The Energy-Water Nexus:

A Case Study of Tampa Bay Water

Emerging Energy Issues and Topics In-Service Training
University of Florida, PREC

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UF UNIVERSITY of FLORIDA
IFAS Extension

TAMPA BAY WATER
Supplying Water To The Region

Presentation Objectives

- Share details of a Florida case study that exemplifies the energy-water nexus from a local water supply perspective
- Improve understanding of the complexity and various costs associated with operating a large, regional alternative water supply system
- Convey the values/benefits of water conservation and efficiency as means to reduce energy consumption and associated greenhouse gas emissions
- Discuss practical applications for Extension programming

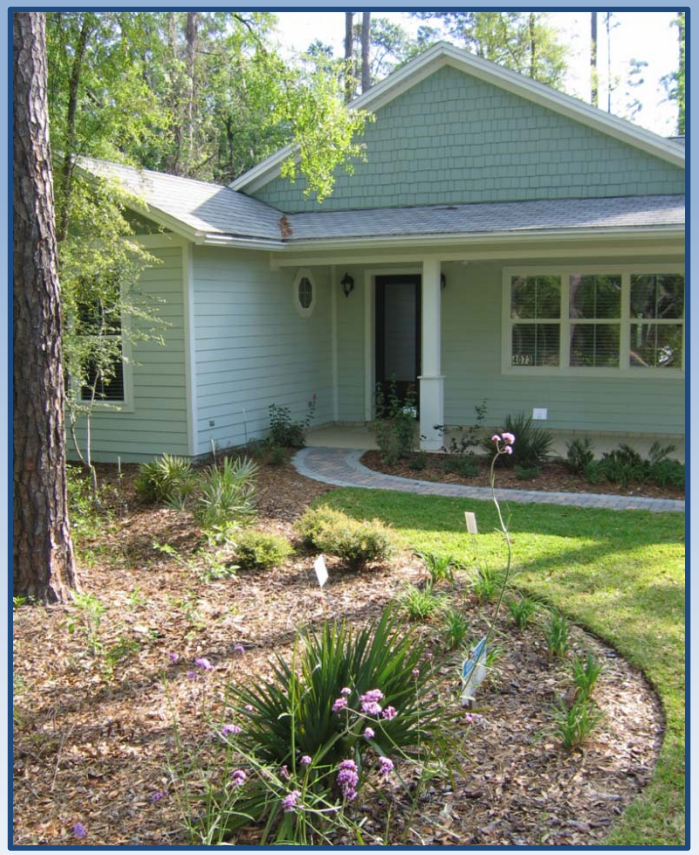
Desalination RO Membranes

**Unless otherwise noted, all images courtesy of Dave Bracciano, Tampa Bay Water*

Motivation

Program for Resource Efficient Communities (PREC) Mission:

- To promote the adoption of best design, construction and management practices that *measurably* reduce energy and water consumption and environmental degradation in residential communities.
- http://buildgreen.ufl.edu



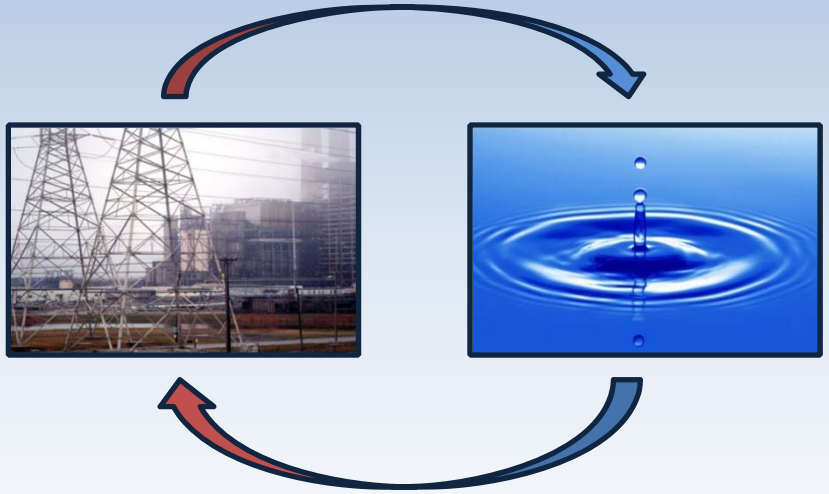
Model Home in *Madera*: a low impact development community
(Image courtesy Glenn Acomb, PREC)

Motivation

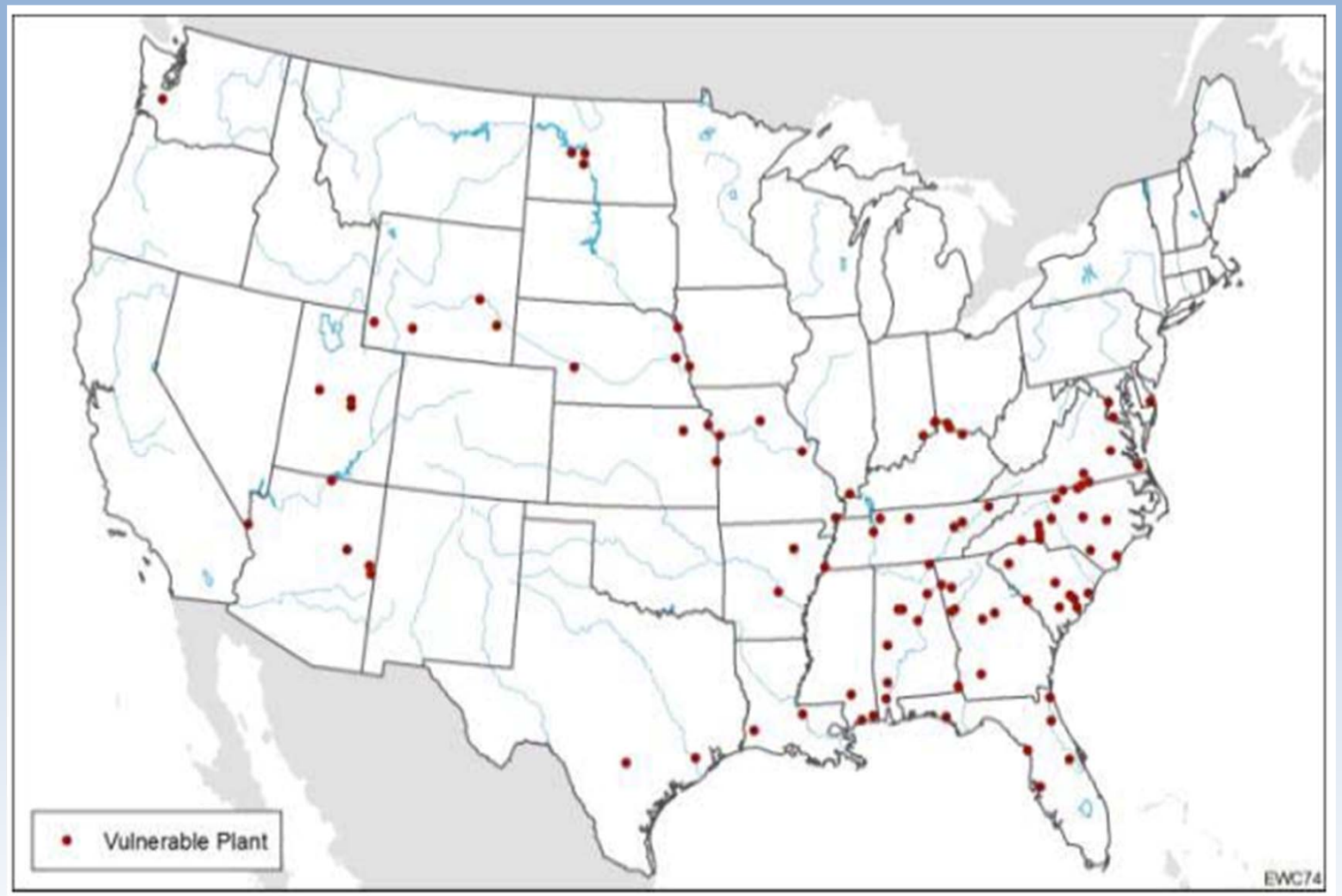

Global Change
Energy, Water, and Land
Natural Systems
Human Systems
Policy, Management, Design, Engineering
LID, Smart Growth, Green Infrastructure, Sustainability
Systems Approaches – Interdisciplinary Solutions

Water-Energy Nexus: National Scope

- Water embedded in energy: ~2/5 of U.S. freshwater withdrawals used for electricity production (DOE, 2006)
- Energy embedded in water: ~1/8 of U.S. electricity production used for water supply (pumping, treating and heating water) (River Network, 2009)
- Climate change both affecting and affected by water and energy use and management decisions



Water-Energy Nexus: National Scope



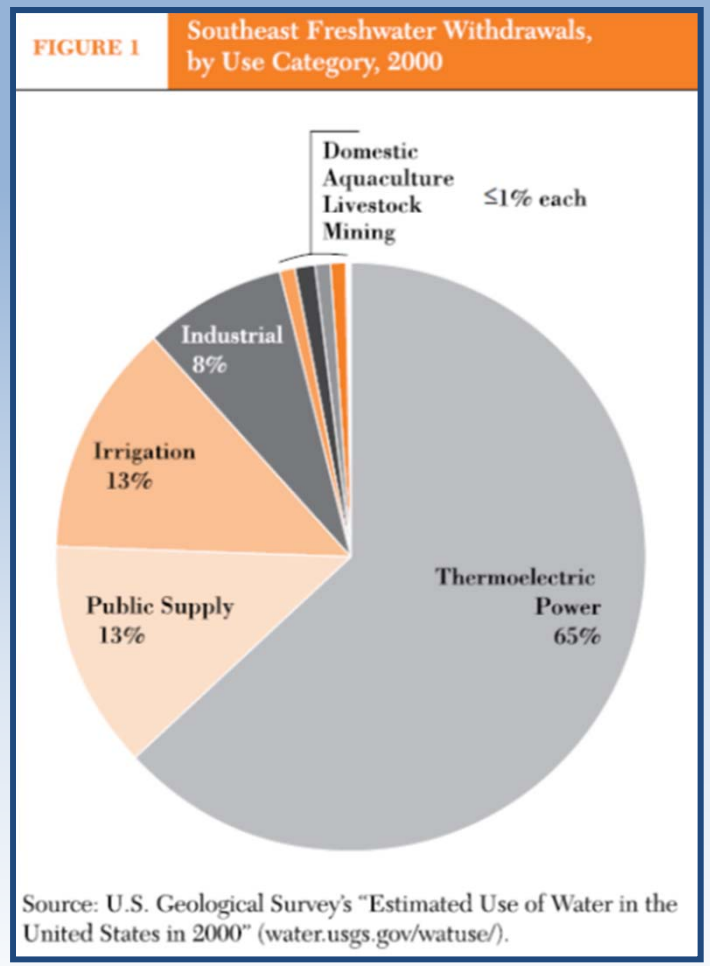
100 Most Water-Vulnerable Coal-Fired Power Plants

Source: DOE NETL, 2010, http://www.netl.doe.gov/technologies/coalpower/ewr/water/pdfs/DOENETL-2010-1429%20WaterVulnerabilities.pdf

Water-Energy Nexus: Regional Scope

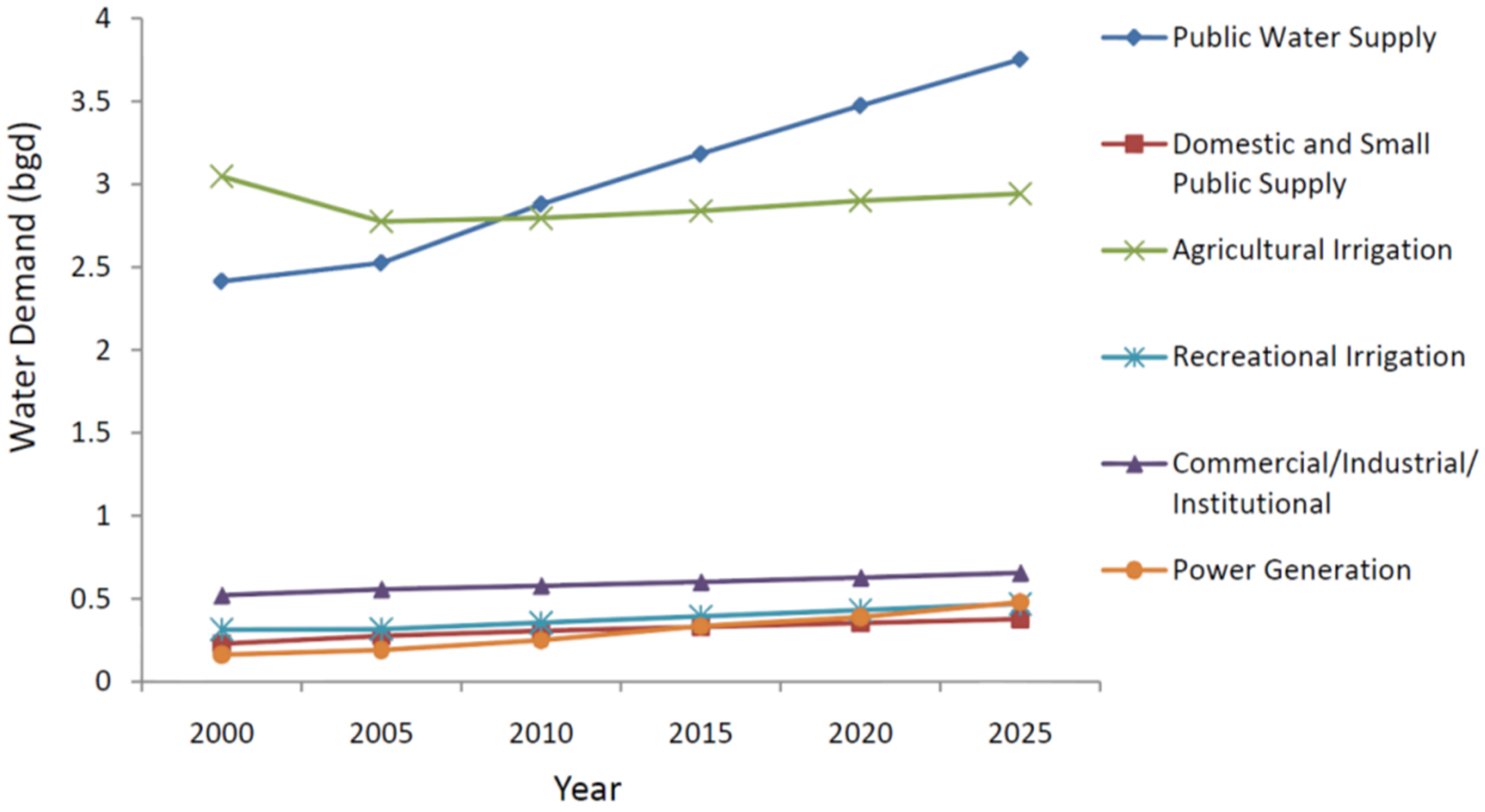
"Water and Watts" in the Southeast (WRI/SEEA/Southface, 2009)

- ~2/3 of regional freshwater withdrawals (40 billion gallons daily) used for thermoelectric power plant cooling needs
- Energy for water and wastewater treatment ~1/3 of municipal energy costs
- Typical home spends about $250 per year on energy for hot water



