern California, priority was also given to the Metropolitan Water District (MWD) and the City and County of San Diego to convey water into the Lahontan and South Coast Hydrologic Regions. Additional Colorado River water is conveyed into the Imperial Valley through the Coachella and All American Canals as part of a Federal project and managed by the Imperial Irrigation District (IID).
- **Groundwater** pumped from local or regional groundwater aquifers or imported from outside

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[4] Retail water suppliers sell water directly to end-users and include city and county municipal water agencies and special districts, irrigation districts, and investor-owned or privately-owned water districts.

[5] Water agencies that manage the distribution of imported California Water Project aqueduct water.

[6] Wastewater utilities own and operate POTWs.

[7] UWMPs are required by the Urban Water Management Planning Act and eligible suppliers must report baseline and water use targets in order to show progress with the statewide goal of reducing urban per capital water use 20 percent by the year 2020 under Senate Bill X7-7. Developing and updating accurate UWMPs within the SCE customer base might benefit the development of a consistent and comparable WEG reporting guidance.

groundwater basins. Groundwater accounts for about 34 percent of the South Coast Hydrologic Region annual supply with 76 percent of this supply going to urban water use and the remaining to agricultural concerns (California DWR, 2013b). Some of the groundwater basins are adjudicated (i.e. court-appointed limits to extraction of groundwater) and most are fully managed with local or regional groundwater authorities. Some groundwater basins also practice conjunctive use strategies between surface and groundwater by engineering surface water recharge basins or wells to help recharge the groundwater aquifer. The South Coast Hydrologic Region has 32 such agencies or regional alliances that provide programs for groundwater conjunctive use and/or groundwater recharge (California DWR, 2013b).

- **Recycled or reclaimed wastewater** is typically tertiary treated and distributed locally as a non-potable water source for uses such as landscape irrigation, indoor toilet flushing, process water, and, in some instances, cooling tower applications. Recycled water use meets more than 7.5 percent of the South Coast Hydrologic Region's water supply demands (California DWR, 2013b). The State of California has a strategic goal of 1,250,000 acre-feet of wastewater reuse annually by 2015 that is projected to increase to 2,535,000 acre-feet annually by 2030 (Bryck et. al., 2008). In a 2008 survey, the Water Reuse Foundation reported there were about 100 POTWs providing recycled wastewater in the United States. The emission intensity of a recycled water resource depends upon the specific recycled water treatment plant energy intensity and energy used to distribute the treated wastewater to customers.
- **Desalted or desalinated water** removes the brackish components to reclaim impaired water mostly for agricultural uses. There are 23 brackish groundwater plants in operation in California with 22 of them in Southern California (California DWR, 2013c). 19 potential desalination plants are being proposed, developed, or constructed in California (Cooley & Heberger, 2013). Overall this energy-intensive source makes up a small portion of California's water use, although it may become more economically feasible as water agencies look for a more predictable, secure water supply that is not as effected by seismic events or long-term climate change.
- **Local and facility-scale recovered water** from industrial processes, rainwater, snowmelt, or graywater used primarily to offset the use of potable water.

Agricultural Water

Most agricultural suppliers consist of irrigation districts, local or district groundwater pumping authorities, on-farm groundwater pumping, and water suppliers to 'ranchettes,' which are typically former farming areas now occupied by private homes on modest farm lots. Some urban water suppliers also supply water to agricultural interests, either by completing inter-basin transfers, wheeling water, or simply selling retail to agricultural end-users. Agricultural water suppliers can also transfer water to urban water users when economics and surplus dictates the transfer.

In California, the large agricultural water suppliers, covering over 25,000 acres of land, must complete an Agricultural Water Management Plan (AWMP), somewhat analogous to the UWMPs that urban suppliers must produce and update. Presently, California DWR has identified 79 large water suppliers to complete the AWMP plus additional agricultural water best management practice plans (O'Connor and Christian-Smith, 2013). None of these large suppliers are located in the South Coast or South Lahontan Hydrological Regions, with only one supplier in the Colorado River Region that is the Palo Verde Irrigation District.

