# Accounting for the Carbon Costs of Alternative Water Supplies in Florida

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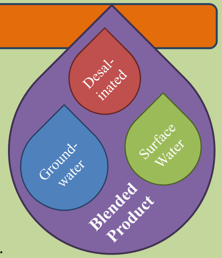
## Objectives

1) **Develop a process for estimating the energy-use carbon costs** of water production from three supply types: *groundwater*, *surface water*, and *desalinated seawater*.

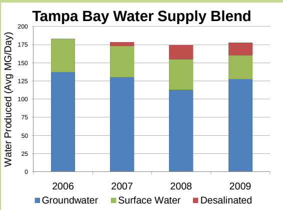
2) **Calculate the total carbon footprint** associated with Tampa Bay Water production facilities' electricity use (for water collection, conveyance, treatment, and delivery).

3) **Estimate the relative carbon intensities**, expressed as *carbon dioxide equivalents ($CO_2e$) per million gallons of water produced*, for each supply type and the blended product.




## Context

**Growing Demand:** Between 2010 and 2025, total demand for public water supply in the Tampa Bay region is projected to grow from 236 to 271 million gallons per day (MGD), a 15% increase in 15 years[1]. Tampa Bay Water is a main provider for the region, and as groundwater supplies are tapped to satisfy demand, it must add alternative sources such as surface water and desalinated water to its supply blend (Figure 1). Production from alternative sources, however, is more costly than production from "traditional" groundwater. This study estimates the carbon costs associated with these alternative sources and compares them to groundwater as a baseline.




(Figure 1)

**Water Supply Constraints:** Groundwater withdrawals are limited by consumptive use permits. Surface water use is limited by source quality and permit limits. Desalinated water production is limited by treatment plant capacity and budget constraints.

**GHG Accountability[2]:** Florida requires utilities and communities to account for GHG emissions:

- Florida Executive Order 07-127 established specific emissions targets.
- Florida HB 697 requires local governments to address GHG emissions in their planning.

## Data

2005 eGRID[3] **GHG Emissions Records** for 6 Power Plants Providing Electricity to Tampa Bay Water Facilities:

- Annual power generation (MWh)
- $CO_2$, $CH_4$, and $N_2O$ Emissions
- Emissions data converted to lbs/kWh
- Weighted emissions average calculated for each Electric Service Provider

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2006-2009 **Production Records** for 37 Tampa Bay Water Facilities:

- Water Pumped (million gallons/day, or MGD)
- Water Produced (MGD)
- Electricity Used (kWh/day)
- Electric Service Provider (TECO, Progress Energy, or WREC)

***The carbon costs we estimate are *conservative*** because they only account for a single operational cost of water production: electricity use. Furthermore, they exclude the costs of delivering water to the end user.

**Facilities and Emissions Data - Examples**

| Water Year | TBW Facility Name | Water Type | Water Produced (MG/yr) | Electric Use (kWh/yr) | Electric Provider | $CO_2$ (lbs/kWh) |
|---|---|---|---|---|---|---|
| 2007 | SWTP | Surface Water | 15,809 | 2,687,400 | Z | 1.6858 |
| 2008 | Well Field | Groundwater | 4,747 | 2,104,700 | Y | 2.0017 |
| 2009 | Treatment Plant | Desalinated Water | 6,192 | 92,122,660 | Z | 1.6858 |

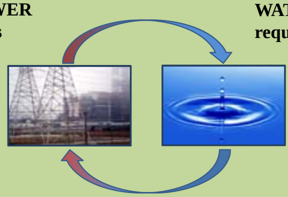
## Abstract

Florida's local governments and water utilities are faced with many challenges in providing a sustainable water supply for a growing population. As freshwater availability for public supply declines, the demand for alternative sources grows. Costs associated with the development of alternative water supplies are extensive and varied, including permitting, capital, operation, maintenance, and now, mitigation for greenhouse gases (GHGs). This study looks at the energy-water nexus of alternative water supplies and calculates the carbon footprint of three supply strategies used in the Tampa Bay Water region: groundwater pumping, surface water treatment, and seawater desalination. Facility-level data collected from Tampa Bay Water and the U.S. EPA are used to analyze the energy costs and carbon footprints of the three alternative water supply strategies. Results support the compelling argument for cost-avoidance through conservation strategies including better land design practices to maintain native vegetation and drainage, low impact development (LID), and resource-efficient design, plant material selection, and irrigation.

## The Energy-Water Nexus[4]

**ENERGY and POWER production requires WATER** for:

- Thermoelectric cooling
- Hydropower
- Fuel production
- Emissions controls
- Energy minerals extraction & mining



**WATER production requires ENERGY** for:

- Collection of groundwater, surface water, and seawater
- Pumping
- Conveyance
- Treatment
- Delivery and distribution

## Methods

1. **Annual GHG emissions**, expressed as carbon dioxide equivalents **($CO_2e$)**, for each electric service provider were calculated as:

   $$CO_2e\ (lbs/yr) = kWh/yr * ((CO_2\ lbs/kWh) + 21*(CH_4\ lbs/kWh) + 310*(N_2O\ lbs/kWh))$$

   where methane ($CH_4$) and nitrous oxide ($N_2O$) are adjusted by their global warming potential factors (GWP)[5] of 21 and 310, respectively. Carbon dioxide is used as the baseline, with a GWP of 1.