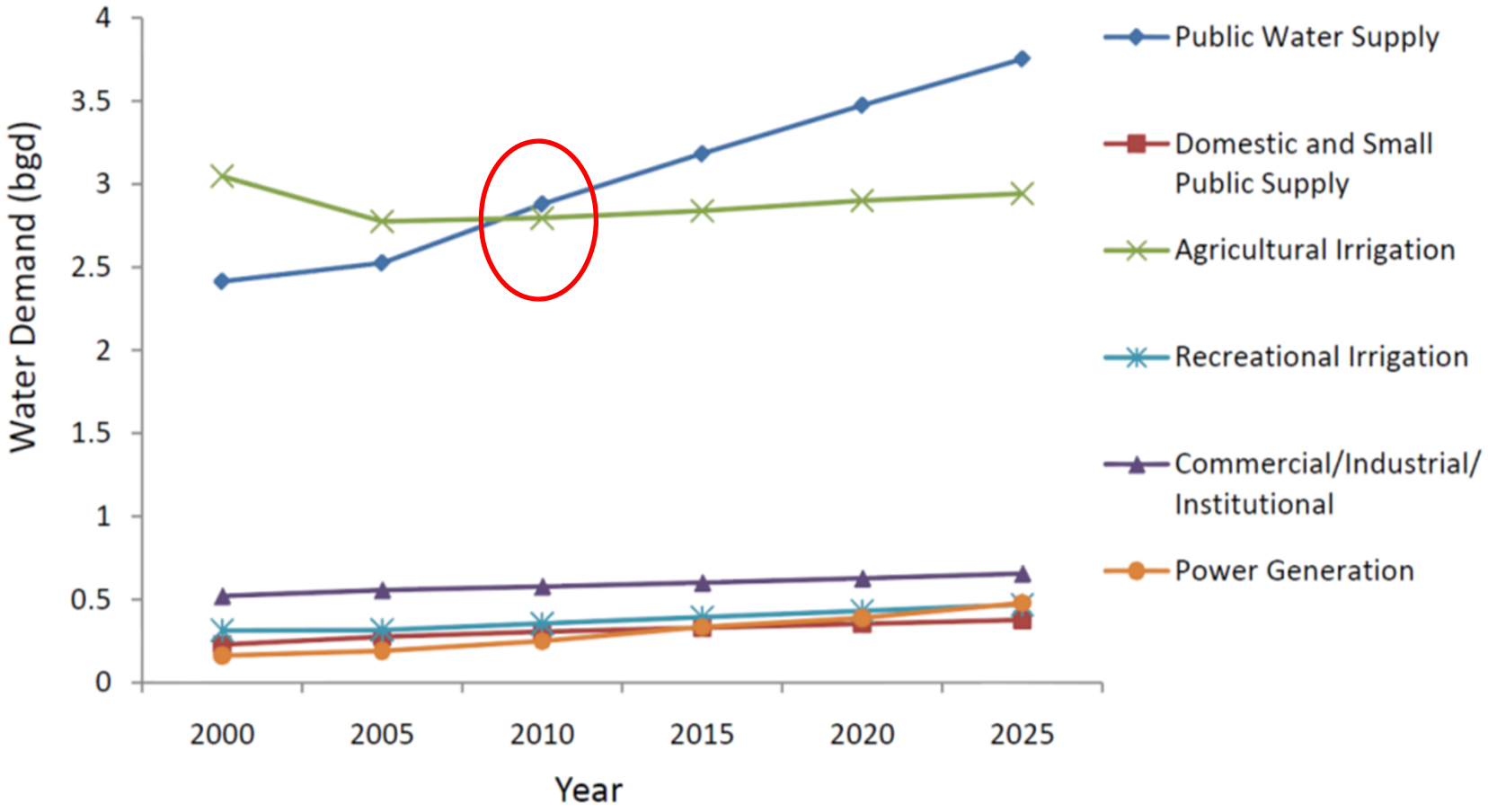
Water-Energy Nexus: Florida

Figure 5. Projected Water Demand by Sector



Water-Energy Nexus: Florida

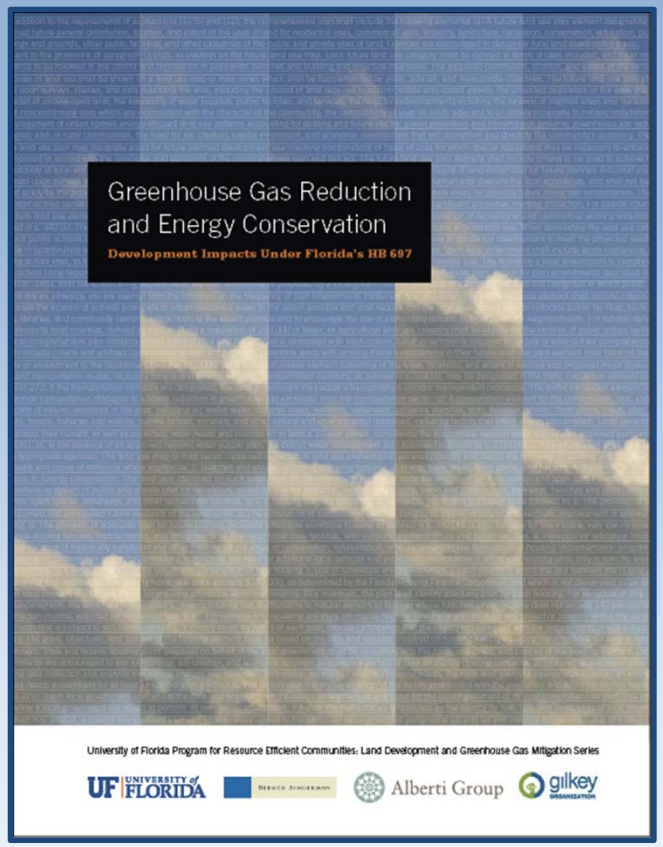
Figure 5. Projected Water Demand by Sector



Water-Energy Nexus: Florida

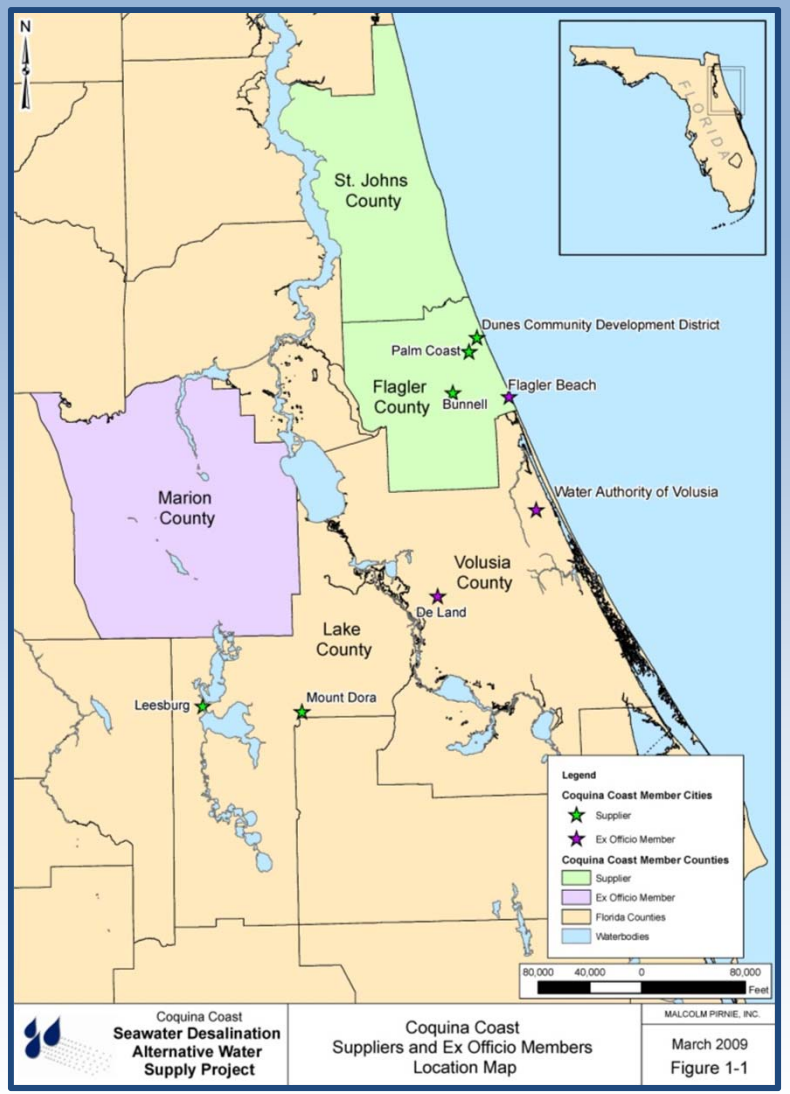
Florida climate legislation

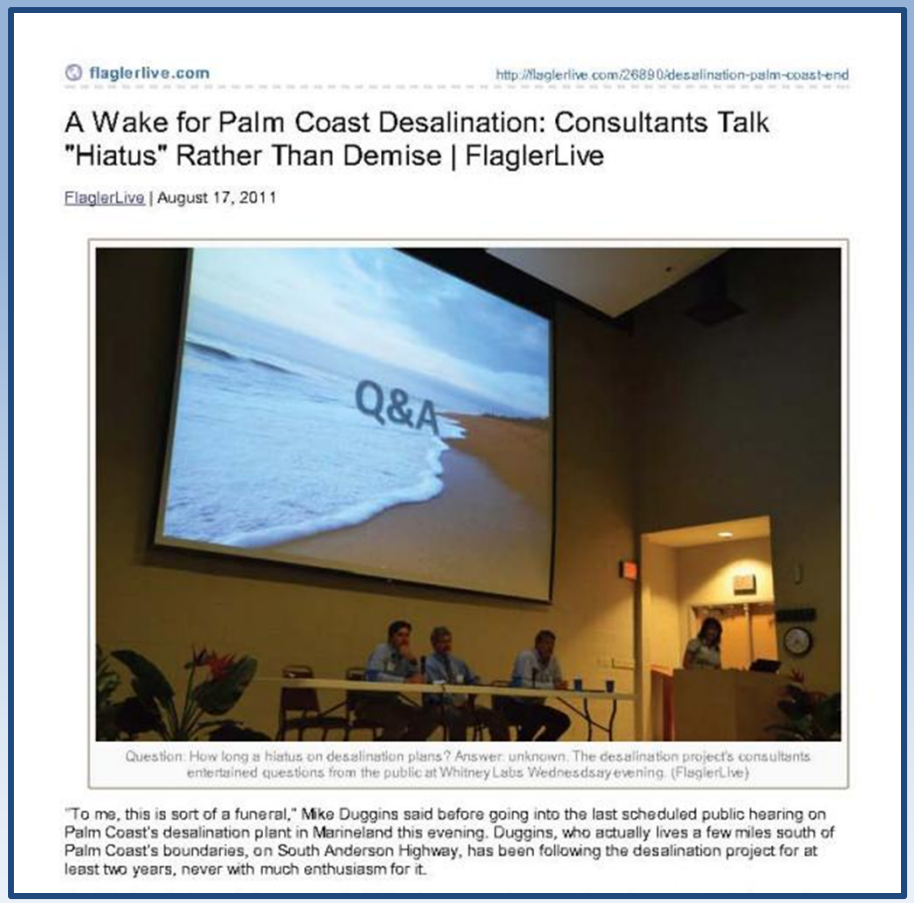
- Executive Orders (2007)
  - 07-127: "Immediate Actions to Reduce Greenhouse Gas Emissions in Florida"
  - GHG Emissions Targets for 2017, 2025, and 2050
- House Bill 697 (2008)
  - Building code standards
  - Local government comprehensive planning and accountability measures addressing energy efficiency



"Greenhouse Gas Reduction and Energy Conservation: Development Impacts Under Florida's HB 697"
(Image courtesy Pierce Jones, PREC)

Coquina Coast Desalination Project





flaglerlive.com http://flaglerlive.com/26890/desalination-palm-coast-end

A Wake for Palm Coast Desalination: Consultants Talk "Hiatus" Rather Than Demise | FlaglerLive

FlaglerLive | August 17, 2011

Question: How long a hiatus on desalination plans? Answer: unknown. The desalination project's consultants entertained questions from the public at Whitney Labs Wednesdsay evening. (FlaglerLive)

"To me, this is sort of a funeral," Mike Duggins said before going into the last scheduled public hearing on Palm Coast's desalination plant in Marineland this evening. Duggins, who actually lives a few miles south of Palm Coast's boundaries, on South Anderson Highway, has been following the desalination project for at least two years, never with much enthusiasm for it.

Proposed 10-15 MGD Seawater Desalination Plant in Palm Coast

Coquina Coast Desalination Project

FlaglerLive.com – August 17, 2011:

A Wake for Palm Coast Desalination: Consultants Talk "Hiatus" Rather Than Demise

"Palm Coast itself is not running out of water by any means."

"Consultants found out from Florida Power and Light that there is capacity to generate the 7 to 40 megawatts needed to run the plant without need for – as one individual wondered – nuclear power. But it is less clear whether the existing grid can support a [desalination] plant located in Palm Coast."

http://flaglerlive.com/26890/desalination-palm-coast-end

Research Goal

Energy-for-water analysis

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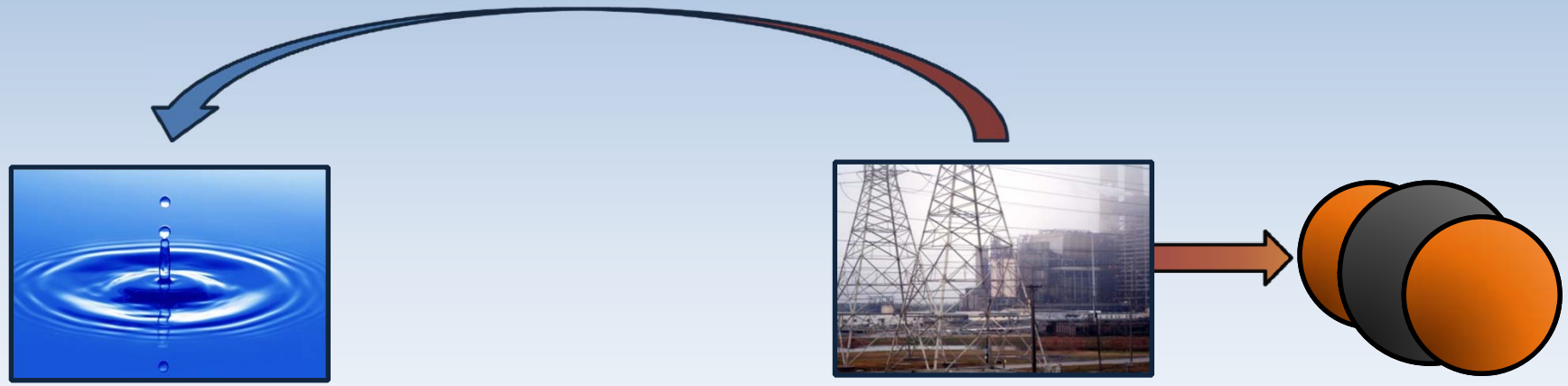
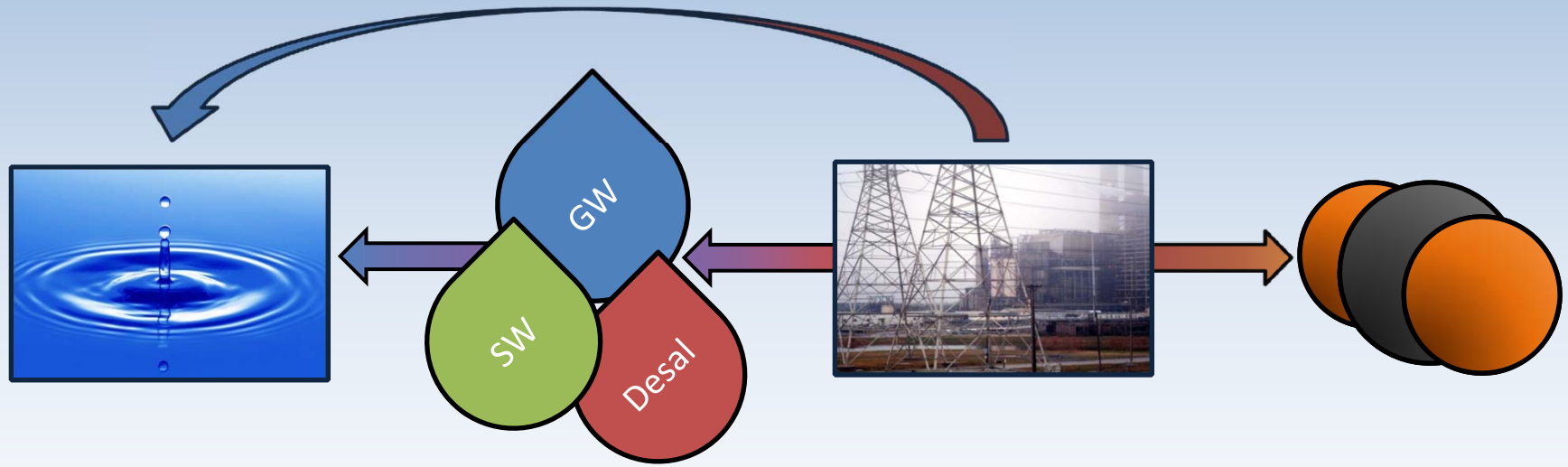
Energy-for-water/embedded energy analysis: Estimate and compare the annual ***carbon footprints*** and ***carbon intensities*** associated with producing potable water…



Research Goal

Energy-for-water/embedded energy analysis: Estimate and compare the annual *carbon footprints* and *carbon intensities* associated with producing potable water from traditional (**groundwater**) and alternative (**surface water and desalinated seawater**) sources in **Tampa Bay Water's** system.



Research Goal

***Conservative in scope*:** We evaluate **only the electricity use of Tampa Bay Water's production facilities for water collection, treatment, and delivery to member governments** (their wholesale customers). Excludes energy and carbon costs of distribution to end users, end use consumption, and wastewater treatment.