Downstream Water Treatment

There are many joint water and wastewater utilities in California that treat wastewater under the Federal Clean Water Act and California Porter-Cologne Water

Quality Control Act. Most publically owned treatment works (POTWs) use standard activated sludge primary and secondary treatment. Many of these treatment plants also have advanced nutrient (phosphorous and nitrogen) removal mandated by regulatory consent because of nutrient impacts on receiving stream quality. The wastewater treatment GHG emissions profile includes direct facility-specific Carbon Dioxide (CO_2) emissions from internal combustion, Methane (CH_4) emissions from anaerobic digestion and anaerobic lagoons, Nitrous Oxide (N_2O) emissions from denitrification treatment, and downstream N_2O emissions in the receiving aquatic environment.

CH_2M Hill (2007) compared different estimation methodologies of CH_4 and N_2O emissions from wastewater treatment that have been developed by the Intergovernmental Panel on Climate Change (IPCC), United States Environmental Protection Agency (US EPA), mass balance calculations, and more recently, facility-specific source testing and computer modeling. The rigor of the latter methodology is well-suited for facility-specific emission estimates, whereas the IPCC top-down method is more conservative and suited for aggregated wastewater operations. The study concludes that the IPCC method grossly overestimated N_2O emissions and does not account for all fugitive emission sources of CH_4 (CH_2M Hill, 2007).

One additional factor highlighted by CH_2M Hill's 2007 study is the sizeable component of total septic system CH_4 emissions. The US EPA estimates 76 percent of the total CH_4 emissions are from septic systems, 23 percent from anaerobic treatment, one percent from anaerobic digesters, with negligible emissions from aerobic activated sludge wastewater treatment (US EPA, 2007). These septic systems are not considered to be within the wastewater treatment sector, but nevertheless, could be a large contributor to the water use cycle in rural areas that predominantly incorporate septic wastewater treatment.

High Level Literature Review

A number of studies and reports regarding the water-energy nexus and its relationship to embedded GHG emissions have been published in recent years. This paper briefly summaries each of these publications to provide a broader context to the challenges of WEG reporting. Please note that the majority of the available literature addresses urban water. Little was found in regards to GHG emissions intensity of treated water or agricultural water in California.

CEC and CPUC Publications

California's Water-Energy Relationship was published in 2005 by the CEC (CEC, 2005) and refined in December 2006 by Navigant Consulting (2006). The CEC and its consultants determined that the energy intensity of the water use cycle for imported water in California could be estimated based on pumping, treatment, and conveyance records. They reported a range in energy intensity of six different water-use cycle segments (supply and conveyance, treatment, distribution, wastewater collection and treatment, wastewater discharge, and recycled water treatment and distribution) for both urban and agricultural water supply that ranged from a low of 0 kWh/million gallons (MG) to a high of 16,000 kWh/MG for potable water treatment. The highest total energy intensity was assigned to imported CWP potable water in Southern California (CEC, 2006).

The California Public Utilities Commission (CPUC) funded three additional studies in 2010 and 2011, which included the CPUC study 1 *Statewide and Regional Water-Energy Relationship* (GEI Consultants/Navigant Consulting, Inc., 2010a), CPUC study 2 *Water Agency and Function Component Study and Embedded Water-Energy load profiles* (GEI Consultants/Navigant Consulting, Inc., 2010b), and CPUC study 3 *End-Use Water Demand Profiles (*Aquacraft, Inc., 2010). These studies used software-based data analytics to further refine the estimates of water-related energy consumption for certain California water agencies. The data results of CPUC studies 1 and 2 show that that the electricity amount actually consumed in the complete water use cycle is 55.7 percent higher than CEC's 2006 refined estimates (GEI Consultants/Navigant Consulting, Inc., 2010a & 2010b).

The CPUC study 1 also defined the difference between embedded and physical energy within the water use cycle (GEI Consultants/Navigant Consulting, Inc., 2010). According to the study, embedded energy is the cumulative quantity of energy needed for water to be collected and pumped into another specific hydrologic region versus physical energy being the quantity of energy to meet the demand within a specific hydrologic region. The relationship between embedded energy and physical energy can vary widely by hydrologic region. For instance, the Sacramento River hydrologic region energy intensity consists of mostly equal physical and embedded energy in GWh (about 2,000 GWh/year from mostly groundwater pumping) whereas the South Coast Hydrologic Region has embedded energy intensity (approximately 7,500 GWh/year) that is at least three times greater than physical energy of approximately 2,000 GWh/year. The largest contributor to embedded energy (and the entire water use cycle) is the supply and conveyance of urban water, whereas physical energy originates mostly from the regional groundwater pumping segment.