2. **Carbon footprints** ($CO_2e$ pounds per year) **for each water type *and* blended supply** were then estimated by merging GHG emissions with facilities data:

   $$CO_2e(lbs/yr)_{WT=i} = \Sigma F_{WT=i}(CO_2e\ lbs/yr)$$

   where F = facility and WT = water type

3. **Carbon intensities** ($CO_2e$ pounds per million gallons produced) **for each water type *and* blended supply** were then calculated:

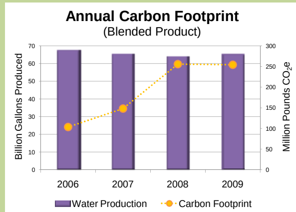
   $$CO_2e(lbs/MG)_{WT=i} = \Sigma WT_i(CO_2e\ lbs/yr)/\ \Sigma_{WTi}(MG/yr)$$

   where WT = water type and MG = million gallons produced

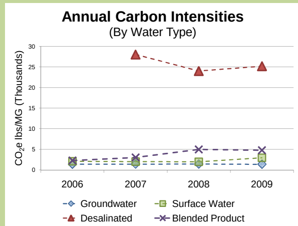

## Results & Conclusions

**Tampa Bay Water Production and Carbon Costs ('06-'09 Averages)**

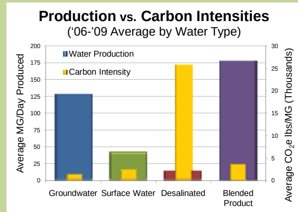
| Water Type | Production (MGD) | Portion of Production | Carbon Footprint ($CO_2e$ lbs/day) | Portion of Carbon Footprint | Carbon Intensity ($CO_2e$ lbs/MG) | Intensity Relative to Groundwater | Average Electricity Cost ($/MG) |
|---|---|---|---|---|---|---|---|
| **Groundwater** | 127 | 71% | 176,147 | 34% | 1,387 | 1:1 | $70 |
| **Surface Water** | 41 | 23% | 90,236 | 17% | 2,248 | 2:1 | $135 |
| **Desalinated Water** | 14 | 8% | 340,345 | 65% | 25,741 | 18:1 | $1343 |
| **Blended Product** | **178** | **--** | **521,641** | **--** | **3,764** | **3:1** | **$194** |




(Figure 2)




(Figure 3)




(Figure 4)

### Key Conclusions:

- Annual water production has fluctuated little since 2006, while the carbon footprint has more than doubled **(Figure 2)**. (The desal. plant began sustained operations in 2007.)
- On average, desalinated water has a carbon intensity 11 times greater than surface and 19 times greater than groundwater **(Figure 3)**.
- The carbon intensity of the blended product is highly dependent on the portion supplied from desalinated water **(Figure 4)**.

## Broader Implications

- **Next Steps:** Comprehensive carbon accounting will go beyond the research presented here to include all costs (financial, energy, environmental, social, etc.) of water supply from source to end use. It will also evaluate all likely scenarios for supply sourcing (e.g., reclaimed water use).
- **Local Governments and Water Utilities:** Policy and planning decisions must consider the full costs of marginal increases in water demand, particularly those necessitating investment in energy-intensive processes (e.g., seawater desalination). Utilities should include carbon costs in their evaluation of future supply scenarios, identify when alternative sources are necessary, and continue to incentivize conservation.
- **Homeowners**: Before each gallon of water is delivered to users, its production has created a substantial carbon footprint; once consumed – for humans or landscapes – the "energy-for-water" footprint grows. Conservation and efficiency can reduce this footprint and reduce utilities' reliance on costly, energy-intensive supply sources.

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### Notes & References

1) Tampa Bay Water October 2009 Demand Forecasting Model, via personal communication.

2) See: http://myfloridaclimate.com/2007_climate_summit/ and www.dca.state.fl.us/fdcp/DCP/Legislation/2008/HB697Resources.cfm

3) US EPA eGRID (Emissions & Generation Resource Integrated Database), www.epa.gov/cleanenergy/energy-resources/egrid/index.html

4) Graphic and text adapted from "Energy-Water Science & Technology Research Roadmap" presentation, Mike Hightower, Sandia National Laboratories, August 2006, at www.sandia.gov/energy-water/docs/EW_RoadmapSum_Solar8-06.pdf

5) Global Warming Potential factors equivalent to those used by the IPCC (www.ieta.org/ieta/www/pages/index.php?IdSitePage=123) and the US EPA's GHG Equivalencies Calculator (www.epa.gov/RDEE/energy-resources/calculator.html).