Context

- Over 2.4 million customers served
- Member demand forecasts:
  - 2010: 236 MGD
  - 2025: 271 MGD
- Tampa Bay Water supplies > 150 MGD
  - Supplemented by the City of Tampa

Context

Tampa Bay Water Regional Facilities

- Groundwater
  - Consolidated water use permit
  - 90 MGD 12-month running average

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- Surface water
  - Hillsborough River, Alafia River
  - Regional surface water treatment plant
  - 120 MGD treatment capacity

Context

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- Groundwater
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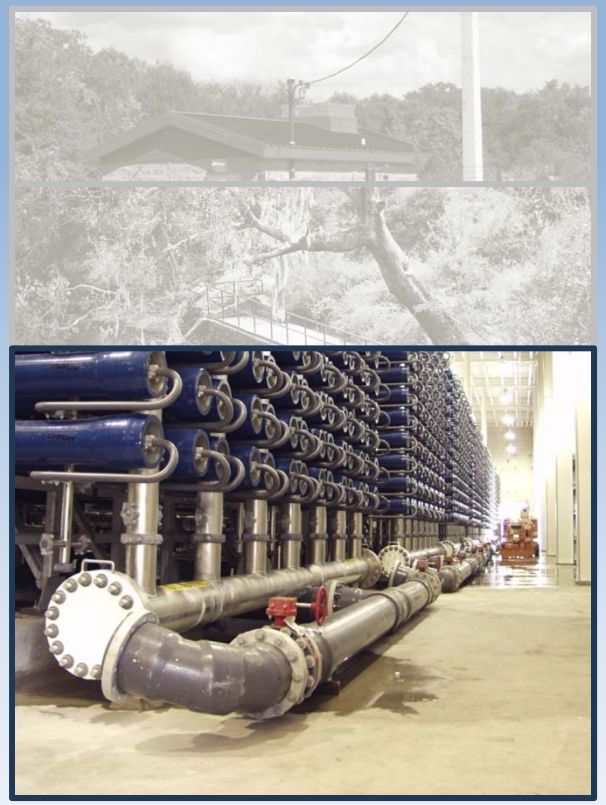
  - 90 MGD 12-month running average
- Surface water
  - Hillsborough River, Alafia River
  - Regional surface water treatment plant
  - 120 MGD treatment capacity
- Desalination treatment plant
  - Seawater intake via TECO Big Bend facility
  - 25 MGD treatment capacity
  - Largest desal plant in North America



Context

Tampa Bay Water Regional Facilities

- Groundwater
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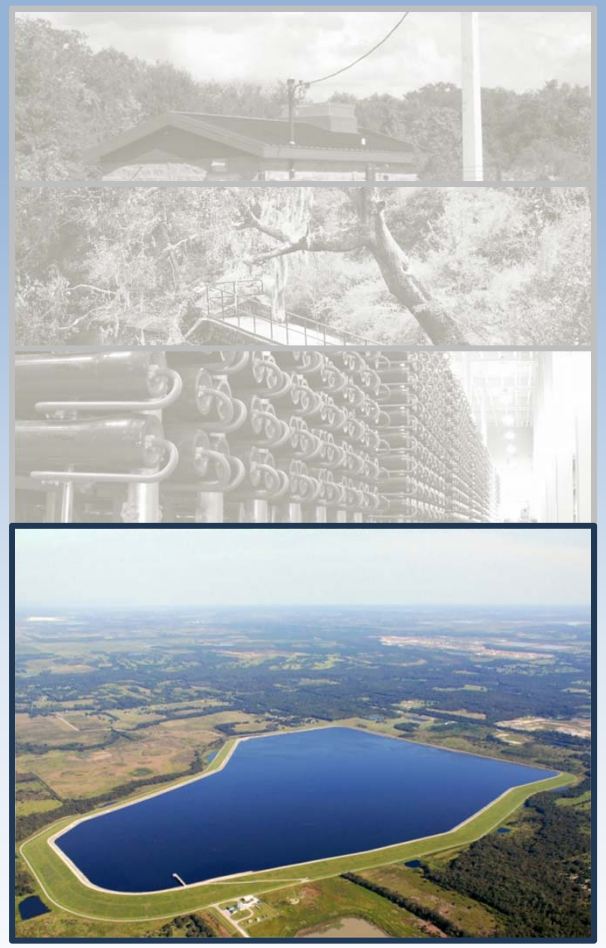
- Desalination treatment plant
  - Seawater intake via TECO Big Bend facility
  - 25 MGD treatment capacity
  - Largest desal plant in North America
- Regional reservoir
  - 15.5 billion gallon storage capacity



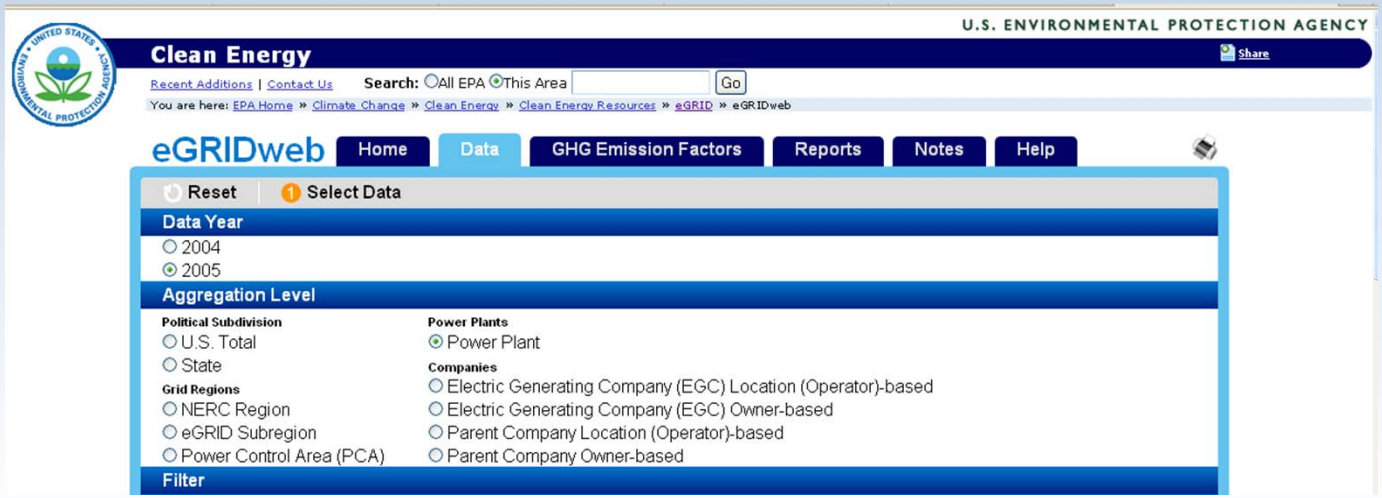
Data & Analysis

Tampa Bay Water

- 37 collection, treatment, and delivery facilities
- Water Years (WY) 2006-2009 water pumped and produced, electricity used, electricity cost, electric provider

U.S. EPA's eGRIDweb

- Year 2005 greenhouse gas emissions for 6 power plants
- http://cfpub.epa.gov/egridweb/view.cfm



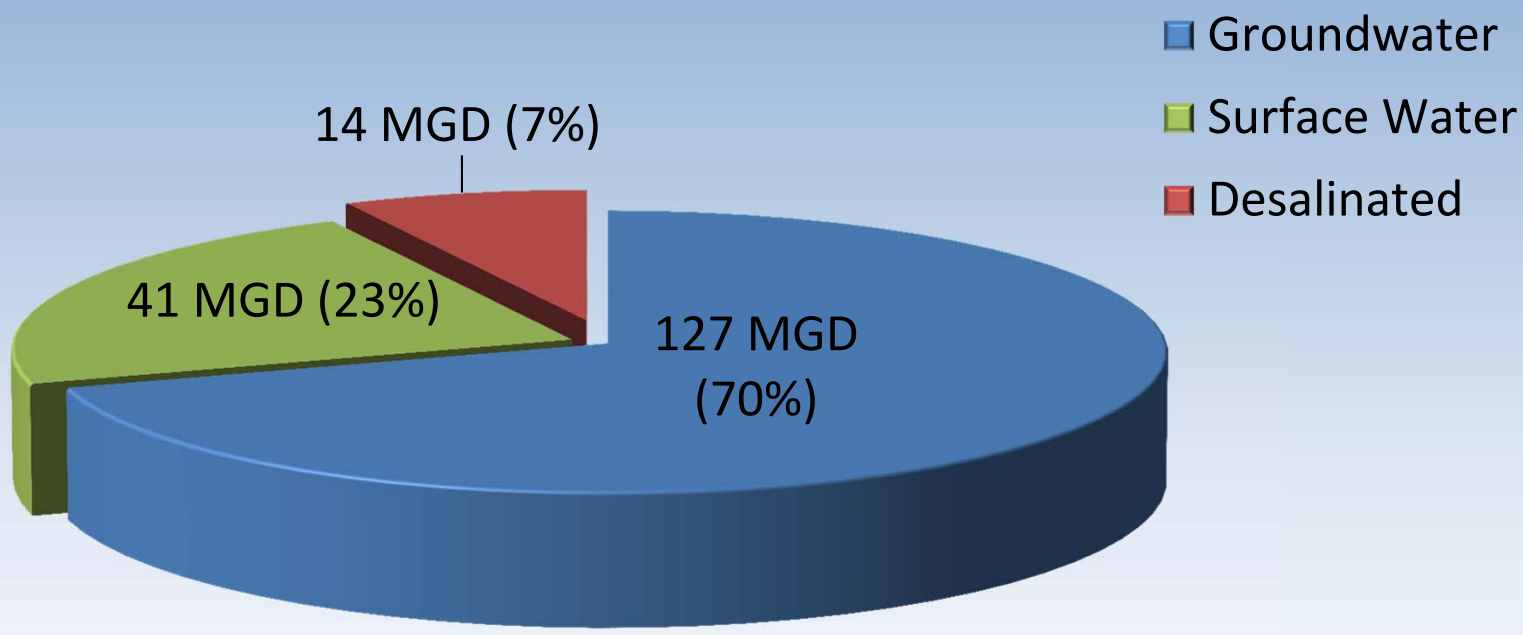
Data & Analysis

Power Plant GHG Emissions Factors

TECO	Generation Fuel Mix	CO_2e lbs/kWh
Big Bend	97% Coal / 3% Oil	2.40
H.L. Culbreath	100% Natural Gas	0.90
	Weighted Emissions Factor	**1.69**
Progress Energy		
P.L. Bartow	97% Oil / 3% Natural Gas	2.00
Anclote	99% Oil / 1% Natural Gas	2.01
	Weighted Emissions Factor	**2.01**
WREC		
Seminole	74% Coal / 26% Oil	2.07
Hardee	98% Natural Gas / 2% Oil	1.03
	Weighted Emissions Factor	**2.04**

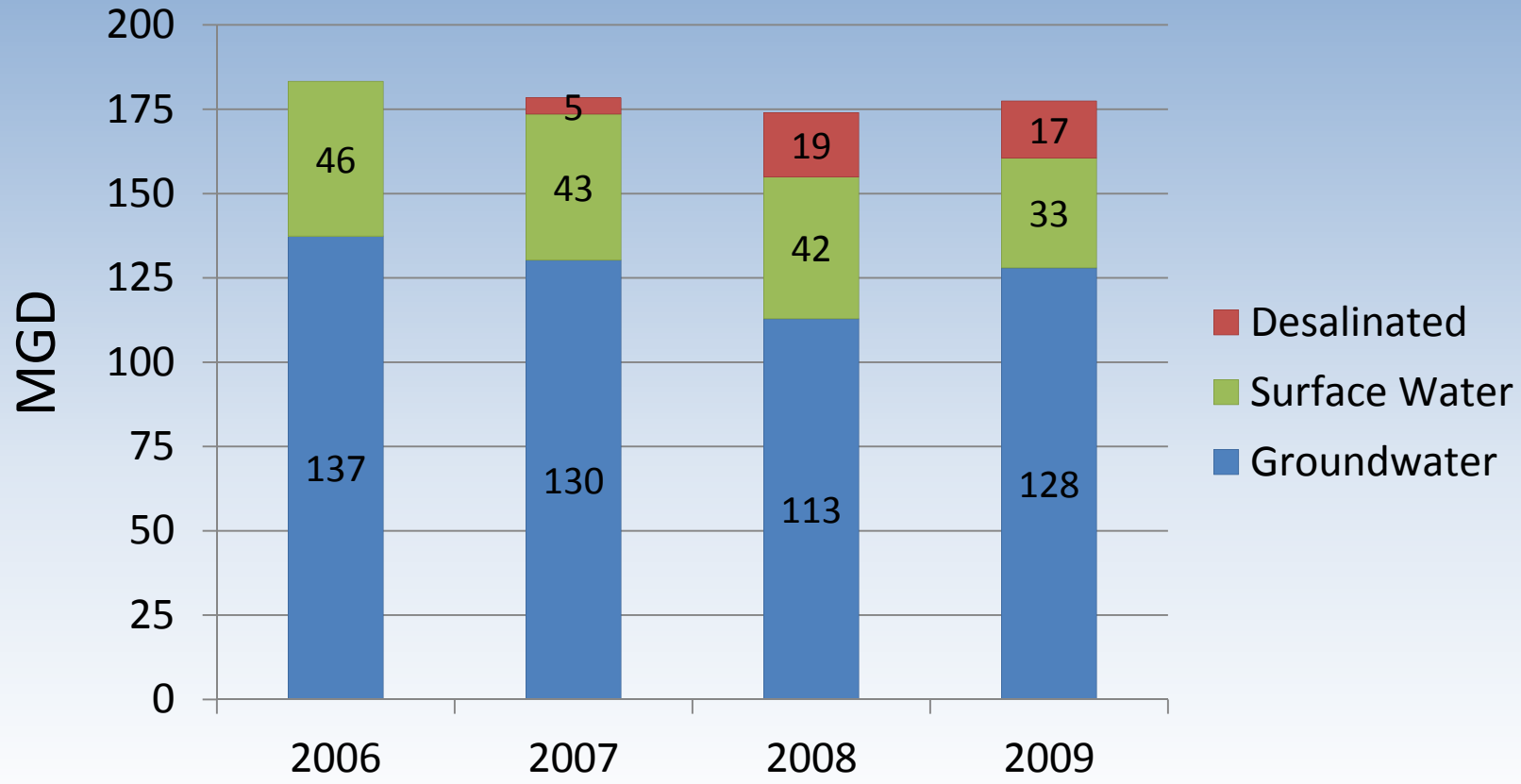
Results

Tampa Bay Water Production Blend (2006-2009 averages, by supply type)



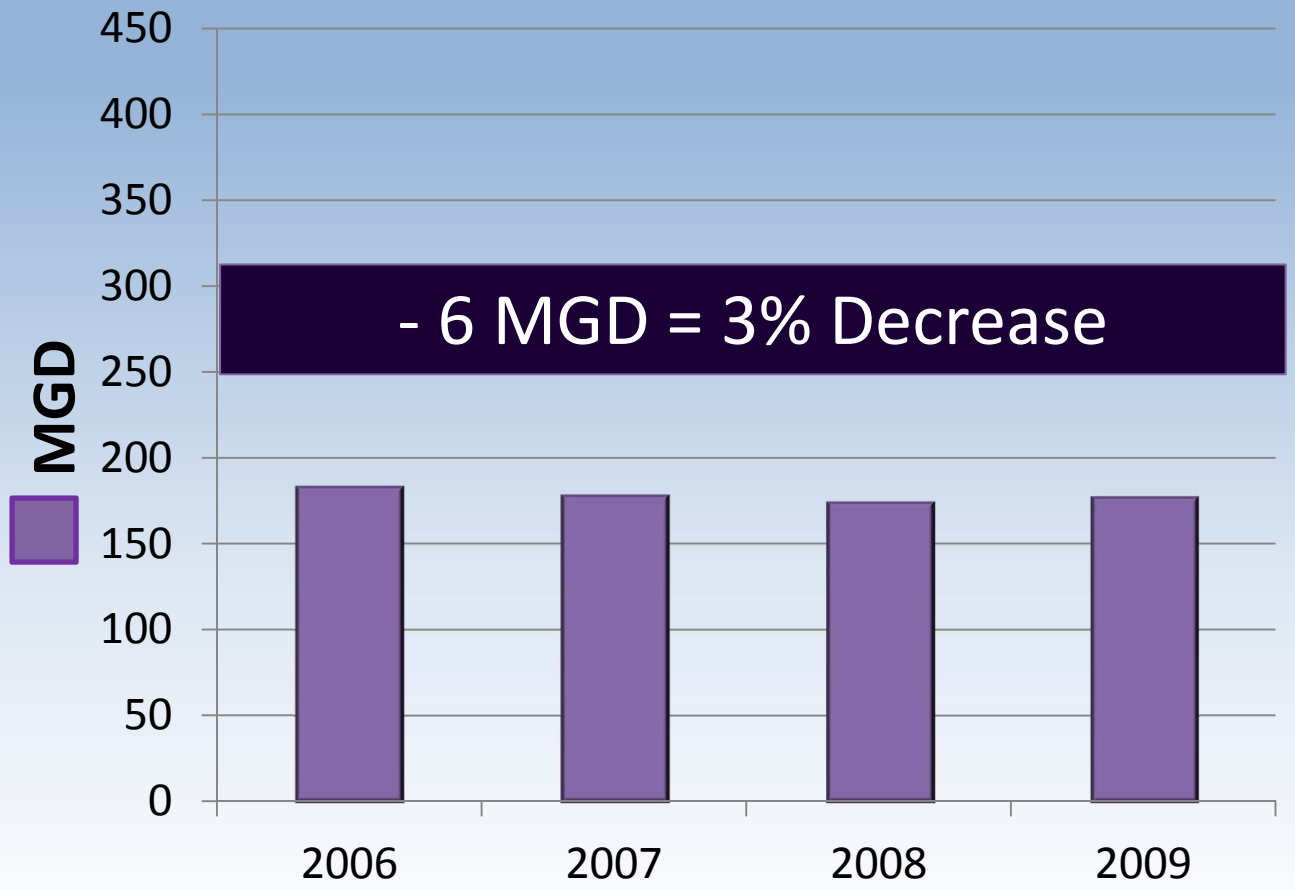
Results (2006-2009)

Annual Production by Supply Type (Average 178 MGD)



Results (2006-2009)