The CPUC study 3 (Aquacraft, Inc., 2010) considered hourly water consumption patterns in a number of different end-use categories to help link water savings with energy savings. The goal of the study was to better refine how water savings can link to state and utility energy efficiency incentive and demand response programs. The results suggested targeting such programs to the water use categories with the strongest link to peak energy period. These categories included residential toilets and showers, car washes, and agricultural irrigation.

These three CPUC studies indicate that there is an opportunity to develop an organized, statewide data collection system that has an energy consumption inventory for all water agencies wholesale and retail. These studies, however, were limited in linking physical and embedded energy of water to GHG emissions, especially for the complete water use cycle, which includes wastewater treatment.

The CPUC in 2014 focused its efforts on developing a framework or software tool for assessing the cost-benefits of demand-side[8] water-energy programs to ensure these programs meet CPUC's cost-effectiveness approach. CPUC's consulting team assessed the cost-effectiveness of three demand-side water conservation benefits. These benefits included the avoided cost of embedded Investor Owned Utility (IOU) energy in water, avoided costs of water capacity, and lastly, environmental benefits of reduced water use (Navigant Consulting, 2014a).

In order to properly assess the avoided cost of reduced water demand, the CPUC team first determined the value of embedded energy in water. Instead of considering the typical or average value of embedded energy, the team determined that the relevant metric for this application was the embedded energy from marginal water supply sources[9]. Marginal water supplies could include any high cost marginal supply within the water use cycle. For instance, ocean seawater was determined to be the most applicable short and long-term (over 10 years) marginal water supply for the South Coast Hydrological Region (Navigant Consulting, 2014b). Once the marginal water supply scenarios were determined, a cost-effectiveness tool was produced to calculate the avoided cost of embedded energy in marginal water resources saved

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[8] In this case, demand-side refers to managing the quantity of water or energy that an end-user consumes.

[9] Marginal water supply refers to the future water supply a supplier or utility would need to develop in the absence of water conversation based on the assumption water efficiency reduces reliance of water supply 'on the margin' Navigant Consulting (2014b). This term has been used for many years in the energy conservation industry for considering the cost-benefits of avoiding the construction of power generation or infrastructure.

by demand-side conservation measures. The tool multiplies water use cycle marginal energy intensity (kWh per acre-foot) by the impact of annual water conservation measure(s) to estimate a marginal embedded energy savings in kWh per annum (Navigant Consulting, 2014b).

This embedded energy savings valuation tool may integrate well with WEG reporting guidance that assesses avoided GHG emissions resulting from water conservation measures.

Urban Water Publications

Greenhouse Gas Emissions Calculator for the Water Sector: User's Manual Santa Ana Watershed Basin Study: This regional study focused on water sector GHG emissions in the Santa Ana River Watershed and was funded by the USBR. The objective of this study was to develop a basin-wide GHG emissions calculator that could be used to forecast GHG emissions in urban water use through 2050 (Blickenstaff, 2013). The member agencies from the Santa Ana Watershed Project Authority (SAWPA) provided water usage activity data, including Eastern Municipal Water District (EMWD), Western Municipal Water District (WMWD), Inland Empire Utilities Agency (IEUA), Orange County Water District (OCWD), and the San Bernardino Valley Municipal Water District (SBVMWD).

The spreadsheet-based calculator estimates annual Carbon Dioxide-equivalent (CO_2e) emissions from four of five categories of the water use cycle including extraction, conveyance, treatment, and distribution, but not wastewater treatment. Activity data inputs include total water consumed by population and water use per capita. Water agency-specific input data included water source contribution (by percent of the total procured from groundwater extraction, the Colorado River, or the State Water Project), the energy intensity for each water source, and energy intensity of treatment. Default emission factors include the annual average electricity emission factors from the 2007 California Air Resources Board GHG Inventory, and 2009 eGRID[10] emission factors (Blickenstaff, 2013), although the user can customize emission factors. The tool assumed continued increase in population and decrease in water use per capita. Modeled scenarios included a business as usual baseline and different decreases in per capita water use. The calculator also predicted project-level GHG emissions reductions for 20 separate water conservation projects to be implemented in the SAWPA member agencies and continues to be used in the region to assess proposed projects (Blickenstaff, 2013).

