Future Transportation Energy Water Use Under California's Climate Goals

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Issue

California has built a water management infrastructure that is among the most sophisticated, extensive, and energy-intensive in the world. Approximately 19 percent of the State's electricity and 30 percent of its non-power plant natural gas is used to store, convey, conserve, use, and treat water and wastewater. Through its Climate Change Scoping Plan, the California Air Resources Board recognizes the need to develop integrated management strategies for energy and water conservation.

Transportation accounts for the largest share of California's greenhouse gas (GHG) emissions and still relies overwhelmingly (~93 percent) on petroleum products. As California progresses toward meeting its 2020 GHG reduction commitment and its 2030 target towards the 2050 goal (eighty percent reduction of GHG emissions below the 1990 level), transportation energy sources will realize a radical shift to alternative fuel sources that might include biofuels, natural gas, electricity, and hydrogen. These pathways require different types and amounts of water use per unit delivered energy than gasoline and other petroleum-derived fuels. Understanding these differences will be key to understanding how California's policies for water, energy and climate intersect.

Research Findings

We examine four scenarios, which bound the realm of probable future developments in energy and water in two dimensions: climate policy (a '*Reference*' scenario that meets the state's 2020 targets versus a '*Deep GHG*' emissions reduction scenario that meets the state's 2050 targets), and water policy (a '*Baseline*' current water use intensity versus a '*Smart*' more aggressive and conservation approach). Our projections indicate that California's low-carbon energy transition in the transportation sector will increase non-petroleum energy use from a current 177 PJ (2012) to 830 PJ (*Reference scenario*) or 760 (*Deep GHG scenario*) in 2030. At the same time, oil consumption decreases 13-24 percent, from 3,480 PJ to 3,000 PJ (*Reference*) or 2,660 PJ (*Deep GHG*). The increased reliance on biofuels, natural gas, and electricity and reduced oil production in California can have significant water use and quality implications.

Oil and Refineries water use. In the *Reference* Scenario, due to increases in gross water injection in California's aging oil fields, water use for oil extraction is projected to increase from 88 to 108 billion liters by 2030. Net freshwater consumption for oil extraction, currently at 14.3 billion liters, may decrease to 11.8 billion liters (a 17 percent reduction) (Figure 1). Water consumption by refineries within California, estimated for 2012 at 147 billion liters, is projected to decrease 14 percent to 127 billion liters as consumption of petroleum fuels decreases.

As California oil fields have aged over the past 15 years, produced water volumes have increased, with the majority of this water re-injected for enhanced oil recovery or storage. Between 1999-2012, water sent to unlined percolation ponds increased by 55 percent, and water disposed to surface water sources doubled. Increasing volumes of produced water represent a growing concern and an opportunity; as freshwater becomes scarce, treated produced water can become an important supplemental water source.

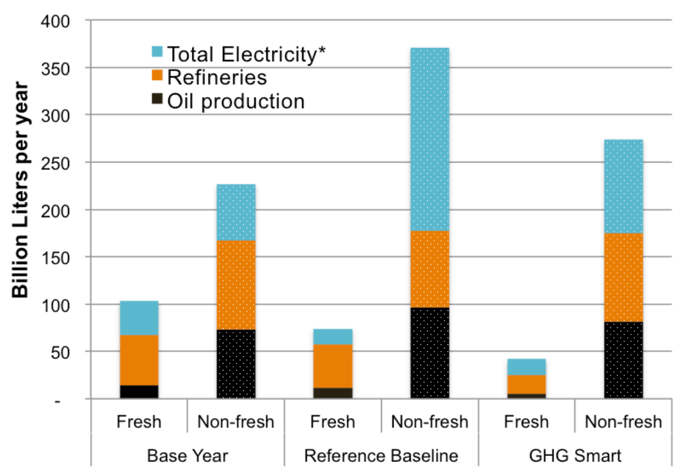

Figure 1. Projected Water Consumptive Use for Transportation in 2030 by Scenario. *Net out-of-state water consumption incurred due to energy supply imports is not included. The base year varies by supply chain (oil is 2012 and electricity is 2008). Transportation accounts for 0.4% of total in-state electricity generation in the base year, and 1.2% and 1.5% in the Reference and Deep GHG scenarios, respectively, in 2030. Non-Fresh water includes recycled (treated waste water from municipal and industrial sources and treated produced water from oil fields for oil production), degraded, waste, and other (unspecified) water types.*

Electricity. Electricity use in transport will grow substantially to meet the state's ambitious 2050 emission reduction targets under the Deep GHG scenario. In the Reference scenario, more geothermal plants as well as greater capacity of natural gas plants, will consume more water than the present generation mix. The Deep GHG scenario requires the same amount of fresh water for electric generation compared with the Reference scenario, but less degraded and recycled water as a result of less geothermal generation, more solar PV and NGCC. The smart water scenarios further reduce requirements for recycled and degraded water by assuming higher proportions of hybrid and dry-cooling.