Annual Production



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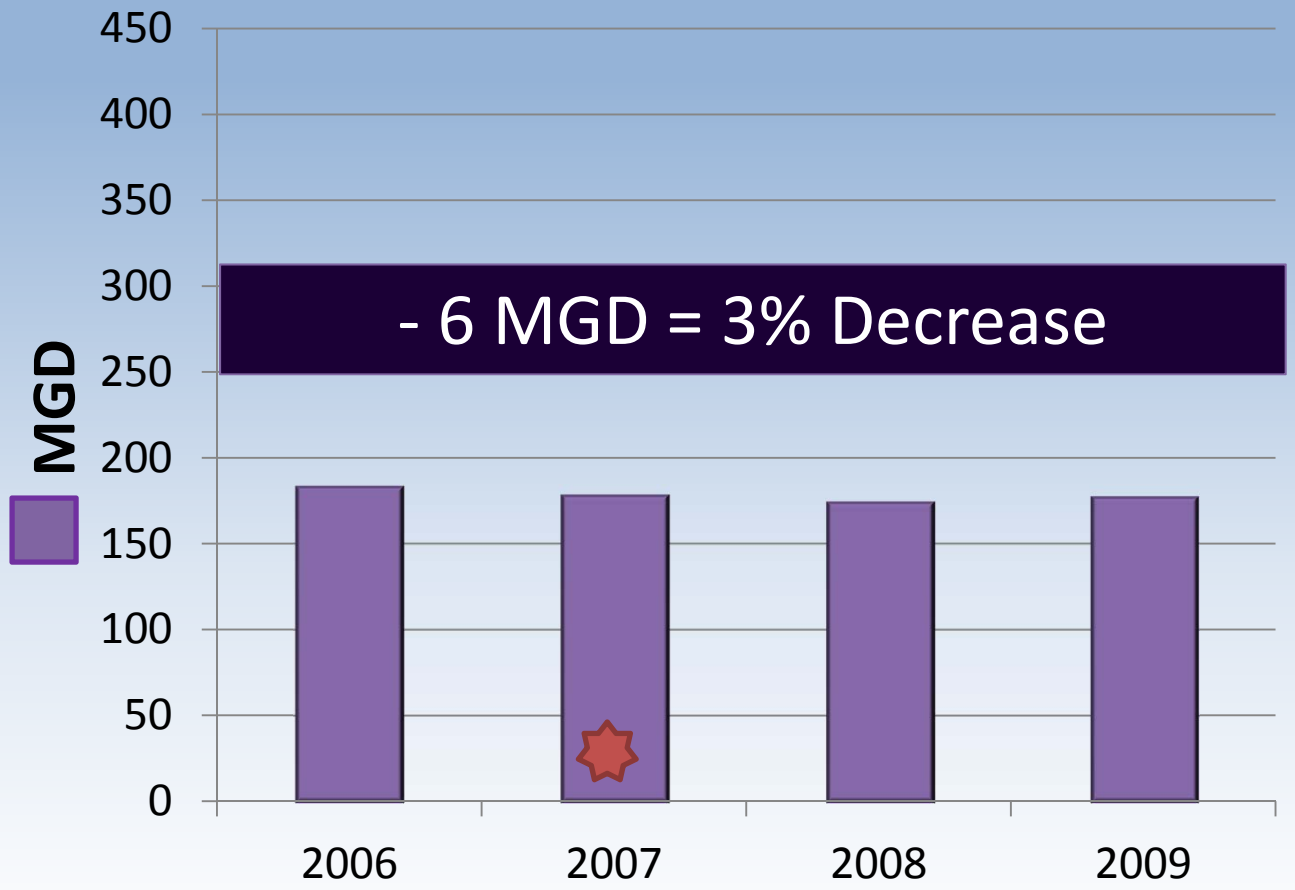
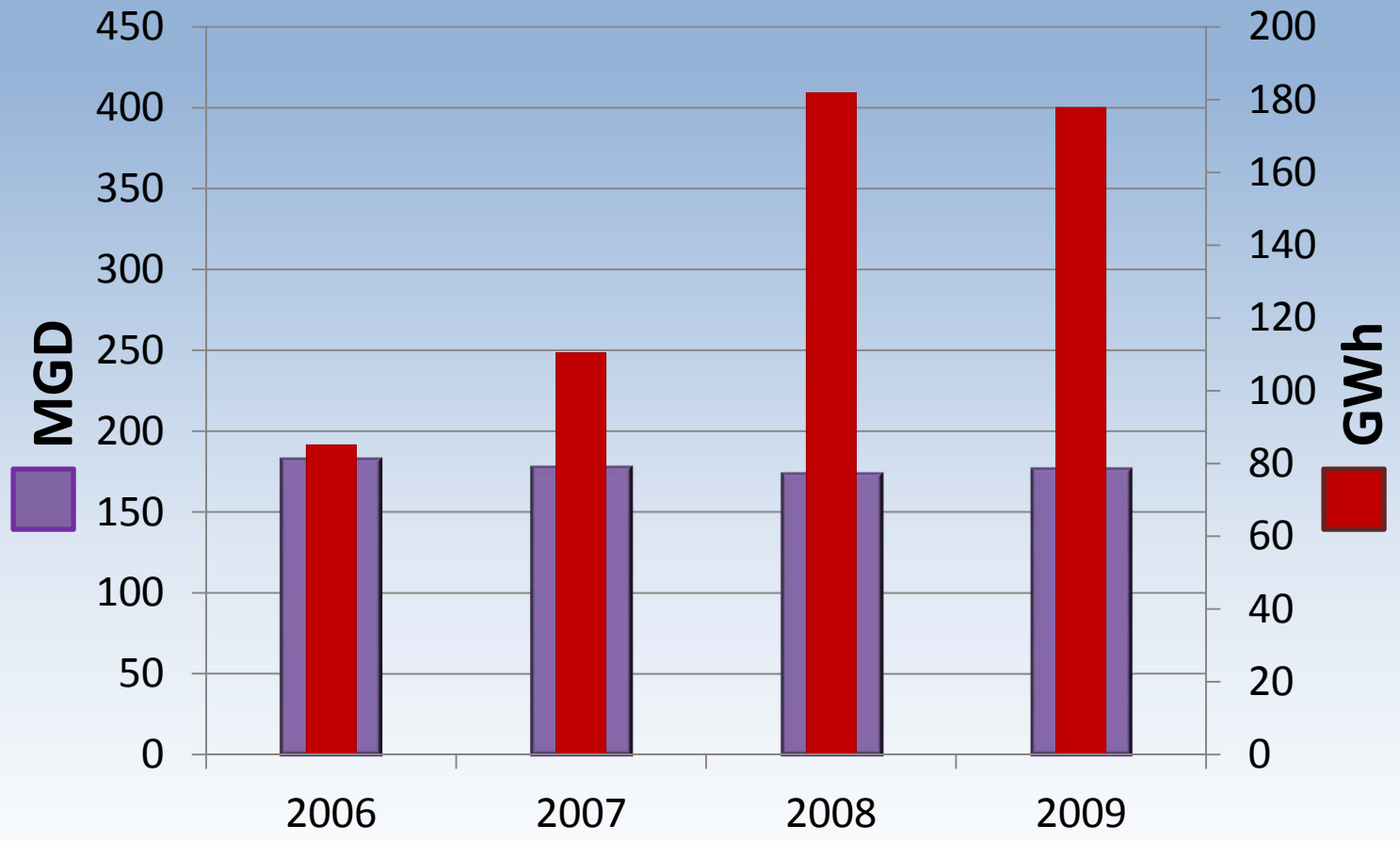


Results (2006-2009)

Annual Production vs. Electricity Use



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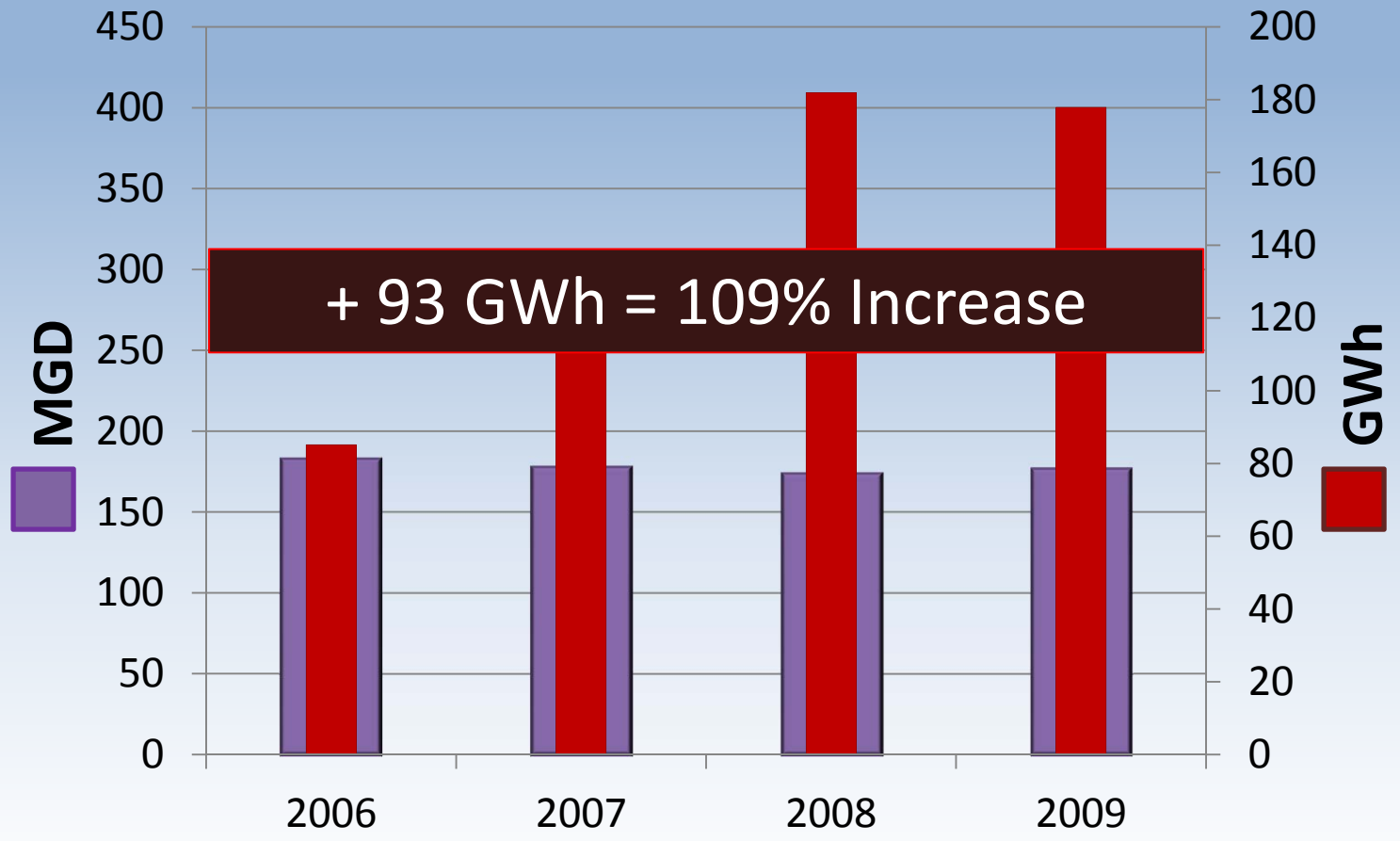
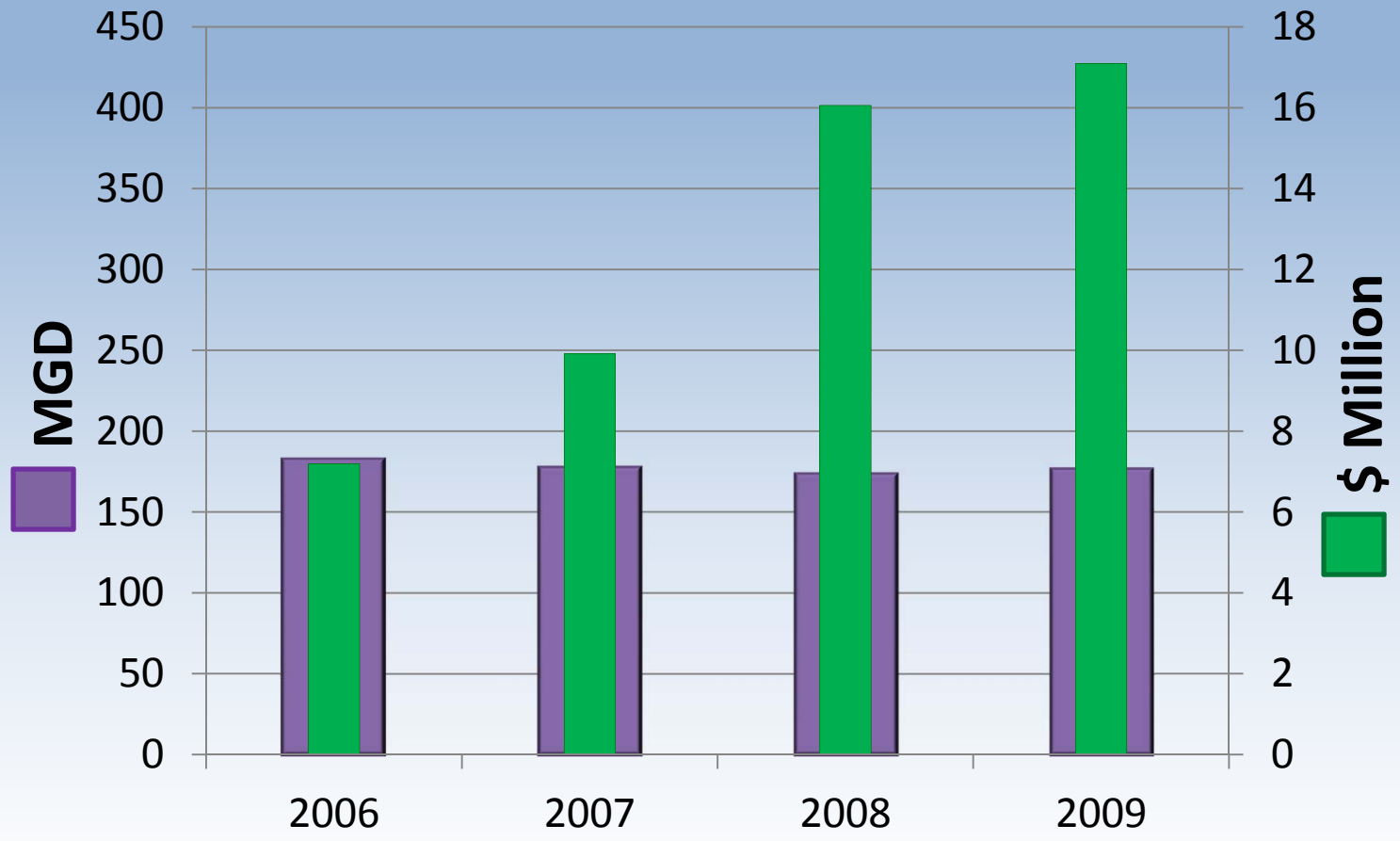


Results (2006-2009)

Annual Production vs. Electricity Costs



Results (2006-2009)

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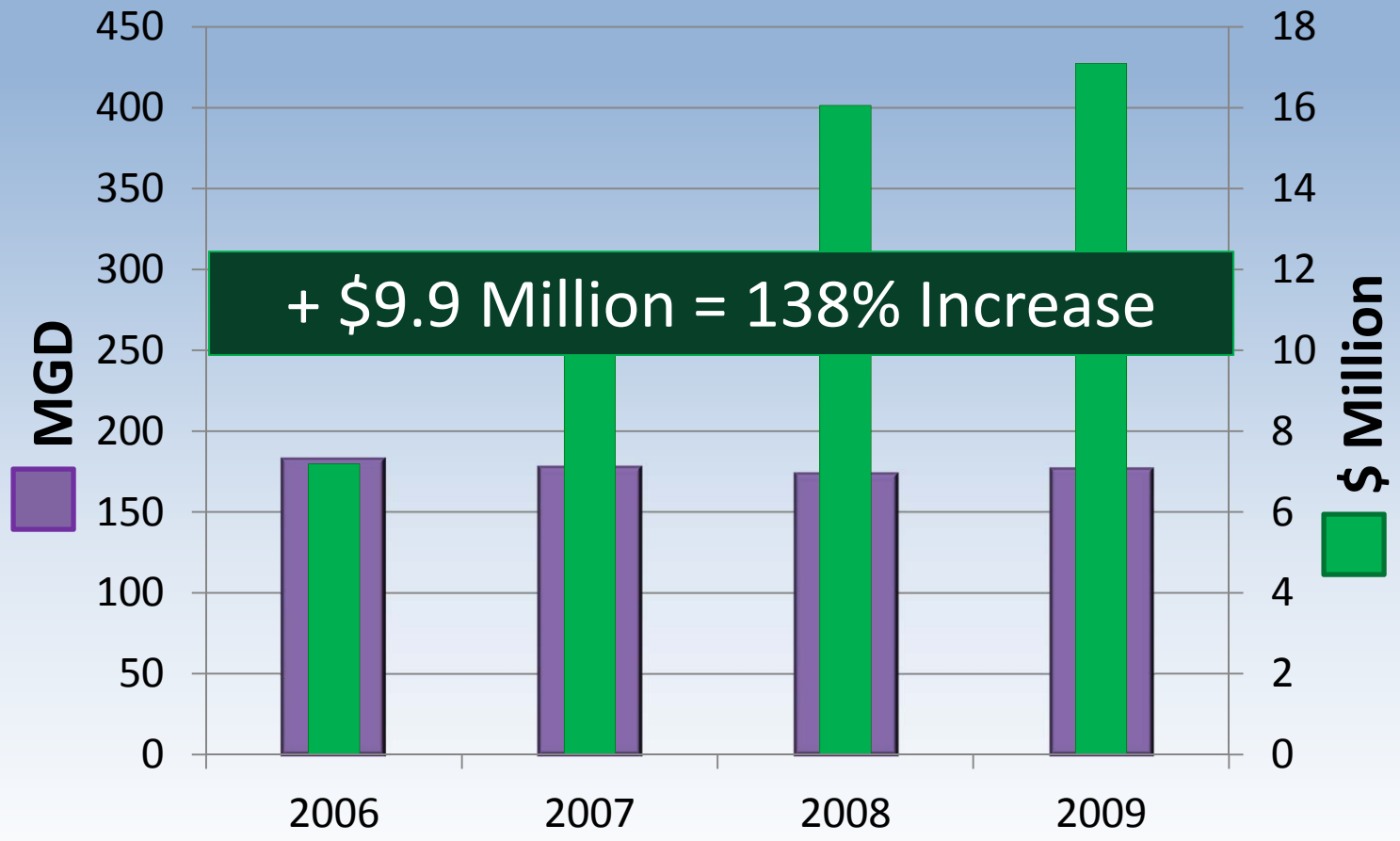
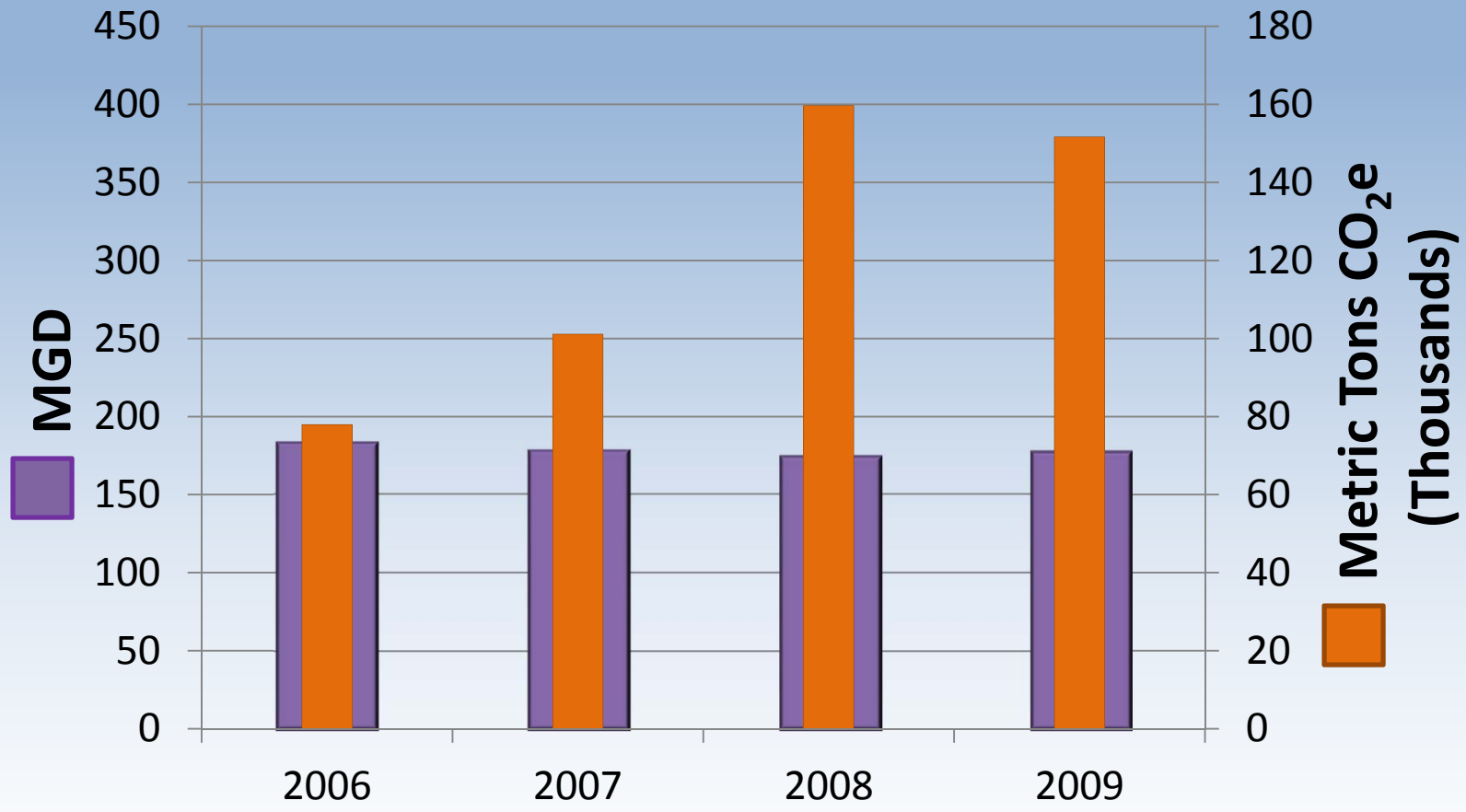