LEEDing the Way: This paper illustrates the relationship between avoided GHG emissions and building-level water efficiency in Leadership in Energy and Environmental Design (LEED) certified buildings in Southern California (Miller, 2009). The study used the refined 2006 CEC estimates to develop urban water indoor and outdoor GHG emissions intensity for both Northern and Southern California applications. An urban water carbon intensity of 1,765 lbs CO_2e/acre-foot for Northern California and 3,568 lbs CO_2e/acre-foot for Southern California imported water were reported in the paper. While the results were largely as expected, it was surprising how much the direct emissions of CH_4 and N_2O from wastewater treatment contributed to the Northern California total urban water carbon intensity. This study was important for illustrating how energy intensity estimates can be used to estimate avoided embedded GHG emissions caused by building-scale water conservation measures.

Statewide assessment of Water-Related Energy Use for the Year 2000: The Pacific Institute authored a study for the CEC in May 2011, which used the Institute's models to estimate the energy intensity

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[10] The eGRID (Emissions & Generation Resource Integrated Database) provides average utility GHG emission factors from electrical generation in a regional or sub-regional context. It is maintained by the United States Environmental Protection Agency (USEPA).

of state-wide urban water to be 2,029 kWh/acre-foot of imported water delivered to customers. The report also calculated the contribution of different sources of electricity to the energy embedded in water in California, by quantifying municipal and agricultural water uses at every step in the water cycle and assigning them representative electricity values. (Pacific Institute, 2011). Results indicated that water-related electricity constituted about 20 percent of total electricity used within the state and also roughly 20 percent of the state's GHG emissions in 2000.

The Carbon Footprint of Water: Looking at the national level, the River Network estimated water-related energy use is equivalent to 13 percent of the nation's electricity consumption, which equates to a GHG emissions intensity of 1,401 CO_2e/acre-foot of water. This estimate includes everything upstream of point-of-use energy consumption. The River Network also found that embedded CO_2 in the nation's water supplies represents five percent of all U.S. carbon emissions using data from 2005 (Griffiths-Sattenspiel and Wilson, 2009).

Additional Resources

Finally, we considered the following eight studies that are also relevant to WEG issues in Southern California and thus are important to consider during the guidance development process.

California's Water-Energy-Climate Nexus: Jointly prepared by Water Energy Innovations and TCR, this white paper addresses the need for an integrated water-energy GHG emissions reporting protocol in California and beyond (Water Energy Innovations & The Climate Registry, 2013).

California's Water-Energy Nexus: Pathways to Implementation: This landmark publication summarizes the water-energy nexus research up to the date of publication. It identifies the top strategies to reduce water supply and conveyance as: segmenting electricity profiles by reducing the energy intensity of water supply portfolios, reducing summer pumping loads, and reducing water losses by evaporation, pipeline leaks, and conveyance/storage seepage (GEI Consultants, 2012).

Climate Action Plan Phase 1: Greenhouse Gas Emissions Reduction Plan: Developed by the California DWR, this report presents a strategy for substantially reducing its overall GHG emissions footprint by reducing its operational, construction, maintenance footprint while increasing its renewable energy profile. This approach includes eliminating purchasing of electricity from coal-fired power plants, and changing DWR's approach for purchasing excess electricity during peak demand periods (Schwartz, 2012).

California Water Plan Updates 2013: These updates were published by various state agencies and summarize the present state of the California urban water use cycle, and present/future management strategies. There is one section addressing the water-energy nexus and mitigation of GHG emissions (California DWR, 2013a).

Toolbox for Water Utility Energy and Greenhouse Gas Emission Management: Prepared by the Water Research Foundation and Global Water Research Coalition, this publication contains comprehensive resources for discussing GHG emissions accounting for water and wastewater treatment utilities. Three wastewater case studies are discussed, of which two are located in Southern California, including case study 3, which is a Southern California reclaimed wastewater facility that reported a total GHG emissions intensity of 945 lbs CO_2e/acre-foot of treated reclaimed wastewater distributed as "purple-pipe" irrigation water (McGucken et. al., 2013). This data indicates that reclaimed wastewater potentially has GHG emissions intensity at least 2.5 times less than urban landscape irrigation with potable water (Miller, 2009).

The Role of Recycled Water in Energy Efficiency and Greenhouse Gas Reduction: This publication outlines how the use of recycled wastewater can avoid GHG emissions. Table 5-1, “Quantifying the Societal Value of Recycled Water,” illustrates an associated carbon benefit of 1.43 short tons of GHG emissions per acre-foot of potable water, which converts to 2,860 lbs CO_2e/acre-foot of net avoided emissions. Please note that this report only considers the savings from energy using an emission factor of 0.4207 short tons CO_2e per MWh. This report did not consider of the contribution of CH_4 and N_2O emissions from advanced wastewater treatment, which may have reduced the projected avoided emission rate (California Sustainability Alliance, 2008).