Biofuels. The results of an analysis of the water use impacts of biofuels are reported separately.

Regional Impacts. Figure 2 shows the spatial locations of water use in the base year (top), and in the *Deep GHG Smart* scenarios (bottom), disaggregated by water source type and energy supply chain.

A climate policy that cuts transport emissions will reduce the state's petroleum use, alleviating increasing net water consumption in oil production and produced water sent to evaporation pond and disposed to surface water seen in the *Reference* scenario. Moreover, decreased oil consumption translates to lower water consumption for oil refining. Increased consumption of freshwater for oil production and electricity generation across a wide geographic area can be effectively managed with *Smart* water management that shifts water use from higher quality freshwater to lower quality water types such as degraded and recycled water.

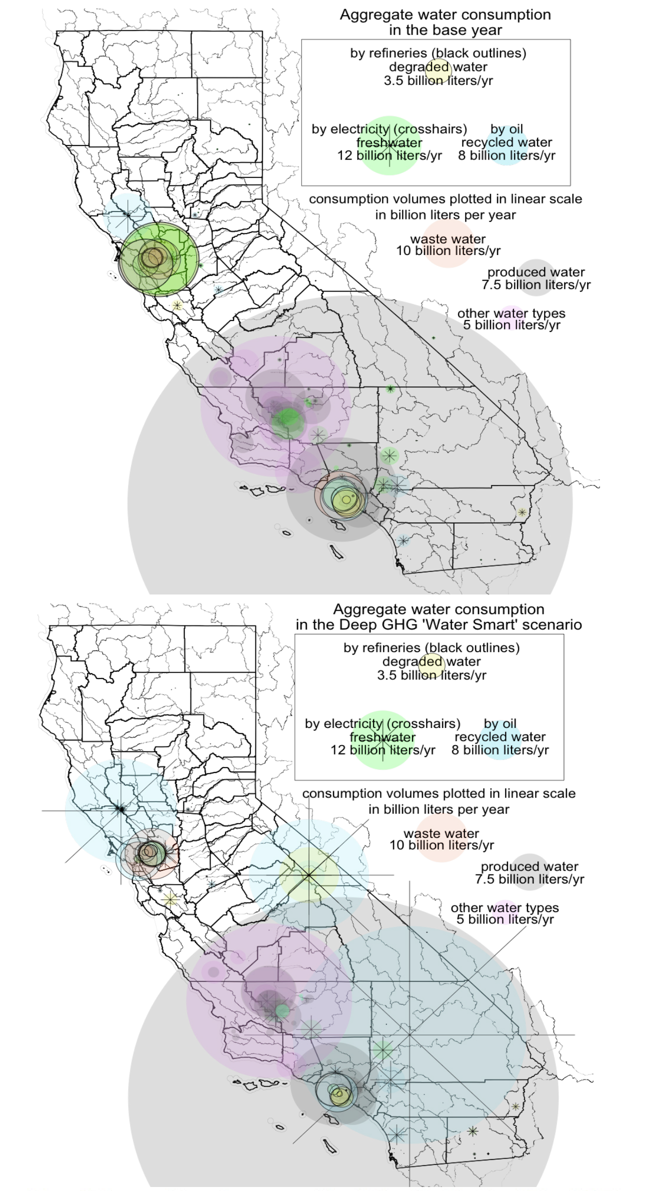

Figure 2. Aggregate water consumption in baseline (top) and Deep GHG Smart (bottom) scenarios for oil production & refining and electricity production

Policy Implications

Taking all of the effects together, meeting the State's 2020 climate target (Reference scenario) can reduce absolute fresh water consumption by 28% in 2030 from today's level. Meeting the 2050 climate goal (Deep GHG scenario) can further reduce fresh water use by another 7%. And by adopting policies to shift to non-fresh water sources, fresh water use drops by another 25%. That's 60% or 61 billion liters per year in water savings in electricity generation, refineries and oil production compared to today's level.

The most effective strategies for mitigating the water use impacts of providing energy vary across supply chains. For instance, in the case of oil and gas production, legislative and technical means may be sought to source water of usable quality (e.g. wastewater, recycled, or degraded water). In the case of oil refineries and electricity generation, minimum regulatory standards or pricing of water, may be designed to incentivize siting in regions with easy access to low-grade water resources. Siting decisions must also be properly balanced against competing economic and operational considerations (e.g. transport accessibility and distance to markets and consumers).

Further Reading

This policy brief is drawn from the full report, Teter, J., Tiedeman, K., Mishra, G.S., Yeh, S. 2014. *Water Use Impacts of California's Future Transportation Fuels.* A report prepared for the California Energy Commission.