Results (2006-2009)

Annual Production vs. Carbon Footprints



Results (2006-2009)

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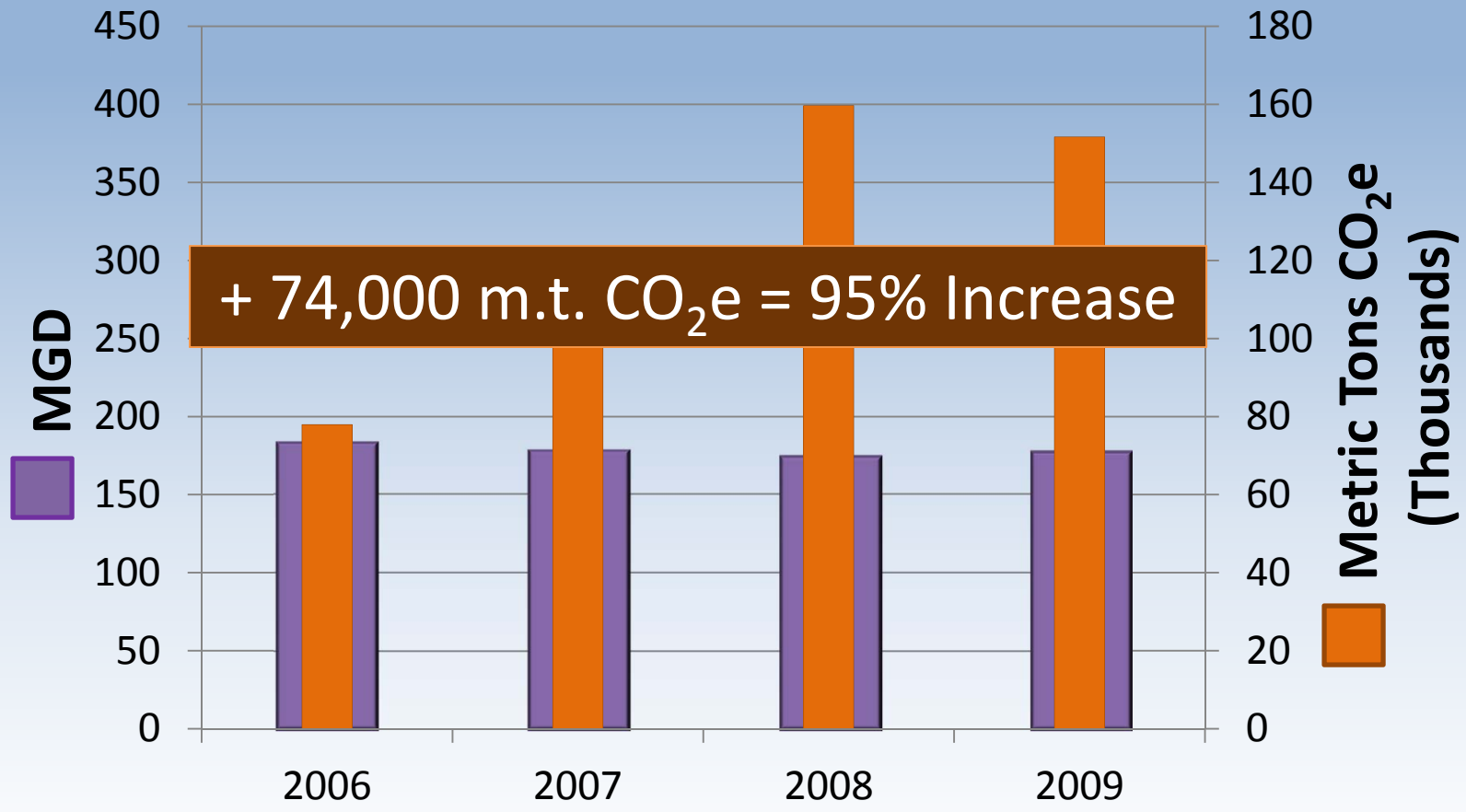

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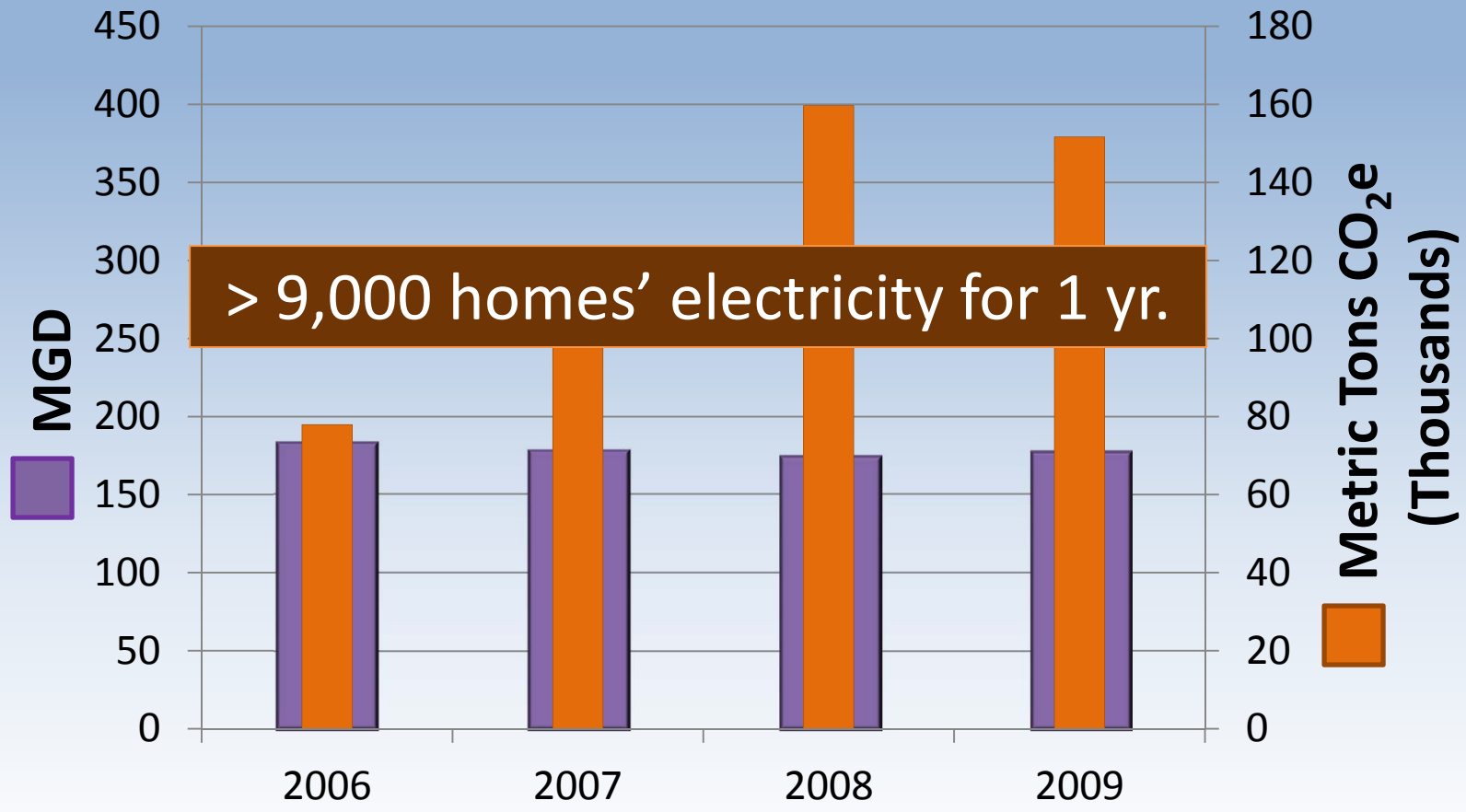
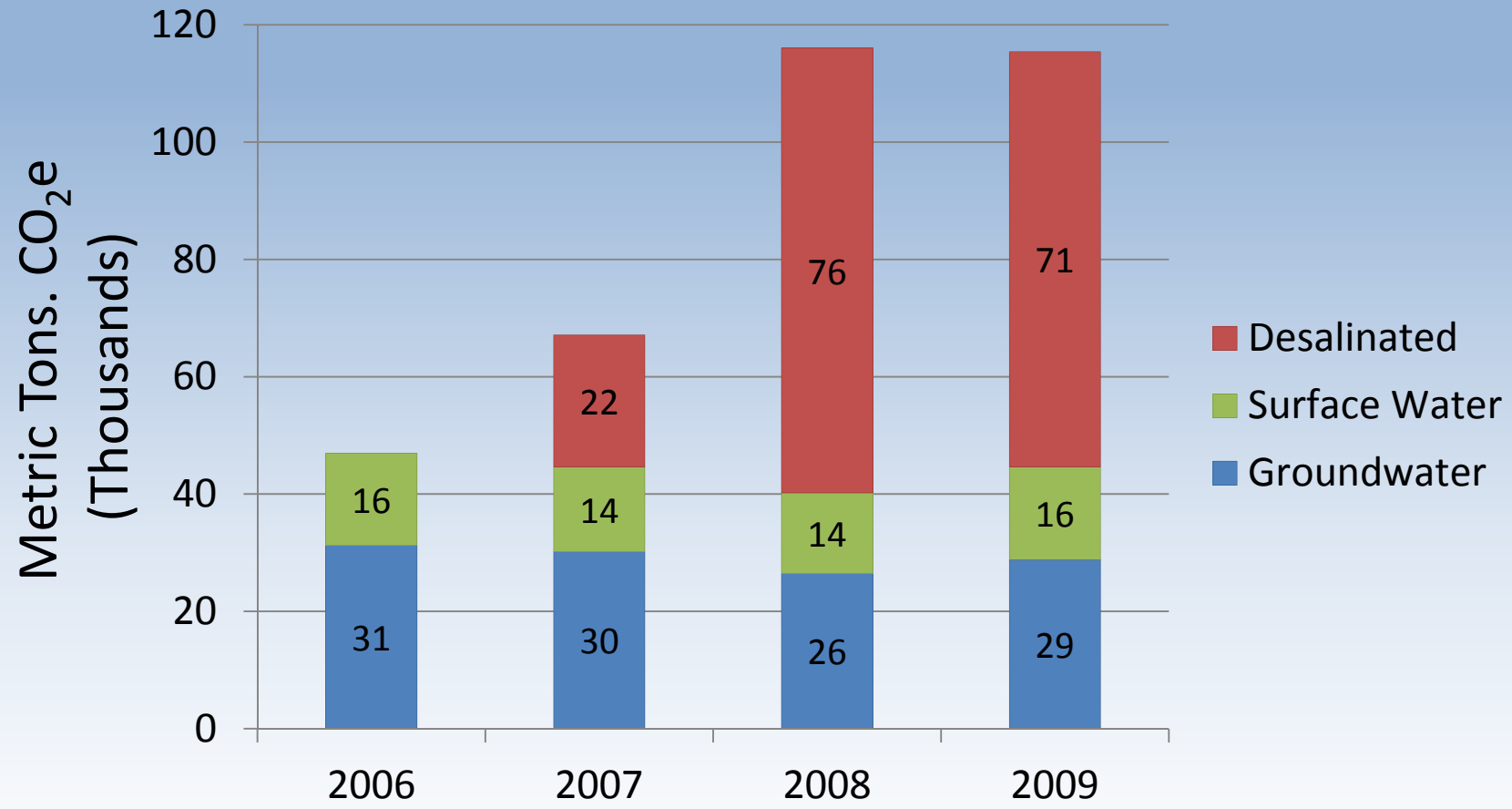


Results (2006-2009)

Carbon Footprints by Supply Type



Results (2006-2009)