Beverage Industry Sector Guidance for its Greenhouse Gas Emissions Reporting, *Version 2.0:* In this guidance, the Beverage Industry Environmental Roundtable (BIER) does consider water ingredients under its Scope 3 value chain emissions “associated with production/treatment of water” but does not provide any emission factors or protocols on how to estimate the embedded emissions in the water used in the beverage industry (BIER, 2010).

Avoided GHG Emissions from Stormwater Reuse: There is a current study in Los Angeles County by Community Conservation Solutions (CCS) that is estimating avoided GHG emissions resulting from the use of captured stormwater and dry weather runoff on a watershed scale. CCS and its engineering consultants are developing a unique approach to forecasting the avoided GHG emissions that will result from displacing energy-intensive imported potable water with captured and cleaned stormwater and dry weather runoff, using publicly-owned lands in the upper LA River Watershed. The vast majority of water supplies in this watershed are imported, resulting in high levels of GHGs. Dry weather runoff in the Upper L.A. River Watershed totals over 40,000 acre-feet per year (Kidman, 2015).

Preliminary Guidance Content

The studies described above together with feedback provided during TCR’s consensus-based policy development process will form the foundation of the forthcoming optional WEG guidance. The guidance will include sector-specific information for WEG accounting and will serve as an addendum to the GRP. An outline of the guidance content follows below, as well as a description of the challenges that need to be considered and addressed.

Introduction

The introduction will describe the purpose, context, and scope of the WEG guidance. It will also define key terms and describe any relevant state and/or regional legislation affecting the guidance.

As described above, the majority of available studies and data pertain specifically to urban water. The lack of background information regarding agricultural water may make it challenging to develop embedded GHG emission factors for agricultural water at this time. However, definitions of urban and agricultural water must be clarified in the guidance, along with a consensus on whether agricultural water will be considered and included in the WEG guidance.

Determining What to Report

When reporting a GHG inventory to TCR, three types of boundary conditions must be defined by the Member: geographic, organizational, and operational. The Member will need to select organizational boundary conditions of either operational, financial, and/or equity share control in order to properly account for its portion of the water use cycle GHG emissions. Most water agencies have an existing enterprise structure that will use operational control with a minority of water agencies additionally using equity share control. For instance, eight of the eleven water agencies publicly

Table 1: Water Use Cycle GHG Emissions Calculations

Water Use Cycle Modes	(A) Water Activity Data (ac-ft)	(B) Energy Intensity (kWh/ac-ft)	(C) Scope 2 Indirect Emissions Intensity (kg CO_2e/ac-ft.)	(D) Scope 1 Direct Emissions Intensity (kg CO_2e/ac-ft.)	(E) Overall GHG Emissions Factor D=∑C..+∑D.. (kg CO_2e/ac-ft.)
Supply & Conveyance					
Treatment					
Distribution					
Point of Use	¥	¥	¥	¥	¥
Wastewater Treatment/Disposal	#	#	#	#	#
Wastewater Reuse	*	*	*	*	*

¥ For discussion purposes only and would be considered Scope 3 emissions.

Relevant only for urban indoor water that discharges to the sewer as wastewater

* Only considered in cases where reused wastewater is available from the water supplier.

Where:

(A) Water activity is the total water quantity being moved through each water use cycle component that may or may not be sold, wheeled, shared, and banked between wholesale, retail, and resale partners.

(B) Energy Intensity (EI) is the total energy consumed in moving the water through the water use cycle.

(C) The The Scope 2 indirect emissions intensity is the summation of all sources of purchased electricity and its reported emission factor for all electricity purchased throughout each water use cycle mode. The Scope 2 emission factor based on eGRID factors (Southern California is the CAMX sub region), or utility-specific emission factors.

(D) The Scope 1 direct emissions that may result from the use of fossil or biogenic fuels to convey or treat the water and direct emissions of CH_4 and N_2O during wastewater treatment. This Scope 1 factor should also include fugitive emissions from the use of refrigerants used in any of the water use cycle modes where the water supplier has control.