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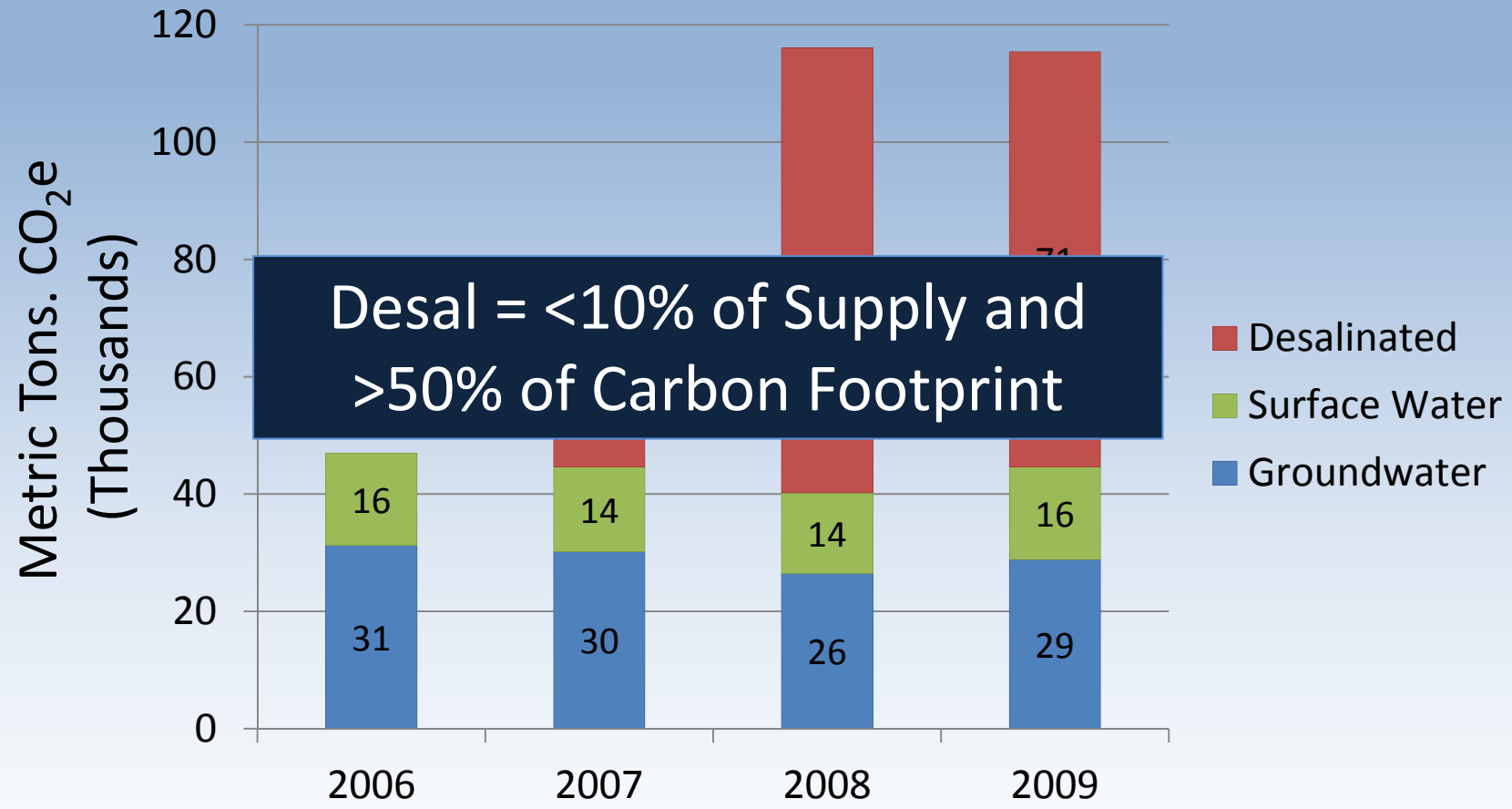
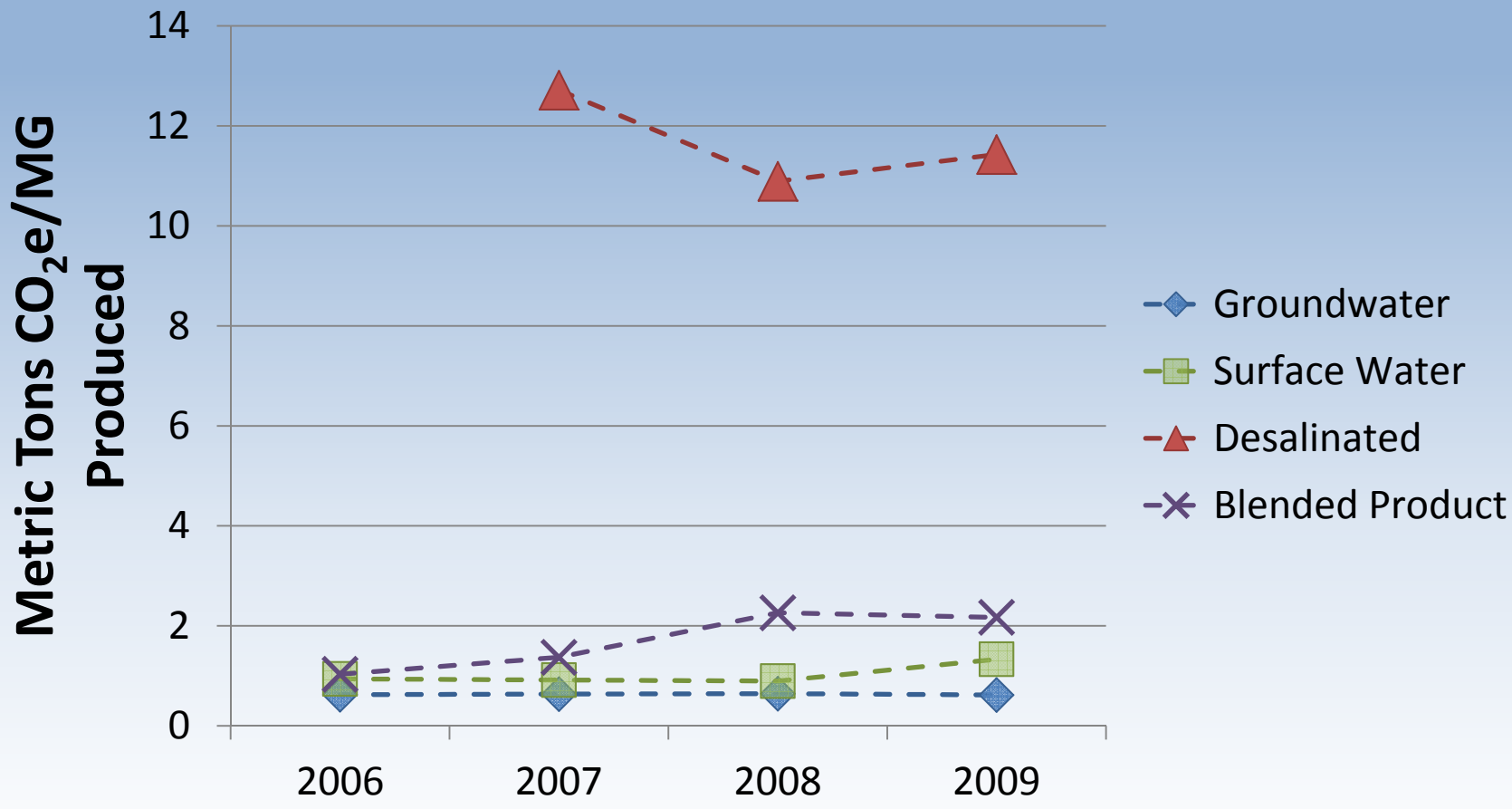


Results (2006-2009)

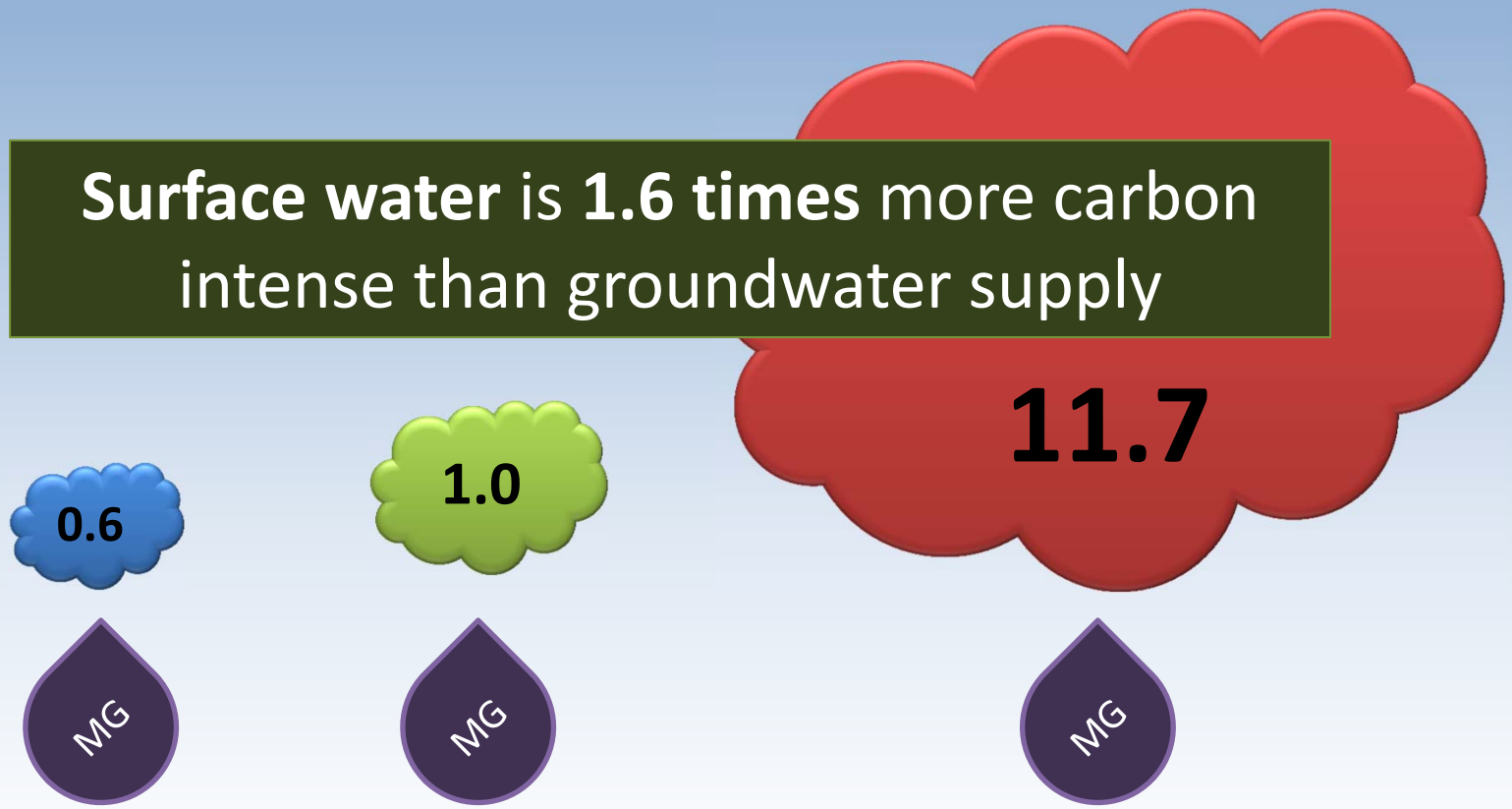
Carbon Intensities by Supply Type



Results (2006-2009)

Average Carbon Intensities by Water Supply (Metric Tons CO_2e/MG Produced)

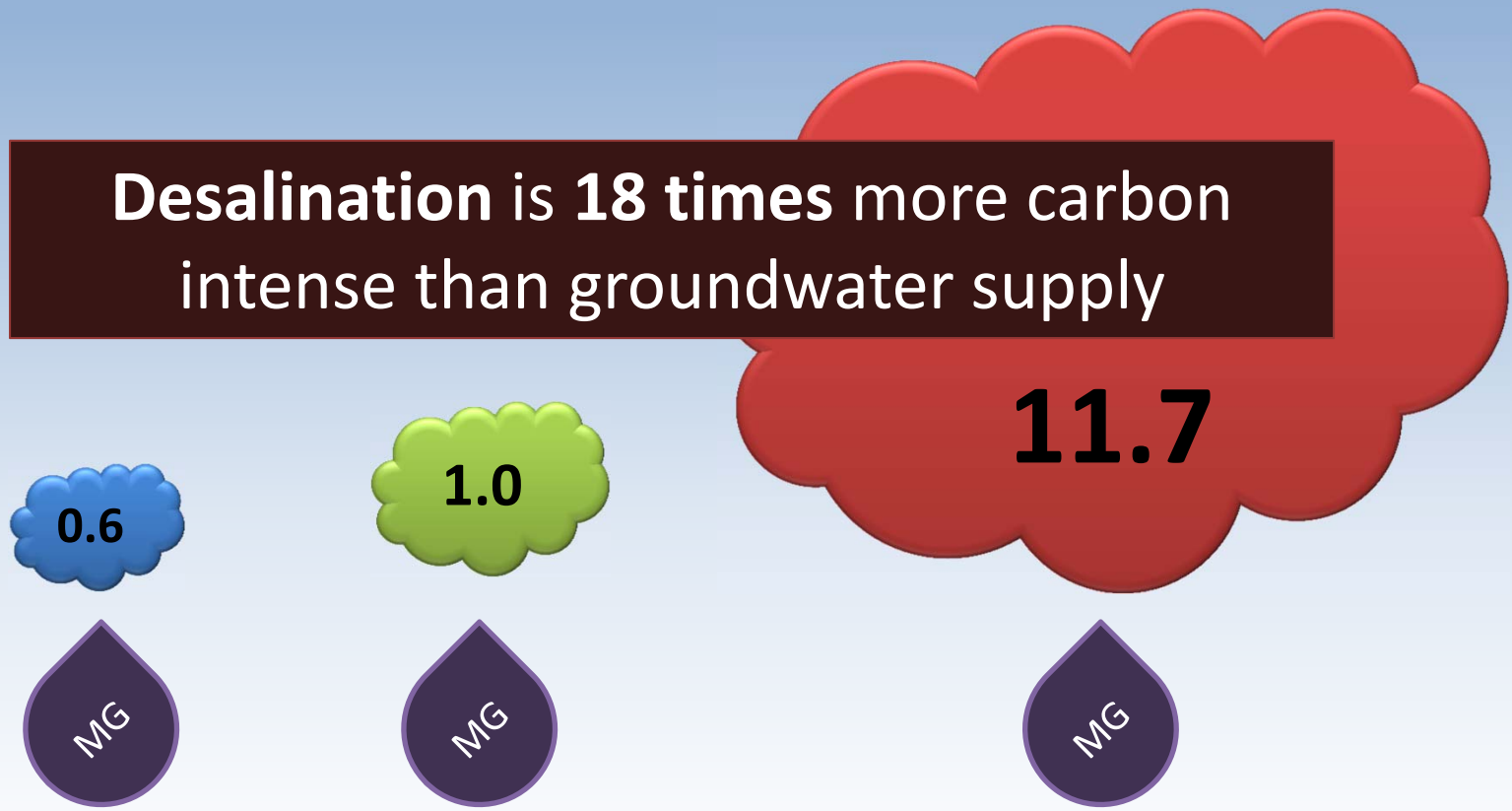
Surface water is **1.6 times** more carbon intense than groundwater supply



Results (2006-2009)

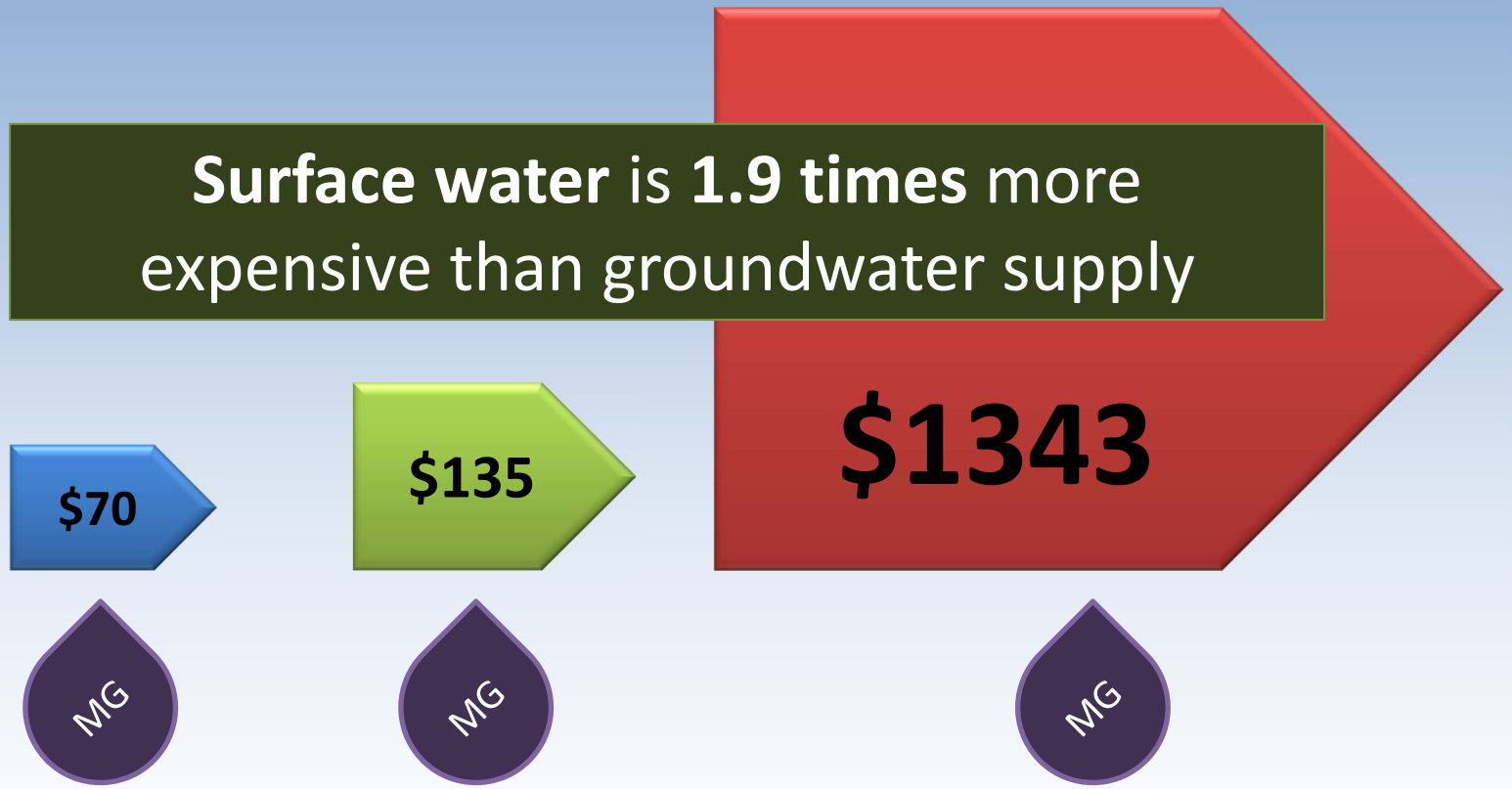
Average Carbon Intensities by Water Supply (Metric Tons CO_2e/MG Produced)

Desalination is **18 times** more carbon intense than groundwater supply



Results (2006-2009)

Average Unit Cost by Water Supply (Electricity Costs/MG Produced)

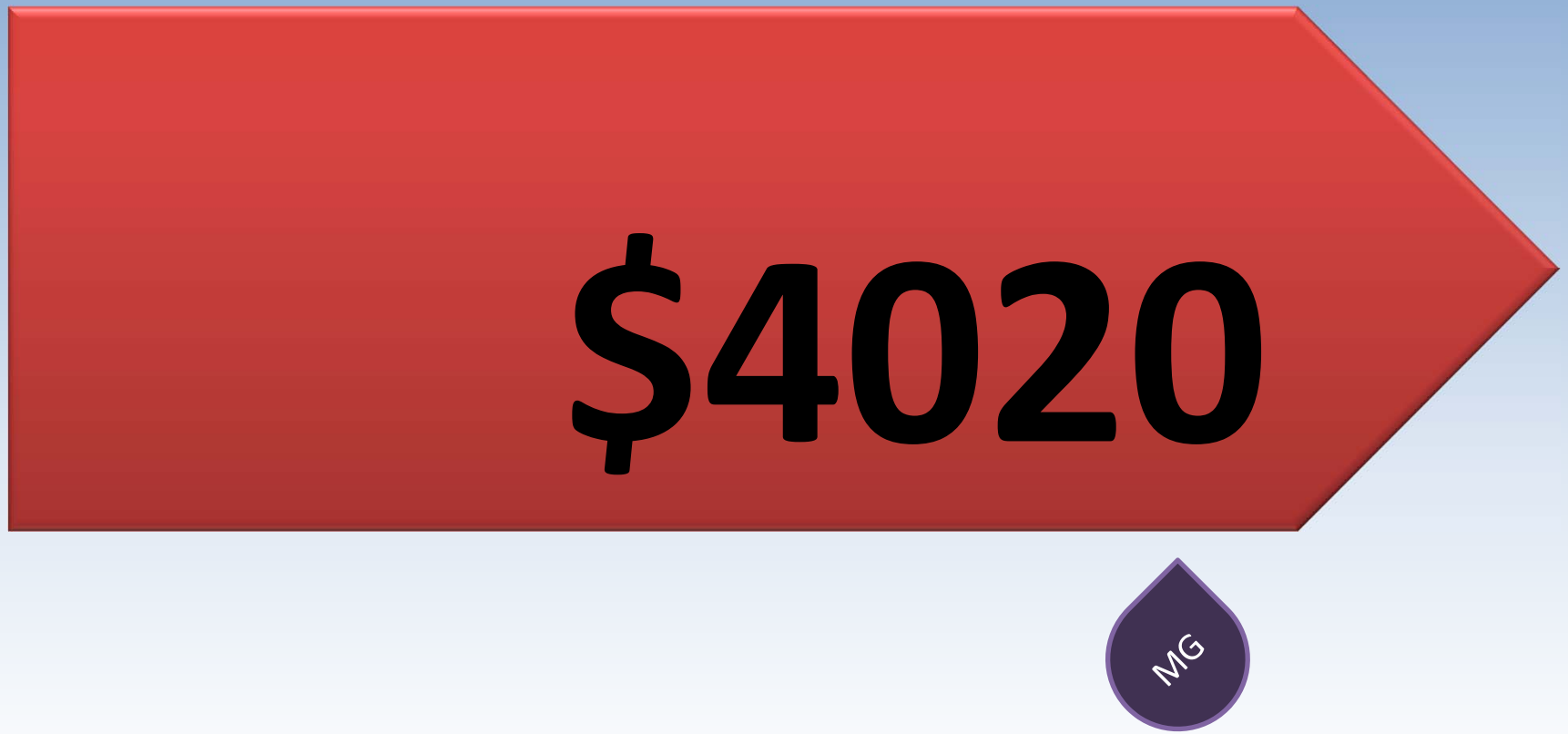


Results (2006-2009)

Average Unit Cost by Water Supply (Electricity Costs/MG Produced)

Results (2006-2009)

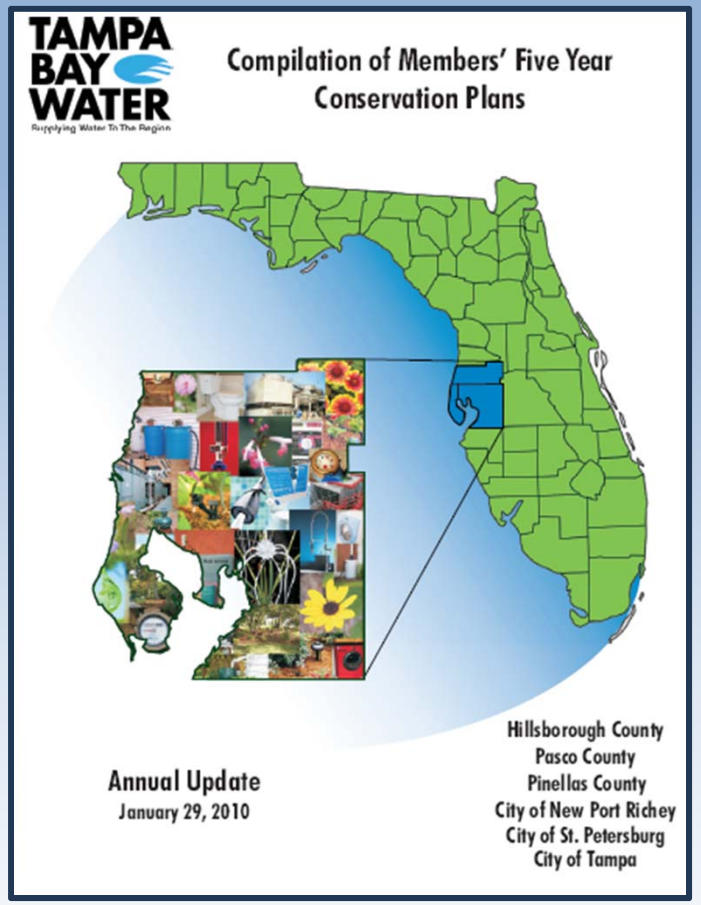
Average cost for desalinated water, including other fixed and variable costs ($/MG Produced)



Applications: Conservation

Tampa Bay Water Member Governments' Water Conservation BMPs

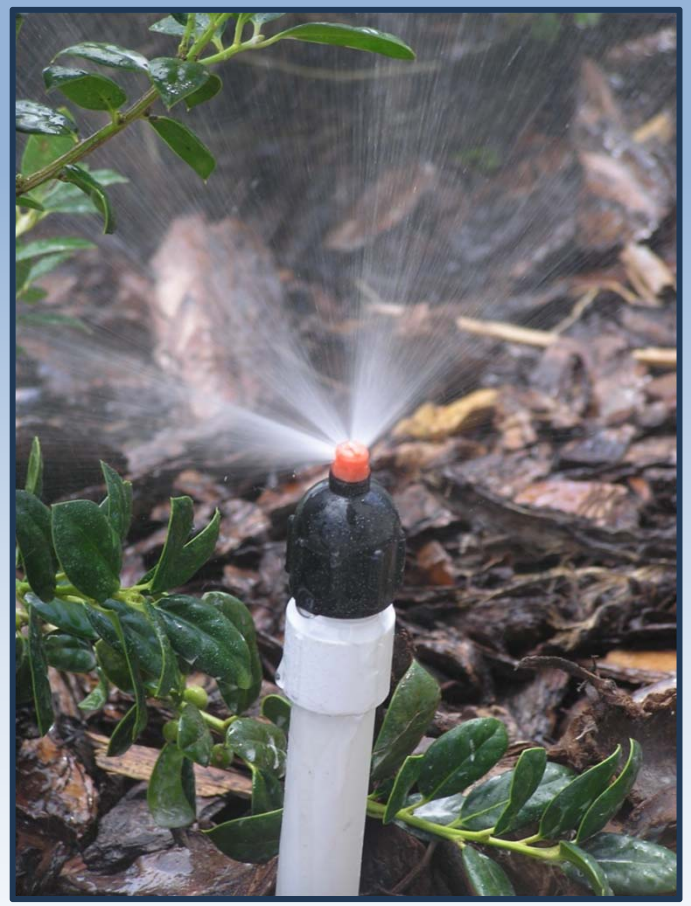
- Non-potable irrigation source replacement or rebates
- Water-efficient landscapes and irrigation evaluations and rebates
- High-efficiency clothes washer retrofits
- Ultra low flush toilet retrofits
- High efficiency toilets
- Urinal rebates
- Non-residential water use evaluations/implementation



Applications: Water Conservation

Tampa Bay Water member governments' avoided GHG emissions (m.t. CO_2e) via water conservation

- 2009: 1,346
- 2009 at the margin (i.e., assuming avoided supply from desal): 7,090
- Cumulative (since 1996): 20,267



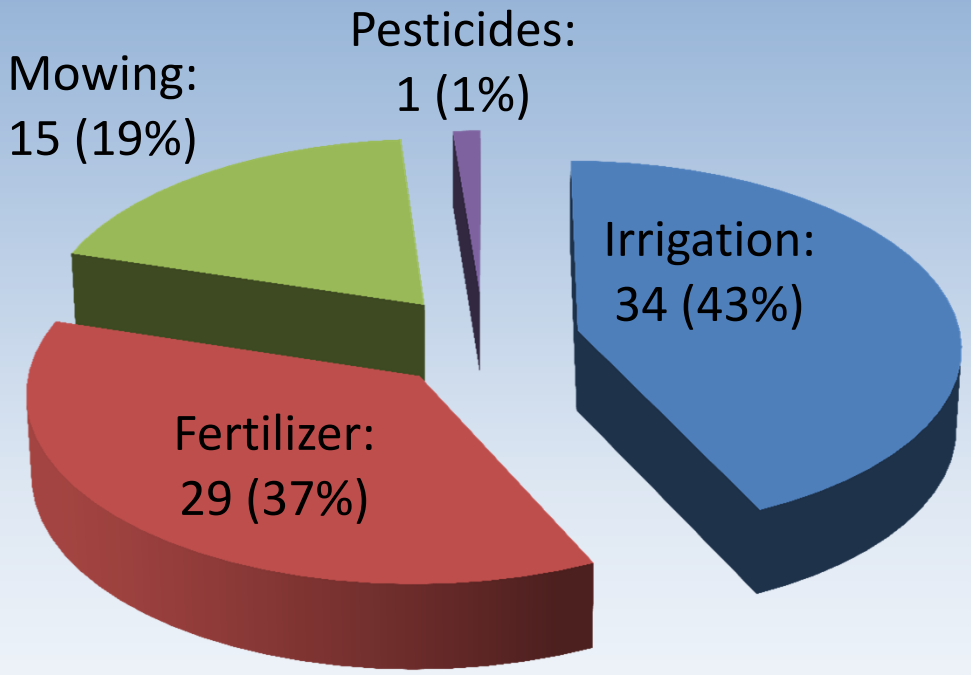
Applications: Water Conservation

Opportunity Costs of Water Consumption / Benefits of Water Conservation

- 2009: 1,346 m.t. CO_2e
  = 163 homes' electricity for one year
- 2009 at the margin: 7,090 m.t. CO_2e
  = 1,390 passenger vehicles' fuel for one year
- Cumulative (since 1996): 20,267 m.t. CO_2e
  = 47,133 barrels of oil

Applications: Landscape Management

79 lbs CO_2e per 1000 ft^2 landscaped area

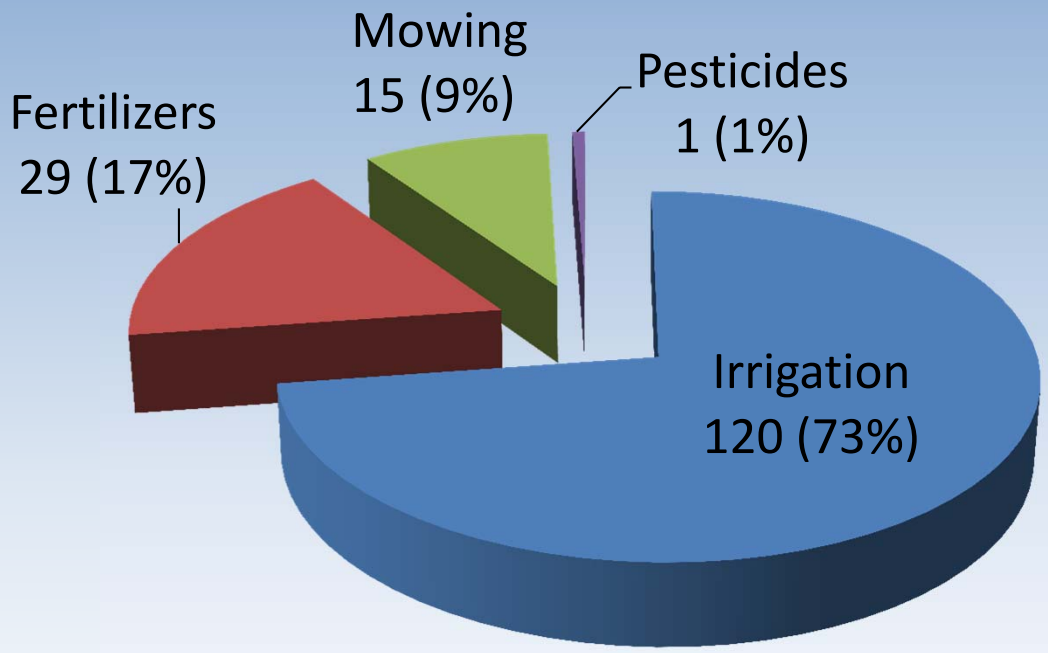


Groundwater Supply

(Image credits: UF/IFAS)

Applications: Landscape Management

165 lbs CO_2e per 1000 ft^2 landscaped area



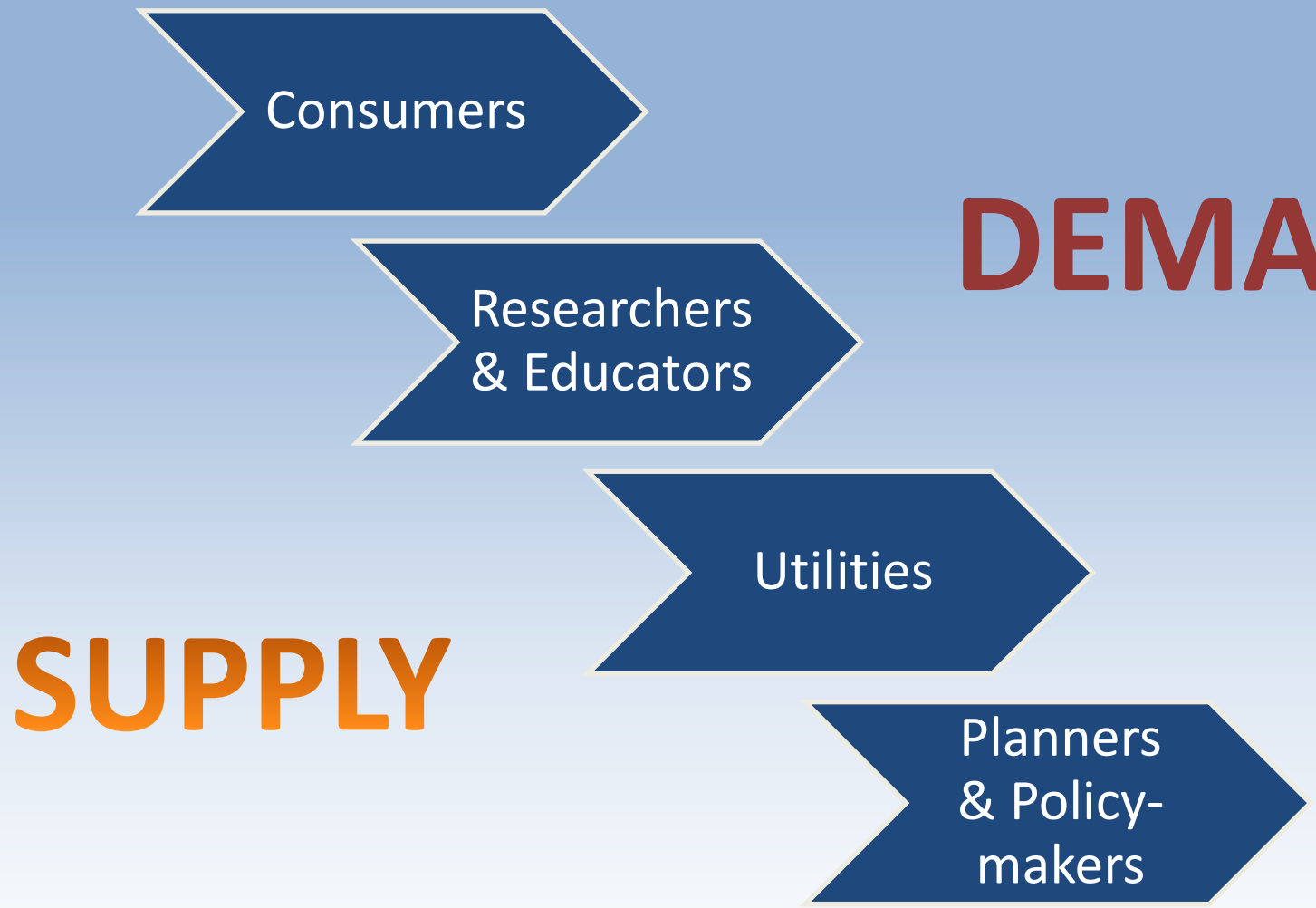
Blended Supply

(Image credits: Pierce Jones (top) and UF/IFAS (bottom))