(E) The overall GHG emission factor would include the aggregation of GHG emission factors for a water supplier for each water use cycle mode. Most water suppliers may have only one overall GHG emission factor to report for each mode, whereas some suppliers may need to aggregate a number of facility-specific GHG emission factors if water is blended together from facility to facility. Some retail suppliers may not need to report supply and conveyance and treatment modes because they may gain custody of the water only during the distribution mode. There may also be the instance where water suppliers report different source-specific GHG emission factors containing different levels of rigor. For instance, data used in calculating GHG emission factors from pumped groundwater may be less certain than data used in calculating GHG emission factors from piped water.

reporting GHG emissions through TCR's web-based Climate Registry Information System (CRIS) reported using operational control, two reported using equity share with operational control, and one reported equity share with financial control.

Operational boundaries will include both direct and indirect GHG emissions during the water use cycle. The entity that controls these emissions will need to account for all emissions within the defined water use cycle boundary. Under Scope 1, examples of reportable direct GHG emissions include CO_2 emissions from combustion and CH_4 and N_2O emissions from wastewater treatment. Under Scope 2, reportable indirect GHG emissions of CO_2, CH_4, and N_2O are principally from the purchase of imported electricity.

Quantifying Your Emissions

This section will provide a basis for consistent comparison of the GHG emissions of reporting entities and allows entities to track carbon intensity (lb/MWh) over time. The carbon intensity (efficiency metric) can also be used by the purchaser of the water to report more accurate Scope 3 emissions.

Preliminary water use cycle GHG emissions can be estimated based on key water use modes, activities, and emission factors in order to estimate an overall GHG emission factor. The water cycle use modes are the main components for the water use cycle, and all components contain definable embedded GHG emissions. The point-of-use mode has been included in Table 1 for discussion purposes only. Any of these point-of-use emissions would be considered the Scope 3 emissions of the water supplier.

Table 1 provides an example of a possible calculation approach.

For a small retail water supplier with a single treatment facility and local distribution, the GHG intensity metric should be implemented easily. For the larger wholesale or retail water supplier that is vertically integrated with conveyance, treatment, distribution and wastewater treatment, the overall emission factor developed may be more complex and depend on where the water is sold within the supplier's distribution grid.

Key Guidance Considerations

Key elements that need to be considered in developing the WEG guidance include organizational boundary challenges, applicable reporting entities, water use cycle accounting, data & data uncertainty and verification.

Organizational Boundary Challenges

Because of the heterogeneous nature of the California water use cycle, consistency of the water supplier organizational boundaries could be impacted by complex water supply scenarios.

How will complex organizational issues be considered? For example, for entities with shared assets, unique agency structures, long-term purchase agreements, water transmission rights, groundwater banking, and water exchanges?[11] Water exchanges, for instance, may end after one year and would not be accounted for until the water is returned the following year and may, ultimately, be returned in an uneven exchange. These exchanges can be difficult to account for within the water supply cycle. The guidance may look to TCR's existing frameworks to maintain consistency, such as the GRP and Electric Power Sector (EPS) Protocol.

How will wholesale water utilities define organizational boundaries? For example, for facilities that supply water to multiple retail water suppliers? The guidance

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[11] Water exchanges are typically water delivered by one water user to another water user, with the receiving water user returning the water at a specified time or when the conditions of the parties' agreement are met (California DWR, 2013d). Sometimes this water exchange is done without a sales agreement and can be returned at a much later date.

may treat each turnout as a unique water supply, so that the retail agency would report a separate GHG intensity for each source depending on the availability of verifiable data.

How will wholesalers aggregate these facilities with the proper accounting control over multiple retail water customers? For example, consider the following scenario, Wholesale Entity 1 has long-term sales agreements with Retail Entities 1, 2, and 3 for 50 percent, 20 percent, and 10 percent of the water respectively to be distributed out of Wholesale Entity 1's pumping plant 1, with the additional 20 percent of pass-through water being conveyed to Retail Entity 4 downstream at Wholesale Entity 1's pumping plant 2.

Applicable Reporting Entities

Of the 373 retail agencies in California, we estimate there are 170 UWMP-eligible retail water agencies that reside in the South Coast Hydrologic Region[12]. In addition to the UWMP-sized suppliers, there are also a larger number of smaller urban water suppliers (less than 3,000 acre-feet or 3,000 urban connections) that may be considered in this WEG reporting guidance development[13].

What state water suppliers should be considered within this water-energy GHG emissions guidance? Should agricultural water suppliers and supplies be considered in this guidance? If so, what water is being used for agriculture in SCE territory (urban potable, reclaimed, groundwater)? *How will the guidance properly represent the urban water suppliers that supply the overwhelming majority of California urban water?* As mentioned previously there could be 2,300 agencies involved with the California water supply. This does not include the tribal areas. These agencies include state and Federal agencies such as the DWR and the USBR.

Should the use of the guidance be limited for use by larger agricultural and urban users that are required to prepare state-mandated management plans, or can it also support do we include smaller water suppliers including in-farm groundwater suppliers? What about agricultural water suppliers that appear to have the greatest uncertainty in their water usage activity data? The guidance will likely need to include separate requirements for wholesalers, retailers, and wastewater entities.

What should the operational boundary be for water suppliers? Do we exclude point-of-use or end-of-retail energy use (i.e. energy for heating or process) in the guidance? It likely will require an additional reporting protocol independent of this water supplier-driven guidance.

A broad-based sector-driven approach is another way to consider applicable water suppliers by using the North American Industry Classification System (NAICS) 22131 and 221310 Water Supply and Irrigation Systems.

Water Use-cycle Accounting

There is variability in measurement, metering, and estimation of water use throughout the California water use-cycle. In many instances, there are no metered records of agricultural water withdraws, transfers, and exchanges.

How will the guidance account for water losses? How do loss rates differ between chronic and acute losses? What measurements on losses are available and what typical loss rates are being seen? Layered within the uncertainty of water measurements is the uncertainty of water losses mainly along supply, conveyance and distribution cycles caused by evaporation, evapotranspiration, seepage, leaks, environmental take-outs, or

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[12] Many of whom are SCE customers.

[13] The California Department of Public Health (CDPH) Drinking Water Program lists an additional 868 smaller urban suppliers on its website as of July 3, 2014 (CDPH, 2014).

unauthorized exchanges. For instance, below are four instances of major water suppliers assuming or estimating loss rates. It is evident that comparing the loss rates for each of the studies would be difficult because of uncertain boundary conditions and different measurement methodologies.

- The California DWR includes a two percent transmission loss factor for long range transmission in determining its total default emission factor for DWR unspecified electricity purchases (Schwartz, 2012). CA DWR does not consider a water loss consumption factor across the entire water use cycle.
- The Bureau of Reclamation estimates a five percent loss rate in its conveyance system in its Central Valley Project aqueduct (Cohen, Nelson, and Wolff, 2004).
- The LADWP has conducted a distribution system water loss audit and estimates a total distribution system loss of 5.2 percent for the audit year of 2010–2011 (LADWP, 2013). This loss rate does not include the loss of water during supply and conveyance of water in canals or storage in reservoirs.
- Southern California Edison and Water Systems Optimization (WSO) completed pilot studies on embedded energy and estimated water loss for 17 water utility audits in California and estimated an average real water loss of nine percent (Sturm and Thomas, 2010). It appears these utility audits only considered the loss of water during distribution and not the supply and conveyance portion of its water use cycle. It should be noted that since the boundaries of these studies may vary, the rates may not be directly compared.

It should be noted that loss rates change over time spatially and temporary. These results demonstrate the need for the industry to adopt water loss rate coefficients that can be used throughout the water use cycle.

How will the water-energy GHG guidance consider disaggregating supplier-specific losses when multiple suppliers have joint ownership of the water or conveyance/distribution system? One approach to consider is using a similar methodology to TCR's EPS Protocol for reporting transmission and distribution (T&D) system losses. In that document there are two methods that can be used—either the more complex energy balance method or the default aggregated power flow method.

How will the guidance consider advanced treatment? How can the guidance account for CH_4 and N_2O emissions from downstream treatment if standard methods are not available? How to properly represent desalination plants as they come online? How to account for new regulation of storm water runoff and dry weather flow? For many reporters, these emissions may fall under Scope 3.

How will the guidance account for water used for electricity generation, both for fossil- and renewable-generated energy? How will the guidance consider synergistic benefits of hydroelectric generation during transmission and distribution? Many water suppliers are also power generators.

How will the guidance consider biogenic emissions? Does the WEG guidance need to provide guidance for quantifying and reporting biogenic CO_2 emissions from wood, biomass, landfill and digester gassources? TCR's GRP requires that biogenic emissions are reported separately. Separate WEG metrics may be needed.