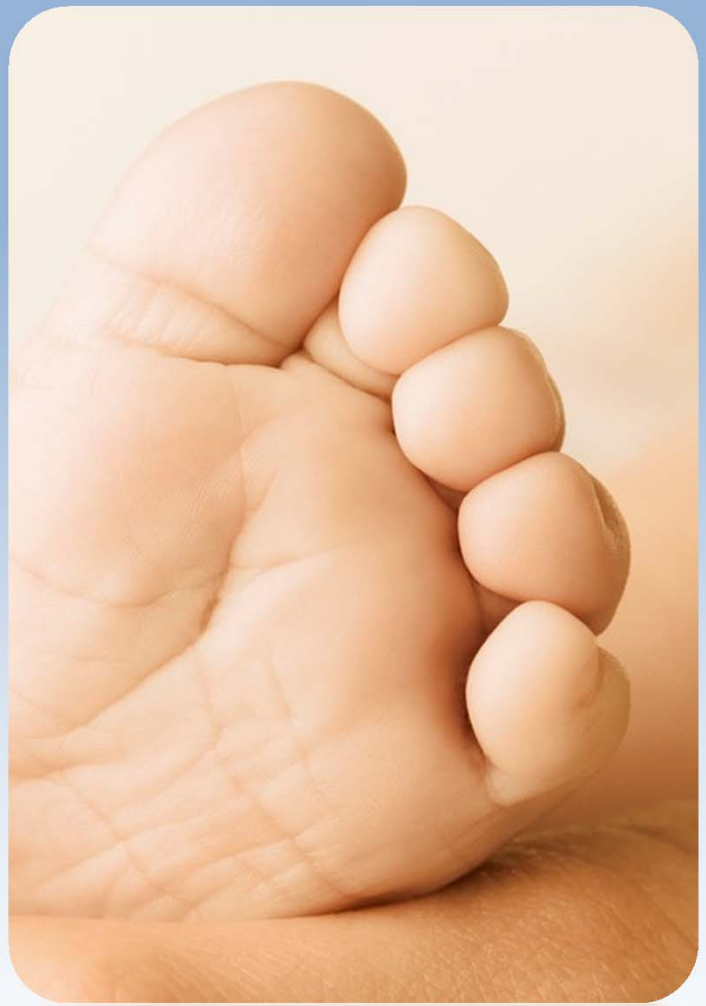
Bottom Line – True Costs

- When we flip the switch, we also turn on the tap; when we turn on the tap, we also flip the switch
- At the margin with existing systems, and to an even greater extent with those yet to be constructed, energy-intensive water supplies are costly economically, ecologically, and socially
- Conservation and efficiency are often the most cost-effective "alternative supplies"
- Demonstrated value/benefits of DSM programs, and land use planning for resource efficiency

Bottom Line - Opportunities



Water-Energy-Land Ethic



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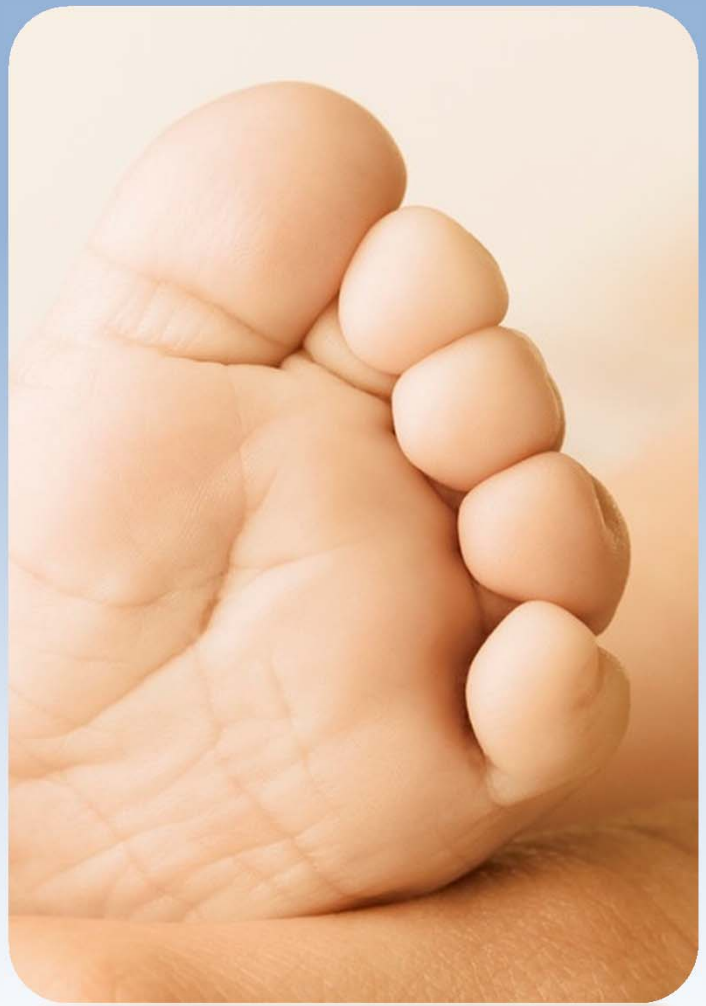
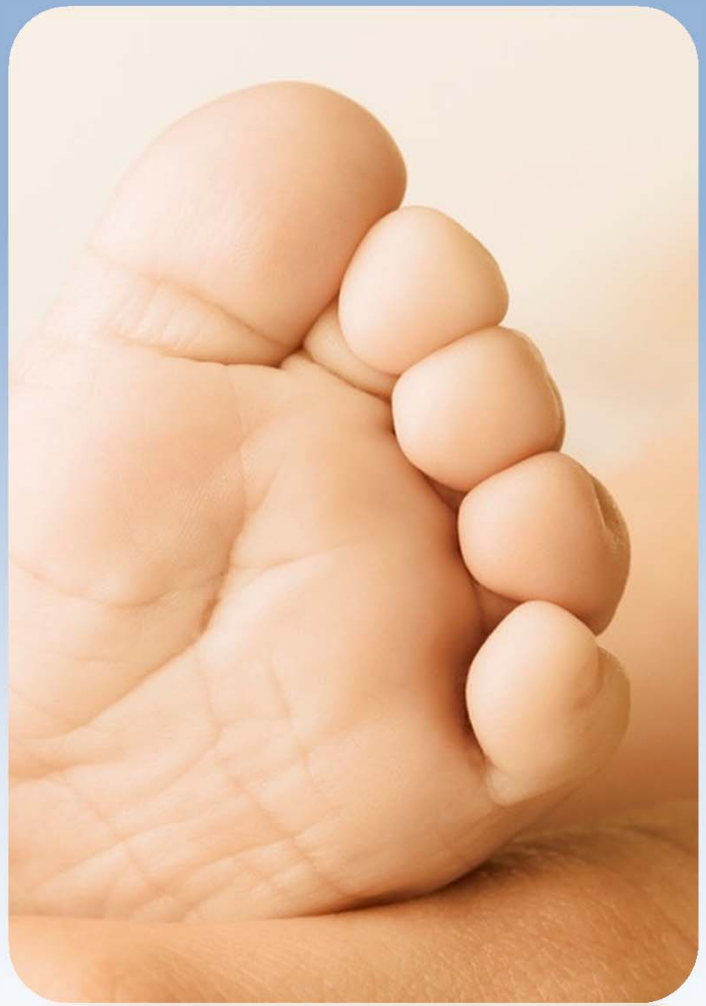


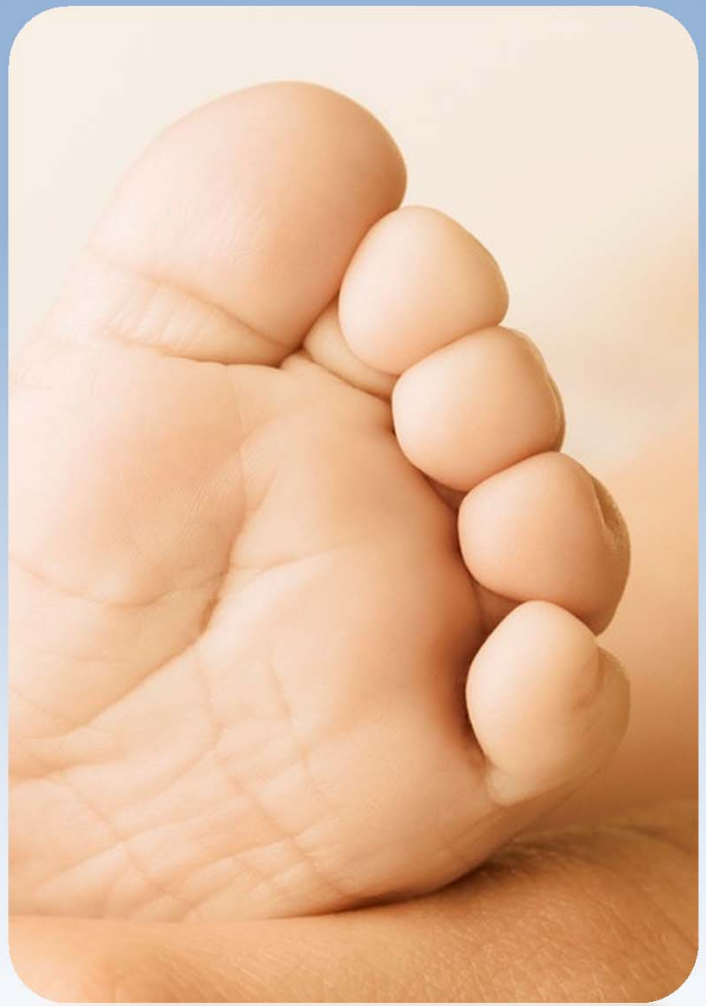
1. Transportation

Water-Energy-Land Ethic



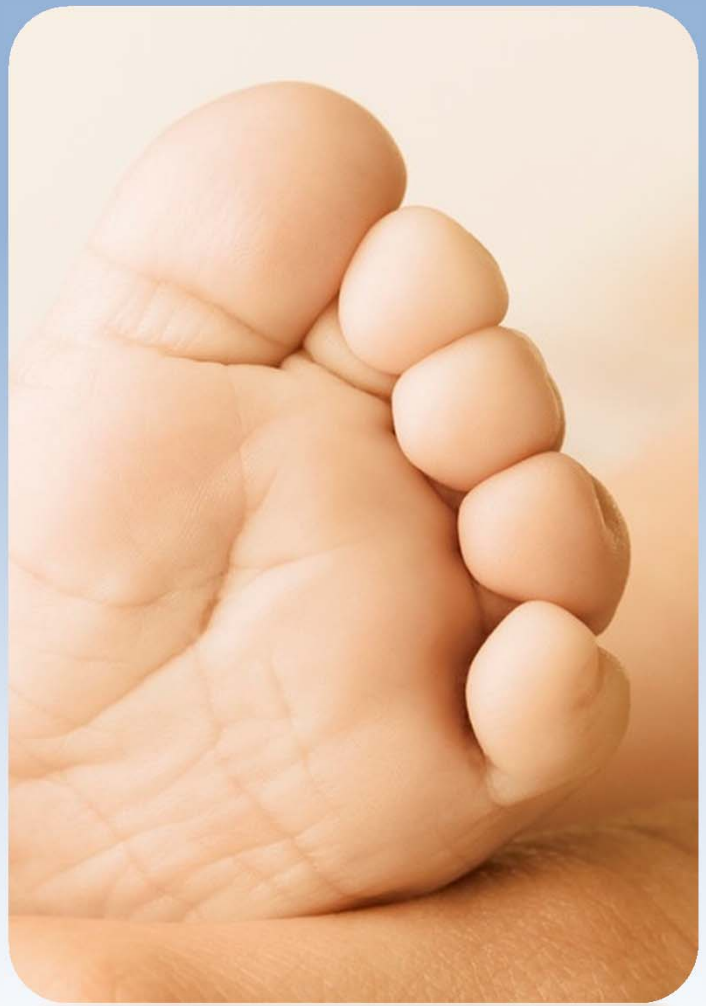
1. Transportation
2. Housing

Water-Energy-Land Ethic



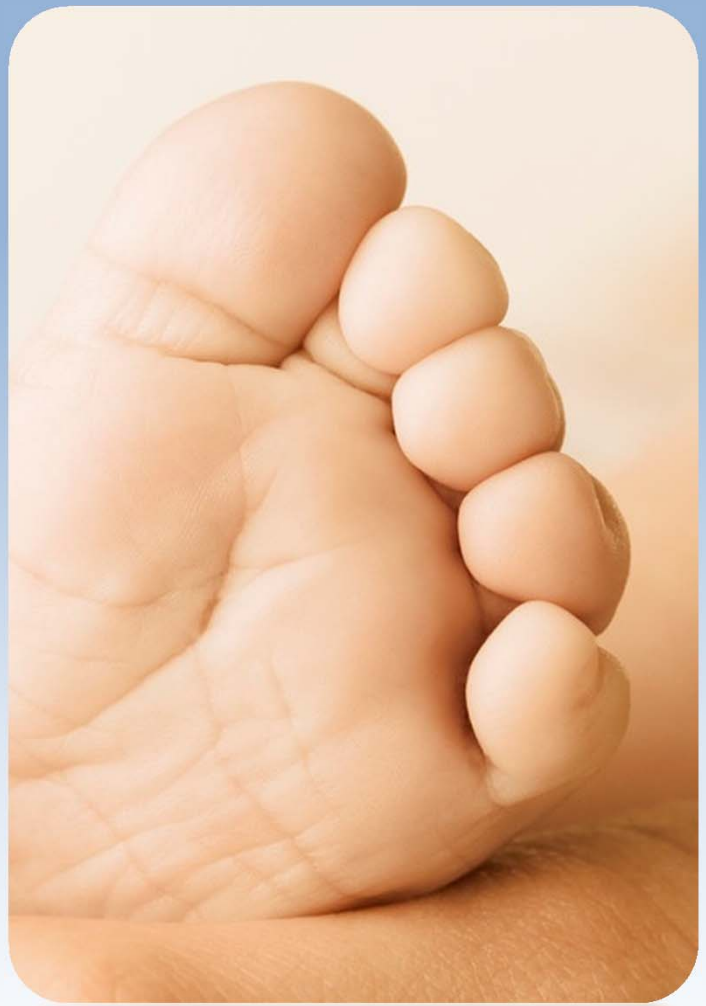
1. Transportation
2. Housing
3. Food

Water-Energy-Land Ethic



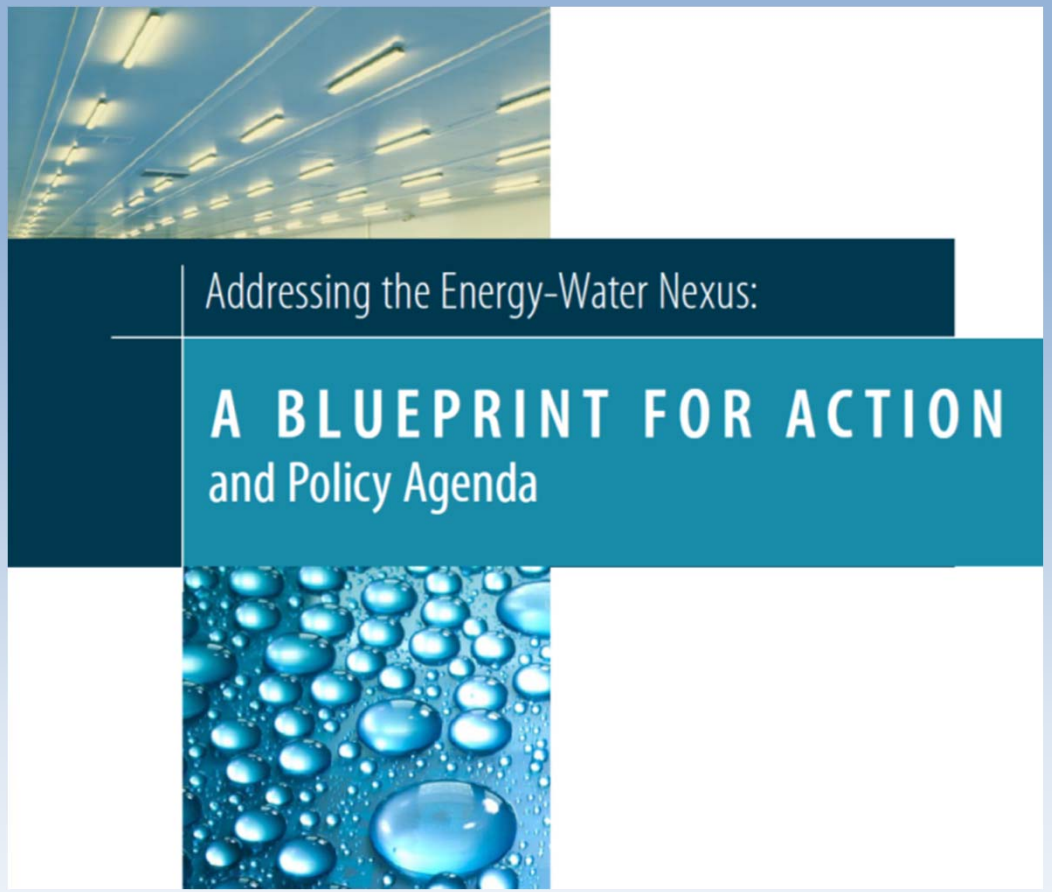
1. Transportation
2. Housing
3. Food
4. Conservation and sufficiency

Water-Energy-Land Ethic



1. Transportation
2. Housing
3. Food
4. Conservation and sufficiency
5. “WE”
   - Systems approaches and interdisciplinary collaboration

Moving Forward



- Alliance for Water Efficiency, American Council for an Energy-Efficient Economy (May 2011)
- Identifies eight thematic elements and specific strategies to address the energy-water nexus and collaboratively promote energy and water efficiency

http://www.aceee.org/white-paper/addressing-the-energy-water-nexus

Water-Energy Nexus Blueprint for Action

1. Increase the level of collaboration between the water and energy communities in planning and implementing programs.
2. Achieve a deeper understanding of the energy embedded in water and the water embedded in energy.
3. Learn from and replicate best practice integrated energy-water efficiency programs.
4. Integrate water into energy research efforts and vice versa.

Water-Energy Nexus Blueprint for Action

5. Separate water utility revenues from unit sales, and consider regulatory structures that provide an incentive for investing in end-use water and energy efficiency.
6. Leverage existing and upcoming voluntary standards that address the energy-water nexus.
7. Implement codes and mandatory standards that address the energy-water nexus.
8. Pursue education and awareness opportunities for various audiences and stakeholders.

Emerging Issues / Tough Questions

- We are facing real and increasing constraints on water, energy, and land that directly affect human quality of life and ecosystem health.
- Extension can play an important role in finding solutions to address these constraints, but there is no silver bullet.
- What are the practical applications of this type of research for Extension programming?
- What should Extension's "energy-water nexus" role be?
- What information and technical resources will help advance our sustainability programming?

Thank You

Questions?

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