How will the guidance distinguish between indoor and outdoor urban water? These two types of urban water may have different water use cycle impacts, and thus different emission intensities. For example, indoor water is often heated or cooled by the end-user and then discharged as wastewater, while outdoor water used for cleaning or irrigation is typically not treated and requires no treatment post-use.

How will the guidance consider the reporting of Scope 3 emissions? Should any categories be recommended? For some suppliers, the upstream and/or downstream treatment of the water may constitute a substantial contribution to the energy embedded in the water. The guidance should aim to treat water and suppliers fairly, recognizing the varying levels of availability in data for some Scope 3 categories.

Would the guidance consider including a chain of custody? A chain of custody is a chronological documentation of tracking physical materials or ownership and is used in many environmental certification programs. A chain of custody for water supplies would be a declaration from the custody holder or water supplier that its water has an emissions factor determined using the WEG guidance.

Data & Data Uncertainty

Data uncertainty is the predominant challenge to ensure that the end-user GHG emissions inventories uphold the principals of relevance, completeness, consistency, accuracy, and transparency. High quality water usage activity data and Scope 2 emission factors will be necessary to ensure reported metrics conform to these principles.

What units should be used to report activity data? Should it be acre-foot, million gallons, 1000 gallons, or per gallon?

How will the guidance handle the uncertainty of water usage activity data? Could the guidance consider an acceptable level of uncertainty? There is an uncertainty of the accuracy of water data, including water measurement metering accuracy, calibration, data recording/acquisition, and verification. Metering of flow may occur in open channels or closed conduits (i.e., pipes). Open channel measurement techniques typically include weirs or flumes. These open channel measurement techniques commonly suffer from poor accuracy. For instance, California is now requiring a measurement accuracy of ±12 percent by volume for agricultural water suppliers as part of the SBx7-7 regulations (Burt and Geer, 2012). Closed conduit or pipeline flow rates are measured by inline flow meters that may or may not have totalizers that typically have accuracies better than open channel devices and range from the ±0.1 percent to ±10 percent range when considering the diameter of the pipe and type of measurement device (Fletcher and Deletic, 2008).

What industry standards should be considered for measurement devices, calibration and automated or manual data logging and acquisition? Consideration should be given to the rigor of groundwater pumping activity data since most water suppliers estimate their production volume or estimate volume using regional water balance calculations.

Would wholesalers provide a statewide average energy intensity? How will the guidance account for the spatial and temporal variation in energy intensity? Wholesalers change blends of source water often, so that energy intensities change seasonally.

How will the guidance consider the uncertainty of Scope 2 emission rates? Could emission factors be provided for distinct water sources from wholesalers? Could emission factors be provided for each node along the water use cycle? There is an uncertainty of future emissions rates resulting from water suppliers purchasing unspecified spot market Scope 2 power purchases. For instance, DWR purchases electricity from the California ISO spot market where it is not possible to know from where the electricity originated or if it has a specific emission factor. They, instead, use a default emission factor plus a transmission loss rate of two percent (Schwartz, 2012). Since a certain level of uncertainty is inherent and unavoidable in emission factors as a result of calculation methods and defaults, the guidance could consider an acceptable level of uncertainty. Then, the guidance could recognize emission rates from certain mandatory regulatory programs that meet this criteria, establishing a hierarchy of emission rates that should be used, if available.

Would the guidance use updated and electricity supplier-specific Scope 2 emission factors for each node *along the water use cycle?* For instance, the most recent 2012 eGRID Subregion CAMX has a 2009 CO_2-only emission rate of 658.68 lbs CO_2/MWh. This is an average emission rate from multiple power sources in the CAMX region.

How will the guidance consider setting base years? What is the availability of historical data? The choice would be to be verifiable.

Would the guidance require integration into CRIS? The reporting process can be enhanced considerably if the host database allows for user-friendly data transfers and uploads. CRIS can also be developed to automate calculations (e.g. for electricity emissions based on reported kWh). It would be preferable to avoid having duplicate tracking systems (for TCR's GRP and water-energy GHG specific data).

Verification

How will the WEG guidance allow for verification of GHG emission assertions[14] *of water suppliers by third party validators or verifier entities? Can the level of assurance be reasonable or limited?* The WEG guidance may have to be written to allow for an aggregated material discrepancy of greater than five percent when considering water cycle use measurement uncertainties and other data uncertainty related to conveyance and distribution losses, and measuring annual groundwater sales.

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[14] Assertion is considered to be the claim by the water supplier of its GHG emissions intensity or emission factor in CO_2e/unit of water.

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